SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2257	2	0	0	0	0	Excellent comprehensive and rich report. I have only few rather technical remarks. A more general recommendation relates to the new landscapes which are rapidli forming in deglaciating mountain areas and need comprehensive anticipation/modeling/treatment. This is an emerging research field (Haeberli, W. (2017): Integrative modelling and managing new landscapes and environments in de-glaciating mountain ranges: An emerging trans-disciplinary research field. Forestry Research and Engineering: International Journal 1(1). doi:10.15406/freij.2017.01.00005). This could be more strongly emphasized, for instance, in section 2.4 on page 47 an don page 5, line 53. Such new landscapes will be characterized by strong and long-lasting disequilibria, especially concerning slope stability, sediment cascades or eco-systems. One important factor thereby is the strongly different response time of cryosphere components: snow = almost immediate, mountain glaciers = years to decades, mountain permafrost =decades to centuries to even millennia. As an example, in many mountain chains, permafrost inside high peaks will probably continue to exist (far out of thermal equilibrium) when glaciers will have already long disappeared. [Wilfried Haeberli, Switzerland]	Taken into account – sentence included in permafrost section
2259	2	0	0	0	0	The figures are interesting but rather overloaded and not easy to read and understand. [Wilfried Haeberli, Switzerland]	Accepted - The figures have been revised to improve readability.
2415	2	0	0	0		It is puzzling to see that chapter authors have consciously chosen to ignore the pre-industrial, pre-Little-Ice-Age palaeoclimatic context. This is fully unacceptable and will significantly corrode robustness of this chapter. It is generally accepted wisdom that present-day climate can only be understood in the context of pre-industrial natural climate variability. By failing to mention pre-industrial late Holocene and Holocene climate, the chapter loses its basis its and interpretations remain uncalibrated. This is like building a house with weak foundations which eventually will collapse. I have recommended to include pre-industrial natural warm phases such as the Medeval Cimate Anomaly, Roman Warm Period and Holocene Thermal Maximum in my comments on the FOD. I am truely shocked to see that chapter authors have not even included most basic references such as Solomina et al. 2016 (doi: 10.1016/j.quascirev.2016.04.008) or Solomina et al. 2015 (doi: 10.1016/j.quascirev.2014.11.018) who have elaborated in detail on the pre-industrial high mountain glacial Holocene history. Please keep in mind that the review comments as well as your replies will be made public eventually and that your justification to ignore pre-industrial Holocene warm phases will be studied carefully. [Sebastian Luening, Portugal]	Rejected - Pre-industrial changes are not part of the government approved outline of this section. AR6 will have more on that topic. Here we focus on the recent changes, this is clearly indicated in Chapter 1 and in the introduction of Chapter 2.
5175	2	0	0	0		Despite the extensive range of impacts described in this chapter there is little indication given of the cocts of these and the resulting responses. [Debra Roberts and Durban Team, South Africa]	Taken into account - Additional figures have been added wherever possible for some huma sectors (hydropower, tourism), even if the evidence is often scattered.
5177	2	0	0	0		This chapter would benefit from the sort of impacts/responses summary table presented in Chapter 3 (pg 90-91) in order to pull the policy relevant material into clearer focus. [Debra Roberts and Durban Team, South Africa]	Taken into account - The Supplementary tables provide regional evidence for relevant impacts and adaptation (2 different tables). This supports the corresponding figures.
5473	2	0	0	0		With the global warming trend rising, mountainous conditions are developing for farming and population growth. [rashidian leila, Iran]	Noted
5477	2	0	0	0		study of climate change impact on snow cover; case study: Taleghan basin. Rccc 15-01280083 ; Manizheh Ezzati, Alireza Shokuhi- Mojtaba Noori - Faateme Karimi - Ahmad Abrishamchi [rashidian leila, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"
5479	2	0	0	0		Climate change impact on trend and changing of snow fall ; Case study : Middle West of Iran. Rccc 15-00560026 ; Oji Roohollah - Daavoudi Mahmoud [rashidian leila, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"

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5481	2	0	0	0		Climate change impact on snow depth and its durability ; Case study ; Koohrang Station . - rccc 15 -00530336 ; Ghatreh Saamani Saeed ; Ghatreh Saamani Merdad ; Nowroozi Maesoomeh [rashidian leila, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"
5527	2	0	0	0		considering that With the global warming trend rising, mountainous conditions prepare for farming and population growth, it's suggestede that the subject will be considered in the report. [Government of Iran, Iran]	Taken into account - Agriculture is Taken into account in the report, when there is a connection to past or future cryosphere changes.
5531	2	0	0	0		study of climate change impact on snow cover; case study: Taleghan basin. Rccc 15-01280083 ; Manizheh Ezzati, Alireza Shokuhi- Mojtaba Noori - Faateme Karimi - Ahmad Abrishamchi [Government of Iran, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"
5533	2	0	0	0		Climate change impact on trend and changing of snow fall ; Case study : Middle West of Iran. Rccc 15-00560026 ; Oji Roohollah - Daavoudi Mahmoud [Government of Iran, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"
5535	2	0	0	0		Climate change impact on snow depth and its durability ; Case study ; Koohrang Station . - rccc 15 -00530336 ; Ghatreh Saamani Saeed ; Ghatreh Saamani Merdad ; Nowroozi Maesoomeh [Government of Iran, Iran]	Taken into account - Additional references for Iran were Taken into account for the Final Government Draft"
10883	2	0	0	0		Excellent, what we were waiting for..... See comment for the SPM, could even tolerate more socio-economic data and information. FAQ (only one?) and case studies are a welcome addition. [otto otto simonett, Switzerland]	Taken into account - more socioeconomic data added. Only FAQ was allotted for this chapter.
10885	2	0	0	0		The different target audience of the full report from the SPM may justify a higher complexity of figures, although in general I believe that these should also in a more 'scientific' paper be understandable. My general impression is that most figures of chapter 2 are far too complex even for an advanced reader. [otto otto simonett, Switzerland]	Accepted - many figures have been simplified
10999	2	0	0	0		Consider including content about the expected changes in microbial diversity within terrestrial mountain ecosystems. [Karen Cameron, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - though due to text limitations, this is included as references in the impacts table in relation to glacier retreat.
11723	2	0	0	0		Definition of mountain region and high mountain region shall be provided (may be separation by defining elevation). High mountain region shall be again differentiated by definition into high mountain and high mountain Asia. Further, mountain region shall also be differented by definition into mountain and mountain Asia. Degree of impact of climate change is different in these region. The conclusion shall not be the average of degree of impact/drivers in these regions. The results shall be presented correspondingly in these regions separately. Althoug Climate change is global phenomenon, the policymaker wants to know the degree of impact in his/her region. [Maheswor shrestha, Nepal]	Taken into account - However, to remain consistent also with other feedback and comments on a definiton for mountains, we have focused on regions where glaciers, snow or permafrost are prominent features of the landscape, without a strict and quantitative demarcation. This is consistent with the scope defined in the approved outlined for this Chapter.
12061	2	0	0	0		Landslide and debris-flow related to the melting glacier are an important type of mountain disasters. So it is suggested to make relevant additions. At the same time, in spite of the fact that this chapter in part refers to the impact of climate change on glacial disasters, the report as a whole does not mention the disaster-driven mechanism or its potential future developments. So it is suggested to make relevant additions. In addition, the report, which focuses much on the impact of warming on the balance of glacier mass, gives little consideration to the impact of double increases of temperature and precipitation on the stability of glaciers and the proneness to disasters. So it is suggested to make relevant additions. [Government of China, China]	Taken into account - however, this request falls beyond the mandate of the report to assess disasters specifically, since these manifest where natural hazards interact with other non-climate-related factors and human dimensions that are not part of this assessment. The relevant sections that deal with the issue of natural hazards as a result of cryosphere change are already addressed in sections 2.3.2.1.1 Unstable slopes and landslides and responses to these imapcts under section 2.3.2.3. Disaster risk reduction and adaptation to flood and landslide hazard
12761	2	0	0	0		Many sentences should be greatly simplified. Maybe cutting them into 2 or 3 more (active) simple sentences. Use sub-headings. [David Crookall, France]	Taken into account - many sentences rewritten

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12763	2	0	0	0		Plenty more comments in the accompanying marked-up pdf file. [David Crookall, France]	Noted - pdf was not made available and reviewer did not respond to email request
12769	2	0	0	0		Too many things to comment on - please see attached pdf file. [David Crookall, France]	Noted - pdf was not made available and reviewer did not respond to email request
12775	2	0	0	0		Worse, a reader might draw the conclusion that it is not even possible to attribute certain changes to CC, when it is actually 'clear' that such atrtributions can be made, even if precise instrumental measures to quantify have not been possible up to now. What is obvios and visible, and lived daily by communities, and witnessed by citizen scientists, may be too difficult or expensive to measure quantitavely. Also an absence of measurtes does not mean that the phenomena suddenly dissappear. Expressing things in this way is playing right into the hands of deniers, and giving them material with which to spin their crazy yarns. [David Crookall, France]	Noted - comment unclear; not clear what other comment it refers to
14987	2	0	0	0		We wish to express our sincere appreciation to the author team of Chapter 2 for keeping close to the allocated page limit. The chapter provides a comrehensive assessment, with supporting material in the Annex. Thank you for supporting an effective review process. [Government of Germany, Germany]	Noted
15229	2	0	0	0		The approved outline asks for an assessment of the impacts from changes in the mountain environment on habitability, community livelihoods and culture, which includes response strategies influenced by limits to adaptation and the emerging concept of loss & damage. While the ES refers to adaptation limits, we note that a statement on loss and damage is absent. Please add if possible. [Government of Gambia, Gambia]	Taken into account - text revised in the ES to include a statement on loss and damage, which is in fact addressed in the synthesis section 2.4.2 High mountains, global policy frameworks, and climate resilient dev pathways.
15231	2	0	0	0		Please provide information about future glacier loss at 1.5 and 2°C including beyond 2100. This has been a research gap in the SR1.5. [Government of Gambia, Gambia]	Rejected - altough desirable we are not aware of literature making such projections. Glacier projections typically end in 2100 or before.
15233	2	0	0	0		The chapter mentions some observed impacts throughout (see e.g. Figure 2.10). These de-facto losses should be reflected and named as such in the Executive Summary [Government of Gambia, Gambia]	Accepted - many impacts included in ES
15235	2	0	0	0		Despite the announcement to extensively cover mountainous LDC regions as part of the SROCC, we have noted that Chapter 2 lacks some crucial regional information. In the following, we provide references from the ICIMOD project that should be assessed by the Chapter 2 authors: Hoy A, Katel O, Thapa P, Dendup N and Matschullat J 2016 Climatic changes and their impact on socio-economic sectors in the Bhutan Himalayas: an implementation strategy Reg. Environ. Chang.; Krusic P J, Cook E R, Dukpa D, Putnam A E, Rupper S and Schaefer J 2015 Six hundred thirty-eight years of summer temperature variability over the Bhutanese Himalaya Geophys. Res. Lett.; Nepal S and Shrestha A B 2015 Impact of climate change on the hydrological regime of the Indus, Ganges and Brahmaputra river basins: a review of the literature Int. J. Water Resour. Dev.; Shea J M, Immerzeel W W, Wagnon P, Vincent C and Bajracharya S 2015 Modelling glacier change in the Everest region, Nepal Himalaya Cryosph. 9 1105–28 ; Tshering P and Fujita K 2016 First in situ record of decadal glacier mass balance (2003–2014) from the Bhutan Himalaya Ann. Glaciol. 57 289–94; Vinke K, Martin M A, Adams S, Baarsch F, Bondeau A, Coumou D, Donner R V., Menon A, Perrette M, Rehfeld K, Robinson A, Rocha M, Schaeffer M, Schwan S, Serdeczny O and Svirejeva-Hopkins A 2017 Climatic risks and impacts in South Asia: extremes of water scarcity and excess Reg. Environ. Chang. 17 1569–83 [Government of Gambia, Gambia]	Taken into account - papers were considered but since paper address mostly individual glaciers and several hundred of similar papers in other regions have been published, we are not able to include studies from individual glaciers due to space limits but all glacir regions are considered in aggregated form (e.g. in figure on regional mass balances)

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16265	2	0	0	0		The hard work of the Chapter 2 authors is much appreciated, congratulations on the SOD! [Alexander Nauels, Germany]	Noted
18363	2	0	0	0	0	In general, the group agrees that the content reflects its outline. The chapter is well organized, following a logical structure. However, sometimes figures may be too complex (or not described in sufficient detail) for readers not familiarized with the disciplines involved. We think that too much detail may prevent non-specialists from fully understanding the main message those figures are aimed to convey. For instance, the hypsometry plots in Fig. 2.2 are not described in enough detail in the text and thus seem to be unnecessary, considering that the objective of the figure is to show the distribution of mountain areas. The complexity found in Fig. 2.2 contrasts with Fig. 2.1, a much simpler and easy to understand diagram whose description only needs a sentence in the document. On a similar note, and despite overall clarity, accuracy and homogeneous writing style, the group has minor concerns regarding readability of the chapter for non-academic readers due to a high level of technical vocabulary. In addition, we found that in several instances key IPCC terms, such as "significant" or "likely" are not used following the language guidelines and need either editing or re-wording if they do not refer to their designated IPCC meaning (see, for example, P10L29 and P37L29). Regarding topics that might be overlooked in the chapter, we suggest adding a brief discussion on recent anomalous glacier trends in glaciers from Patagonia, Iceland, and Alaska, among other regions; including a few sentences on the well known cases of (for instance) Pio XI and Perito Moreno glaciers will provide a context to ponder the importance of local conditions modulating glacier fluctuations in locations other than High Mountain Asia (HMA). Overall, the text in its current form seems to neglect examples from regions other than HMA. The group also notices that literature on permafrost is less prominent compared to other features of the cryosphere despite world's high mountain permafrost area seems to be larger than that for mountain glaciers. Therefore, the group suggests that the chapter could be further improved by including relevant and/or recent literature and brief discussion on the importance of high mountain permafrost and the emerging (hydroclimatic) impacts from its thawing. [APECS Group Review, Germany]	Accepted - the figures have been revised. IPCC terms are used according to guidelines.
21769	2	0	0	0		There are many places using "Altitude" in this Chapter, I think use "Elevation" better than "Altitude". [Haijun DENG, China]	Accepted - the term "elevation" is preferred over "altitude" and the change was performed were necessary.
22097	2	0	0	0		Chapter organization: Section 2.3 (“Change in mountain ecosystems, their services, managed system, and human responses”) is a large catchall. Separate sections for physical impacts (hazards, biodeiversity, water) and human impacts (tourism, economics, spiritual/intrinsic) might be more valuable to a reader. [Joseph Shea, Canada]	Taken into account - title of section and structure has been revised, however, the integration of physical and human dimensions is deliberate to enhance integration.
22099	2	0	0	0		A very brief and passing mention is made of surface energy fluxes in the section on drivers of cryospheric change. The focus on air temperature is understandable, since regional/global scale models of snow and ice melt typically rely on this easy-to-extrapolate variable. Yet for snow and ice on the ground, the surface energy balance is the true driver of change. An expanded discussion of the potential energy balance changes and feedbacks [e.g. surface albedo (Painter et a.., 2013), enhanced regional warming due to air pollution (Ramanathan et al., 2005); clouds and their role in shortwave/longwave fluxes; the potentially significant role of sublimation (e.g. Stigter et al., 2018) in high, arid, mountain environments] should not be neglected. [Joseph Shea, Canada]	Taken into account - Box 2.1 provides some background information on the driving processes, but space constrains do not allow expanding on all details.

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22101	2	0	0	0		There is no discussion of limitations in the projections of glacier change (Sec 2.2.3.2, 2-16), or whether the uncertainties are related to model formulations (structural or parametric uncertainty) or in the climate change inputs themselves. A brief comparison of different global glacier projection models (Marzeion et al., 2012; Giesen and Oerlemans, 2013; Huss and Hock 2015; Radic et al. 2015) across the regions would lend support to the assessed 'very likely' probability of continued mountain glacier mass loss in the coming decades. Huss et al. (2017) provide a good comparison. [Joseph Shea, Canada]	Taken into account - section largely revised and moved to cross-chapter box
22103	2	0	0	0		Just a general comment that the science presented is perhaps too succinct – there are a lot of nuances in observed and projected cryospheric responses to climate change, and the chapter could be improved by sketching some of these out. (For example: the subsection on local adapations to cryospheric change is about the same length as the section on other meteorological drivers of cryospheric change!) [Joseph Shea, Canada]	Taken into account - some processes were added, however, due to space limits it is not possible to add descriptions of processes also to keep the report policy relevant.
22105	2	0	0	0		There are some terms that should be revised throughtout the chapter. "Cryospheric shrinkage" is problematic, as is "cryosphere changes" (see some specific comments below) [Joseph Shea, Canada]	Taken into account - the text has been revised
22107	2	0	0	0		There are some disconnects between the cryospheric change that is quantified in the early sections and the adaptation responses described in later sections. Glacier meltwater, for example, feeds directly into river systems: changes in glacier contributions thus affect irrigation-fed agriculture primarily. Snowmelt is a more distributed source of water and represents an important local soil moisture for agriculture. Agricultural adapation practices should be related specifically to the changes in the mountain cryosphere. [Joseph Shea, Canada]	Taken into account - structure slightly changed to allow for a better flow
22451	2	0	0	0		Suggest the Chapter 2 authors consider research commissioned by the Alpine Resorts Co-ordinating Council - Harris et al (2016) The Potential Impacts of Climate Change on Victorian Alpine Resorts. A Report to the Alpine Resorts Co-ordinating Council. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Australia. [Government of Australia, Australia]	Taken into account - SE Australia is mostly outside the scope of the chapter. However, reference is noted for consideration in AR6 WGII Cross-Chapter paper on "Mountains", where broader geographic scope on mountains is expected to be addressed.
22631	2	0	0	0	0	One of the aspects I'm missing is the temporarily difference in the future changes between the glacial and the periglacial environment. Figure 3 in Haebrerli et al., (2017) shows that surface ice is changing at a much different rate than ground ice. This means we have completely different rates of changes in these two environments. However, one aspect I typically do not see discussed is that this also shows that the periglacial environment does not react immediately to changes in the climatic conditions. This further means that the changes in the periglacial environment, such as permafrost degradation, will continue for a very long time even if the climate could be stabilized or even trends reversed. This very much contrasts the glacial environment that reacts much faster (in particular in high mountain areas, where large ice fields are not that common). [Lukas Arenson, Canada]	Taken into account – sentence added in permafrost section
23093	2	0	0	0		For the attribution work related to Appendix 21, Table 5, and SPM figure, is it possible to have examples of sequential attribution (e.g. when there is attributing of regional warming trend to human influence, and attribution of cryosphere change to temperature)? This would be novel within the IPCC context and relevant for AR6 as well. The D&A chapter of AR5 WGI could be used as a starting point + updated literature research. Authors of WGI AR6 chapter 3 could provide some support too. [Valerie Masson-Delmotte, France]	Taken into account - Efforts were made to explicitly articulate the reasoning behind sequential attribution as often as possible in the chapter. However, in many cases the evidence is not readily available in the published literature, and formal expert elicitation was not performed.

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23323	2	0	0	0		I congratulate the authors for the quality of the second order draft (well structured, with new knowledge, and concise). I have provided comments to the SPM that are relevant for executive summaries of all chapters. Chapter 2 could provide more substance from the main text to the ES and SPM for specific aspects. The use of the IPCC calibrated language is still missing in the expression of key findings at the end of sections. [Valerie Masson-Delmotte, France]	Taken into account - ES substantially revised in the final draft, including updated confidence statements.
23327	2	0	0	0		For the attribution work related to Appendix 21, Table 5, and SPM figure, is it possible to have examples of sequential attribution (e.g. when there is attributing of regional warming trend to human influence, and attribution of cryosphere change to temperature)? This would be novel within the IPCC context and relevant for AR6 as well. The D&A chapter of AR5 WGI could be used as a starting point + updated literature research. Authors of WGI AR6 chapter 3 could provide some support too. [Valerie Masson-Delmotte, France]	Taken into account - Efforts were made to explicitly articulate the reasoning behind sequential attribution as often as possible in the chapter. However, in many cases the evidence is not readily available in the published literature, and formal expert elicitation was not performed.
24209	2	0	0	0		Very rich material, well compiled with a reasonable structure. I'm wondering whether the synthesis and assessment character could be enhanced, especially for the non-physical parts of the chapter. E.g. synthesis tables or figures could be a good way to do this. and where possible provide numbers (important in view of policy relevance). Currently it is often quite descriptive, with many case study experiences (which are important and good but if the synthesis character could be enhanced I think the chapter could strongly benefit). [Christian Huggel, Switzerland]	Taken into account - text revised and expanded
24347	2	0	0	0	0	I was expecting a lot from this chapter, and it terms of content it is quite good. However, the overall tone is very complacent, I would have expected much more urgency. The projected loss of glacier coverage by end of century in high mountains is staggering and unprecendented, and language to that effect should be used. Not to cry wolf, but to very clearly signal that based on the science we are looking at very significant changes, that have not been seen in the mountain cryosphere for at least the past 1 million years. [Philippus Wester, Netherlands]	Taken into account - text has been revised substantially
24357	2	0	0	0	0	Surprised to see no references to Bolch et al. (2019) Status and Change of the Cryosphere in the Extended Hindu Kush Himalaya Region in P. Wester et al. (eds.), The Hindu Kush Himalaya Assessment, https://doi.org/10.1007/978-3-319-92288-1_7 in Section 2.1 Introduction. [Philippus Wester, Netherlands]	Accepted - This was referred to in SOD in submitted status, and the reference is now updated.
24529	2	0	0	0		In general, the whole chapter show a lack of homogenety between the sections (maybe it is consequence of the number of different authors who have written the text). Moreover, the degrees of confidence use is very unequal. [Armand Hernández, Spain]	Taken into account - text has been revised substantially since SOD, given the interdiscplinary nature of the intergated content assessed (and the interdiciplinarity among aurthors), some lack of homogenety among sections could be expected, however consistency in the application of confidence language is a key criteria for the Final Draft.
24531	2	0	0	0		There is a huge amount of references to be published (i.e., submitted, under review). Thi is acceptavle for a reduced number of references but it is not for the current number of them. [Armand Hernández, Spain]	Taken into account - only references that are Accepted/published by the cutoff date are included

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24821	2	0	0	0		for the entire chapter: the usage of 'mean snowline elevation' is confusing. As defined as on p10, it is unclear whether the 'averaging' is applied in a spatial or temporal sense. Apparently, from the executive summary, I understand that the quantity refers to a baseline period since changes are reported relative to this reference. a statement is needed specifying this baseline period. Given that the term is widely used in this chapter (I counted 17 occurrences) its meaning needs to be clearly defined. [Thomas Schuler, Norway]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
25179	2	0	0	0		For me knowledge gaps should not be highlighted in an executive summary (see Chapter 2 and possibly others). This was the approach of WG1 during AR5, to avoid any impression of conflicting interests, i.e., authors potentially using IPCC as an opportunity to argue for/ encourgage funding in their fields of research. This is ultimately a decision for the Co-chairs to consider, but there should be a consistent approach to this across all chapters. [Simon Allen, Switzerland]	Noted - However, ES and SPM focus largely on key findings and enablers. Key gaps remain in the body of the chapter, for this chapter in Section 2.5
27273	2	0	0	0		No comments [Gleyci Moser, Brazil]	Noted
28079	2	0	0	0		I have not reviewed sections 2.3.3 and 2.3.6 [Frank Paul, Switzerland]	Noted
28703	2	0	0	0	0	Overall assessmetn: of the chapter: I congratukate the authors and the co-authors on the great contribution to the general IPCC report. The chapter os really well prepared and I hope my minor comments can help to finalize the report. Iam trully looking forward to reading the final/published version. [Irena Mrak, Slovenia]	Noted
30217	2	0	0	0		There is no specific mention of Yukon Glaciers in this chapter. It's unclear whether these are included in the 'Alaska' category or in the 'Western US/Canada' category. From the content and Fig. 2.2. it suggests that Yukon is included in 'Alaska' but this should be made explicit. [Christine Dow, Canada]	Taken into acoount - made clearer in the text and several figure that the so-called Alaska region includes the adjacent glaciers in the Yukon
30287	2	0	0	0		In the glossary, I would recommend to follow original definitions, for example, permafrost: Ground (rock or soil or rock and included [NOT containing] ice and and organic material) ... Or [Charles Fierz, Switzerland]	Accepted
30289	2	0	0	0		In the glossary, Ablation: "snow pack" does not seem appropriate here. Replace by either "snowfield" or "snow cover". [Charles Fierz, Switzerland]	Accepted
30611	2	0	0	0		Sometimes it is not clear whether “likely” etc are used more broadly, or should be italicised. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The text was revised for clarity.
30613	2	0	0	0		The hazard “fire” first appears in the biodiversity section but should be picked up in section 2.3.2, together with the other hazards. Perhaps it should also occur in the ES (and SPM). [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - fires given more prominence also mentioned in ES
30615	2	0	0	0		The chapter team is congratulated on this assessment chapter. It has matured much since the previous draft, is more balanced, has better readability and language use, and jargon is even more reduced, The logical flow has also improved – well done. [Hans-Otto Poertner and WGII TSU, Germany]	Noted
30617	2	0	0	0		Gaps of this chapter, or topics on which the assessment should still somewhat be strengthened include: Adaptation / Solutions space; Downstream effects – cities dependent on mountains, water availability in cities, human side; Food security / production; clear indication of what is news since SR15 / AR5 including clear indication of e.g., contradicting, gapfilling, completely new, strengthening information (if this was left out purposely please state so) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Text has been revised substatially, in some cases (e.g. adaptation) the evidence available has been revised and assessed with a clearer characterisation of gaps. A figure has also been added to convey this evidence.
30619	2	0	0	0		whenever mentioning "low latitudes" please provide regional information, e.g. Africa/northern Andes /other [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Efforts were made to make greographical references as explicit as possible.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30621	2	0	0	0		select biodiversity information very carefully for the ES - what is really relevant a) for policymakers and b) for the world to know? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into acount - ES completely rewritten
30893	2	0	0	0		Consequences for water availability, crops etc., adaptation measures are described mostly in qualitative terms. Readers would benefit from an understanding of the scales and magnitudes of associated problems, the magnitude of observed and projected changes (% changes) and when successful adaptation is able to compensate, as well as when adaptation limits are reached and what the consequences are. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - A figure is being developed to quantify and illsytate doscutrbutions of adapation per sector and per mountain regions, to provide more quantifiable substance. Few papers mention ex-post evaluations of adapation practices with economic figures. We may be in a position to address this gap in AR6, pending available evidence to assess.
32507	2	0	0	0		Various references to SW Australia in Appendix 2A should be SE Australia. [Blair Trewin, Australia]	Accepted – text revised
33063	2	0	0	0		It is easy to think that a discussion of "cyrsophere change" does not need to include places like Los Angeles, Phoenix, and Las Vegas. Yet Las Vegas is 90% reliant on the Colorado River for its water, Phoenix maybe 50%, and Los Angeles 25%, and the vast majority of this Colorado River water comes from the cryosphere. It seems like that whole connection between cryosphere change and impacts in western North American -- and especially in the western US -- has been missed. Not quite sure how to integrate into the chapter, but this is a pretty big oversight. [Government of United States of America, United States of America]	Taken into account - more description on runoff change due to snow change is added and more overall assessment of cryoshpere change and runoff are added, including western US.
33065	2	0	0	0		The sections vary considerably in thoroughness of their treatment of the complexity of climate impacts (cryosphere included) on mountain ecological phenomena. For example, both the biodiversity and wildfire sections mostly confine remarks to cryosphere relationships without acknowledging the more complicated climate factors that drive changes in these systems, while the fisheries section is clear up front that various interacting drivers make them complex then highlight the specific cryosphere relationships. The authors must acknowledge that the cryosphere IS always important in mountain systems, and the changes in its various elements will lead to profound changes in mountains, BUT the drivers include other climatic variables that are sometimes (as in fire) more important, and the impacts and outcomes are dependent also on those other factors. [Government of United States of America, United States of America]	Taken into account - The ecosystem section was considerably revised for better balance and clarity.
33067	2	0	0	0		There is a high degree of variation in the completeness and density of citations among some of the sections. The tourism and recreation section is longer, better cited, and more information dense than the biodiversity section. This may be in part because biodiversity impacts are spread across other sections, but it is a bit striking. None of the few GLORIA (repeat observation of alpine plants) network papers are cited here, but they would increase the density and authority of the biodiversity section, while also lending to the overall credibility of discussions on terrestrial ecological impacts. [Government of United States of America, United States of America]	Taken into account - Care was taken, in preparation for the final draft, to reach a better balance in text and citations, and to overall harmonize writing style, to the best possible extent.
33069	2	0	0	0		There is a striking and perplexing lack of literature from the North American cordillera. Including information from western NA would only strengthen the arguments given in the chapter. Moreover, bringing in examples from the Rocky Mountains, Sierras, Cascades, Coast Ranges, Alaska, etc., would serve to make this work far more relevant for readers in Canada, the US, and Mexico. This is a major oversight on the part of the authors. [Government of United States of America, United States of America]	Taken into account - including substantial revisions to the text and additional references included in text and in the impacts table

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15445	2	0	2	0		General comment: redundant sections and lengthy 'peripheral' sections Redundant sections: our comments have noted several redundancies - areas where the same information is repeated in different places. Please, consider deleting them and using cross-references instead to deal with instances where the same point can be relevant in more than one area. 'Peripheral' information: there are several instances where the report includes lengthy sections on issues that, while not irrelevant to climate change, do not require lengthy discussion here. Some examples include the different drivers of tourists' decisions to visit mountain areas, the cultural-spiritual significance of mountains, and the various drivers of migration from high mountain. In these cases, the main points related to climate change should be summarised and stated up-front. Discussion of the wider issue should come only later - potentially as part of an annex. [EUCE, Belgium]	Taken in to account - text revised
12751	2	0	5	0	5	"evidence of a comprehensive risk assessment approach" -- I thought that you were looking at evidence of CC effects, not of approaches -- and what do you mean by a "risk assessment approach"? [David Crookall, France]	Taken into account - Text revised to clarify this isue in the context of other similar comments.
12757	2	0	7	0	18	What part of mountains do you include in the report?? Only the parts that are frozen? That is somewhat shortsighted! as glaciers and frozen ground disappear (as they have done) faster than other phenomena. Does that suddenly exclude the regions from being high mountain areas? The report is for now, but under your definition, regions included in the report will soon exit the report, unless ALL mountain regions are included. When does mountain cryosohere become invalid for consideration in your report? Presumably when they have no more ice?? But they achieved that status of being ice free because of climate change. So, your report looks at CC, but stops when the CC damage is done?? [David Crookall, France]	Rejected - The scope for this chapter and the mandate given for assessment were defined by the requesting governments, with emphasis and focus on elements of the high mountain cryosphere (snow, glaciers, permafrost) where these are prominent elements of the high mountains landscape, and their changes in response to climatic stimuli. A broader assessment on mountains is part of the scope of AR6 WGII Cross-Chapter Paper on "Mountains".
12755	2	0	8	0	9	this seems to be a dangling modifier -- that too can change the meaning completely -- copy editors find these even more difficult, so make sure that YOU get them correct [David Crookall, France]	Taken into account - Text was revised for clarity, throughout the entire chapter,, and care was taken to avoid ambiguity as much as possible.
12741	2	0	46	0	48	What kind of degradation? Mention should be made of reinforcing feedback loop of CH4 [David Crookall, France]	Taken into account - The ES text was revised considerably.
12745	2	0	50	0	51	"promote resilience" gives the impression that things will be ok -- not at all the case !! [David Crookall, France]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
12747	2	0	56	0	57	difficult to understand what is to "account for" --- why globally? Some places clear, some less so -- giving a sort of average hides the fact that in some places the evidence is clear -- provide detail -- and show the variation globally in what is known -- otherwise, you give the impression that things are better than they are -- specifiy the exceptions [David Crookall, France]	Accepted - the text has been revised
2607	2	1	0	106		In general the chapter is very nicely written and I am happy to see that authors have included studies over Himalayan region in this version. So no more ammendments are required. [Pushp Raj Tiwari, United Kingdom (of Great Britain and Northern Ireland)]	Noted
13791	2	1	0	106		General: the authors should make a clearer differentiation of the impact of changes in the cryosphere to different types of water resources. For instance, for the large rivers of Asia (particularly Ganges) the impact is likely to be relatively localised to the head waters as the majority of the basin relies on rain-fed recharge. However, for smaller rivers and local groundwaters the impact may be severe. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - different impact on basin characteristics (size, other sources of impacts) are clarified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13793	2	1	0	106		General: the authors repeatedly refer to 'down valley' impacts, but rarely try to put any quantification of how far such effects will be felt and thus this sounds very vague. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - as the effect of cryosphere on runoff varies in b
24513	2	1	0	106		General comment on whole chapter. It was really good work! The document is clear almost in all sections, and I don't have any doubt that this will be a large contribution in providing scientific information to government's stakeholders, which they can use to develop climate policies. I want to congratulate and to thank all of the people that worked on this report Chapter [Francisco Barraza, Chile]	Noted
26889	2	1	0	49		The chapter itself is very well written and clearly articulated. I found it a joy to read. This is not true of the ES, which is incomplete and not coreesponding to the main story line of the chapter. Please revisit the ES to reflect the clarity of the chapter and capture the important, salient points. [Ko Barrett, United States of America]	Taken into account - The ES was extensively revised.
1005	2	1	1	100	1	Falk Huettmann, University of Alaska Fairbanks Climate Change mountain publications Huettmann F. (2018) Advanced Data Mining (Cloning) of Predicted Climate-Scapes and Their Variances Assessed with Machine Learning: An Example from Southern Alaska Shows Topographical Biases and Strong Differences. In: G. Humphries, D.R. Magness and F. Huettmann. Machine Learning for Ecology and Sustainable Natural Resource Management. pp 227-241. Han X., F. Huettmann, Yu. Guo, C. Mi and L.Wen (2018) Conservation prioritization with machine learning predictions for the black-necked crane Grus nigricollis, a flagship species on the Tibetan Plateau for 2070. Regional Environmental Change Regmi G.R., F. Huettmann, M. K. Suwal, V. Nijman, K.A.I. Nekaris, K. Kandel, N. Sharma and C. Coudrat (2018). First Open Access Ensemble Climate Envelope Predictions of Assamese Macaque Macaca Assamensis in South and South-East Asia: A new role model and assessment of endangered species. Endangered Species Research 36: 149–160 https://doi.org/10.3354/esr0088 Huettmann F. (2017) Climate Change Effects on Terrestrial Mammals: A Review of Global Impacts of Ecological Niche Decay in Selected Regions of High Mammal Importance. Encyclopedia of the Anthropocene, Volume 2, 2018, Pages 123-130 Xuesong H, Yu. Guo, C. Mi, F.Huettmann and L. Wen (2017) Machine Learning Model Analysis of Breeding Habitats for the Blacknecked Crane in Central Asian Uplands under Anthropogenic Pressures. Scientific Reports 7, Article number: 6114 doi:10.1038/s41598-017-06167-2. https://www.nature.com/articles/s41598-017-06167-2 Mi, C.,Q. Zu, L. He, F. Huettmann, N Jin, J Li (2017) Climate change would enlarge suitable planting areas of sugarcanes in China. International Journal of Plant Production 2017 11(1). Baltensperger A., J. Morton and F. Huettmann (2017) Expansion of American marten (Martes americana) distribution in response to climate and landscape change on the Kenai Peninsula, Alaska. Journal of Mammalogy; DOI:10.1093/jmammal/gyx011 Young, B, J. Yarie, D. Verbyla, F. Huettmann, K. Herrick and F.S. Chapin (2017) Modeling and mapping forest diversity within the boreal forest of interior Alaska. Landscape Ecology 32: 397-413 Jiao S., F. Huettmann, Y. Guoc, X Li and Y Ouyang (2016) Advanced long-term bird banding and climate data mining in spring confirm passerine population declines for	Taken into account - References considered for FGD preparation.

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Comment id	**Chapter**	**From page**	**From line**	**To page**	**To line**	**Comment**	**Chapter Team Response**
1407	2	1	1	174	28	The report suffers strongly from readability by having references to authors in full text (author1, author2, .. 200x), not just a refernene number [1], [2] ... deleting author names would make the text volume some 20% smaller. This critique applies to all chapters. Overall Chapter 2 is way too long - especially in the last part (mitigation/adaption) [Rene Forsberg, Denmark]	Rejected - The report follows IPCC style guide.
1409	2	1	1	174	28	Too much weight is put on "submitted papers", IPCC focus should be on peer-reviewed papers, otherwise a lot of other reports, e.g. national status reports etc., should be admitted too. Please make sure all "submitted" papers are actually peer-reviewed in final version. [Rene Forsberg, Denmark]	Accepted - more reviews on High Mountain Asia and Andes are added and all references are now in Supplementary Table 2.A.
3989	2	1	1	106	34	I appreciate all the work that went into this document. The tabulated information in the supplemental material is very useful. Some of my comments about thermal habitat suitability for fish may be too detailed to incorporate fully, but it would be useful to clarify the potential effects of changes in snow dynamics and the complex relations between thermal regimes and fish. I offer some examples that I am aware of, but there may be more suitable ones that could be cited. [Robert Moore, Canada]	Taken into account - we added percentage in area of glacier regions where peak water has passed in future. As the effect of cryosphere on runoff varies in basins, it is difficult to quantify amount.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12783	2	1	1	223	19	I could not find the refs below in Chapter 5 - there seem to be many more. I did not search in the other chapters. Probably, worth citing at least some at their appropriate points: Pelto https://blogs.agu.org/fromaglaciersperspective/2017/10/03/34th-annual-2017-north-cascade-glacier-climate-project-field-season/ Abrupt Impacts of Climate Change: Anticipating Surprises. NAP. A WWF article titled 'Going, Going, Gone' Alpine Glacier Change in the Eastern Altun Mountains of Northwest China during 1972-2010. Plos One International Frameworks for Disaster Risk Reduction: Useful Guidance for Sustainable Mountain Development? Mountain Research and Development, 35(2):195-202. Energy- and mass-balance comparison between Zhadang and Parlung No. 4 glaciers on the Tibetan Plateau. Zhu et al. Journal of Glaciology, Vol. 61, No. 227, 2015 Sensitivity of Very Small Glaciers in the Swiss Alps to Future Climate Change. Front. Earth Sci. 4:34. Region-wide glacier mass balances over the Pamir-Karakoram-Himalaya during 1999–2011. The Cryosphere,7,1263–1286, 2013 Modelling glacier change in the Everest region, Nepal Himalaya. The Cryosphere, 9, 1–24, 2015 Just published: The state of climate change research in Swiss protected areas. Emiliano Tolusso. eco.mont – Volume 11, Number 1, January 2019 UNDERSTANDING DEMAND AND SUPPLY OF CLIMATE CHANGE KNOWLEDGE MANAGEMENT IN NEPAL	Accepted - rephrased
13141	2	1	1	106		use photos -- eg glaciers before & after [David Crookall, France]	Taken into account - rephrased the text and more reviews are added in text and Supplementary Table.
13143	2	1	1	0		what are the objectives of this part of the report?? - why is this being done?? [David Crookall, France]	Noted - not clear which part is meant. The rationale of the report is explained in chapter 1

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13155	2	1	1	106	1	"When the ice melts: the catastrophe of vanishing glaciers" is an article that should be mentioned and referenced. It is not the usual academic science, but is as valid for people of all walks of life. https://www.theguardian.com/news/2019/jan/08/when-the-ice-melts-the-catastrophe-of-vanishing-glaciers As one of my colleagues said "It captures both the emotive trauma of the those closely connected to the Natural World, whilst scientifically describing the scale and extent of the ecological impacts unfolding in our generation. This is a must read, not only for environmentalists to maintain their self driven obligations to the earth, but for all and especially corporations and governments whose interests are driving this ecological catastrophe." [David Crookall, France]	Rejected - Focus of assessment is on peer-reviewed literature
14931	2	1	1	25	57	It seems kind of random, which statement includes a citation or a confidence assessment. Can there be (or is there anywhere) a definition on how a decision (whether or not either of them is included) is made? Please carefully revise chapter text in order to make references and the use of uncertainty language more consistent. [Government of Germany, Germany]	Taken into account - confidence statements were assigned more consistently, typically for statement resulting a multitude of evidence and not for individual studies.
17749	2	1	1	6	1	Throughout the Executive Summary the word 'hydropower' is used when talking about sectoral impacts and adaptation. However, perhaps saying 'water management and hydropower' would be a more inclusive and representative framing (i.e. framing captures energy and supply related issues). [Graham McDowell, Canada]	Taken into account - the ES was limited in terms of space, hence hydropower only is used.
17751	2	1	1	6	1	Throughout the Executive Summary socio-economic 'challenges' related to cryospheric changes are mentioned. However, in the full report, 'opportunities' are also discussed. Perhaps the potential for socio-economic opportunities should also be mentioned in the Executive Summary? [Graham McDowell, Canada]	Taken into account - text revised to include a mention on opportunities.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17811	2	1	1	106	33	A key point missing from Section 2.3.1.1 (and, in fact, the report as a whole) is how large-scale climatic oscillations (e.g., ENSO, PDO), climate change/glacier recession, and downstream water resources all interact. Interannual variability drivers like El Nino-Southern Oscillation are a key feature of hydrologic systems and are even routinely used as predictive tools in operational seasonal-scale water supply forecasting models used for managing water resources for hydropower, flood control, agriculture, municipal and industrial water supplies, and meeting legal requirements such as international treaty obligations (e.g., Columbia River Treaty). Several studies have shown, however, that the presence or absence of a glacier can radically change the downstream water resource response to such climatic variability, so that even adjacent watersheds wihtin an otherwise quite climatically homogeneous region demonstrate very different year-to-year and decade-to-decade variations (Neal et al., 2002, "Linking the Pacific Decadal Oscillation to seasonal stream discharge patterns in Southeast Alaska," Journal of Hyrology, 263, 188–197; Lafreniere and Sharp, 2003, "Wavelet analysis of inter-annual variability in the runoff regimes of glacial and nival stream catchments, Bow Lake, Alberta," Hydrological Processes, 17, 1093–1118; Fleming et al., 2006, "Glacier-modulated streamflow teleconnections to the Arctic Oscillation," International Journal of Climatology, 26, 619-636). Yet these differential effects within a larger water resource planning and management region will gradually decline and disappear as glaciers recede under climate change, fundamentally altering the interannual and interdecadal hydroclimatic dynamics of water resources, changing the way that the seasonal water supply forecasts used for active water resource management (across western North America, for example) are made, and rendering regions more hydroclimatically homogeneous (Fleming et al., 2016, "Seasonal flows of international British Columbia-Alaska rivers: the nonlinear influence of ocean-atmosphere circulation patterns," Advances in Water Resources, 87, 42-55). This point needs to be made, with the associated literature citations; without it, the passage may hold far less value for a lot of water resource scientists, engineers, managers, and planners than we would like. [Sean Fleming, United States of America]	Taken into account - due to limitation in page, however, we focus direct cryosphere related changes.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27153	2	1	1	106	34	General comment on Chapter 2: My main concern regarding this chapter is that in my opinion, the section "Changes in Mountain Cryosphere" (section 2) is too short, compared with other sections. There is very little information regarding processes controlling the evolution of snow cover or glacier mass for instance, although there is a large number of studies dealing with these questions. For instance, nothing is mentioned regarding debris-covered glaciers, the evolution of debris cover as a function of rising temperature... There is almost nothing about surface energy balance over snow or glacier surfaces, although many studies have addressed these questions in the recent years. Same for glacier flow. By contrast, there are sections that are less relevant and that could be summarized. I liked the story of ice stupas, or the case study of Peruvian farmers, but this is more anecdotic and could be summarized. In the same way, the section regarding the impact on tourism could be summarized. According to me, this would save some space in the report to address the question of processes responsible for cryospheric changes, where there is still a lot to do, with many research gaps to be listed. Here is a non-exhaustive list of relevant processes that need to be addressed in the future, if we want to understand the present cryospheric changes and their future evolution in a changing climate: accumulation processes via direct precipitation, refreezing, avalanches; wind redistribution, in-transport sublimation, englacial melting inside the hydrological englacial network, supraglacial lake and cliff dynamics over debris covered glaciers, influence of thickness variability and debris characteristics on melting of debris covered glaciers, evolution of the thermal regime of glaciers, interaction between glacier sliding and the englacial hydrology… [Patrick Wagnon, France]	Rejected - The focus of this chapter is on documented changes in the cryosphere and the effects rather than progress in understanding the physical processes driving these changes
28677	2	1	11	1	21	Pasang Yangjee Sherpa is listed twice - one time as Nepač/USA, second time as USA - I am not sure if he is the same person listed twice or there are two contibuting authors? [Irena Mrak, Slovenia]	Accepted
22109	2	1	46	1	46	Suggest revising title for FAQ2.1: "How does glacier change affect downstream water supplies?" [Joseph Shea, Canada]	Rejected - FAQs are intended to have simpler text than rest of the chapter and the title reflects this.
961	2	2	1	2	50	Needs to state Co2 and industrialization, and contamination [Falk Huettmann, United States of America]	Taken into account - However, the chapter focuses on past and future changes in the high mountain cryosphere and its impacts and risks.
963	2	2	1	2	50	The link with water, estuaries, flooding and hydrodams is lacking or weak but must be stated more and clear [Falk Huettmann, United States of America]	Noted - chapter modified to the extent possible within scope.
959	2	2	2	2	10	The cryosphere also includes air and water, must be added and mentioned [Falk Huettmann, United States of America]	Taken into account - definition of cryosphere added. Air and water is not considered here.
12737	2	2	11	0	15	Whole para should be re-written to make it clear. Also do not mix tenses!!. [David Crookall, France]	Taken into account - paragraph was deleted due to space constraints
1109	2	2	13	2	13	Consider specifying that the statement refers to (I assume) air temperature [Daniel Farinotti, Switzerland]	Taken into account - paragraph was deleted due to space constraints
1111	2	2	13	2	14	The sentence makes reference to some temperature trends at the 0°C isotherm. The 0°C isotherm has no temperature trend by definition. [Daniel Farinotti, Switzerland]	Taken into account - paragraph was deleted due to space constraints
8559	2	2	13	2	13	I find the sentence “Temperature trends often increased with increasing elevations” a bit confusing. Maybe the sentence should be re-phrased. [Deborah Verfaillie, Spain]	Taken into account - paragraph was deleted due to space constraints
13083	2	2	24	0		80 kg m-2 yr-1 should probably be 80 kg m2 yr-1 [David Crookall, France]	Rejected - The unit was correct

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1113	2	2	25	2	25	"in units of kg m2 yr-1" should be removed. The sentence holds true independently of the unit. [Daniel Farinotti, Switzerland]	Accepted - text revised
13085	2	2	39	0		(medium confidence) -- worth checking that it is only medium [David Crookall, France]	Accepted
13087	2	2	43	0		check that you cannot describe it as "exceptional speed of decline" [David Crookall, France]	Rejected - not all changes are exceptional and term, it depends on time frame
8557	2	2	45	2	46	I would add "and in most regions the Burned Area is correlated with meteorological drought (Turco et al. 2018)" Ref: Turco, M., Jerez, S., Doblas-Reyes, F. J., AghaKouchak, A., Llasat, M. C., & Provenzale, A. (2018). Skilful forecasting of global fire activity using seasonal climate predictions. Nature communications, 9(1), 2718. [Marco Turco, Spain]	Rejected - chapter focuses on cryospheric change and though the drought may include less snow, this was unclear.
15237	2	3	0	0		The current executive summary lacks regional information. However, not all mountainous regions have the same vulnerability. Mountainous LDCs are particularly vulnerable to changes in cryosphere. Furthermore, local information is required to inform succesful adaptation. The aggregated way information is provided here is not sufficient. [Government of Gambia, Gambia]	Taken into account - Within the limits of space constrains for the ES (2 pages), geographical information was provided as often as possible.
28007	2	3	0	49		I suggest replacing all "glacial" and "glaciated* with "glacier" and "glacierised", respectively. According to a UNESCO document only the latter terms should be used for contemporary glaciers. This is not well known by the community, in particular from other disciplines. [Frank Paul, Switzerland]	Taken into account - we removed all occurrences of 'glacierized', although the proper scientific term it is often misunderstand. We replaced with wording that is easier to understand. Glacial is removed and glaciated only used if referring to past glaciation.
965	2	3	1	3	2	Untrue when you look at large marine mammals living in those systems, even river sharks and crocodiles [Falk Huettmann, United States of America]	Taken into account - Focus has been placed on impacts of changes of the high mountain cryosphere.
1551	2	3	1	6	7	Could there be an explicit bullet point in this chapter on abrupt/irreversible changes and tipping points in high mountain regions? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - abrupt/irreversible changes are dealt with in chapter 6. due to space limitation not taken up here
1609	2	3	1	6	7	There is no mention of lake and river ice in the summary, although it is mentioned at later points in the report. Include one or two sentences on how these are expected to change our state of knowledge. [Nora Richter, United States of America]	Taken into account - Text included.
25163	2	3	1	0		Very little use of likelihood langauge in this executive summary/chapter. I found only two instances in the entire ES. Can this aspect be strengthened to provide stronger concluding statements? [Simon Allen, Switzerland]	Taken into account - added where appropriate
30815	2	3	1	6	7	To avoid repetition and to help readers find information, I suggest to re-structure this Executive Summary. Its first section could focus on crucial changes, describing 1. observed and 2. projected changes. The second part could highlight challenges for society and economy as well as adaptation and explain what knowledge gaps need to be closed to address these issues. At the moment, there are overlaps between the first and the second section of this Executive Summary. I also assume that readers will find it more helpful to see 1. what is already happening and 2. what will happen in the future, what will/might be the consecuences - spelled out for the respective changes - before another section explains what could be done. The Executive Summaries of Chapters 3 and 4 are structured like this. It might increase the readbility of the report and the Technical Summary (likely a compilation of Executive Summaries) if chapters could follow a similar structure. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - structure follows SPM structure (past, projections, response options)

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32235	2	3	1	5	51	This ES is not well represented in the SPM. This requires considerable effort to have a clear line of sight and traceability of the SPM statements to the ES to the unerlining chapter text. [Andreas Fischlin, Switzerland]	Accepted - ES is significantly rewritten
5289	2	3	3	3	4	Cryosphere also includes e.g. firn patches or rock glaciers. You may give a general definition and then name the single elements of the cryosphere. [Simone Schauwecker, Chile]	Taken into account - term defined in glossary. Here it is not meant as an inclusive definition but to provide the main components
5293	2	3	3	3	4	you may add "firn" as a feature of cryosphere [Simone Schauwecker, Chile]	Rejected - to technical for an executive summary and firn is part of the glacier
12697	2	3	3	3	6	The Chapter 2 document on High Mountain Areas focuses on changes of the cryosphere in high mountain environments and its influences on lowlands far beyond the mountains themselves. This perspective of inter-related effects between mountains and lowlands, and the high relevance of climate change on this interdependance, is a crucial message from the report. It is supported by a host of references and evidence for related impacts are manifold. The report also clearly states in many cases the need for place-specific assessment and a differentiated view and assessment of implications and the extent and pace of change attributed to climate change. Overall this focus is very useful and reflects a high confidence level which should entail substantial consequences in terms of assessing societal challenges and transformation actions required if mitigation is taken serious. [Thomas Dax, Austria]	Noted
18507	2	3	3	3	3	Regarding the definition of the Cryosphere with respect to high mountain environments – I would suggest to add “ice caps” or “ice sheets” to the sentence and maybe give up “river/lake ice” or at least spell out “/” as “and”. [APECS Group Review, Germany]	Rejected - terminology consistent with AR5 avoiding the term ice cap (it's included in the term glacier)
21647	2	3	3	41	43	Change in glacier and snow on high mountain influence on wild ecosystem (or riparian ecosystem, forest..) from up-stream to down-stream including coastal waters. IPCC report has to mention scientific content on these issue. This reports focuses on significant shifts in downstream nutrients (DOC, nitrogen, phosphorus) and influence water quality through increases in heavy metals, particularly mercury, and other legacy contaminants. Change in glacier shrinkage and snow cover eventually accompany change in riparian ecosystem through energy transfer process. Content and referecnes are needed to be added; e.g. 1) Lovisa Lind, Christer Nilsson, Christine Weber, Effects of ice and floods on vegetation in streams in cold regions: Implications for climate change, Ecology and Evolution 2014; 4(21): 4173–4184. 2) SARAH C. FELL, JONATHAN L. CARRIVICK, LEE E. BROWN, The Multitrophic Effects of Climate Change and Glacier Retreat in Mountain Rivers, BioScience 2017; 67(10); 897-911 3)Lovisa Lind, Christer Nilsson, Lina E. Polvi and Christine Weber, The role of ice dynamics in shaping vegetation in flowing waters, Biological Review 2014;, 89, 791–804. [Government of Republic of Korea, Republic of Korea]	Taken into account - Text describes influence of snow and glaciers on vegetation, though does not specifically include riparian areas due to space limitations.
28009	2	3	3	0		To avoid confusion, I suggest writimg also here "The mountain cryosphere" [Frank Paul, Switzerland]	Taken into account - ES largely revised
30291	2	3	3	3	3	Change "snow cover" to "snow" as I'd rather consider the latter to be a component of the cryosphere [Charles Fierz, Switzerland]	Taken into account - text revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17725	2	3	4	3	6	Suggest revising sentence as follows to improve clarity: "This chapter synthesizes recent and projected changes in the mountain cryosphere, associated impacts on society and biological systems, and existing adaptation responses." As written, the sentence does not mention biological systems and adaptation is introduced in an ackward manner. [Graham McDowell, Canada]	Taken into account - text partly revised as suggested, since we assert that this is an assessment and not a synthesis.
26851	2	3	4	0		Sentence flow would be improved if it read,"...cryosphere and associated risks, impacts and adaptation responses are assessed in this chapter." [Ko Barrett, United States of America]	Taken into account - text partly revised as suggested, incorporating also other comments.
1533	2	3	8	0	9	too many words are capitalized than needed. Would italics be more effective? [Jacinta Clay, United States of America]	Accepted - text revised
25159	2	3	8	3	9	For me it's a bit strange to see an ES structured according to questions. If this is a uniform approach across all SROC chapters then fine, otherwise I would avoid. [Simon Allen, Switzerland]	Accepted - questions replace
30845	2	3	8	0		These questions are nice guidelines to structure the ES but would such approach would need to be adopted by other chapters as well in order to be maintained. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - questions replace
1539	2	3	11	3	15	Can the amount of warming and decrease in snowfall be quantified? The very high confidence of this statement suggests they should be. Perhaps not a global number but at least for some well-observed regions. [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The warming level is now quantified in the main text, but not elevated to ES because of size constraints and focus on cryospheric elements.
1937	2	3	11	3	11	you may change to: "High mountains regions, strongly influencing the global climate system, have experienced..." [Harald Pauli, Austria]	Taken into account - This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
13803	2	3	11	3	11	higher intensity and have higher rainfall rates' - is this under all scenarios? Please specify. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
13805	2	3	11	3	13	Does the phrase "since the beginning of the 20th century" apply to just the warming, or the snowfall as well? Please either move this phrase to the beginning of the sentence, or add a few words to explain the time period to which the statement about snowfall applies. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
23611	2	3	11	3	15	Using past tense (increased, were, showed, experienced) sounds misleading, given that trends are still ongoing. Has/have been is also used in subsequent paragraphs. [Government of Sweden, Sweden]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32879	2	3	11	3	11	Replace "...as part of the global climate system..." with "...similar to other global regions..."? Otherwise this is just stating that mountains exist as a component of a global system. [Government of United States of America, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32881	2	3	11	3	15	The finding that snowfall amounts have decreased is reported twice (also in lines 17-20). Why include in two separate paragraphs? Have separate paragraph on temperature, precip, and snowfall. [Government of United States of America, United States of America]	Taken into account - Note, however, that the first bullet point is about snowfall (snow precipitation) and the second about snow cover (snow on the ground). These are two different things. Nevertheless, the snowfall element was not retained in the ES FGD due to space constrains and focus on cryospheric elements.
5291	2	3	12	3	12	The term "mean snowline elevation" is not clear. Is it a mean over the last years? How is it estimated? [Simone Schauwecker, Chile]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14933	2	3	12	0		Please clarify what is meant by "mean snowline elevation". It seems that a mean would refer to a (reference) period, however due to the changing air temperature, any mean snowline elevation would change over time, as would the permanent snowline (moving up and poleward). [Government of Germany, Germany]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
15167	2	3	12	3	12	With the term snowline do you refer to the average elevation at which snow occurs regularly? (e.g. Hammond et al., 2018. International Journal of Climatology) [Michele Freppaz, Italy]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
17799	2	3	12	3	18	References to the "mean snowline elevation" as used here may be confusing for many readers, particularly given that the snowline itself has been rising under warmer winter temperatures and will continue to do so. Suggest phrasing this more clearly. [Sean Fleming, United States of America]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
32423	2	3	12	3	13	In this sentence it is not clear when did the snowfall decline occur. The end of 20th century compared to the beginning or the entire 20th century? In this period there were periods when snowfall increased (e.g. in the 60s and part of 70s). I would be more precise here [ROBERTO RANZI, Italy]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
1617	2	3	13	3	14	What is meant by "were more pronounced around the mean 0C elevation" since presumably the temperatures increased? Is this the best metric for talking about changes in temperature trends? [Nora Richter, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
18509	2	3	13	3	14	Clarity could be improved by adding: […] “and elevation-dependent warming was” or were more pronounced […] [APECS Group Review, Germany]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
25161	2	3	13	3	15	If possible, avoid wording like "often" because its too qualitative and vague. [Simon Allen, Switzerland]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
26853	2	3	13	0	14	"Temperature trends increased" is an unclear formulation. [Ko Barrett, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
28273	2	3	13	3	13	It would be helpful to include a short phrase quantifying the range of historical change, and using the word "generally" rathern than "often" so that it reads "Temperature trends, ranging from nn to nn ºC century-1, generally increased… [Patrick Gonzalez, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32553	2	3	13	3	14	Chnage "medium confidence" to "high confidence" [John Diiwu, Canada]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32883	2	3	13	3	13	What does it mean for a temperature trend to increase over elevation? Suggest more precise formulation: "The rate at which temperatures increase over time often increased with elevation" or "The magnitude of positive changes in temperature often increased with elevation." [Government of United States of America, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32885	2	3	13	3	14	What are "more pronounced" trends? Presumably the magnitude was greatest at the freezing line? But this contradicts the earlier statement of increasing changes with elevation. [Government of United States of America, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32887	2	3	13	3	14	"Temperature trends were more pronounced" Does this mean that the increases in temperature were more pronounced at the mean 0°C elevation, or that temperature trends, whether increases or decreases, were more pronounced at the mean 0°C elevation? [Government of United States of America, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1411	2	3	14	3	15	Only "high confidence", " Very high" not supported by main report text [Rene Forsberg, Denmark]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
28275	2	3	14	3	15	It would be good to be more specific on preciptiation, something like "Total precipitation trends were not significant for over nn% of high montain surface area..." [Patrick Gonzalez, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
32889	2	3	14	3	14	Specify whether this is the mean zero degree isotherm. [Government of United States of America, United States of America]	Taken into account in the main text. This text section was however deleted from the ES due to space constrain and focus on cryospheric elements.
30817	2	3	15	3	15	If trends are insiginificant, suggest to omit them in the Executive Summary to avoid confusion in comparison to the first sentence of the paragraph and only describe variations in more detail. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - This bullet point was not retained in the FGD ES, due to space restrictions and focus on cryospheric elements.
1541	2	3	17	3	20	Can snow cover and duration be quantified? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The FGD includes statements about snow cover duration changes.
18437	2	3	17	3	20	If time series show that the snow cover decline is synchronous with the recent warming, then I suppose that a likelihood could be computed (quantitative assessment of the confidence level). [APECS Group Review, Germany]	Taken into account - Detection/attribution for snow cover changes is covered in the main chapter.
18633	2	3	17	3	19	Mean snowline elevation is not defined until page 10 in footnote 3, which is insufficient for such a loaded term. I would also argue that this term should not be used as it is uncommon in the snow hydrology literature. The definition presented in the SROCC is incredibly ambiguous as the solid-liquid transition varies by elevation within storm events and across years. There is little physical evidence for a static mean snowline elevation. Isotherms, mean annual snowfall fraction, snow cover persistence are all more quantitative examples of metrics that more precisely convey whether a site would be rain- or snow-dominated. [APECS Group Review, Germany]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
26855	2	3	17	0	19	How can we have both very high confidence that snow cover amount and duration has declined and say this is subject to high variability? Confusing. [Ko Barrett, United States of America]	Taken into account - This is indeed possible, and trends can be detected as long as observations cover a sufficiently long time periods.
28011	2	3	17	0		I suggest writing "The snow amount and snow cover duration" as snow cover does not really have an amount. [Frank Paul, Switzerland]	Taken into account - text revised for clarity.
30293	2	3	17	3	17	Change "snow cover amount" to either "snow amount" or "mass of snow cover" [Charles Fierz, Switzerland]	Taken into account - text revised for clarity.
30847	2	3	17	0		Can you say by what amount on average snow cover has decreased? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - It is not possible to provide a value (or range of value) which would apply to all mountain regions worldwide (and there is no literature available to do so).
13801	2	3	18	3	19	'associated decrease': I thought ppt was variable, so perhaps more due to snow melt decrease than ppt decrease per se? [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised for clarity.
23613	2	3	18	3	19	"although subject to high variability" can be interpreted as making the finding of decline more uncertain than it probably is. Suggest deletion. [Government of Sweden, Sweden]	Taken into account - It is important to stress that the cover exhibits a high interannual variability, even if it undergoes long term declines.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18635	2	3	19	3	20	Saying there has been an "increase in snow melt" is factually incorrect. By volume, there has been an increasing amount of winter snowmelt (Harpold and Brooks, 2018 Proceedings of the National Academy of Sciences), while snowmelt rates typically decrease due to warming (Musselman et al., 2017 Nature Climate Change). [APECS Group Review, Germany]	Taken into account - text revised for clarity.
28277	2	3	19	3	19	Because the bold-face statement does not quantify the changes, the following sentence really should, saying something like "Snow cover has reduced nn to nn% in area and nn to nn% in duration from year1 to year2." [Patrick Gonzalez, United States of America]	Taken into account - Text was considerably revised, and further condensed.
29615	2	3	19	3	20	Might it actually be the case that the decrease is due in large part to the increase in downward IR radiation occurring due to the increased CO2 radiation, and the result of the melting is the higher temperature. The phrasing here seems to imply it is due mainly to advection of warm air into the region, whereas the higher downward IR radiation is really the cause and drives the warming. I would add that another cause of greater susceptibility to melting is that the higher CO2 concentration does not allow the glacial ice to cool as much in the winter (the extra energy source being downward IR), so one ends up with warmer ice than previously, and it is then more subject to warming. [I am not going to be able to review the whole chapter, so hope this comment might be carried through also the chapter text itself--it just seems to me that it would be appropriate to put the blame for the reductions in ice where they belong, so specifically on the increased CO2 concentration, so that critics cannot say that the loss of ice is just part of a warm fluctuation, etc. [Michael MacCracken, United States of America]	Taken into account - The main text was revised (attribution/detection of snow changes). The ES was considerably revised and shortened.
1939	2	3	20	3	20	"…snowfall, resulting in accelerated snow melt." [Harald Pauli, Austria]	Taken into account - The main text was revised (attribution/detection of snow changes). The ES was considerably revised and shortened.
15169	2	3	20	3	20	Do you mean the rate of snowmelt? [Michele Freppaz, Italy]	Taken into account - The main text was revised (attribution/detection of snow changes). The ES was considerably revised and shortened.
10189	2	3	22	3	23	According to World Glacier Monitoring Service (https://wgms.ch/faqs/), the global cumulative mass change of glaciers has been negative since late 1970's. Saying that glaciers have lost mass in the last two decades sounds quite conservative. [SAI MING LEE, China]	Accepted - revised
13795	2	3	22	3	28	I think it is worth noting that in some regions the apparent slower retreat may in fact reflect that there is very limited knowledge of overall precipitation, particularly above-snow line. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - additional causes for the retreat other than warming vary regionally but beyond the scope of this summary to add more details
13797	2	3	22	3	28	it would be useful to note here what the limits are for mountain communities. Likewise, useful to note here what the changes in activities related to the mountain cryosphere will be. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Noted - comment not clear
15185	2	3	22	3	25	I wonder if we should put in here glacier volume loss acceleration versus the long term (centennial, since Little Ice Age) trend…e.g. Carrivick et al. 2019. Geophysical Research Letters. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - paper is about Greenland which is dealt with in Chapter 3
16267	2	3	22	3	28	Please check units and revise. [Alexander Nauels, Germany]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18439	2	3	22	3	28	Here again, I don't see why we cannot use a likelihood since the retreat of glacier is based on quantitative metrics. Moreover, it would be useful to give the proportion (in %) of glaciers that have been retreating. [APECS Group Review, Germany]	Taking into account - text revised. Proportion of glaciers retreating is not known
18511	2	3	22	3	28	"Regional-scale average mass losses" is a dense metric and seems introduced here to justify a generalized statement about larger regions. Weidemann et al (2018): Glacier Mass Changes of Lake-Terminating Grey and Tyndall Glaciers at the Southern Patagonia Icefield […] especially references in Introduction indicate that local meteorological conditions and topography are offsetting effects driving increased ice loss (in their work areas around the Northern and Southern Patagonian Ice Fields). My point is that local effects are not unique to "High Mountain Asia" which could be assumed from paragraph in current form. "Outliers" as in glaciers with positive mass balance or comparatively low retreat rates are common to all regions. [APECS Group Review, Germany]	Taking into account - text revised. Proportion of glaciers retreating is not known
18637	2	3	22	3	27	The use of units for annual glacier mass loss is inconsistent throughout the chapter. It is sometimes presented as m w.e., kg m-2, and as a percentage. Only one unit should be used for clarity. [APECS Group Review, Germany]	Rejected - The unit kg/m2/yr is used for the past since this is typically done in the literature. We use % mass loss for the future since it presents and easy to understand way of expressing future changes (esp since mass losses reach >80% in some regions.
25165	2	3	22	3	25	Why is the statement on glaciers limited to the last 2 decades? This seems really weak and is strange given that the sentence that follows covers a range from 1986 to 2015? Given that AR5 provided a statement on glacier mass loss since 1971 this comes across as a backwards step in what the science can tell us. [Simon Allen, Switzerland]	Accepted - text revised
25753	2	3	22	3	28	Overall this section is fine, except in the lines 22-28, it has been given that High Mountain Asia is losing mass at least rate. The least rate can be acceptable but, correlating it with balanced or slightly balanced mass balance is wrong for entire high mountain Asia. This statement should either be removed or modified. The recent work of Dehecq et al (2019) have shown that the slight positive or balanced status is only true for Karakoram and West Kunlun areas, whereas, the east Himalaya, North West Himalaya mostly show negative mass balance. (Amaury Dehecq, Noel Gourmelen, Alex S. Gardner, Fanny Brun, Daniel Goldberg, Peter W. Nienow, Etienne Berthier, Christian Vincent, Patrick Wagnon & Emmanuel Trouvé (2019). Twenty-first century glacier slowdown driven by mass loss in High Mountain Asia. Nature Geoscience volume 12, pages22–27 (2019)) [Praveen Kumar Thakur, India]	Accepted - text revised
32891	2	3	22	3	28	There is a lack of clarity in the way mass balances are reported with respect to the words "loss/gain" and the sign of the stated value. First, mass balance is reported as a loss and the numbers are positive. Then there's a statement that mass was balanced or slightly positive. This potentially creates confusion for the reader who just saw a bunch of positive numbers that referred to a decrease in glacier mass. It's important to be precise and consistent throughout. [Government of United States of America, United States of America]	Accepted - text revised
1941	2	3	23	3	24	If you mean the mountain regions within the eleven areas delimited in Figure 2.2, you virtually speak of all glaciated mountains outside the polar regions. Therefore, it would not make much sense to speak of eleven regions, especially not here in the summary, which precedes the figure. Instead, I suggest: "Mass loss from high mountain glaciers outside of the polar regions increased …" [Harald Pauli, Austria]	Taken into account - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10191	2	3	23	3	28	The units of mass loss don't match. Should it be kg m2 or kg/m2 ? [SAI MING LEE, China]	Accepted - text revised
10193	2	3	23	3	28	Suggest the mass loss unit be given in Gt, if possible, to facilitate the comparison of ice losses from glaciers and ice sheets. [SAI MING LEE, China]	Accepted - text revised
13807	2	3	23	3	23	The National Snow and Ice Data Centre says (https://nsidc.org/cryosphere/glossary/term/glacierized) that the term "glacierized", meaning covered by a glacier, has not found general favour, and it isn't in the Glossary for this report, so should it be used? It could be omitted here and the sentence would still make sense. More importantly, this text is reproduced in the SPM (page SPM-3 row 9) with the word "glaciated" instead of "glacierized" but are these words interchangeable? A dictionary suggests not, because "glaciated" can mean subjected to the effects of glaciers. Please check which is the correct word, use it consistently and add it to the glossary. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taking into account - since term is not widely understood we avoid it and paraphrase it depending on context
23615	2	3	23	3	23	It is not readily clear why the statement is limited to the last two decades. Is this due to data limitation? [Government of Sweden, Sweden]	Accepted - text revised
25623	2	3	23	3	25	The figures on mass losses cited here seem to be taken from a single publication (Zemp et al. Submitted) should this be indicated with a “medium agreement” indication? [Floortje van den Heuvel, Switzerland]	Taken into account - since several new publications have emerged we compiled a composite estimate that is reported here (new section in appendix lists all values of all publications and describes our procedure in detail
24515	2	3	24	3	24	Comment on a section within a chapter. The sentence could be easier to understand if the mass losses levels were in percentages. For example, read the paragraph on page 15, from line 14 to 16). [Francisco Barraza, Chile]	Noted - unclear what is meant since these lines don't report any glacier mass losses
13799	2	3	25	3	26	Please make clear in the headline message if the 'consequences for climate and ecosystem services' are global or polar-specfic. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted
18441	2	3	25	3	25	"kg.m-2.yr-1" instead of "kg.m2.yr-1" [APECS Group Review, Germany]	Accepted
23617	2	3	25	3	25	"in units of kg m2 yr-1" would seem to be unnecessary and as such, confuses. [Government of Sweden, Sweden]	Accepted - text revised
28205	2	3	25	3	25	Suggest replacing with “Area-averaged regional mass losses in the latter period …”, because the relevant point is area-averaged, not units used. [Martin Truffer, United States of America]	Accepted - text revised
32893	2	3	25	3	25	Remove "in units of kg m2 yr-1" since every time a number is reported the units are included. Or if this is a required element, move it earlier in the paragraph, before the other mass balance numbers are stated. [Government of United States of America, United States of America]	Accepted - text revised
18545	2	3	26	3	26	"…the low latitudes and central Europe (>900 kg/m2/year)". This is a new information. In the main chapter body, on p. 14, line 33, we read: "…mass budgets were most negative in the Southern Andes (-1200 kg/m2/year)". Please make sure that all information provided in Excecutive summary and the rest of the chapter are homogenous. [APECS Group Review, Germany]	Accepted
30623	2	3	26	0		“low latitudes” - suggest adding “including Africa” (or clearly specifying the region referred to here) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - numbers have changed wth new literature and low latitudes no longer mentioned here

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10423	2	3	27	3	28	Are we speaking about local condition or regional condition. Definition of scale in meterology is very important. [Elzbieta Czyzowska-Wisniewski, United States of America]	Accepted - text revised
30843	2	3	27	0		The executive summary gives a nice general, mostly qualitative overview but would be more punchy if key findings could be detailed (specified and quantified), also and especially with respect to solution options by adaptation and mitigation efforts. This would also help the development of the SPM as a stand-alone document. I have indicated where such question marks come up when reading the present ES. If quantitative statements are not possible for global scale they may still be possible for key regional examples (case studies). Providing semi-quantitative estimates or orders of magnitude would also help to understand better and e.g. differentiate between whether projected mean global or regional changes are by e.g. 5 or 95 %. [Hans-Otto Poertner and WGII TSU, Germany]	Noted
32895	2	3	27	3	28	"...due to local meteorological conditions..." As pointed out in this report, the cause of positive mass budgets in some regions of high mountain areas might be attributed to regional scale changes in moisture transport associated with changing evapotranspiration fluxes resulting from irrigation practices in India. So not sure it's correct to only say it's local meterological conditions. [Government of United States of America, United States of America]	Taken into account - study mentioned in main text and text in ES revised
18443	2	3	28	3	28	By "meteorological conditions", do you mean "increase in precipitation/snowfall"? If so, this would be more explicit to state it this way. [APECS Group Review, Germany]	Accepted - text revised
816	2	3	30	3	33	In the Executive Summary of Chapter 2 it is written: "In situ measurements in the European Alps, Scandinavia, and the Tibet Plateau show that permafrost has undergone warming, degradation and ground-ice loss in the past two decades (high confidence). The observed rates of change in the 21st century are higher than in the late 20th century (medium confidence). Other mountain regions lack in-situ observations to assess trends. {2.2.4}".In Section 2.2.4, author team may want to consider publications on Central Asian permafrost, see the list in comment 2, and to alter the Executive Summary correspondingly. [GRIGORY INSAROV, Russian Federation]	Taken into account – central asian published changes, even pre-AR5, now included
1543	2	3	30	3	33	Can the rate of loss be quatified in this statement? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account – no, it cannot
16269	2	3	30	3	33	Permafrost related changes are more extensively presented in the SPM than in executive summary - should be consistent (compare SPM p.3 14-22) [Alexander Nauels, Germany]	Taken into account – also better integrated with Ch3
28013	2	3	30	3	31	Do all three changes refer to all three regions or is a "respectively" missing (e.g. warming belongs to the Alps, degradation to <scandinavia, etc.)? [Frank Paul, Switzerland]	Taken into account – text reformulated
32897	2	3	31	3	31	Non-experts would not understand the difference between "permafrost degradation" and "ground-ice loss". [Government of United States of America, United States of America]	Taken into account – Degradation is explained in the Glossary
30849	2	3	32	0		Some quantitative estimate o rates of change and their degree of change would be very useful. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account – this content has been reworded, more quantitative data is not available, though.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17425	2	3	35	3	41	It must be important to mention as an example, the close relationship that exist between high mountain regulatory systems (cryosphere) and large basins such as the Amazon basin. The Amazon basin, collects the runoffs of many mountain areas and both physical and biological dynamics are experiencing some of the affectations described in this section (i. g. increment in mercury concentrations due to runoff). People usually do not connect the lowlands and the high elevations through their intrinsic physical functional dynamics. The increment in the input of mercury is associated with an increment in the runoffs from Andean glaciers, and it is particularly true for superficial soil layers which have been repeatedly disturbed by burning, ploughing and trampling. Intense rainfall promotes the production of large volumes of runoff from deforested areas. Runoff erodes highly contaminated soil particles originating in these layers and transfers them to surface waters, increasing mercury concentrations in water bodies, this dynamic has been documented at the Tapajos River catchment (Eastern Amazon), Amapa watershed (Northern Amazon) and several lakes in the Pantanal and Alta Foresta (Southern Amazon), places in where mercury concentrations are well correlated with an increment in suspended sediment loads (Roulet et al., 2000; Fostier, 2000; Cordeiro et al., 2002). Roulet, M., Lucotte, M., Saint-Aubin, A., Tran, S., Rheault, I. (1998a) The geochemistry of mercury in Central Amazonian soils developed on the Alter-do-Chao formation of the lower Tapajós river valley, Pará state, Brazil. Science of the Total Environment, 223:1-24.Fostier, A. H., Forti, M. C., Guimarães, J. R. D., Melfi, A. J., Boulet, R., Santo, C. M. E., Krug, F. J. (2000) Mercury Fluxes In A Natural Forested Amazonian Catchment (Serra Do Navio, Amapá State, Brazil). Science of the Total Environment, 260: 201-211. Cordeiro, R. C., Turcq, B., Ribeiro, M. G., Lacerda, L. D., Capitaneo, J., Da Silva, A. O., Sifeddine, A., Turcq, P. M. (2002) Forest Fire Indicators And Mercury Deposition In An Intense Land Use Change Region In The Brazilian Amazon (Alta Floresta, Mt). Science of the Total Environment, 293: 247-256. [Hugo Mantilla-Meluk, Colombia]	Taken into account - we added sentence to connect cryosphere change and downhill. Unfortunately we did not include the suggested references because it is out of the target of this chapter and because of page limitation.
17729	2	3	35	3	41	Perhaps some mention of peak water dynamics could be included here so that increases/decreases in discharge are understood as regional vignettes of a generalized, nonlinear glacio-hydrological response to climate change (i.e. peak water). [Graham McDowell, Canada]	Accepted - peak water is mentioned in Exective Summary.
17731	2	3	35	3	41	In addition to mentioning impacts on water quality, I think it would be appropriate to mention impacts on water availability. [Graham McDowell, Canada]	Accepted - changes in runoff and its impact (availability) is described in the same paragraph.
25167	2	3	35	3	41	I appreciate there is now much better balance in the regional coverage of this chapter (compared to the ZOD I reviewed earlier). However, here it seems some further details on high mountain asia and the andes would be justified, given it is more the developing mountain regions that are discussed later in terms of impacts. Otherwise there is a bit of a disconnect between what is said on the phyical changes and what is said on impacts/adaptation. [Simon Allen, Switzerland]	Accepted - more reviews on High Mountain Asia and Andes are added and all references are now in Supplementary Table.
30851	2	3	35	0	36	Again, some quantitative estimate of the changes in amount and timing of river runoff in many mountain regions would be very useful. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - we added percentage in area of glacier regions where peak water has passed in future. As the effect of cryosphere on runoff varies in basins, it is difficult to quantify amount.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32899	2	3	35	3	35	Here and throughout the report the terms "shrinkage" and "recession" are used presumably to refer to a reduction in glacier surface area. The term "shrinkage" connotes both area and elevation changes. It's much more precise to refer to positive or negative changes in glacier surface area. [Government of United States of America, United States of America]	Accepted - rephrased with careful use of terms
29617	2	3	36	3	39	The phrasing here needs a bit of modification. Saying that runoff is down due to shrinkage seems very strange in that shrinkage is a key contributor to the runoff, so presumably there has been increased runoff as a result of the glacier shrinking. Perhaps say that as the glaciers have shrunk in size, with greater evaporative loss due to the warmer temperatures, each year's melting is leading to less runoff. [Michael MacCracken, United States of America]	Accepted - rephrased
17727	2	3	37	3	38	Perhaps add Peru as example of region with small glaciers and declining stream flow. Perhaps select another region with large glaciers like Nepal, as 'western USA' (small glaciers example) 'Alaska' (large glaciers example) overlap spatially. [Graham McDowell, Canada]	Taken into account - rephrased the text and more reviews are added in text and Supplementary Table.
17801	2	3	37	3	37	As noted above regarding the corresponding section of the SPM, "(eg., western USA and Canada)" is scientifically inaccurate - this should instead read "(e.g., conterminous USA and southwestern Canada)". The trends downstream from the huge icefields of northwestern Canada have been completely different from those in southwestern Canada and much more similar to those in adjacent Alaska. Refer to Fleming and Clarke, 2003, "Glacial control of water resource and related responses to climatic warming," Canadian Water Resources Journal, 28, 69-86; and to the widely cited review article by Moore et al., 2009, "Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality," Hydrological Processes, 23, 42-61. [Sean Fleming, United States of America]	Rejected - for consistency across the chapter, we use region name of high mountains defined as 11 domains in overall chapter. Detail information (mountain name or country) is given in supplementary information or in main text when we show examples from references.
17803	2	3	38	3	39	Also as noted in a comment above regarding the corresponding section of the SPM, suggest changing "(e.g., Alaska)" to "(e.g., Alaska and Yukon)" (see foregoing comment). I'm also not sure why line 28 reads only as medium confidence; I might call it "high" given the evidence for it. Additionally, I suggest preceding the sentence starting with "Runoff changes…" with "Additionally, glacier recession and snow cover reduction have changed flow regime characteristics, such as peak timing and late-summer river levels, which may exacerbate ecosystem, hydropower, and water resource impacts of climate change even where total runoff changes are modest." [Sean Fleming, United States of America]	Accepted - rephrased the sentence. Based on reviews, we changed the statement as high confidence. We use region name of high mountains defined as 11 domains in overall chapter.
23619	2	3	38	3	38	"typically" may not be the clearest expression here. Perhaps use "with predominantly large glaciers" or suclike. [Government of Sweden, Sweden]	Accepted
1519	2	3	39	3	40	I agree with most assessments in the section, but feel that the confidence is under assessed here-- I would say that runoff from glaciers has increased with High Confidence in some regions [Kimberley Miner, United States of America]	Accepted
24533	2	3	39	3	41	I miss level of confidence for this statement [Armand Hernández, Spain]	Accepted - level of statesment are added
18445	2	3	40	3	41	What is the level of confidence of these statements? If we are aware of spatial heterogeneitites, state here which regions are more affected than others. [APECS Group Review, Germany]	Accepted - level of statesment are added

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14935	2	3	41	3	43	Please add into the brackets as additional references subchapter 2.2.3 and FAQ 2.1: ... (2.2.3, 2.3.1, FAQ 2.1), because the issue of glacier shrinkage and water supply/nutrients in water is discussed under 2.2.3 and in FAQ 2.1 as well. [Government of Germany, Germany]	Accepted
18447	2	3	43	3	43	Suggestion: "increased" instead of "affected". [APECS Group Review, Germany]	Rejected - revised to changed; not all hazards increased!
25169	2	3	43	3	43	I believe "decades" should be replaced with "century" here. We can be extremely confident that the retreat of glaciers since the LIA has had a large impact on paraglacial slope stability and lake formation. We can be more confident about this then we can about more recent processes. Somehow this should be reflected here, and is a bit lost by focussing only on the past decades. [Simon Allen, Switzerland]	Accepted - text revised
30625	2	3	43	3	51	Fire as a hazardous factor is missing from this statement [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - linked to ecosystem impacts
30819	2	3	43	3	44	Please mention the hazards in the first sentence instead of using the word "some" or at least specify this refers to natural hazards typical for mountain regions. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
32901	2	3	43	3	43	"... decline of the cryopshere..." lacks precision. Maybe "...the loss of the cryosphere..."? [Government of United States of America, United States of America]	Accepted - changed to "reduction"
2359	2	3	45	3	46	whether the number of lakes increased there is also evidence of reduction in lake area, at least in the Himalayan Mountains (Sun et al 2018 Earth-Science Reviews 185 (2018) 308–324). [Ruben Sommaruga, Austria]	Accepted - specified that lakes increased in "most" regions; reference cited in main chapter
13809	2	3	47	3	47	Please define wet snow avalanches and dry snow avalanches in the Glossary [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Clearer and more explicit language was used in the report, so that it was ultimately not needed to add avalanche-related terms in the glossary.
23621	2	3	48	3	49	Exposure can depend on different things. The meaning here would seem to be that exposure has increased because of changes in hawards. This could be clarified. [Government of Sweden, Sweden]	Accepted - text revised
30627	2	3	48	3	49	This statement about exposure of people might be highly relevant to policymakers but somewhat vanishes among the other statements. Could it perhaps be a headline statement of its own, with the following sentence as supporting text (similar to the next HS about biodiversity? [Hans-Otto Poertner and WGII TSU, Germany]	Noted - statement made bold
30853	2	3	48	0	51	This should clearly be a separate bullet. [Hans-Otto Poertner and WGII TSU, Germany]	Noted - statement made bold, but left in same paragraph
1607	2	4	2	4	2	Biodiversity is a broad term. Define this somewhere and specify whether increases in diversity are associated with alpha or beta-diversity. This can have different implications. [Nora Richter, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
1943	2	4	2	4	4	I'm not fully confident if we can say "...biodiversity has increased overall...". Further, although species numbers have increased where glaciers retreat and permafrost thaws, it may have a positive connotation. I suggest to change to: "In terrestrial and freshwater ecosystems, species numbers have increased due to changes in snow cover, permafrost thaw and degradation, and glacier retreat, although some specialist taxa have been declined in abundance (..." [Harald Pauli, Austria]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10987	2	4	2	4	4	I think that it should be clarified that this is macro-scale biodiversity. Also in other places where macro-diversity is commented on without context, I think that it should be stated that the statement does not include microorganisms. [Karen Cameron, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
14937	2	4	2	4	8	Please amend this statement to clarify why biodiversity would increase under the given circumstance. The content of the following paragraph seems to mainly support the second part of the headline statement, indicating negative effects on specialist taxa, while other (positive?) effects leading to increased biodiversity are not spelled out. You may also wish to reconsider the chosen formulation, as the "overall increase in biodiversity" may not adequately reflect the loss of unique systems. [Government of Germany, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
17427	2	4	2	4	8	Changes in the spatial biology of the species related with climatic factors include the emergence and spreading of vector-borne diseases, a problem that continue to contribute significantly to the global burden of disease, and cause epidemics that disrupt health security and cause wider socioeconomic impacts around the world. All are sensitive in different ways to weather and climate conditions, so that the ongoing trends of increasing temperature and more variable weather threaten to undermine recent global progress against these diseases. Every single species has a natural load of parasites and viruses, potentially harmful to humans under certain ecological conditions. My suggestion is to include this aspect, in order to help in the generation of better health surveillance programs and early warning plattforms. Support in the scientific literature is extense, if considered more information in: Campbell-Lendrum D, Manga L, Bagayoko M, Sommerfeld J. 2015 Climate change and vector-borne diseases: what are the implications for public health research and policy? Phil. Trans. R. Soc. B 370: 20130552. http://dx.doi.org/10.1098/rstb.2013.0552 [Hugo Mantilla-Meluk, Colombia]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
26857	2	4	2	0	7	This paragraph could use some editing to clarify the main points. Are we making a broad statement that biodiversity in terrestrial and freshwater ecosystems has increased? We may need to clarify this is in high mountain systems. The sentence beginning with "Camouflage" is not easy to understand. Perhaps something like,"Reduction of snow cover resulting in brown snowless ground has affected the ability of some white-coated wildlife to be camouflaged, therby…" [Ko Barrett, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
29619	2	4	2	4	4	I'd urge a bit of an adjustment here. It is true that the warming can (and has) led to an increase in local biodiversity (meaning the number of species), but globally the loss (extinction) of specialist species is really a loss of global biodiversity. I think it is important to make this distinction here (and in similar discussions). There is then the issue of whether number of species is the right metric to be using in considering such influences--what one is interested in is presumably the effective functioning of ecosystems and it is not just total number of species that matters, but having the right combination of species for effective functioning (something that itself is hard to define), so it might be that a point needs to be made on this as well. [Michael MacCracken, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30821	2	4	2	4	2	Please clarify these are terestrial ad freshwater mountain ecosystems. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30823	2	4	2	4	4	Can a little more detail and explanation be given for the increase in biodiversity?` [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32237	2	4	2	4	3	Most non-specialists do not understand why CC causes biodiversity to increase in mountainous areas. They expect the opposite due to CC and generally do not know that biodiversity tends in general to decrease with increasing altitudes ("the altitudinal biodiversity gradient"). Therefore you need to make clear that lowland species invade mountain areas by exploiting new territories that were previously too cold for them to inhabit while the species with realized niches characterized by colder climata tend to move upwards, hereby shifting in general the altitudinal biodiversity gradient also upwards. Then you need also to give a hint what specialist taxa have been lost. [Andreas Fischlin, Switzerland]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
1545	2	4	3	4	3	Should taxa be defined somewhere? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
23623	2	4	3	4	3	"although" may not be the clearest expression here. Perhaps "... and glacier retreat. At the same time..." [Government of Sweden, Sweden]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
28279	2	4	4	4	4	Better to specify "white coats on mammals and white plumage on birds" [Patrick Gonzalez, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30855	2	4	4	0		Unclear whether this loss of taxa represents regional or global extinction [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
32239	2	4	4	4	7	There would be much more to be assessed than merely wilflife, which is given here an unjustifiable emphasis. Plants need to be discussed as well. Moreover and muchmore importantly, this seems to be the only contribution to the entire ES from the ecological systems part of this chapter, which is not acceptable. Moreover, there are many more ecosystems service mountain ecosystems provide than merely biodversity maintenance. All these need to be considered and assessed. Given the fact how much space is taken up in the ES by changes in the cryosphere such as snow cover, permafrost, ice etc. that a differentiated impact assessment on what these changes mean for ecosystems and their services from providing, regulating, to cultural services, is crucial. It needs to be added, since of paramount relevance for most high mountains and this assessment must not be missing from this chapter, in particular also given the plenary approved indicative bullets. [Andreas Fischlin, Switzerland]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
32241	2	4	4	4	6	Uncertainty assessments for the various parts of the statement missing [Andreas Fischlin, Switzerland]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
32903	2	4	4	4	4	Change sentence "Camouflage has affected..." to "Wildlife relying on the cryosphere for camouflage have been compromised in their movement, subject to increased predation and experienced a reduction in range. This occurs for example as more brown snowless ground is exposed." [Government of United States of America, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
8819	2	4	5	0		"lead" - perhaps make this "has led" as it may read better [Nina Hunter, South Africa]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12739	2	4	5	0		grammar? Should it be "leads"? [David Crookall, France]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
1945	2	4	6	4	8	you may omit "including survival under a shallower and denser snowpack" as it sounds a bit weird, especially in the context of "ungulates". [Harald Pauli, Austria]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
28207	2	4	6	4	8	This sentence sounds odd: Survival under a thinner denser snow pack is an issue for wolverines and ungulates? [Martin Truffer, United States of America]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30629	2	4	6	4	7	Nice point, but what exactly is meant with “high profile species”? Does this refer to their ecological relevance, or to their charisma and interest to alpine tourists? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
32243	2	4	6	4	7	Uncertainty assessments for the various parts of the statement missing [Andreas Fischlin, Switzerland]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
13815	2	4	7	4	7	ungulates'? This term may need explaining as it's not a word many people use. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
4985	2	4	10	4	21	It will be useful to also include how human settlements in these regions are responding to the changes [Debra Roberts and Durban Team, South Africa]	Taken into account - Adaptation is now clearly addressed in the ES.
17429	2	4	10	4	21	Associated processes to water regulation are important not only for local (cryosphere) tuouristic activities. Dowstream activities, including, rafting, canoing, bird watching (camping and hiking in general) [Hugo Mantilla-Meluk, Colombia]	Taken into account - Both the water resources and the tourism sections refer to the many uses of water in mountains, and related challenges.
17733	2	4	10	4	13	I am not sure if "since the mid-twentith century" is necessary information here, and there is so little evidence of the efectiveness of adaptaions that I am not sure it makes sense to say that the evidence is uneven. I think it's just limited at this point. Futhermore, it would be nice to allude to limited understanding of the sustianability of existing adaptation efforts. I suggest revising sentence as follows: "Observed changes in the cryosphere are exerting considerable yet differentiated impacts in agriculture, hydropower, tourism and recreation activities, and other sectors in high mountain areas since, yet evidence of the long-term effectiveness and sustinability of adaptation responses remains limited (medium confidence)." [Graham McDowell, Canada]	Taken into account - text partly revised to reflect this suggestion. The time reference is needed here as per required guidelines to mention timeframes of observed change/impacts in the body of evidece assessed.
26859	2	4	10	0		I would posit that "yet differentiated" is unnecessary in this sentence. [Ko Barrett, United States of America]	Taken into account - text revised accordingly.
26861	2	4	10	0	21	The bolded statement implies this paragraph is going to be primarily about observed changes in the cryosphere and their impacts, with an ancillary treatment of adaptation. However, the entire paragraph is about adaptation. If you are going to keep the bolded sentence, you need to add some detail on the considerable, observed changes we are seeing in these sectors before the discussion you have on adaptation. In any case, this discussion should come after Pg.5 , line 20. [Ko Barrett, United States of America]	Taken into account - text revised. Adaptation is now featured as a specific headline statement in the revised ES.
30857	2	4	10	0	11	Can % changes be given? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Quantitative figures were given where it was possible to do so, based on available literature and knowledge.
30859	2	4	13	0	14	Can you say something whether previous impact was fully reversed? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES was considerably revised in preparation of the FGD.
1947	2	4	16	4	19	Suggest to mention that measures such as snow making also require considerable water and energy resources. [Harald Pauli, Austria]	Taken into account - This information is provided in the chapter text. Water governance is also addressed in the chapter text.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12699	2	4	16	4	18	The Executive Summary concludes here that "snow management … has reduced the vulnerability of some mountain ski resorts …". Although this assessment is evidence based and represents an important information on current adaptation strategies for some specific contexts, limitations of such action and future extended pressures for skiing areas should not be neglected, and should also be mentioned in the summary to provide a balanced perspective on this topic. [Thomas Dax, Austria]	Taken into account - The ES was considerably revised to address many review comments and newly available evidence. This concerns snowmaking for past and future climate change, too.
30861	2	4	16	0		Can you say something about how the provisioning of water has changed and what was used to buffer its variability? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Water availability is covered in the water section (ES and chapter), for both past and future changes.
13089	2	4	17	0		give examples of ski resorts [David Crookall, France]	Rejected - Unfortunately, there is no space available for citing individual ski resorts.
18449	2	4	17	4	21	It could be useful to state here whether there is (or not) a competition between water supply for agriculture, hydropower and the use of water for recreative purpose (e.g. artificial snow). [APECS Group Review, Germany]	Taken into account - Water governance is explicitly mentioned in the revised ES, in particular in its section C.
23625	2	4	18	4	18	If this refers to adaptation measures so far / until now, it should be made clearer. I.e., so as not to confuse with adaptation potential and possible future measures. [Government of Sweden, Sweden]	Accepted - The text was revised for better clarity.
1949	2	4	19	4	21	A bit difficult to grasp the meaning of this sentence. [Harald Pauli, Austria]	Taken into account - The ES was considerably revised for better clarity.
13091	2	4	19	0		Para starting "The diverse" needs to be re-written, with more, but shorter sentences. [David Crookall, France]	Taken into account - Text has since been revised and has changed substatially in the final draft, with clearer and shorter statements.
17735	2	4	19	4	19	What is meant by 'fragmented'? Can this be clarified? Perhaps sentence could read: "However, adaptation measures are generally limited in scope, short-term focused, and carried out without guidance from formal adaptation plans." Note, I also removed "in agriculture, hydropower, tourism and other sectors" for brevity, as these sectors are mentioned in the lead sentence. [Graham McDowell, Canada]	Taken into account - Text has since been revised and has changed substatially in the final draft, with clearer and shorter statements.
17737	2	4	19	4	21	This sentence is rather unclear. It seems like the goal is to highlight two ideas: 1. The diversity of the socio-economic factors that condition adaptability and adaptation actions, which in turn produces the 'differentiation' alluded to in the header sentence and 2. that the diversity of adaptation actions as well as uneven socio-economic/institutional realities makes systematic evaluation of adaptations difficult. Perhaps the sentence can be revised to reflect these ideas more precisely? [Graham McDowell, Canada]	Taken into account - Text has since been revised and has changed substatially in the final draft, with clearer and shorter statements.
30863	2	4	19	0		Can adaptation limits be quantified and residual risks be determined? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The papers assessed were limited in their content/treatment of limits to quantified adatation, residual risks are addressed in general terms in the text based on available evidence.
26321	2	4	23	0		How are high mountain ecosystems expected to change? Is biodiversity projected to continue increasing, level off, or decrease? [Ethan Pierce, United States of America]	Taken into account - The ES was considerably revised for better clarity and consistency with chapter content.
10195	2	4	26	4	28	Suggest providing the projected warming rates. [SAI MING LEE, China]	Taken into account - However, the ES was considerably amended and the warming rates are not provided in the ES, because of space constraints and focus on cryospheric elements. Warming rates are provided in the main text, however.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18451	2	4	26	4	28	Here again, I am suprised that we cannot specify a likelihood. [APECS Group Review, Germany]	Taken into account - The ES was considerably revised and the warming rates are not provided in the ES - but in the text, along with a likelihood for the warming rate (past and future).
29629	2	4	26	5	51	The length and completeness of the findings changes significantly from the first few being quite terse to the latter ones being much more expansive. I'd suggest working toward a bit better balance, with more descriptive text added to the first few and the last ones made a bit more punchy. [Michael MacCracken, United States of America]	Accepted - The ES was considerably revised.
30825	2	4	26	4	26	Non-experts might not recall here which scenarios have been considered or what these scenarios are. Can you give a little more information? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Scenarios are defined as a footnote at their first occurrence.
30831	2	4	26	4	48	Can anything be said here about consequences of the changes described in these paragraphs? As long as only the changes themselves are described, it would feel more logical for me and might be easier to understand to re-structure the Executive Summary as said above. Otherwise this feels slightly repetitive and requires readers to jump between paragraphs in case they want to find out how a certain element or aspect of the mountain cryosphere has changed/is changing and how it will change in the future. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES was considerably revised and more integration was sought. However, multiple drivers are causing multiple impacts, so that it is not possible to describe the impact of each physical change without a lot of repetition.
30865	2	4	27	0		Can this be quantified, x-fold? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES was considerably revised and more quantitative information on changes in physical drivers was added to the main text.
1521	2	4	28	4	29	I would argue that the amplification of elevation dependant warming should be represented as "high confidence" [Kimberley Miner, United States of America]	Rejected - The body of evidence assessed for the preparation of this report does certainly not support "high confidence" attached to elevation dependent warming. The chapter text was revised to better reflect the state of the art.
23629	2	4	28	4	28	It is not totally clear what the "mean snowline elevation" refers to. Is it some climatological reference? Or the evolving (with time, with warming) dynamic snowline. Please clarity. [Government of Sweden, Sweden]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
1951	2	4	29	4	31	what means "limited long-term changes"? You may put instead: "Total precipitation is projected to show regionally variable long-term changes, except at ...". Further, please check if increases at highest elevations are a general projection. [Harald Pauli, Austria]	Taken into account - The ES was shortened with a stronger focus on cryospheric elements - but changes in the main text were performed to address this comment.
23631	2	4	29	4	30	What does "limited long-term changes" imply? Section 2.2.1.2 would not seem to clearly underline this statement. Is the regional total precipitation trend small? Or does the mountaineous area subject to smaller total precipitation changes than the surrounding region? [Government of Sweden, Sweden]	Accepted - The main chapter text was revised for clarity ; atmospheric changes are not anymore covered in the ES, due to space constraints and focus on cryospheric elements.
25845	2	4	29	4	31	The origin of this conclusion is unclear. It cannot be drawn from the referenced 2.2.1.2 sub-section (nor Box 2.1) which includes a discussion on future precipitation. As stated in this sub-section, future total precipitation change is at first regionally dependent and it is the change of the solid (liquid) precipitation that is elevation dependent. [Serge PLANTON, France]	Accepted - The main chapter text was revised for clarity ; atmospheric changes are not anymore covered in the ES, due to space constraints and focus on cryospheric elements.
30867	2	4	29	0		A number/factor quantifying amplification would be useful. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The main chapter text provides more quantitative information where possible.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1547	2	4	30	4	30	Maybe define the "highest elevations". [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - while this statement did not remain in the revised ES due to space constrains and focus on the cryospheric elements, the text was revised for clarity on this topic and more information was added on how to define and address specific elevation domains (lower, higher).
1413	2	4	33	4	39	This conclusion is too long - it make no sense to include the very uncertain confidence intervals. Just keep a %-number and state there is a large uncertainty [Rene Forsberg, Denmark]	Taken into account - However, there is considerable regional variability, which is bracketed (likely range) by the stated confidence range. We feel this is more useful than stating a percentage change without an uncertainty range.
2661	2	4	33	4	39	The mean snowline elevation (MSE) is expected to increase as air temperature increases. How much will the MSE is expected to change? Does the projected reduction in snow cover account for the likely change in MSE? [Thian Yew Gan, Canada]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
14939	2	4	33	4	38	Please clarify what is meant by mean snowline elevation. It seems that a mean would refer to a (reference) period, so without that reference period it is difficult to understand what difference is meant here. Also, due to the changing air temperature, any mean snowline elevation would change over time, as would the permanent snowline (moving up and poleward). Please rephrase in a way that is accessible to the reader and concise. [Government of Germany, Germany]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
15447	2	4	33	4	39	This conclusion is too long - it make no sense to include the very uncertain confidence intervals. Just keep a %-number and state there is a large uncertainty. Consider re-ordering for readability (for example dealing with above and below snowline separately). [EUCE, Belgium]	Taken into account - However, there is considerable regional variability, which is bracketed (likely range) by the stated confidence range. We feel this is more useful than stating a percentage change without an uncertainty range.
18453	2	4	33	4	37	What is the confidence interval / likelihood of these [10-40%] and [50-90%] ranges? [APECS Group Review, Germany]	Taken into account - As per IPCC formatting guidelines [] refer to likely range. For better clarity, the statements were expanded explicitly stating this is a likely range.
18513	2	4	33	4	39	This paragraph states that the overall decline of snow pack is expected independent from RCP scenario but also that the mass and duration of snow cover is highly variable. Maybe the RCP projection could be backed by a likelihood statement as the precision of the projections seems to be wide. [APECS Group Review, Germany]	Taken into account - The projections are indeed wide, but they cover the range of changes from the literature assessed for various mountain regions of the world. Furthermore, the ES was edited for better clarity, within strict space constraints.
18639	2	4	33	4	36	The use of "mean snowline elevation" is particularly confusing here. Most projections show that snow losses are expected to be greatest at middle elevations with winter mean air temperatures slightly below freezing. To my thinking, these areas are above, not below, the mean snowline elevation as defined in footnote 3. Again, I feel this term "mean snowline elevation" should not be used in the report as it is unnecessarily ambiguous and not commonly used. [APECS Group Review, Germany]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
23633	2	4	33	4	33	"remain highly variable" is probably not the main point here, but the trend/change. Emphasis should be moved here, or the variability aspect omitted (rather obvious). [Government of Sweden, Sweden]	Rejected - It may be obvious to some readers that variability is a key attribute of the mountain snow cover, but this is an often overlooked point which we think deserves being written clearly, even under future climate change.
24211	2	4	33	4	34	it is unclear what 'below the mean snowline elevation' means. [Christian Huggel, Switzerland]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26863	2	4	33	0	34	To the lay reader (me) the significance of the mean snowline elevation is not clear. This is the second time the term has been used in the chapter so far and I don't know why it matters. Is this a 30 year average? Is it moving due to climate change? Could Ithe description of snow cover be conveyed accurately without the distinction below/above the mean snowline elevation? [Ko Barrett, United States of America]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
29621	2	4	33	4	36	This finding needs to be more clearly phrased--it is very hard to get a sense of what the finding is. [Michael MacCracken, United States of America]	Taken into account - The ES text and chapter text were revised for better clarity.
30827	2	4	33	4	37	Why did you give such a large range [10 - 40%] for the decline and continue by saying "...regardless of the Representative Concentration Pathway"? Would the range be smaller if you were more specific about the individual RCPs? This might be misunderstood as with repect to this change, it makes no difference if we use a high-reduction pathway or not. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The changes and the range are independent on the RCP for mid-century.
32905	2	4	33	4	37	Excessively long sentence construction leads to lack of clarity here. A suggested fix: "Below the mean snowline elevation, the mass and duration of mountain snow cover are projected to remain highly varible and decline by 25% [10-40%] between the recent past period (1986-2005) and the near future (2031-2050). This is projected to occur regardless of the ....". Also, it may be better to report the 25% trend, and qualify this with "although variability is projected to be high". [Government of United States of America, United States of America]	Taken into account - The text (ES and chapter) was revised for better clarity.
23635	2	4	34	4	34	What is the mean snowline - historical/climatological position, or the position that changes with warming? [Government of Sweden, Sweden]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
32907	2	4	34	4	34	Statement that "except at highest elevations where it is projected to increase" does not seem well supported in the literature. Such results are likely very geographically dependent. There is some literature on this whereby convective processes tend to enhance mountain precipitation (e.g., Giorgi et al., 2016). However, orographic processes may limit high elevation gains (e.g., Siler et al., 2014), particularly where changes in atmospheric dynamics weaken crossbarrier flow (e.g., Luce et al., 2013). [Government of United States of America, United States of America]	Taken into account - The ES and chapter text were revised for better clarity and better consistency with existing literature.
8821	2	4	36	0		Consider inserting "of" before "up" [Nina Hunter, South Africa]	Accepted - The ES and chapter text were extensively revised for clarity.
23637	2	4	36	4	37	Please explain the ranges. (Likely? Interquartile?) [Government of Sweden, Sweden]	Taken into account - As per IPCC formatting guidelines [] refer to likely range. For better clarity, the statements were expanded explicitly stating this is a likely range.
8823	2	4	37	4	39	Sentence difficult to understand - is it possible to rephrase to make more understandable? [Nina Hunter, South Africa]	Accepted - The ES and chapter text were extensively revised for clarity.
13811	2	4	37	4	42	Recommend that the report should note that the dearth of data of what is happening above the snow line is a major evidence gap and should be considered a research priority. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The knowledge gaps section of the chapter include this fact as a gap. This is however not elevated at the ES level, because of size constraints.
22879	2	4	37	4	39	steady or inreased snow amounts only possible for winter months. [Christoph Marty, Switzerland]	Taken into account - The ES and chapter text were revised for better clarity, including the assessment of winter snow civer future changes.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
23639	2	4	37	4	38	Suggest changing "steady" to "stable" or "unchanged", or suchlike. [Government of Sweden, Sweden]	Accepted - The ES and chapter text were extensively revised for clarity.
10197	2	4	41	4	44	What is the baseline of the projection? [SAI MING LEE, China]	Taken into account - it's the year 2015 as clearly stated
14941	2	4	41	4	44	Please provide a confidence assessment for this paragraph. [Government of Germany, Germany]	Taken into account - ES largely revised
16271	2	4	41	4	44	Please add confidence statement if possible. [Alexander Nauels, Germany]	Taken into account - ES largely revised
18455	2	4	41	4	42	What do these uncertainties (±7 % and ±10%) represent? Are they 1 or 2 sigma confidence interval? Are they an estimate of the regional variability? [APECS Group Review, Germany]	Taken into account - explained in main text
23905	2	4	41	4	41	Most sentences in bold in each paragraph of the Executive Summary includes a confidence level with the exception of certain cases (lines 43-44 in page 3 and 33-37 in page 4). It seems possible to add a confidence statement here. [Government of Japan, Japan]	Taken into account - ES largely revised
24349	2	4	41	4	44	Glaciers in High Mountain Asia are projected to loss 64% mass by EoC under RCP8.5. Would be good to also highlight this, phrased as "In regions with large ice cover, mass losses are also projected to be substantial, e.g. 64% +/- 5% in High Mountain Asia under RCP8.5. [Philippus Wester, Netherlands]	Taken into account - ES largely revised
25171	2	4	41	4	44	As these are model based results, surely likelihood language can be used here? [Simon Allen, Switzerland]	Taken into account - ES largely revised
29623	2	4	41	4	44	The mass loss figures are, I am assuming, an integrated measure of all glaciers in a region--the phrasing, however, could easily be misinterpreted to indicate that this applies to each glacier in a region, and this is simply not the case. Small glaciers will likely completely disappear while larger ones will lose a good share of their mass. It seems to me that a revision is needed to make clear than many of the glaciers there now will be gone (in the near future for many) and it will likely be only the ones now that are quite high or very large that will have any mass. The documentary "Chasing Ice" very clearly presented examples of how the relatively small glaciers can very rapidly disappear--the process seems very non-linear, such that once small, they can disappear very rapidly. [Michael MacCracken, United States of America]	Taken into account - ES largely revised
18515	2	4	42	4	44	This paragraph could include a statement about uncertainty in the projections for “regions with relatively little ice cover”. It only state “80%” where I would expect a range or statement of confidence in this number. [APECS Group Review, Germany]	Taken into account - added in main text
25625	2	4	42	4	42	The figures on projected mass reductions here seem to be raken from a single publication (Hock et al. Submitted). should this be indicated with a “medium agreement” indication? [Floortje van den Heuvel, Switzerland]	Taken into account - made clearer that this paper is comparing the data of 6 different modeling studies, these are all cited now
14943	2	4	43	4	43	Please insert: …in regions dominated by smaller glaciers and with relatively….. (consistent with p:16; l: 26) [Government of Germany, Germany]	Accepted
18457	2	4	43	4	44	Can you give a likelihood/confidence for this projection? [APECS Group Review, Germany]	Taken into account - ES largely revised
24909	2	4	44	4	44	for the 80% glacier loss given the corresponding RCP should be given (as in the SPM B1.2: "under RCP8.5") [Dirk Hoffmann, Germany]	Accepted
32425	2	4	44	4	44	I would add that 'a significant fraction is projected to disappear' [ROBERTO RANZI, Italy]	Taken into account - not added in ES due to space constraints but added to the main text
1549	2	4	46	4	48	Is the high confidence justified in the absence of quantitative projections? [Matthew Collins, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account – yes, quantitative studies exists but are difficult to summarise, as explained in text now

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2663	2	4	46	4	48	How much will the ALT active layer thickness increase due to rising air temperature? [Thian Yew Gan, Canada]	Taken into account – this cannot be quantified easily due to high heterogeneity
13093	2	4	46	0	48	What kind of degradation? Mention should be made of reinforcing feedback loop of CH4 [David Crookall, France]	Taken into account – degradation is explained in Glossary
14945	2	4	46	4	46	Please insert: ...century, high mountain permafrost is....(to specify the type of permafrost) [Government of Germany, Germany]	Taken into account – this is the high-mountain chapter and we conserve space
24911	2	4	46	4	48	I would suggest to include a short reference here to the contribution permafrost degradation is making to global warming, e.g. saying "further encanhing global warming throught the release of methane" [Dirk Hoffmann, Germany]	Taken into account – This effect is not as prominent for mountains as for polar lowlands. It is mentioned in this chapter but not so prominently.
29625	2	4	46	4	48	It seems to me that a more nuanced conclusion is needed. There are quite a number of simulations that indicate a large change in the area where the top level of permafrost will be melting each summer and perhaps even not be fully frozen well into the winter period, so one loses year-round frozen soils at the surface (with consequent impacts) even while there remains permanently frozen ground (permafrost) below the surface such that one would not say that the permafrost is permanently gone. Somehow, the phrasing here seems to underplay how much change will be going on in the surface layer in order to be accurate in saying that the full depth of permafrost has not been lost. In that there can be different impacts from different depths of thawing of the permafrost, I'd suggest preparing a more nuanced explanation of what is to be expected in phrasing the overall finding about permafrost. [Michael MacCracken, United States of America]	Taken into account – Yes, however these models are too coarse to represent mountauin environments well, assuming horizontal cells of tens or hundrets of km instead.
30829	2	4	46	4	46	Please specify: mountain permafrost [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account – this is the high-mountain chapter and we conserve space
23641	2	4	47	4	48	The second sentence ("Quantitative...") may not be needed as it may appear difficult to reconcile with the first sentence. Rather, the reference to the relevant section enables finding why numbers are nor provided.. [Government of Sweden, Sweden]	Taken into account – statement shortened
30869	2	4	47	0	48	Adding one prominent example would be an option. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account – examples are in main text but were kept from the ES to keep it brief.
8825	2	4	48	0		"of" should be "in" [Nina Hunter, South Africa]	Accepted - the text has been revised
2665	2	4	50	4	51	I expect risk of flooding due to snowmelt & glacier melt could increase to a certain stage, and then there will be decline as glaciers diminish in mass? [Thian Yew Gan, Canada]	Accepted - deleted the word risk here. the sentence is revised to more focus on physical change (runoff) and related impact. Observed and projected change is separately discussed.
14947	2	4	50	4	51	The statement that freshwater related risk are likely to increase only by the end of the century in particularly vulnerable regions seems very cautious, and partly in contradiction with statements that impacts on water resources have already been observed (p 3 ln 35-41) and material in the underlying report (e.g. Figure 2.7) showing drastic change (peak water) occurring already in the first half of the century in some regions, and adaptation already under way (e.g. Box 2.3). Please consider to revise this statement in order to better reflect the temporal variation and early onset of freshwater related risk in e.g. semi-arid low latitude regions or Central Asia. [Government of Germany, Germany]	Accepted - rephrased sentence substantially

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24213	2	4	50	4	51	I think the statement that freshwater related risks increase by the end of the 21st century is not supported by the evidence and contrasts somewhat with Fig. 2.7 where I would say this would at least be around mid-21st century or likely earlier in some regions. Please consider that risks are not only a fucntion of water supply/runoff but also of exposure and vulnerability aspects, in particular changes in water demand (which will very likely increase in many regions). [Christian Huggel, Switzerland]	Accepted - rephrased sentence substantially
29627	2	4	50	4	50	The phrase "freshwater related risks" needs to be elaborated in that it neither gives a sense of the risks nor indicates whether risks will increase or decrease, etc. It just seems to me this phrase makes it too hard for the reader to figure out what important changes are occurring and what their significance is. And "risk" does not convey that changes are actually happening--what is happening is that the frequency of occurrence is changing, or likelihood of occurrence is changing--just changing the risk does not really clearly mean that any changes have actually happened. [Michael MacCracken, United States of America]	Accepted - the sentence has rephrased substantially
30871	2	4	50	0		Can this be quantified in relation to time and water needs? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - relation to time and water needs is not quantified in references. It is raised in knowledge gap.
13813	2	4	53	5	7	It would be good to give more evidence on downstream impacts and differentiate these (e.g. maybe significant on smaller rivers, but relatively limited for large rivers [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - differene in impact due to basin characteristics are discussed in main text. Unfortunately, due to page limitation, it is not included in Executive Summary.
15239	2	5	0	0		The head-line (bold) statement of this paragraph is not consistent with the main text, which speaks of limits to adaptation. One way to make this more consistent is to cut the two sentences following the bold statement and migrate them to the following paragraph (starting line 44). Please note comment on bold statement in paragraph 44 though. [Government of Gambia, Gambia]	Accepted - the sentence has rephrased substantially to keep consistency with main text
15241	2	5	0	0		The wording "cryospheric change along with climate change" is confusing. Is it cryospheric change due to climate change, or do both changes happen to occur alongside each other? [Government of Gambia, Gambia]	Accepted - delete the word cryospheric and rephrase the sentence
15243	2	5	0	0		The head-line (bold) statement of this paragraph is not consistent with the main text. While the bold statement relates to adaptation limits, the remaining text speaks of different other topics. Substance on adaptation limits, as identified throughout the chapter and other paragraphs of the ES (see page 5, lines 35-27) should be summarized under the heading of adaptation limits, while other elements of the text should be migrated to relevant sections. [Government of Gambia, Gambia]	Accepted - the sentence has rephrased substantially to keep consistency with main text
30873	2	5	1	0	3	Okay, a semi-quantitative estimate or order of magnitude would also help to understand whether the projected mean global change is by e.g. 5 or 95 %. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - we added quantitative assessment in main text as possible. As the effect of cryosphere on runoff varies in basins, it is difficult to quantify in Executive Summary, but we describe this as a knowledge gap.
18459	2	5	3	5	5	It could maybe be useful to state here that one of the main source of uncertainty here is the capacity of GCM models to predict regional changes in precipitation. [APECS Group Review, Germany]	Taken into account - Executive Summary has revised substantially and this paragraph is deleted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1523	2	5	4	5	4	Potential grammar issue: "uncertainty in decision making and whether to take adaptation...." [Kimberley Miner, United States of America]	Taken into account - Executive Summary has revised substantially and this paragraph is deleted. Challenges to model in high mountain is mentioned in main text.
5633	2	5	4	0		"taking adaptation measures" - suggest replacing with "necessitating adaptation measures" [Nina Hunter, South Africa]	Accepted - the text has been revised
12743	2	5	7	0		Put propositions in same order (as above) - be consistent [David Crookall, France]	Accepted - text revised
22659	2	5	7	5	7	I personally do not think there is sufficient data available to data to make this conclusion with high confidence, in particyular on a global scale. I suggest to use "medium confidence" maybe add (high agreement). [Lukas Arenson, Canada]	Accepted - statement specified
30835	2	5	7	5	20	The fact that these risks have been described in the previous section of the Executive Sumary raises again the question if information about the current status and projections with respect to certain changes (slope stability, glacier lakes) should be kept together and the Executive Summary be restructured accordingly. [Hans-Otto Poertner and WGII TSU, Germany]	Rejected - entire ES structered Observations, Projections, Response.
30833	2	5	8	5	9	Can the risks brought about by an increase in the number and area of glacier lakes already be mentioned in this sentence? [Hans-Otto Poertner and WGII TSU, Germany]	Noted - added under observations that there is no clear increase in lake outbursts
30875	2	5	10	0	11	This would benefit from being specified (what kind of disaster?) and quantified to the extent possible. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
8827	2	5	12	0		What are 'lahars'? Not in glossary. Perhaps insert brief definition in parentheses? [Nina Hunter, South Africa]	Taken into account - Definition of lahar is added
11643	2	5	12	5	12	Please, include definition of lahar. [Government of Mexico, Mexico]	Taken into account - Definition of lahar is added
32909	2	5	12	5	12	Consider defining "lahars (mixtures of meltwater and volcanic debris)". [Government of United States of America, United States of America]	Taken into account - Definition of lahar is added
4987	2	5	16	5	17	Is it possible to quantify these? [Debra Roberts and Durban Team, South Africa]	Noted - too few quantitative studies
23643	2	5	16	5	17	Is the idea here that the exposure will increase, or remain as present? Please clarify. [Government of Sweden, Sweden]	Accepted - text revised
30631	2	5	16	5	17	No mention yet re. how people & infrastructure are already exposed [Hans-Otto Poertner and WGII TSU, Germany]	Noted - revised in Section A
30877	2	5	16	0	19	Can the fraction of infrastructure or poulation exposed to such risk (high mountain natural hazards, high mountain floods, landslides and avalanches) be quantified? [Hans-Otto Poertner and WGII TSU, Germany]	Noted - no sufficient studies. Existing studies mix cryospheric and non-cryospheric drivers
10425	2	5	17	5	17	will continue further' taking into consideration that changes in floods, landslides, permafrost, etc will increaes significantlly at the end of the 21st century, therefore, influence on human will increase significantly as well. Please consider changes in words. [Elzbieta Czyzowska-Wisniewski, United States of America]	Accepted - text revised
25173	2	5	17	5	17	What is meant with "will continue further"? Of course there will also be exposure. I guess you mean that the increasing trend will continue in the future (as written in the chapter text). [Simon Allen, Switzerland]	Accepted - text revised
23645	2	5	19	5	20	Should be clarified that it is about existing strategies are insufficient, and there are possible other/future measures. [Government of Sweden, Sweden]	Accepted - text revised
25175	2	5	20	5	20	The line of cite provided here seems wrong. I guess all need careful checking. [Simon Allen, Switzerland]	Accepted - text revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1953	2	5	22	5	23	change to bold letters [Harald Pauli, Austria]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
2377	2	5	22	5	23	After reading the whole chapter, I did not find evidence for effects on human health as mentioned here: "There is high confidence that the structure and functioning of terrestrial and freshwater mountain ecosystems will change thereby affecting human health" This is a strong statement and should be revised [Ruben Sommaruga, Austria]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
5295	2	5	22	5	31	Highlight the main message [Simone Schauwecker, Chile]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
5341	2	5	22	5	31	Is there no bold/highlighted sentence in this paragraph? [Alvaro Ayala, Chile]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
14949	2	5	22	5	31	Please add a headline statement to this paragraph [Government of Germany, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
17431	2	5	22	5	31	The same comment: Changes in the spatial biology of the species related with climatic factors include the emergence and spreading of vector-borne diseases, a problem that continue to contribute significantly to the global burden of disease, and cause epidemics that disrupt health security and cause wider socioeconomic impacts around the world. All are sensitive in different ways to weather and climate conditions, so that the ongoing trends of increasing temperature and more variable weather threaten to undermine recent global progress against these diseases. Every single species has a natural load of parasites and viruses, potentially harmful to humans under certain ecological conditions. My suggestion is to include this aspect, in order to help in the generation of better health surveillance programs and early warning plattforms. Support in the scientific literature is extense, if considered more information in: Campbell-Lendrum D, Manga L, Bagayoko M, Sommerfeld J. 2015 Climate change and vector-borne diseases: what are the implications for public health research and policy? Phil. Trans. R. Soc. B 370: 20130552. http://dx.doi.org/10.1098/rstb.2013.0552 [Hugo Mantilla-Meluk, Colombia]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30633	2	5	22	5	23	Headline statement should be bold [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
1955	2	5	23	5	24	suggest ot change to : "Key future shifts may include further upslope migration of lower-elevation species, habitat loss of high-elevation species and changes in..." [Harald Pauli, Austria]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
9173	2	5	23	5	23	kg m-2 yr-1 [Luzi Bernhard, Switzerland]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
23647	2	5	23	5	23	It should be included that the systems' change is already important by itself. Perhaps "...thereby also affecting..." [Government of Sweden, Sweden]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
24517	2	5	23	5	27	Comment on a section within a chapter. The sentence between lines 23 and 27 is relevant, so it could be better to highlight (in bold) this sentence like the other relevant sentences. [Francisco Barraza, Chile]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30635	2	5	25	0		Could you list these “characteristic traits” briefly (e.g., body size??) - to make it clear why these matter and should be in the ES [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30637	2	5	26	0		It is good that fire is included in the ES but it should be listed under the hazards as well [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30879	2	5	26	0	27	Can the degree of such change and habitat loss be quantified or order of magnitude be given for any of these phenomena? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
8829	2	5	28	0		What are 'refugia'? Not in glossary. Perhaps insert brief definition in parentheses? [Nina Hunter, South Africa]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
23649	2	5	30	5	31	Suggest rearranging the sentence, to read: "Wide-ranging effects on large animals are projected to lead to population declines, changes in behaviour, and smaller ranges where the species occur." [Government of Sweden, Sweden]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
30639	2	5	30	5	31	Not clear why a change in behaviour is relevant. Do the predicted changes in animal behaviour impact their survival probability? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES text was considerably revised for clarity and consistency with the results of the assessment.
2667	2	5	33	5	35	There will be an earlier onset of spring snowmelt in temperature climatic regimes. But for mountains located in or near the Tropics, the impact will be more of rainfall than snowfall, and the rise of snowline? [Thian Yew Gan, Canada]	Accepted - different impact on basin characteristics (size, other sources of impacts) are clarified
26865	2	5	33	0	42	There is much in this paragraph that is duplicative of the paragraph on pg 4. starting line 10. Please combine info in one place and refine. Further, the information about local adaptation measures reaching their limits around 2C is not found in the referenced sections. Well, there is not even a 2.3.4.1 or a 2.3.5.1 as far as I can tell. [Ko Barrett, United States of America]	Taken into account - The ES was considerably revised for better clarity.
32555	2	5	33	5	35	Change text to "In mountain regions, future cryosphere changes are projected to pose challenges to livelihoods and other economic activities in mountain regions, including agriculture, hydropower and tourism, especially under high-end climate scenarios (high confidence)". [John Diiwu, Canada]	Taken into account - The ES was considerably revised for better clarity.
23651	2	5	34	5	35	Does "especially under high-end climate scenarios" imply that mid/low end scenarios do not pose challenges? (That high-end ones increase impacts is trivial.) Please revise as appropriate. [Government of Sweden, Sweden]	Taken into account - The ES was considerably revised for better clarity.
30641	2	5	34	5	35	"high-end"? perhaps rather "high emission"? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The ES was considerably revised for better clarity.
15449	2	5	35	5	38	(Also relevant for the underlying sections of the chapter): the concept of adaptive capacity and limits to adaptation is dynamic, as also indicate by the use "existing" in the paragraph. However, the current phrasing seems to indicate fixed limits. Suggest adding a reference to the need to continue improving adpative capacity and implement transformational adaptation actions in order to complement existing adaptation measures to better address climate change impacts. [EUCE, Belgium]	Taken into account - The ES was revised for better clarify, although space constraints do not make it possible to provide information with very high information detail.
23057	2	5	36	5	36	Please provide more regional detail about adaptation limits around 2°C, is it the case everywhere? Confidence? [Valerie Masson-Delmotte, France]	Accepted - The sentence was revised and more regional information is now provided.
30881	2	5	36	0	37	This is the kind of information that for key findings would be beneficial to lift into the SPM. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Considerable revisions of the ES and SPM were carried out in prepartion for SROCC chapters FGD and SPM SOD.
17739	2	5	37	5	38	This sentence reads as if mountain societies have inherently low adaptive capacity. This is a problematic framing that might be read as environmental determinism. I think it would be more appropriate for the sentence to read: Moreover, vulnerabilities of mountain societies are projected to increase because of socio-economic conditions that limit adaptive capacity in many mountain regions. [Graham McDowell, Canada]	Taken into account - The ES text was revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12701	2	5	38	5	42	The sectors affected relate to all land management activities, including particularly agriculture and forestry, and it might be appropriate to mention these general implications here. In particular this seems advisable as socio-ecological systems are shaped by all different, place-based activities and influenced by spatial interrelations with other (also non-mountain) areas. [Thomas Dax, Austria]	Taken into account - The ES text was revised at depth, and multi-sectoral issues are addressed explicitly in the ES (including in section C of the revised ES)
17741	2	5	38	5	42	The last sentence reads as if changes may be driven by climate-related changes OR (possibly) socio-economic changes. In reality, it is most likely that the nexus of these processes of change will shape impacts and adaptation in sectors such as agriculture and tourism. Removing the 'however' after the semicolon would help to avoid the sharp distinction in drivers of change. [Graham McDowell, Canada]	Taken into account - The ES text was revised at depth, and multi-sectoral issues are addressed explicitly in the ES (including in section C of the revised ES)
30837	2	5	38	5	42	Can be said more clearly if these "changes" are positive or negative? What kind of "changes" do you refer to? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The ES was considerably revised for better clarity.
30885	2	5	38	0		limits to adaptation capacity reached at the same temperature? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The sentence was revised and regional information is now provided.
14951	2	5	44	5	45	the terminology "under the influence of cryospheric change along with climate change" is confusing, as cryospheric change can be considered a part of climate change, and at the same time "climate change" here is not clearly specified: do you mean warming? or "cryospheric change and other effects of climate change"? Please clarify. [Government of Germany, Germany]	Accepted - text revised
15451	2	5	44	5	45	Similar to above (and also referred to the underlying chapters). Include reference to the concept of acceptable risk - as limits of socio-economic sectors are not "hard limits". [EUCE, Belgium]	Taken into account - text revised, ES has substantialy changed. Limitis to adaptation is a concept addressed in various parts of the chapter, illustrated better with examples in various sectors and contexts.
16273	2	5	44	5	44	“limits to adaptation capacity” should be “limits to adaptation and/or adaptive capacity” [Alexander Nauels, Germany]	Accepted - text revised.
17743	2	5	44	5	45	Suggest deleting "along with climate change" from end of first sentence. [Graham McDowell, Canada]	Taken into account - text revised along with other similar comments
17745	2	5	44	5	51	It would be great to see some mention of underlying socio-economic determinants of limited adaptability here. For example, the last sentence could be revised to read: "Recognition and integration of indigenous and local knowledge as well as efforts to address underlying socio-economic determinants of vulnerability can enhance resilience and adaptability to changing cryospheric conditions." [Graham McDowell, Canada]	Taken into account - text revised along with other similar comments
30839	2	5	44	5	50	Readers of the Executive Summary might find it more useful if adaptation options or successful approaches could be described briefly here. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text revised along with other similar comments, ES has substantially chnaged since the SOD to account for this request.
30883	2	5	44	0		The nature of such adaptation measures remains obscure and their limits as well. Can these be developed further into more illustrative statements? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text revised along with other similar comments. Limits to adaptation also raised in context in the chpater text, using references to cases and examples to clarify.

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10909	2	5	45	5	46	Integrated approaches = cross- or multi-sectoral. Governance, however, generally involve multiple stakeholders, often coming with different perspectives/backgrounds/visions. I would therefore recommend adding "inclusive of multiple stakeholder types" - or similar. Suggested edit: "Integrated (cross-sectoral) governance approaches that duly consider and incorporate multiple stakeholder groups' perspectives, including indigenous voices, hold potential in promoting..." [Marc Foggin, Kyrgyzstan]	Accepted – text revised as suggested, although this may potentially change in final version of the report (still to be completed).
13095	2	5	47	0		Evidance cannot be low; it can be patchy or sparse. [David Crookall, France]	Rejected - Here we use the calibrated assessment language as per the IPCC guidanc note to authors
13097	2	5	49	0		How can needs and options be"challenged"?! How about writing more simply: eg, Meeting needs is becoming more difficult !! [David Crookall, France]	Accepted - text revised, however text may undergo further revisions and changes once SOD reviews are concluded
13099	2	5	49	0		not "induced"! Why not keep it simple and say "caused" ? [David Crookall, France]	Accepted - text revised, however text may undergo further revisions and changes once SOD reviews are concluded
967	2	5	50	5	55	Section is way too short [Falk Huettmann, United States of America]	Taken into account - text revised and Executive Sunmmary has sinece been updated
13101	2	5	50	0		What does "Recognition for ... indigenous knowledge" mean? [David Crookall, France]	Taken into account - There is a specific cross-chapter box on Indigenous Knowledge and Local Knowledge.
13103	2	5	50	0		Difference between indigenous & local ?? [David Crookall, France]	Taken into account - There is a specific cross-chapter box on Indigenous Knowledge and Local Knowledge.
13105	2	5	50	0	51	"promote resilience" gives the impression that things will be ok -- not at all the case !! [David Crookall, France]	Taken into account - text revised to add 'where there is potential to address these within limits of adaptation'. Term 'resilience' used here with intended meaning as per IPCC SROCC Glossary, in promoting strategies to 'cope with a hazardous event or trend or disturbance'.
23059	2	5	50	5	50	The last sentences read like prescription more than assessment. Confidence? [Valerie Masson-Delmotte, France]	Taken into account - text revised.
1957	2	5	53	6	7	Knowledge gaps differ; e.g. smaller for glaciers than for other components. It appears to be important and helpful to actually mention where particularly large gaps occur, notably, e.g., on past and projected permafrost and on ecosystem patterns. If the areas where largest gaps exist and not mentioned directly, the risk that things continue to remain so is high - and thus a comprehensive risk assessment would remain incomplete. [Harald Pauli, Austria]	Taken into account - given the restricted space in the ES, this elaboration and differentiation will be done in more detail in Section 2.4, and summarised accordingly in the ES.
2669	2	5	53	5	53	One of the biggest challenge is the lack of ground observed data in high mountains. Snow cover distribution depends on terrain features, and also on the effects of snow re-distribution by winds. We generally expect depressions or valleys to be filled with thick snowpack, in contrast to fairly barren mountain slopes. [Thian Yew Gan, Canada]	Noted
17433	2	5	53	6	7	It is important not only to establish an up - down relationship among the different physical processess associated with changes in the cryosphere. Many changes, that are related with the ammount of water that is carried out through advection into the upper portion of the elevational gradient depends on the type of vegetation cover. In particular, among South American mountain ranges, cloud forests and paramos determine the amount of capture and its redistribution, through evaporation and advection (wind speed). [Hugo Mantilla-Meluk, Colombia]	Noted - although the scope in this chpater assesses specific changes associated with cryospheric change

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22633	2	5	53	5	53	One of the major gaps is the unknwon in the extent of permafrost, its change with time, and even more importantly the extent of groudn ice in the permafrost. As indicated in the comment above re: Figure SMP1, the permafrost cannot be quantified gobally. This also results in major uncertainty regarding the change in hydrology in respoinse to permafrost degradation. [Lukas Arenson, Canada]	Noted
24215	2	5	53	6	7	Please consider that knowledge gaps and challenges should not make the statements of the chapter less robust, or vulnerable to (policy) critique. [Christian Huggel, Switzerland]	Noted
25177	2	5	53	6	8	For me knowledge gaps should not be highlighted in an executive summary. This was the approach of WG1 during AR5, to avoid any impression of conflicting interests, i.e., authors potentially using IPCC as an opportunity to argue for/ encourgage funding in their fields of research. This is ultimately a decision for the Co-chairs, and should be consistent across all chapters. [Simon Allen, Switzerland]	Noted - We have addressed knowledge gaps primarely in the body of the chpater text.
30841	2	5	53	6	7	This last paragraph adds rather negative flavour to the Executive Summary and might determine how the complete chapter is read. I would suggest to add this paragraph to the previous section of the Executive Summary and point more specifically to questions that could be answered as more scientific knowledge becomes available. How would readers of this Executive Summary benefit from supporting science? What does society need to know to address challenges brought about by changes in the mountain cryosphere? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
1115	2	5	55	6	7	These sentences are particularly wordy. Simplification would be welcome. [Daniel Farinotti, Switzerland]	Noted
14953	2	5	55	6	7	While we understand the intention to highlight data scarcity in high elevation and remote mountain regions, we'd strongly encourage the authors to revise the formulation of the knowledge gap paragraph presented here. in its current form, if read in isolation, it could jeopardize the whole chapter as it gives the impression that there are not enough data to make general statements apart from those referring to high elevation glaciers - while the ES presents a whole range of clear and strong statements from other areas of mountain research, that are well backed by evidence throughout the chapter. Please revise in order to avoid this (seeming) contradiction. [Government of Germany, Germany]	Accepted - text revised to substantially address the message/intention to have key gaps presented in a way that does not contradict statements based on robust evidence.
23061	2	5	55	5	55	Key finding about limits of monitoring networks and implications could be lifted to SPM if well crafted. Gaps in the use of local knowledge? Any deep uncertainty aspect? [Valerie Masson-Delmotte, France]	Taken into consideration - text has been revised.
23653	2	5	55	5	57	This sentence can be deleted, as the same is said (better) in the following sentence. [Government of Sweden, Sweden]	Accepted - text revised accordingly, however final version of the text may change once entire SOD review is completed and all other comments addressed.
13107	2	5	56	0	57	difficult to understand what is to "account for" --- why globally? Some places clear, some less so -- giving a sort of average hides the fact that in some places the evidence is clear -- provide detail -- and show the variation globally in what is known -- otherwise, you give the impression that things are better than they are -- specifiy the exceptions [David Crookall, France]	Taken into account - text has been revised
2671	2	6	1	6	3	This is expected and unfortunate, unless countries will invest in monitoring high mountain environment, but we expect a major challenge in terms of cost, lack of manpower, and accessibility problems in a mountain environment. [Thian Yew Gan, Canada]	Noted

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12749	2	6	2	0		you may find paucity in the classic academic publications, but there is no paucity if you look, at some of the citizen science, often reported in web sites and blogs -- this should also be reported -- check out highly valid research, eg, by Créa Mont Blanc, among other initiatives. [David Crookall, France]	Rejected - evidence presented in blogs not suffieintly reported/reflected or supported by the peer-reviewed published literature for assessment purposes.
30887	2	6	2	0	7	While such deficiency in quantitative knowledge exists it would be great if results from regional case studies would exemplify and illustrate the magnitude of such changes and the associated risks. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text revised, and improved figures (e.g. Impacts Figure 2.10) improved to convey these changes and extent of the impacts as evidenced in the papers assessed.
8831	2	6	3	0		"impact" not "impacts" [Nina Hunter, South Africa]	Accepted
12703	2	6	3	6	7	The indication of limited evidence of a comprehensive risk assessment approach (in the last sentence of the executive summary) might divert atttention from the increasing risks and imminent changes and substantial consequences on socio-ecological systems in high mountain regions due to climate changes in the cryosphere. [Thomas Dax, Austria]	Accepted - text revised accordingly.
17747	2	6	3	6	7	Suggest revising last sentence for conceptual clarity and brevity as follows: "Regarding human systems, there is limited evidence of comprehensive efforts to systematically characterise and compare impacts and adaptation across high mountain regions, particularly studies that consider underlying drivers of vulnerability, compounded risks, and cascading impacts." [Graham McDowell, Canada]	Accepted - text revised accordingly. However, additional changes as a result of extensive revisions to the ES may stil be required.
32911	2	6	3	6	7	What does "limited evidence of a comprehensive risk assessment approach" mean? Presumably, risk assessments have been done and are available or they have not been done/were done but are not available. Is this trying to imply that risk assessments have been completed for a limited number of areas? Typically language around evidence strength is used for findings, not to point out gaps in assessment. [Government of United States of America, United States of America]	Taken into account - text revised
13109	2	6	5	0	5	"evidence of a comprehensive risk assessment approach" -- I thought that you were looking at evidence of CC effects, not of approaches -- and what do you mean by a "risk assessment approach"? [David Crookall, France]	Taken inot account - text revised
13817	2	6	10	6	22	Two of the pieces of evidence for the threat to human wellbeing include: decreases in nutrient cycling in deep seafloor ecosystems (high confidence) and reduced carbon sequestration and loss of carbon stocks in saltmarshes. These do not seem to relate directly to the other ' human wellbeing' factors and - due to their high importance for climate regulation - should perhaps be discussed separately to avoid diluting this message. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - comment may refer to a another chapter/section, not applicable to this Chapter 2.
969	2	7	0	0		Figure 2 2 lacks Antarctica but must be there [Falk Huettmann, United States of America]	Accepted - The coastline of Antarctica was added to the map.
10887	2	7	0	0		2.1 The drivers and impacts figure is at least simple enough but would in my opinion need professional 'overhaul' / redraw (just imagine the impact IPCC has in redistribution. E.g.. the two 'icons' within the graphic are obsolete, alternatively it could be fully 'iconized' [otto otto simonett, Switzerland]	Taken into account - This figure has been deleted in FGD.
23065	2	7	0	7		The fact that this is the first IPCC chapter on high mountain regions could be emphasized [Valerie Masson-Delmotte, France]	Taken into account - the figure has been deleted.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24419	2	7	0	7		Figure 2.1 need to be revised. Even if the energy flux mainly is top-down in the diagram, there are important feedback loops between the layers in the triangle. [veijo pohjola, Sweden]	Accepted - The figure has been deleted
27995	2	7	0	0		I would eliminate "intrinsic" from the box on tourism and recreation, changing this to "spiritual values and wellbeing" (reason given below in Comment #4) [Marcos Mendoza, United States of America]	Taken into account - the figure has been deleted.
1959	2	7	3	7	5	An important and obvious globally common feature of high mountain regions is "low-temperature regime". Therefore suggest to change: "High mountain regions share common features, including rugged terrain, low-temperature climate regime, institutional and spatial remoteness that..." [Harald Pauli, Austria]	Taken into account - text revised
2673	2	7	3	7	9	Assuming the earth is subjected to an external forcing of 1 Wm-2 due to the rising concentration of greenhouse gases. Using the blackbody equation, R = ϵσT4, where σ = 5.67 x 10-8 Wm-2oK-4, and assuming ϵ = 1, we can compute the outgoing longwave radiation at the high elevation with an average temperature of, say, -20oC and at the sea level with an average temperature of, say, 30oC. Then use the blackbody equation to estimate the temperature at the high elevation and at sea level, in response to the external forcing of 1 Wm-2. Based on the computed temperature, the increase in temperature (warming) ΔThigh elevation in oC at the high elevation will be about 0.27oC, and the increase in temperature ΔTsea level in oC at sea level will be only about 0.16oC, which demonstrates the difference in temperature feedback to external forcing between the high elevation and sea level, which partly explains why mountains are expected to experience larger changes than at sea level. The idea is similar to Arctic amplification that has been observed in recent years. [Thian Yew Gan, Canada]	Taken into account - elevation dependent warming considered later in the chapter.
3129	2	7	3	7	5	A precise definition of high mountain areas is lacking in the introduction of the chapter (maybe the one provided in the caption of figure 2.2?). [Fanny Brun, France]	Taken into account - definition is in caption of figure 2.2
17435	2	7	3	7	9	Same comment, as part of the introduction the down - up must be speciefied. [Hugo Mantilla-Meluk, Colombia]	Taken into account - the text has been revised and figure has been deleted
12753	2	7	4	0		You canNOT use "that" and "which" interchangeably -- make sure that you use them correctly -- otherwise you could be saying the opposite of what you want to say --- and do not count on copyeditors, even professional ones, to be able to correct this for you -- it depends on what you want to say, and sometimes cannot be inferred, by non-authors or non-specialists, from the text [David Crookall, France]	Accepted - text has been revised
1961	2	7	5	7	5	"elevation" is a very relative term for defining high mountains, where lower limits globally differ from a few 100 m to over 4000 m abive sea level. Change, e.g., to "Due to their higher elevations,..." (compared to surrounding landscapes) [Harald Pauli, Austria]	Taken into account - text revised
13819	2	7	5	7	7	This statement needs more nuance as many mountains, whilst holding some snow (e.g. Scottish Highlands) would not really be said to be in the cryosphere. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text has been revised
2361	2	7	6	7	7	Will delete here "seasonal" as it can be permanent too [Ruben Sommaruga, Austria]	Accepted - text has been revised
5297	2	7	7	7	7	Remove this reference or add other references [Simone Schauwecker, Chile]	Accepted - reference has been changed
11197	2	7	7	7	8	Beniston et al., 2018 should be preferred or at least added to Beniston, 2003 [Antoine Rabatel, France]	Accepted - reference has been changed

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13113	2	7	7	0	18	What part of mountains do you include in the report?? Only the parts that are frozen? That is somewhat shortsighted! as glaciers and frozen ground disappear (as they have done) faster than other phenomena. Does that suddenly exclude the regions from being high mountain areas? The report is for now, but under your definition, regions included in the report will soon exit the report, unless ALL mountain regions are included. When does mountain cryosohere become invalid for consideration in your report? Presumably when they have no more ice?? But they achieved that status of being ice free because of climate change. So, your report looks at CC, but stops when the CC damage is done?? [David Crookall, France]	Rejected - report is focused on present cryopshere and changes in the recent past, present and near future
28015	2	7	7	0		"critical role": It is not clear here what the role is and why it is critical. Please better introduce or explain it. [Frank Paul, Switzerland]	Accepted - text has been revised
13111	2	7	8	0	9	this seems to be a dangling modifier -- that too can change the meaning completely -- copy editors find these even more difficult, so make sure that YOU get them correct [David Crookall, France]	Taken into account - text revised
13115	2	7	8	0		2.2 -- is Greenland in another part of the report? If so, then say this. You cannot expect readers to remember every single detail, or even that they read linearly, from start to finish. Almosy nobody reads like that! Map is too busy! Consider doing several maps, eg, the americas, europe/russia/himalayas, asia. Small graphs need to be a lot bigger. Basically, you cannot do justice to your detailed report in a small map. [David Crookall, France]	Taken into account - reference to polar regions/chapter 3 is in following paragraph
13821	2	7	8	7	9	it would be useful to comment on the accuracy of remotely-sensed assessment of both areal and depth and the degree of ground-truthing that is required. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - this comment may be misplaced.
10911	2	7	11	7	12	The chapter focuses mainly on recent/projected changes, along with drivers of change, and also the impacts of these changes on different services. However, there would be place to also include - more systematically - some examples and the evidence available about the effectiveness of the different "response options" available for mitigating or halting the negative changes (and/or adapting to these changes). In short, can more be included in this chapter about potential responses to changing environment, not only (or primarily) on evidence of the changes themselves? Greater balance in this would be helpful. Responses can include technical interventions, but beyond this, also matters of governance and resilience, etc. [Marc Foggin, Kyrgyzstan]	Taken into account - governance and resilience are covered elsewhere in the chapter. Technical innovations are generally outside of the scope of this report
18517	2	7	12	7	12	“different services provided by the cryosphere” - I understand the human perspective here, but think the term “services” is oddly placed. Would suggest “features”, “function”, “aspects” [APECS Group Review, Germany]	Taken into acount - section largely rewritten

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1963	2	7	13	7	15	This is a very important paragraph for the entire chapter, where clear definitions of the area considered will be crucial for the comprehensibility of this report. I think, you can state that you included "all mountain regions where glaciers or permafrost are prominent features of the landscape", which would be consistent with the areas covered in Figure 2.2. For "snow", however, this is not suitable. The ocurrence of snow is not an easygoing component for the delimitation of the area. A delimitation of the area considered, nevertheless would much strengthen the meaningfulness of the chapter. It could be done by considering all sufficiently rugged pixels within the focal rectangles shown in Fig. 2.2. This would include non-alpine areas below the timberline (which are not high mountain areas in the strict sense), which would be suitable because these lower areas may be (or are) also affected by changing cryosphere components. Snow, of course, should not be neglected, but should not be used for defining the focus area nor as reasoning for refraining from a strict and quantitative demarcation. [Harald Pauli, Austria]	Taken into acount - how definition is deliberately vague given the focus of this report on cryosphere. A clear delineation is not desirable here.
9175	2	7	13	7	16	delete the first word 'here' of the sentence [Luzi Bernhard, Switzerland]	Accepted - text revised
22113	2	7	13	7	13	Since the IPCC AR5, a number of peer-reviewed cryospheric synthesis studies have been recently published for large mountain regions (e.g. High Mountain Asia, Bolch et al. 2018; European Alps, Beniston et al., 2017; Andes, Vuille et al. 2018) and these should be referenced here. [Joseph Shea, Canada]	Accepted - these articles are referred to.
2363	2	7	14	7	15	The definition of what a "High" mountain means is not straightforward and the one used here is different from other, e.g. Sayre et al. (2018) http://www.bioone.org/doi/full/10.1659/MRD-JOURNAL-D-17-00107.1 BioOne, so it would be good to acknlwledge that there are other definitions but for practical reasons this is here applied. [Ruben Sommaruga, Austria]	Taken into account - However, consistent with other similar comments and suggestions, 'High mountain areas' as discussed in Chapter 2 include all mountain regions where glaciers, snow or permafrost are prominent features of the landscape, without a strict and quantitative demarcation - this is also consistent with the scope given as part of the approved outline for SROCC.
1965	2	7	15	7	15	The 'distinct regions' in Fig. 2.2 virtually include all non-polar mountain regions where glaciers or permafrost occurs. I think, this must be stated - otherwise one could have the impression that the chapter just focuses on some 'case-study' mountain ranges. [Harald Pauli, Austria]	Accepted - the text has been revised
3387	2	7	15	0	17	Maybe reverse this sentence (i.e. starting with "rather") as the link between recent decades and the future would be clearer in my view. [Sven Lukas, Sweden]	Taken into account - text revised somewhat differently
24913	2	7	16	7	18	Maybe include a sentence on the reasons for and consequences of putting the emphasis "on changes over recent decades". This would facilitate understanding, I think. [Dirk Hoffmann, Germany]	Accepted - the text has been revised
2675	2	7	17	7	18	I would suggest also including perspective ver a longer period, and projected changes over the 21st century, as what we would expect from reports published by IPCC, including special reports. [Thian Yew Gan, Canada]	Taken into account - the palaeo perspesctive is covered in AR6, and projected changes in the 21st century are discussed here.
25181	2	7	17	7	17	Some explanation is needed as to why the focus was given to recent decades, when in some cases stronger statements may have been possible if a longer-term perspective was taken. [Simon Allen, Switzerland]	Taken into account - is stated in same paragraph focus on literature published since IPCC fifth assessment report.
1117	2	7	19	7	21	It looks like there are breaks in the logics of the text (e.g. topic-break between line 18 and 19, despite the wording "also", or unrelated "although" at line 21). The text would benefit from some rearrangement. [Daniel Farinotti, Switzerland]	Accepted - text has been revised

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1967	2	7	19	7	21	These sentences include a number of different features and are difficult to understand. Further, they easily can be misleading as leaving the impression that there are only some cases occur, where changes of cryospheric components cannot be unambigously attributed. Instead, we should suppose that it is very difficult to disentangle cryospheric effects from climatic effects such as warming. [Harald Pauli, Austria]	Accepted - text has been revised
28017	2	7	19	0		For clarity, I suggest adding "in Chapter 3 rather than here". [Frank Paul, Switzerland]	Accepted - text revised
28555	2	7	19	7	20	The sentence « Mountain environments [..] developments » is quite unclear at first reading and may benefit from simplification. [Isabelle Gouttevin, France]	Accepted - text has been revised
30401	2	7	19	7	21	Most biodiversity and climate change studies do not distinguish between cryosphere-related and unrelated drivers of biodiversity and focus on temperature effects. I believe it is very unfortunate that temperature effects are not considered in the biodiversity chapter. [Manuela Winkler, Austria]	Rejected - this is outside of the scope of this report, but much is covered in IPCC SR1.5 report
3347	2	7	21	7	21	It is mentioned that non-cryospheric drivers are not considered, but they are discussed. A few lines may be added for these factors. For example section 2.2.2 Page 11, lines 45-48 discusses the impact of anthropogenic activities. [Divyesh Varade, India]	Accepted - there is more discussion of these factors
31585	2	7	21	0		Figure 2.1. The upper part needs labels too (temp, cloud cover, rain...?), and similarly, the lower part needs a subheading (are these impacts or things that are impacted?) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - the figure has been deleted.
31587	2	7	21	0		Figure 2.1. The arrows cascading down to the other compartments are doubled - avoid repeating elements - if the connection is between upper and lower compartments, then one arrow is sufficient - if the connection is between elements across compartments, then the placemnt needs to made more accurate. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - the figure has been deleted.
1611	2	7	22	7	27	Figure 2.1: This image is blurry, please fix. Maybe label the bottom panel as "Impacts/Consequences" [Nora Richter, United States of America]	Taken into account - the figure has been deleted.
18413	2	7	22	7	25	E1a: Figure 2.1: I suggest a silhouette of a mountain (double summits?) showing intuitively the complex terrain in the figure layout. The atmospheric drivers could be depicted atop the mountain; all other elements can stay. [APECS Group Review, Germany]	Taken into account - the figure has been deleted.
24217	2	7	22	7	26	I basically like this kind of conceptual model and think it is a useful tool to visualize the interlinkages. The problem I see with this particular figure is that it is very top-down oriented and possibly too simplistic. It transports the notion that everything depends on atmospheric drivers. However, those processes or issues at the bottom of the pyramid are influenced by many non-physical / social drivers. Can this be considered in the visualization? maybe by adding arrows that point from outside the pyramid towards the different aspects? [Christian Huggel, Switzerland]	Taken into account - the figure has been deleted.
11845	2	7	23	7	26	The figure is interesting to using for stakeholders so I recommend improving with: 1. Atmospheric drivers: colocate/emphasizes temperature and rain-snow, snow, rain (the type of precipitations, solid and liquids), maybe graphics 2. Changes in the mountain cryosphere: could interact with both directions generate impacts and this could affect the cryosphere 3. Need a title in the pyramid as "Impact on the services" [Isabel Ramos, Peru]	Taken into account - the figure has been deleted.

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15181	2	7	23	47	1	Figure 2.1, 2.5, 2.8, 2.10 to be improved (better definition or enlarge the characters) [Alessandro Pezzoli, Italy]	Taken into account - figure 2.1 has been deleted and other figures have been improved
17437	2	7	23	7	24	Figure 2.1 emphasize in the pattern established in the text. It looks like if the problem of climate regulation would be only an up - down process, that needs to be corrected as well in the Figures. Arrows most be in two directions. [Hugo Mantilla-Meluk, Colombia]	Taken into account - the figure has been deleted.
18745	2	7	23	7	24	Figure 2.1: Figure edges are fuzzy and wording seems blurry. Resolution needs improvement. [APECS Group Review, Germany]	Taken into account - the figure has been deleted.
30229	2	7	23	7	26	The bottom panel is missing sea level rise potential and damage to infrastructure as consequences of changes to mountain cryosphere. This figure also doesn't address the feedbacks that occur, particulalry in relation to atmospheric conditions, which can be locally influenced by the presence of absence of glaciers and snow etc. [Christine Dow, Canada]	Taken into account - the figure has been deleted.
32913	2	7	24	7	28	The eye is drawn from top to bottom of Figure 2.1. Is this to mirror physical processes, from atmosphere to downstream impacts, or is this purely just a conceptual model? Also a triangle often is used to show varying breadth or complexity across levels, but that doesn't fit here. Some components are also missing, such as ocean temperature forcing on tidewater glaciers, and impacts of the cryosphere on sea level. This space could be used more effectively. Figure 2.8 is a much better illustration of physical processes. [Government of United States of America, United States of America]	Taken into account - the figure has been deleted.
21771	2	7	26	0		The second floor of this figure, I think the "precipitaiton types" is indispensable, because of global warming has a significantly imapct on precipitation types changes over the inter-annual and seasonal scales in high elevation mountains in many previous studies. [Haijun DENG, China]	Taken into account - the figure has been deleted.
24535	2	7	26	7	26	This figure caption is poorly developed, I suggest to add further details [Armand Hernández, Spain]	Taken into account - the figure has been deleted.
23063	2	7	55	7	55	Could the figure also consider the implications for sustainability, including managed ecosystems (farming, livestock), health, food security? [Valerie Masson-Delmotte, France]	Taken into account - the figure has been deleted.
10427	2	8	0	8	0	Font resolution in Figure 2.2 has to be increased. [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Fonts have the same size than the caption
10429	2	8	0	8	0	Central Europe - to of the Figure 2.2. does not have horizontal scale [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - We added the missing x-axis to Central Europe
10889	2	8	0	0		2.2 Overcrowded, too many elements in one graphic, suggest to decongest, separate the map from the graphs and then also generalize [otto otto simonett, Switzerland]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. A layout with the numbering of the regions was tested and causes a loss of connection between the map and the histograms
18433	2	8	0	8		The box inddicating portion of Southern Part of North America, North western part of Sourh America, Middle Africa and west Papua, should be properly mentioned on Area-Elevation graph.(Its seems confusing either these all belong to low latitude area ?) [APECS Group Review, Germany]	Taken into account - A footnote clarifies that Low Latitude englobes Eastern Africa, New Guinea, Mexico and Low Latitude Andes and the lines linking the histogram to the map are improved (solid line).

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22111	2	8	0	8		Number the regions identified in Figure 2.2, and carry throughout the chapter to other figures [Joseph Shea, Canada]	Rejected - Numbering the regions was tested and causes a loss of connection between the map and the histograms. We instead applied the same figure layout and region names in all figures.
23067	2	8	0	8		For which years have the calculations been made? [Valerie Masson-Delmotte, France]	Taken into account - The map uses data covering the IPCC pesent-day period 2006-2015 as indicated in the caption.
23069	2	8	0	9		Amplification of warming with elevation should be quantified and reported in ES and SPM [Valerie Masson-Delmotte, France]	Taken into account - EDW is now better quantified in the text and ES, but not elevated to the SPM consistent with the rest of the report, where temperature changes are not reported either for the polar or ocean, because the focus is on the cryosphere and ocean elements and not their atmospheric drivers.
24537	2	8	0	10		I am not sure if section 2.2.1 should be included in section 2.2. In my opinon it should have other hierarchy than sections 2.2.2, 2.2.3, 2.2.4 [Armand Hernández, Spain]	Rejected - Due to space constraints and internal logics of the chapter, it was decided to not add an addition section.
25643	2	8	0	42		There are references in this report that quote papers in under review or in press. We avoid papers that are yet to be peer reviwed and published. This would greatly help in avoiding the unverified data being incorporated that could reduce the acceptability fo the report. [Government of India, India]	Taken into account - Per IPCC guidelines submitted papers will only be included if they are published by May 2019
25647	2	8	0	42		There are refernces in this report that quote paprs in under review or in press. We may avoid papers that are yet to be peer reviewed and published. This would greatly help in avoidiing the unverified data being incorporated that could reduce the acceptability for the report. [Government of India, India]	Taken into account - Per IPCC guidelines submitted papers will only be included if they are published by May 2019
32585	2	8	0	8		Change "Low Latitude" to "Eastern Africa" Use this for consistency in refencing regions such as "Western North America", "Scandinavia", "Central Europe", "North Asia", etc. [John Diiwu, Canada]	Taken into account - A footnote clarifies that Low Latitude englobes Andes, Mexico, Eastern Africa and New Guinea, Andes.
544	2	8	1	8	13	What do the permafrost area circles within circles indicate versus half moons and light purple versus dark purple? This description in regards to the min and max could be clearer here and with the histograms. Also, there are square colored symbols for mountain area and glacier but not for permafrost. [Jenna Pearson, United States of America]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. Permafrost is not shown on the map as it overlaps mountain regions and glaciers and extends further up north. A choice was made to not plot permafrost extent and overload this already complex figure.
1415	2	8	1	8	13	The figure is nearly impossible to read, too small fonts, and too convoluted. Make separate plots for glacier coverage and permafrost (if that one is needed at all). It is not well-explained what is the "light pink" and "dark pink" for permafrost, e.g what is "min" and "max" referring too? The pink and blue circles should be linked to the areas they refer to by a line or similar, not free-standing on the map. [Rene Forsberg, Denmark]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. Layout with separate map and histogams as tested out but led to more difficult reading as one had to match numbers between the map and the histograms.
1613	2	8	1	8	13	Figure 2.2: There is a lot going on in this figure. I do not understand what the circles are meant to portray. The histograms are useful. I do not understand why Papua New Guinea and the Andes are connected by a dotted line and why there are is not a histogram for these regions even though they are boxed in. [Nora Richter, United States of America]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. A footnote clarifies that Low Latitude englobes Eastern Africa, New Guinea, Mexico and Low Latitude Andes and the lines linking the histogram to the map are improved.

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1969	2	8	1	8	13	Figure 2.2. The figure instructively shows the percentage area glaciers and permafrost per mountain range. Therefore, it should'nt be too much effort to provide quantitiative areas considered in the chapter. This could be included in the figure for each of the eleven regions. [Harald Pauli, Austria]	Rejected - The legend was restructured to highlight that circles and diamonds represent the absolute area of glacier and permafrost per mountain range.
9177	2	8	1	8	1	Map legend: change permafrost (new left) and glacier (new right) as in the area-elevation distribution [Luzi Bernhard, Switzerland]	Accepted - Figure is revised as suggested
14955	2	8	1	8	13	Fig. 2.2 It is not clear from the legend what the dark and bright purple colors indicate. Also, please make sure that all axes are labelled correctly, and expand the map legend in order to guide the reader through this complex graphic. [Government of Germany, Germany]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. Missing labels were added and fonts are larger.
15453	2	8	1	8	13	The figure is nearly impossible to read, too small fonts, and too convoluted. Make separate plots for glacier coverage and permafrost. It is not well-explained what is the "light pink" and "dark pink" for permafrost, e.g what is "min" and "max" referring too? The pink and blue circles should be linked to the areas they refer to by a line or similar, not free-standing on the map. Why is the High Mountain Asia permafrost a concentric circle, while the North Asia circle is a pie chart? [EUCE, Belgium]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. Layout with separate map and histogams as tested out but led to more difficult reading as one had to match numbers between the map and the histograms.
17815	2	8	1	8	1	Since hypsometry distribution of glaciers is scaled to the percentage of the total area there is an underrepresentation of the glaciers in the Southern Andes. Since most of the area covered by debris free-glaciers is located in the southern margins of the Southern Andes (where the large ice fields are located) it looks like there are only glaciers below the 2000 m asl in this region. Nevertheless, due to the large latitude span of the Southern Andes, there is a high concentration of glaciers and glacier area at the Central Andes (between 35 and 31 south degrees) between 4000 and 6000 m asl, which due to the difference in size with respect to Patagonian ice filed is simple not depictable in the plot. This gives the wrong impression that glaciers all along the Southern Andes have an altitude distribution even lower than the ones located in New Zealand and that permafrost is at a higher elevation than glaciers in the Southern Andes. I recognized that this is due to the difference along the Southern Andes and not an error in the data or the plot. The best way to overcome the under-representation of high altitude glaciers in the Southern Andes is dividing the region in two, as it was long time stated by Lliboutry (1958,1999) into the Wet Andes (south of 35S) and Dry Andes (north of 35S). I suggest the author that at least point it out this issue in the caption of the figure to knowledge the under-representation of high altitude glaciers and the difference between the altitude distribution between permafrost and glaciers in the Southern Andes plot. [Lucas Ruiz, Argentina]	Taken into account - we agree with your comments and recognise the issue with the region extent. We tested a split of the histogram, but ithe proximity of both histograms overloaded this part of the figure and caused confusion.
18547	2	8	1	8	1	Figure 2.2. The minor plots related to glacier and permafrost hypsometry were difficult for me to understand at first, eg. there are three different estimates of permafrost area. Reducing the amount of information might help the reader significantly. The references to Figure 2.2 I found in text do not really refer to the hypsometries, so perhaps you might consider removing them. [APECS Group Review, Germany]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
18747	2	8	1	8	13	Figure 2.2 : “High-Mountain Asia” hard to read. Elevation values on y-axis could be shifted to match horizontal lines. [APECS Group Review, Germany]	Taken into accout - labels were shifted as suggested
26867	2	8	1	0	13	This is a really useful figure. However, it is hard to understand what the dots on the map correspond to. Is there a better way to show the correspondence? [Ko Barrett, United States of America]	Taken into account - we tested full lines instead of dashed but this caused confusion with the region extents.

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29031	2	8	1	8	13	Obviously a great deal of work went into this figure; but trying to represent both permafrost and glaciers in the same figure is too "busy," and confuses also the sense of scale between these two structures. Strongly suggest these processes be separated into two distinct figures, to allow comparison between regions in terms of permafrost and glaciers with greater clarity. [Pam Pearson, Sweden]	Taken into account - The proposed layout loses the overview idea behind the figure design (the histogram show the area- elevation distribution and the circles on the map the area or "scale". To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
30069	2	8	1	0		Figure 2.2 inclides a lot of information but is on a complexity level difficult to read and understand if no prior knowledge of what is logic. Especially the crossing of the dashed lines and the fact that not all circular symbols referr to one area alone is confusing. I understand the need for a condensed report, but given that especially relation permafrost/glaciers is a very narrow field fo science I am afraid not many outside the field will be able to, or have the patience to study the figure enough to understand the content. [Lena Rubensdotter, Norway]	Accepted - We now use circles and diamonds to differentiate permafrost and glacier areas. To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
31589	2	8	1	0		Figure 2.2. There is a lot of information on this figure. A bit of rearragment may help the reader to navigate through it better. For example, 1) the dotted lines that connect the polygons with the sublabels could be avoided if you place letter codes to match the polygon with the graph. This way, the main map can be placed on top, and below it you can rearrange the graphs nicely in two or three rows (three might be better because the graphs may then be slightly bigger and allow the reader to appreciate the quantile percentages that are currently hard to see). Also, below each elevation graphs you may place the corresponding glacier/permafrost cover circles - because if you placethem over the poligon, you may lose data the type of cover (mountains vs. glacier), and their placement is not optimal because they are too far away from their matching geographical space. So perhaps its best to take them out of the map, and just place them below on a separate panel. In case you do this, keep arrangement uniform across figures (e.g. 2.5). [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012. A layout with the numbering of the regions was tested and causes a loss of connection between the map and the histograms
3335	2	8	2	8	13	Fig 2.2 contains sufficient information; however, some information still needs to be improved. For example, the expression of permafrost area is bit ambiguous and can't be completely understood using the legend. The reader can't get the permafrost area information quickly based on the legend produced in this figure. [Peng CUI, China]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
1119	2	8	3	8	3	(1) The way regional permafrost is shown on the map is not fully consistent: Sometimes the pies are split in two parts, sometimes they have an outer ring. Consistency should be ensured; or an explanation be given for the different meaning. (2) The permafrost pie for North Asia has a ">"-symbol in it that should probably be removed. (3) For consistency with the hypsometries given with the bar charts., the permafrost legend should have the lighter colour to the left, and the darker to the right. [Daniel Farinotti, Switzerland]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
2677	2	8	3	8	13	I personally don't like the way permafrost areas are presented by circles. Instead, it will be more informative to present them in terms of spatial distributions. Besides, there are three major types of permafrost: continuous, discontinuous and sporadic permafrost. Does the permafrost shown in this figure represent all three types of permafrost? [Thian Yew Gan, Canada]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.

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26323	2	8	3	8	13	It is not clear what is being shown in the area-elevation figures for glaciers. Assuming these plots are taking all glaciers in a region in aggregate, what is the rationale behind using the mean 0C isotherm instead of equilibrium line altitude? If using the 0C isotherm, it might be useful to show projections of how that line might shift in the future in each region and/or include a discussion of the role of the area-altitude distribution in regulating glacier response to increased warming. [Ethan Pierce, United States of America]	Rejected - The 0 degree isotherm is an independent global measure of the existence of the cryosphere (not just glaciers). Pediction of the 0 degree isotherm is indeed of great interest but the figure present the current state of the cryosphere. We do not add the predicted isotherm as the figure is already complex.
32915	2	8	3	8	13	It's unclear what the "greater than" sign in the permafrost area symbols indicates. In addition, many of the histograms don't appear to sum to 100% (perhaps they do, but it's difficult to tell, as the graphs are really small). [Government of United States of America, United States of America]	Accepted - To simplify the figure and the permafrost plots, only the median ensemble of the permafrost extent from Obu et al., 2019 is now plotted instead of showing the minimum and maximum extent from Gruber, 2012.
32917	2	8	3	8	13	Figure 2.2 implies that there are observations of permafrost for regions other than the Alps, Scandinavia, and the Tibet plateau, but they are not discussed in this section at all. If there are such observations, they should be at least passingly mentioned with a summary statement about net trends in active layer or temperature at some depth. If there are insufficient mountain permafrost observations from other mountain regions to form an assessment, that should be explicitly mentioned here, perhaps as part of a statement that describes limited evidence and some degree of confidence for whether these other regions likely follow the ones highlighted in Table 2.1 and Figure 2.6, and why or why not. [Government of United States of America, United States of America]	Taken into account – the map figure now expains better that simulation results, and not observations, are shown. Permafrost text points to gaps.
11847	2	8	7	8	7	It is important to mention that in tropical glaciers there is permafrost, but there few studies currently. [Isabel Ramos, Peru]	Noted
28557	2	8	7	8	11	I suggest it could be specified explicitely to which year (or period or years) these permafrost and glacier data refer to. [Isabelle Gouttevin, France]	Taken into account - The map uses data covering the IPCC defined "pesent-day "
24519	2	8	8	8	8	Comment on a section within a chapter. In the title of figure 2.2, the word “Permafrost is written badly. It was written “permaFRSR” instead of “permafrost”. [Francisco Barraza, Chile]	Editorial – copyedit to be completed prior to publication
16805	2	8	10	8	s	It should be indicated whether the freezing level has been derived from ERA-5 near-surface temperature output (2m temperature) or from atmospheric air temperature (vertical levels). In the first case, the freezing level would reflect near-surface conditions, in the second case free atmiospheric conditions. These are not necessarily the same. [Sven Kotlarski, Switzerland]	Taken into account - the caption was extended and specifies: "the median elevation of the annual mean 0°C free-atmosphere isotherm calculated from the ERA-5 re-analysis of the European Centre for Medium Range Weather Forecasts over each region’s mountain area for the period 2006 to 2015, with 25–75% quantiles in grey"
5471	2	8	16	19	10	In this report, the Iranian plateau is not included in the Zagros and Alborz Mountains. [rashidian leila, Iran]	Acccepted. Additional studies from Iran were included in the assessment.
5525	2	8	16	19	10	In this report, the Iranian plateau, and especially Zagros and Alborz Mountains, have not been considered. [Government of Iran, Iran]	Acccepted. Additional studies from Iran were included in the assessment.
2417	2	8	20	8	28	My previous comment on FOD was unfortunately ignored. Therefore once again, this description of past temperature changes misses the pre-industrial context which is key for robust attribution analysis. Pre-industrial warm phases have occurred in the High Mountain areas, often associated with rapid warming. Why are the Medieval Climate Anomaly, Roman Warm Period and Holocene Thermal Maximum not mentioned here? For the Andes see e.g. Neukom et al. 2011 (doi: 10.1007/s00382-010-0793-3) and Jomelli et al. 2009 (doi: 10.1016/j.palaeo.2008.10.033). [Sebastian Luening, Portugal]	Rejected - as introduced in the framing chapter (Chapter 1) and introduction to Chapter 2 (Section 2.1), this report focuses on time periods spanning since pre-industrial time. This was defined in the scoping phase, and due to space constraints it is not possible to expand into earlier time periods. Paleoclimatological evidence was covered in AR5, including for mountain regions when relevant.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9199	2	8	22	10	3	An interesting study quantifying the effect of snow-albedo feedback mechanisms for Swiss spring temperature trends is Scherrer et al., 2012. They were able to show that snow-albedo feedback mechanisms "enhace the 1961-2012 observed temperature trends along the upward-moving snow line in spring and early summer by about 3-7 %." Scherrer, S.C., Ceppi, P., Croci-Maspoli, M. et al. Theor Appl Climatol (2012) 110: 509. https://doi.org/10.1007/s00704-012-0712-0 Another recently published study investigating elevation-dependent warming trends in the Swiss Alps is Rottler et al., 2018. This study investigates processes related to weather types, incoming solar radiation, cloud cover, air humidity and snow/ice. They detect that "temparature trends in Switzerland differ depending on the time of the year, day and elevation" and "attribute this elevation-dependent signal mainly to elevation-based differences in trends of incoming solar radiation and elevation-sensitive responses to changes in frequencies of weather types." Rottler, E. , Kormann, C. , Francke, T. and Bronstert, A. (2018), Elevation-dependent warming in the Swiss Alps 1981-2017: features, forcings and feedbacks. Int J Climatol. Accepted Author Manuscript. https://doi.org/10.1002/joc.5970 [Rottler Erwin, Germany]	Accepted - This study was Taken into account for the final government draft.
2087	2	8	23	8	23	Please mention the full form of m a.s.l. when it is first mentioned. [Jaee Nikam, India]	Accepted - Text revised accordingly.
9179	2	8	23	8	26	.. Often with a faster rate than global mean values, up to twice faster. Reference(s)? [Luzi Bernhard, Switzerland]	Accepted - A more quantitative analysis was performed for the final government draft.
10431	2	8	24	8	24	Please restate 'or are not of high enough quality' - specify which data are missing, which errors are possible. [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Text revised to better reflect that quality standards are not always met for meteorological observations in mountain regions.
32557	2	8	25	8	26	Change "...often with a faster rate than global mean values, up to twice faster." To "...often at a rate up to twice faster than global ocean values." [John Diiwu, Canada]	Rejected - The comparison is not made to "ocean" values but global surface temperature values, including both ocean and land surfaces.
32919	2	8	26	8	26	Better to clarify if the rate of mountain warming is faster than global mean land surface or global average surface temperature. [Government of United States of America, United States of America]	Accepted - The text was revised for better clarity.
4229	2	8	27	8	27	the "elevation dependent" concept here is reported as medium confidence, but at page 9 line 16 as high confidence [franco salerno, Italy]	Rejected - It is not the EDW concept that is discussed here, but an assessment of EDW magnitude and confidence level for the past (medium confidence), which is dfferent from the confidence placed in future EDW (high confidence), based on available evidence. The text was revised for better clarity.
13119	2	9	0	0		Many sentences should be greatly simplified. Maybe cutting them into 2 or 3 more (active) simple sentences. Use sub-headings. [David Crookall, France]	Accepted - Text for FGD was revised for better clarity. Addtional subheadings are not possible within IPCC formatting guidelines.
13121	2	9	0	0		Plenty more comments in the accompanying marked-up pdf file. [David Crookall, France]	Noted - We understand comments were all provided as comments in the excel file.
24543	2	9	0	21		I see an inconssitent structure between sections 2.2.2, 2.2.3, 2.2.4. I suggest to be more consitent splitting into sections and subsections. [Armand Hernández, Spain]	Taken into account - Structures were homogenized for FGD.
1121	2	9	2	9	2	What "other" mountain regions? "Other" than what? [Daniel Farinotti, Switzerland]	Accepted - The word "other" was incorrectly placed, and was removed.

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1417	2	9	2	9	5	This is a political statement, there is no consencus on to what degree anthropogenic emissions are the dominanrt factor in recent temperature changes. Should be removed. [Rene Forsberg, Denmark]	Taken into account - Literature on detection/attribution of surface warming is assessed and reported.
5299	2	9	2	9	2	This sentence is not clear. "other" than which mountain regions? [Simone Schauwecker, Chile]	Accepted - The word "other" was incorrectly placed, and was removed.
5343	2	9	2	9	2	The connection of this sentence with the previous paragraph is not evident. The authors are not discussing attribution studies [Alvaro Ayala, Chile]	Accepted - Text was revised for clarity.
5345	2	9	2	5	2	"other mountain regions", other than which? [Alvaro Ayala, Chile]	Accepted - The word "other" was incorrectly placed, and was removed.
8561	2	9	2	9	2	In the sentence “Attribution studies specifically focused on other mountain regions are rare”, it is not clear what “other mountain regions” refer to. [Deborah Verfaillie, Spain]	Accepted - The word "other" was incorrectly placed, and was removed.
18415	2	9	2	9	2	E1a: What does "other" refer to? There are no specific mountain ranges mentioned in the lines above. [APECS Group Review, Germany]	Accepted - The word "other" was incorrectly placed, and was removed.
30221	2	9	2	9	2	It's unclear what "Attribution studies specifically focussed on other mountain regions are rare" means. What are the initial mountain region studies that this is referring to? [Christine Dow, Canada]	Accepted - The word "other" was incorrectly placed, and was removed.
32921	2	9	5	9	6	It seems odd to compare two papers [Bonfils et al. (2008) and Dileepkumar et al. (2018)] with WGI AR5 Chapter 10, which cites hundreds of papers. Second, a quick search through Bindoff et al. (2013) did not appear to provide any evidence for (or even mention of) anthropogenic forcing of elevation-dependent warming beyond concluding that anthropogenic activities contributed to loss of mountain glaciers. Perhaps this is just a wording issue, and the authors should instead just note that Bindoff et al. presents evidence linking anthropogenic activity to recent warming generally, though not specifically at elevation. Even a search for terms like "mountain", "elevation", and "altitude" did not reveal anthropogenic influence on specifically elevation-dependent warming. [Government of United States of America, United States of America]	Taken into account - This paragraph does not address EDW specifically, but warming in mountainous areas. The two individual articles quoted are detection/attribution studies for mountainous areas. These mountainous areas are located in regions covered in Bindoff et al. IPCC Chapter. The goal of this paragraph here is provide evidence and context for the fact that warming in mountainous areas proceeds primarily through the same mechanisms and attribution that the regions to which they belong.
11641	2	9	6	9	8	In Mexico has been reported the relation between disminish mountain glacier (Izta-Popo) and industrial areas. In Cortés & Delgado (2015). http://www.redalyc.org/articulo.oa?id=56836855001 [Government of Mexico, Mexico]	Taken into account - The effects of light absorbing impurities on snow and glacier mass balance are discussed in the report. The reference suggested does not add material or information to this aspect of the assessment.
18481	2	9	6	9	6	Since this statement only relies on qualitative metrics, replace "likely" by "medium level of confidence". [APECS Group Review, Germany]	Taken into account - The use of the confidence language was checked in preparation for the FGD
24351	2	9	6	9	6	I disagree with the likelihood and confidence statements here: would suggest at least very likely and medium evidence, high agreement. [Philippus Wester, Netherlands]	Rejected - There are no proper detection/attribution studies in mountainous regions (except those quoted explicitly), so it is not possible to raise the confidence level beyond the assessment.
28679	2	9	6	9	8	I am suggesting additional explanation (if possible, supported with additional references particularily related to high mountain areas) of the statement that anthropogenic influence is the main contributor to surface temperature increases in highmountain areas since the mid-20th century. [Irena Mrak, Slovenia]	Rejected - We do not see in this comment a concrete suggestion for improvement. However, note that the text has been revised for clarity.
12759	2	9	7	0		what is "high" - give a metre altitude range [David Crookall, France]	Rejected - The title of the chapter is "High mountain areas", so the definition of "high mountains" is given in the Framing Chapter (Chapter 1) and the introduction of Chapter 2.
1123	2	9	10	9	10	"Future changes" of what? The context is missing. [Daniel Farinotti, Switzerland]	Taken into account - All of the content of subsection 2.2.1.1. refer to surface air temperature.

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2089	2	9	10	9	10	Please avoid using absolute terms like "currently no initiative" unless absolutely sure that there is no initiative (either published of unpublished) for the mentioned model. Suggestion to change the wording to "no current initiative found". [Jaee Nikam, India]	Rejected - We are absolutely sure that there is no international initiative for coordinated model intercomparison specifically addressing mountain regions, at the global level.
28209	2	9	10	9	17	It would seem appropriate to state why models have trouble in mountainous areas, namely the large variation of topography within the grid spacing of global models make it difficult to resolve processes [Martin Truffer, United States of America]	Accepted - The text was revised accordingly. Note that Chapter 1 (framing) also provides material regarding the main limits of climate models in mountain regions.
3127	2	9	12	9	14	An other challenge for such a comparison is the lack of validation data for climate models in high mountain area [Fanny Brun, France]	Taken into account - However space constraints do not allow describing these issues in details.
13117	2	9	12	0		"there is currently no initiative, such as model inter-comparisons or coordinated model experiments, specifically addressing high mountain climate globally". But why should there be? You said somewhere that mountain areas are exctrememly diverse. With such diversity, how can one hope to develop and integrated a global model of mountain areas -- maybe better to use a specific model for each area? [David Crookall, France]	Taken into account - Globally coordinated modeling exercices do not need to ignore regional differences in mountain climate. Furthermore, global climate models are used for mountain climate climate change studies, although mountain observations are generally not used for GCM intercomparison exercises such as CMIP. It is thus worth noting this technical and knowledge gap, for context.
3353	2	9	14	10	3	The mid-high mountains comprise scattered forests in the Indian Himalayas and the forest cover density has a significant impact on the spatial variability of the Land Surface Temperature (LST). This should be discussed in section 2.1, since the LST at higher elevations is directly related to EDW. May include the reference: Varade D., Dikshit O., 2018:Assessment of Winter Season Land Surface Temperature in the Himalayan regions around the Kullu area in India using Landsat-8 data. Geocarto International. https://doi.org/10.1080/10106049.2018.1520928 [Divyesh Varade, India]	Taken into account - Reference considered for FGD preparation.
26325	2	9	20	0		It may be worthwhile to include a discussion of the geographic coverage of available evidence used in this box. Which regions are under-sampled, if any? [Ethan Pierce, United States of America]	Taken into account - The evidence from observed and projected changes is included in the Table 1 (supplement) and referred to in the main text, not anymore on the Box itself.
2679	2	9	22	9	57	I suggest more discussion on various feedback mechanisms that are related to EDM? For example, temperature feedback = Impact of rising temperatures on outgoing longwave radiation at the top of atmosphere, Planck Feedback = Contribution from vertically uniform warming of the surface and troposphere; Lapse-rate feedback = Contribution from tropospheric warming that deviates from the vertically uniform profile. Water Vapour feedback =Greenhouse effect of additional water vapour; Cloud feedback = Changes in effect of clouds on the Earth's radiative balance; Changes in atmospheric & oceanic heat transport also contribute to EDM? Temperature feedback = Impact of rising temperatures on outgoing longwave radiation at the top of atmosphere, Planck Feedback = Contribution from vertically uniform warming of the surface and troposphere Lapse-rate feedback = Contribution from tropospheric warming that deviates from the vertically uniform profile. Water Vapour feedback =Greenhouse effect of additional water vapour Cloud feedback = Changes in effect of clouds on the Earth's radiative balance Changes in atmospheric circulation could also affect the EDM? [Thian Yew Gan, Canada]	Taken into account - The report is not meant to replace text books and scientific literature on mountain processes, but to focus on policy relevant changes. The box has been further revised in this direction.

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18483	2	9	22	10	5	In the box describing the elevation dependent warming, it could be useful to add few words about the observations of the lapse rate (the temperature gradient) reconstructed for the last glacial maximum, between 21 and 18 kilo-years ago. Looking at such timescale provides additionnal important information: i) this gives an estimate of the sensitivity of the elevation dependence warming under large changes (>2°C) of global temperatures. Independent evidences suggest (with medium to high confidence) that the tropical lapse rate was steeper during the LGM (6.5°C/km) compared to today (5.5 °C/km) (e.g. Fig. S4 in Blard et al., Nature, 2007; Fig. 3 in Loomis et al., Science Advances, 2017). ii) Importantly, state-of-the-art global climate models correctly capture the sign of this change but underestimate its magnitude. Consequently, future warming in high tropical mountains may be larger than indicated by model projections. [APECS Group Review, Germany]	Taken into account - However, note that long term paleo perspective is not explicitly addressed in this Chapter because of space limitations, and that the content of the box was considerably modified for better policy relevance and lower emphasis on assessment figures, provided in Annex (Table 1) and in the main body of the text.
32245	2	9	22	9	22	This title would be fine for a text book or perhaps a FAQ, but not a chapter box. Please avoid text book style in IPCC assessments. As a policy maker I am not the least interested in learning what "elevation dependent warming" is. However, I might be very much interested in this phenomenon if impacts me and my community or some system I care for, or if I need to understand this to make good policies, either for mitigation or adaptation purposes. Please reformulate accordingly. (see also my comment on the content of this box) [Andreas Fischlin, Switzerland]	Accepted - The title and content of the box were considerably revised to increase the policy relevance.
32247	2	9	22	10	3	The same argument I made for the box title applies also to the content. It is far from obvious why policy makers need to know EDW. Please restate it to make it very clear from the very beginning of the box that impacts do not vary with altitude in a linear manner and why therefore the non-linear nature of the relationship between warming and altitude needs to be recognized and considered in policy making. The latter reason and notably its significance does not become clear to me when reading the box. [Andreas Fischlin, Switzerland]	Accepted - The title and content of the box were considerably revised to increase the policy relevance.
5305	2	9	24	9	40	Don't go that much into detail of single studies. It would be better to just summarize, without naming single cases. [Simone Schauwecker, Chile]	Accepted - The content of the Box was considerably revised for better policy relevance.
11199	2	9	24	9	40	The recent paper by Yarleque et al., 2018 showing that EDW contributes significantly to the enhanced warming over the Quelccaya Ice Cap, and that EDW at Quelccaya depends on the rate of anthropogenic forcing could be added to the box 2.1. This could be done in the first paragraph of the box. The reference is Yarleque, C., M. Vuille, D.R. Hardy, O. Elison Timm, J. De la Cruz, H. Ramos, A. Rabatel. 2018. Projections of the future disappearance of the Quelccaya Ice Cap in the Central Andes. Nature Scientific Reports, 8, 15564. doi:10.1038/s41598-018-33698-z [Antoine Rabatel, France]	Taken into account - The suggested references were considered for the preparation of the FGD. Many individual studies are referred to in Annex (Table 1).
14957	2	9	24	9	40	The explanations in Box 2.1 are too complicated and lead to a misunderstanding. That the climate warming has an influence on the (air?) temperature is quite obvious but should be explained more descriptive, e.g. not only numbers (cit: Qixiang et al. (2018) showed both elevation and latitudinal amplification of warming rates over the period 1961-2010, reaching +0.4°C per decade in winter for stations above 500 m compared to +0.35°C per decade for stations below 500 m.) that do not show a real difference but maybe making a comment on the decrease of the 0° isotherm due to climate warming. [Government of Germany, Germany]	Accepted - The content of the Box was considerably revised for better policy relevance.

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24031	2	9	24	12	12	The authors of this chapter do not appear to have taken note of work on the Indian part of the Himalayan Mountains and missed some of the papers published in international journals on warming in Indian Himalaya. The studies on the north-western Himalayas have reported the warming at the rate of about 1.1oC/100 years. Winters have become warmer at a much higher rate (about 1.4oC/ 100 years) which is higher than the global average. The overall impact of the phenomenon has also resulted in decreased monsoon precipitation over the region Most striking feature of this climate variation are non-uniform (both, temporally and spatially) nature of warming over various ranges of Himalayas and its acceleration during past 30 years. Winter precipitation consists now of more rainfall and lesser snowfall. Effective duration of winter has been curtailed with late onset of winter and early onset of spring. (Bhutiyani et al., 2007; 2010) and decreasing/cooling trend at higher altitudes above the equilibrium line (>5300 m) (Shekhar et al., 2010; Dimri and Dash, 2012). Studies have also shown decreasing discharge in majority of the north-western Himalayan rivers after having reached their 'peak water' threshold in early nineties and a significant increase in number of high-magnitude flood events (Bhutiyani et al., 2008). Following few references need to be added to the report. 1. Bhutiyani M.R., Kale,V.S and Pawar, N.J. (2007). Long-term trends in maximum, minimum and mean annual air temperatures across the northwestern Himalaya during the 20th Century. Climate Change, 85:159–177. 2. Bhutiyani M.R., Kale,V.S and Pawar, N.J. (2008). Changing streamflow patterns in the rivers of the northwestern Himalaya: Implications of 'Global Warming' in the 20th Century - 'Current Science', Vol. 95, No. 5, pp 618-626. 3. Bhutiyani M R. (2016). Spatial and Temporal Variability of Climate Change in High-Altitude Regions of NW Himalayas: In "Climate Change, Glacier Response and Vegetation Dynamics in the Himalaya", Ed. R B Singh et al., Springer International Publishing, Switzerland, Pp 87-104. 4. Bhutiyani M R. (2017). Mitigation Strategies to combat Climate Change in the Himalayan Mountains: In "Science and Geopolitics of White World", Ed. Goel, P S. et al., Springer Publications, pp 133-144. 5. Bhutiyani, Mahendra R. and Ravikant Mahto. (2018). Remote sensing-based study of impact of a rock avalanche on North-Terong Glacier in Karakorum Himalaya. International Journal of Remote Sensing. June 2018; DOI: 10.1080/01431161.2018.1480073. 6. Dash S. K. and Hunt, J. C. R., 2007, Variability of climate change in India, Current Science, 93, 6, 782-788.	Taken into account - The suggested references were considered for the preparation of the FGD. Note that individual studies are referred to in Annex (Table 1).
27139	2	9	24	9	40	The reports tends to show an amplification of warming rates with elevation. Actually few measurements are available at high elevation and the conclusions are fragile. Some references are already old (1997, 2000) and some more recent papers should be considered i.e. Gilbert and Vincent (2013). The authors have quantified atmospheric temperature changes over the last century by simultaneous inversion of ice temperature profiles in Mont Blanc area at high altitudes (>4000 m). A mean warming rate of 0.14°C/decade between 1900 and 2004 was found, similar to the observed regional low altitude trend in the Northwest Alps, suggesting that this EDW is not systematic - citation Gilbert, A and C. Vincent, Atmospheric temperature changes over the 20th century at very high elevations in the European Alps from englacial temperatures, Geophys. Res. Lett., 40, doi:10.1002/grl.50401. [Patrick Wagnon, France]	Taken into account - The suggested references were considered for the preparation of the FGD. Note that individual studies are referred to in Annex (Table 1).
1971	2	9	25	9	25	(Mountain Research Initiative EDW working group, 2015)' or '(Pepin et al., 2015)' [Harald Pauli, Austria]	Taken into account - The reference used is Pepin et al. (2015), which is the least ambiguous possible reference.

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10433	2	9	25	9	25	correct citaion - "(EDW working group, 2015)", EDW represents elevation-dependent warming. [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - The reference used is Pepin et al. (2015), which is the least ambiguous possible reference.
14959	2	9	27	9	27	What does "EDW working group" stand for? Not introduced here yet [Government of Germany, Germany]	Taken into account - The reference used is Pepin et al. (2015), which is the least ambiguous possible reference.
10439	2	9	28	9	36	Additional literature review is needed regarding shortwave and longwave radiation and snow cover - VERY IMPORTANT [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Drivers of change for the mountain snow cover are addressed in the corresponding section, but not in the box on elevation dependent changes.
4033	2	9	30	9	30	Page 2-9 Line 30: Add "One possible disturbance factor may be some special underlying surfaces such as glaciers with discontinuous temperature variation with altitude found between glacier and non-glacier surfaces in the Tibetan Plateau (Wang et al., 2013; Zhang et al., 2018)." References: [1]Wang NL, Jian-Qiao HE, Hong-Bo WU and Zhen LI (2013a) Spatial variation in spring surface temperature of the Qiumianleiketage glacier in the Kunlun mountains,Tibetan Plateau, and their influencing factors. J. Glaciol. Geocryol., 35(5), 1088–1094[2]Hongbo Zhang, Fan Zhang, Guoqing Zhang, Yaoming Ma, Kun Yang, Ming Ye. (2018). Daily air temperature estimation on glacier surfaces in the Tibetan Plateau using MODIS LST data. Journal of Glaciology, 64(243): 132-147. doi:10.1017/jog.2018.6 [Fan Zhang, China]	Taken into account - Elevation dependent changes related to the presence of glaciers have the same physical explanation than changes related to snow cover.
5301	2	9	30	9	30	The warming can even be negative in some regions, e.g. Tudoroiu et al, 2016 [Simone Schauwecker, Chile]	Taken into account - The text on Ekevation Dependent Warming was clarified and simplified. The reference suggested was used to refine the assessment.
5347	2	9	30	5	32	I guess that those numbers refer to Figure 2c in the article of Pepin and Lundquist (2008). I think it would be very informative to include some uncertainty ranges (derived from the boxplots in Figure 2c) in the report. This comment about uncertainty ranges on EDW results applies also for the rest of the studies cited in this paragraph. [Alvaro Ayala, Chile]	Taken into account - Individual studies are provided in Annex (Table 1). The content of the box was considerably revised for better policy relevance. Uncertainty ranges could be added for this example but for sake of consistency in Table 1 we have not done this - it is not usually possible if not quoted in original source
13145	2	9	30	9	30	Could the "amplified warming around the 0°C isotherm" be due to latent heat? [David Crookall, France]	Taken into account - The content of the Box was considerably revised for better policy relevance and lower emphasis on physical mechanisms.
13179	2	9	32	9	32	Rottler et al. investigated temperature trends from 93 stations in Switzerland between 1981 and 2017, categorized in three elevation classes. The find that annual average temperature increase is about 0.35°/decade, where the increase is most pronounced in lower regions (200 – 815 m asl). They further showed that the trends differ depending on the time of the year, daytime and elevation. Warming is strongest between March and June with up to 0.55°/decade with enhanced warming of daytime maximum temperatures. Elevation-based differences in temperature trends occur during autumn and winter with stronger warming at lower elevation. They attributed the elevation-dependent temperature signal mainly to elevation-based differences in trends of incoming solar radiation and elevation-sensitive responses to changes in frequencies of weather types, rather from snow/ice albedo feedback mechanisms, which are probably less relevant here. [Axel Bronstert, Germany]	Taken into account - Individual studies are provided in Annex (Table 1). The content of the box was considerably revised for better policy relevance.

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24539	2	9	32	0		I suggest to include the confidence interval (SD) of the trends [Armand Hernández, Spain]	Taken into account - Individual studies are provided in Annex (Table 1). The content of the box was considerably revised for better policy relevance. Uncertainty ranges could be added for this example but for sake of consistency in Table 1 we have not done this - it is not usually possible if not quoted in original source.
24541	2	9	34	0	35	I miss a reference supporting this statement. [Armand Hernández, Spain]	Taken into account - The text was considerably revised and references were further checked before submission of the FGD.
32923	2	9	34	9	34	This sentence references trend values from 1970-2011 quoted in Qixiang et al. (2018), but the trends in that paper appear all to be over the 1961-2010 period. [Government of United States of America, United States of America]	Accepted - This information was checked prior to finalizing the FGD.
25627	2	9	35	9	35	Qixiang et al. (2018) is not in the references [Floortje van den Heuvel, Switzerland]	Taken into account - The text was considerably revised and references were further checked before submission of the FGD.
25629	2	9	35	9	37	perhaps specify “reaching on average +0.4C” etc. or add some measure of spread “reaching +0.4C (+/- .. C) ? [Floortje van den Heuvel, Switzerland]	Accepted - The text was revised for better clarity (and figures were moved to the main text body instead of the Box, which was considerably revised for better polic relevance).
1125	2	9	37	9	40	The sentence is lacking a subject, is therefore unclear, and needs rewording. [Daniel Farinotti, Switzerland]	Accepted - The text was revised for better clarity.
10435	2	9	37	9	38	For the end of the 21st century (between 1961-1990 and 2070-2099) - first mentioned period does nor represent 21st centuary [Elzbieta Czyzowska-Wisniewski, United States of America]	Accepted - The text was revised for better clarity.
16807	2	9	37	9	40	Something is missing in this sentence. [Sven Kotlarski, Switzerland]	Accepted - The text was revised for better clarity.
18417	2	9	37	9	40	E1a: It seems that there is a grammar mistake in this sentence. It is not clear if the given temperature range refers to the SRES scenarios or to a missing subject, e.g. the warming trend. [APECS Group Review, Germany]	Accepted - The text was revised for better clarity.
18519	2	9	37	9	40	“For the end of the 21st century […]” - sentence seems to be lacking a noun. [APECS Group Review, Germany]	Accepted - The text was revised for better clarity.
28211	2	9	37	9	40	This sentence is out of context. It has nothing to do with elevation dependent warming. Also, what is SRES? [Martin Truffer, United States of America]	Accepted - The text was revised for better clarity.
32925	2	9	37	9	40	This statement is not very specific to Elevation Dependent Warming as the approach does not seem to use climate models capable of resolving most mountains (Himalayas OK, but not for other regions). [Government of United States of America, United States of America]	Taken into account - The text was considerably revised and this sentence has been rewritten.
10437	2	9	38	9	38	define SRES [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Climate change scenarios are now introduced in a dedicated Cross Chapter Box
1619	2	9	42	9	56	Consider adding a schematic or figure to help explain the existing text. This would make it easier for the readers to understand. [Nora Richter, United States of America]	Taken into account - However space constrains do not allow for an additional schematic.

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11071	2	9	42	10	3	The concept of EDW is very important to understand some phenomena related to climate change and mountain environment. But the EDW and the physical project contributing to EDW are difficult to understand. The paragraph explaining the physical processes contributing to EDW is too complicated and with too much information. It will be easily to understand if the information was in the form of bullet point (one point for each physical process) and illsutrated. [Charlotte Poussin, Switzerland]	Taken into account - The box was revised for better policy relevance.
17439	2	9	42	10	3	Although the authors mention variables like albedo, as one of the major forcees raegulating the climate, the participation of biological processess is ommited for the most part. It is important to show what is the participation of life at the global scale in regulating the climate. [Hugo Mantilla-Meluk, Colombia]	Taken into account - This special report focuses on the high mountain cryosphere - links to biological systems are provided where appropriate (taking into account strong space constraints).
27391	2	9	42	0		There are some recent studies(Minder et al., 2018; Pallazai et al., 2018) highlighting the dominancy of different factors controlling elevation dependent warming in different mountain ranges which may contribute to improve the literature discussed here. [Government of Nepal, Nepal]	Accepted - References considered for FGD.
28019	2	9	42	10	3	This reads like an explanation of the phenomenon. I would start the box with this section to provide the base for understanding first. The observations(L24-40) are second and can be reported afterwards. [Frank Paul, Switzerland]	Taken into account - The content of the Box was considerably revised for better policy relevance and lower emphasis on physical mechanisms.
10483	2	9	43	9	44	"Most of the physical processes identified are similar to those explaining the observed increase in warming rate towards the polar regions." Yes, in terms of polar amplification generally. But at present it is really only the Arctic that is experiencing accelerated warming, so perhaps say 'the Arctic' rather than 'polar regions'. [James Renwick, New Zealand]	Accepted - Text revised accordingly.
1127	2	9	44	9	45	This sentence is not an explanation and should therefore be removed. [Daniel Farinotti, Switzerland]	Taken into account - The text was considerably revised, for better clarity.
18549	2	9	44	9	44	Box 2.1. Consider adding a reference to Box 3.1., where Arctic Amplification is discussed. [APECS Group Review, Germany]	Accepted - Link to Chapter 3 introduced in the FGD.
3349	2	9	48	9	48	May include the reference: Varade D., Dikshit O., accepted: Improved assessment of Atmospheric Water Vapor Content in the Himalayan Regions around the Kullu Valley in India using Landsat-8 data. Water Resources Research. This paper proposes a methodology for orographic and vegetation based correction of atmospheric water vapor content and asseses the spatial variation in atmospheric water vapor content with respect to changes in elevation, forest cover density and snow grain size for the autumn and peak winter seasons in the Kullu Valley. [Divyesh Varade, India]	Taken into account - However, the reference considers only a few dates in 2017 and 2018, which does not make it appropriate to address long term climate change.
9181	2	9	48	9	51	The snow albedo feedback play a positive role around.. (positive in a mathematical manner) [Luzi Bernhard, Switzerland]	Taken into account - Text revised for better clarity.
27399	2	9	49	0		plays a role or dominant role? [Government of Nepal, Nepal]	Accepted - The sentence was edited and now highlights the fact that the snow albedo feedbackj plays an important role.
27401	2	9	49	0	50	unclear sentence; not only snow fall decrease but rapid melting in snow edge also contributes for acceleration of warming. Later process also need to be mentioned. [Government of Nepal, Nepal]	Taken into account - Text revised for better clarity; although the initial text does not exclude enhanced melting.
32927	2	9	50	9	50	Though stated later in the document, the point should be made here that the snow-albedo feedback should exhibit distinct spatial and seasonal patterns following the snowline. [Government of United States of America, United States of America]	Taken into account - The content of the Box was considerably revised for better policy relevance and lower emphasis on physical mechanisms.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27403	2	9	52	0		some connection is missing. what is its connection to warming? Will latent heating due to condensation increase warming in the high elevation or ?. I think this is not the established fact. [Government of Nepal, Nepal]	Taken into account - The text was revised for more clarity.
1129	2	9	53	9	54	The sentence is out of context. It is unclear, for example, what type of aerosols the sentence is referring to; and the type of aerosol is decisive for the sentence to be true or not. [Daniel Farinotti, Switzerland]	Taken into account - Such statements are now made in the Box 2.2 on "feedback".
26869	2	9	53	0	56	These findings about the reduced cooling effect of aerosols and the deposition of light absorbing particles should be prominent in the Executive summary. They help the reader to understand the disproportionate impacts of warming at higher elevations. [Ko Barrett, United States of America]	Taken into account - Consistent with other chapters and due to space constraints, changes in atmospheric drivers of the cryosphere are not elevated to ES and SPM.
30643	2	9	53	9	54	Is it really the cooling effect which causes solar dimming (singular), or rather the aerosols which cause solar dimming (plural)? please check [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Plural was retained.
11645	2	9	55	9	56	The deposition of light-absorbing particles on snow, in particular black carbon, can enhance warming rates via increased snow-albedo feedback. The word "increased" must be replaced by "diminish". [Government of Mexico, Mexico]	Taken into account - Text revised for clarity.
27405	2	9	56	0		increased or decreased snow-albedo effect? [Government of Nepal, Nepal]	Taken into account - Text revised for clarity.
28213	2	9	56	9	56	Should be ‘decreased snow-albedo feedback’. The snow-albedo feedback refers to additional cooling due the reflection of short wave radiation in the presence of snow. This effect is decreased in the presence of black carbon. [Martin Truffer, United States of America]	Taken into account - Text revised for clarity.
30223	2	9	56	9	56	Here and possible elsewhere, there should be mention about the impact of debris on glaciers. This is particularly important for Himalayan Glaciers and, in terms of albedo, absorption and ice melt effects, can have a significant influence. [Christine Dow, Canada]	Taken into account - The content of the Box was considerably revised for better policy relevance and lower emphasis on physical mechanisms.
27407	2	10	1	0		a term physical process may be the physical parameterizations? [Government of Nepal, Nepal]	Taken into account - Text revised for clarity.
1419	2	10	2	10	3	The sentence is redundant and un-understable. Should be deleted [Rene Forsberg, Denmark]	Taken into account - Text revised for clarity.
15455	2	10	2	10	3	The sentence is redundant and unclear. Please, consider deleting it. [EUCE, Belgium]	Taken into account - Text revised for clarity.
5303	2	10	3	10	3	Explain mention that combinations of these mechanisms may account for contrasting regional patterns (MDW Working Group, 2015). This helps understanding why there are regional differences. [Simone Schauwecker, Chile]	Taken into account - Text revised for clarity.
27409	2	10	3	0		climate regime may be more appropriate word. [Government of Nepal, Nepal]	Taken into account - Text revised for clarity.
3523	2	10	8	10	35	Recent references to consider: Over high altitude US regions, a progression from snow to rain and more moisture transport from atmospheric rivers (Mahoney et al. 2018 J. Clim https://doi.org/10.1175/JCLI-D-18-0118.1) with more rain on snow events increasing flood hazard (Musselman et al. (2018) Nature Clim http://doi.org/10.1038/s41558-018-0236-4) but contrasting effects on snowpack (Goldensen et al. (2018) J. Clim https://doi.org/10.1175/JCLI-D-18-0268.1) [Richard Allan, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Literature considered for inclusion in the Final Government Draft. Note that individual references are provided in Annex 2.A. Literature referred to focuses on assessment of past and future changes, rather than on process studies.
1131	2	10	10	10	10	Why "even"? The implied logics is elusive. [Daniel Farinotti, Switzerland]	Accepted - The word "even" was removed.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2681	2	10	10	10	22	The albedo of solid versus liquid precipitation differs significantly, from say, 0.9 to about 0.05. Therefore, as we receive more rainfall and less snowfall, we would expect the warming of mountain climate to get worse? [Thian Yew Gan, Canada]	Noted - This point is addressed in Boxes 2.1 and 2.2.
17441	2	10	10	10	22	Important to mention the effect of aspect and orientation of mountain ranges (rain shadow effect), as a challenge in documenting precipitation (solid and liquid) patterns. [Hugo Mantilla-Meluk, Colombia]	Taken into account - However, space constraints do not allow to provide detailed description of processes. Text is revised to better reflect the impact of terrain.
28681	2	10	10	10	35	In explanation of the heterogenety of the preecipitation data even within a maountain range the role of terrain should also be considered as it does play a major role in lloacl distribution of rain and/or snowfall. [Irena Mrak, Slovenia]	Taken into account - However, space constraints do not allow to provide detailed description of processes. Text is revised to better reflect the impact of terrain.
3351	2	10	14	10	14	The above reference may also be added here since it also discusses the limitations of remote sensing data in mountainous regions with respect to the water vapor content which is one of the key parameters in the studies on precipitation. [Divyesh Varade, India]	Taken into account - This reference was considered for producing the Final Government Draft.
9183	2	10	14	10	19	Actually new developed downscaling methods and models to few km grids can close the gap of capturing adequatly mountain precipitation (e.g. CH2018 (2018). CH2018 - Climate Scenarios for Switzerland, Technical Report, National Centre of Climate Services) [Luzi Bernhard, Switzerland]	Taken into account - However, this paragraph is about past changes, for which climate scenarios (such as CH2018, which consist of adjusted EUROCORDEX Regional Climate Models), and thus is comment is irrelevant at this location in this report. It is however Taken into account for contributing to revising the paragraph on future changes.
5307	2	10	16	10	18	To say "often dominated", you may need more references [Simone Schauwecker, Chile]	Taken into account - While the preparation of an IPCC report requires an exhaustive (as much as possible) analysis of peer reviewed literature, it is not possible to quote every single study but provide the key references appropriate for the assessment. The text was revised to better account for the fact that not only one study supports this statement.
1917	2	10	17	10	18	Consider adding Winski et al 2018 as a citation: https://www.nature.com/articles/s41598-017-18022-5 [Kimberley Miner, United States of America]	Noted - This reference is actually quoted on the same line.
10441	2	10	17	10	17	Understanding of decadal patterns and large scale atmospheric circulation patterns are essential to analyse regional and global precipitations. I think it is better to state that precipitation are influence by ...., alpine precipitations are influence by elevation, and decadal varaibility, ... [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - It is difficult to convert this comment into a concrete suggestion.
32929	2	10	18	10	18	Winski et al. document decadal shifts in snowfall accumulation. They also correlate accumulation over recent periods with geopotential height. However, the way the analysis was conducted provides relatively weak evidence for atmospheric circulation-driven trends in precipitation, as it cannot clearly differentiate interannual variability from trends. [Government of United States of America, United States of America]	Taken into account - Winski et al. (2017) is quoted here to support the fact that decadal variability and large scale circulation patterns play a strong role in modulating mountain precipitation amounts. The revised text reads :"Regional precipitation patterns are characterized by decadal variability [...] and influenced by shifts in large scale atmospheric circulation (e.g., in Alaska, Winski et al., 2017)"

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25631	2	10	19	10	22	While most mountain regions may not display trends in observed total annual precipitation, observations do indicate shifts towards higher more intense precipitation events and more frequent extreme precipitation events. There are also reported observed shifts in the seasonality of precipitation events. For example: Frei and Schär (2001) Detection Probability of Trends in Rare Events: Theory and Application to Heavy Precipitation in the Alpine Region. Journal of Climate, Vol. 14. Scherrer et al. (2016) Emerging trends in heavy precipitation and hot temperature extremes in Switzerland. Journal of Geophysical Research: Atmosphere, 121. doi. Climate dynamics and extreme precipitation and flood events in Central Europe. Integrated Assessment 1(4):281-300.:10.1002/2015JD024634. And: Frei et al. (2000) [Floortje van den Heuvel, Switzerland]	Taken into account - Text was revised to provide some evidence about past changes in extreme/rare events (which were already quoted in the Annex 2.A.2), but space constraints lead to keeping detailed descriptions to a minimum.
30645	2	10	19	0		Even "no change" is a trend, perhaps rather "do not exhibit clear direction of trends" [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Text revised accordingly.
1133	2	10	21	10	21	(1) The footnote defining "mean snowline elevation" should be placed earlier, since the terminology was used already.(e.g. P. 9 L. 49). (2) The definition should include a statement about the time period to which the "mean" refers to; some statements of change lack context otherwise. [Daniel Farinotti, Switzerland]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
3337	2	10	21	10	22	The research of Chinese scholars on precipitation change in the Qinghai-Tibet Plateau is not fully reflected here. It is therefore, suggested that some studies on snow change in the Qinghai-Tibet Plateau should be added to Appendix 2.A ,Table 2. For example, some studies (Sun et al., 2010; Zhou et al., 2018) indicate a decrease in the frequency and an increase in the mean intensity of snowfalls in the eastern Tibetan Plateau (ETP) since the 1960s. The total amount of snowfall during winter has increased due to the increase in heavy snowfalls. However, it is projected that future global warming will decrease snowfall in ETP. Sun J., H. Wang, W. Yuan, and H. Chen, 2010: Spatial-temporal features of intense snowfall events in China and their possible change. J. Geophys. Res., 115, D16110, https://doi.org/10.1029/2009JD013541. Zhou B., Z. Wang, Y. Shi, Y. Xu, Z. Han, 2018: Historical and future changes of snowfall events in China under a warming background. J Climate, 31: 5873-5889, doi:10.1175/JCLI-D-17-0428.1. [Peng CUI, China]	Taken into account - These references are considered for finalizing the Final Government Draft.
3355	2	10	21	10	21	The snow precipitation patterns are very unpredictable in the lower Himalayan belt. For example, in 2018 the snowfall occurred as early as in September (which usually occurs in the month of December), while in 2017 winter there was no snowfall. The snowfall for this season occured as late as at the end of January in 2018. Subsequently, for 2017, the winter was much shorter than usual, and for 2018, the winter is much longer than usual. Thus, I suggest changing 'high confidence' to 'medium confidence' in line 21. [Divyesh Varade, India]	Rejected - Interannual and decadal variability is recognized as a major component of precipitation changes, climate trends are assessed over multiple decades of observations. Therefore, observations from one or two single years cannot be used as a proof for an IPCC report.
18419	2	10	21	10	21	E1a: Footnote 3: How is the average elevation of the rain/snow transition determined? Could the authors please add half a sentence or a reference? [APECS Group Review, Germany]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
3521	2	10	24	0		precipitations --> precipitation [Richard Allan, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - Text revised accordingly.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10443	2	10	24	10	24	Which precipitation value - annual precipitation - connection with line 31, when solid precipitation is analysed [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Text revised here and line 31 for better clarity.
10485	2	10	24	10	25	A few words missing, change to "...under all Representative Concentration Pathways (RCP) in many regions including the tropical Andes,..." [James Renwick, New Zealand]	Accepted - Text was revised accordingly.
17805	2	10	24	10	35	Poorly worded and incomplete. Not clear what the topic of the paragraph is supposed to be - is it a short summary of GCM-projected future changes in precipitation for high mountain areas? Then why have results been included for some of the world's high mountain regions but not for others? What about the (perhaps more important) question of GCM-projected future changes in winter temperature, which affect the ratio of snow to rainfall? The preceding paragraph discusses past trends in temperature, but not future projections. [Sean Fleming, United States of America]	Taken into account - The text was revised for increased clarity.
1135	2	10	25	10	25	Here and elsewhere: For names of regions, it would probably make sense to stick to the nomenclature introduced with Figure 2.2. [Daniel Farinotti, Switzerland]	Accepted - Names of regions correspond to Figure 2.2
8995	2	10	25	0		First of many times that 'Himalayas' is used in Chapter 2. 'Himalaya' is the plural. Please find and replace. [Nina Hunter, South Africa]	Accepted - Text was revised accordingly.
5349	2	10	26	10	26	Are the projections of precipitation for the Southern Andes negative for all latitudes? I think that the projections of precipitation are relatively neutral, or unclear, for the Patagonian ice sheets (e.g. Schaefer et al., 2013) in comparison to arid and semiarid areas in Chile and Argentina. This is a consequence of the large diversity of climates contained in the definition of the Southern Andes region. I know that this cannot be changed for this report, but I think that when referring to the Southern Andes, one should always specify the sub-region (arid, semi-arid, Patagonia, etc.). The study of Mernild et al. (2015) supports this comment. [Alvaro Ayala, Chile]	Taken into account - The text was revised to better reflect the regional heterogeneity, within the strong space constrains of the report.
24521	2	10	26	10	26	Comment on a section within a chapter. The Andes mountain range is large from North to South, and it forms part of several countries. So, it is not accurate to mention the "southern Andes", because the meaning of "South" will depend on several parameters, points of view, such as climate, geography, or the country. A better statement could be "the Andes glacier at the south of latitude XXXXX". [Francisco Barraza, Chile]	Taken into account - The text was revised to better reflect the regional heterogeneity, within the strong space constrains of the report.
30647	2	10	26	0		"Mediterranean climate": Provide locations; does this apply to the Mediterranean region only, or also to Mediterranean climates as occur, for instance, in Australia? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The text was revised for more clarity regarding the geographical locations.
5309	2	10	27	10	30	It is better to start with a sentece like "precipitation increase depends on the season" and then name examples. [Simone Schauwecker, Chile]	Accepted - Text revised accordingly.
25633	2	10	27	10	29	Also in the Alps, the frequency and intensity of extreme precipitation events are projected to increase: Gobiet et al. (2014) 21st century climate change in the European Alps—A review. Science of The Total Environment Vol 493. https://doi.org/10.1016/j.scitotenv.2013.07.050. [Floortje van den Heuvel, Switzerland]	Accepted - This reference was quoted in Annex 2.A.2. More emphasis is placed on rare and extreme events for the Final Government Draft.
18551	2	10	29	10	29	"This indicates a LIKELY transition...". Please consider to change "likely" to "probably", so that the term "likely" is used as part of the calibrated uncertainty language. [APECS Group Review, Germany]	Accepted - Text revised accordingly.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24353	2	10	29	10	29	The Wijngaard et al. (2017) article published in PLOS One should also be cited here. Probably a better/stronger reference than Panday et al. (2015). Wijngaard RR, Lutz AF, Nepal S, Khanal S, Pradhananga S, Shrestha AB, et al. (2017) Future changes in hydro-climatic extremes in the Upper Indus, Ganges, and Brahmaputra River basins. PLoS ONE 12(12): e0190224. https://doi.org/10.1371/journal.pone.0190224 [Philippus Wester, Netherlands]	Taken into account - This reference was considered for producing the Final Government Draft.
32931	2	10	30	10	30	The finding of 'where it rains, it pours' with a warming climate, likely applies to a much broader region than stated here. Also, see reference by Giorgi et al. (2016), which seems to report similar findings for the Alps and convective summer precipitation. [Government of United States of America, United States of America]	Taken into account - This reference was considered for producing the Final Government Draft, and references referring to wintertime processes were preferably quoted because of the scope of this report on the high mountain cryosphere.
5351	2	10	31	10	32	I find the concept of mean snowline elevation a bit confusing in the context of future projections. Do the authors mean the current mean snowline elevation? I guess that the mean snowline elevation also changes (it most likely increases) in the future projections [Alvaro Ayala, Chile]	Accepted - The term "mean snowline" was removed, and higher/lower elevation used instead.
16809	2	10	31	10	35	You might think about citing Frei et al., The Cryosphere 12, 1-24, 2018 at this place. They investigated future snowfall changes in the European Alps, and results are in line with those presented here. [Sven Kotlarski, Switzerland]	Taken into account - This reference was present in Annex 2.A.2.
1137	2	10	32	10	32	The wording "emerging literature" seems somewhat misleading for studies that are half-a-decade old. Reword. [Daniel Farinotti, Switzerland]	Accepted - Text revised accordingly.
10487	2	10	32	10	33	Papers published 5-6 years ago are hardly "emerging literature". Has nothing more been published since? [James Renwick, New Zealand]	Accepted - Text revised accordingly.
25635	2	10	32	10	35	This is not so new, see: Beniston et al. (2003) Snow pack in the Swiss Alps under changing climatic conditions: an empirical approach for climate impacts studies. Theor. Appl. Climatol. 74, 19–31. DOI 10.1007/s00704-002-0709-1. [Floortje van den Heuvel, Switzerland]	Taken into account - The term "emerging evidence" was removed.
32933	2	10	32	10	34	This sentence references O'Gorman (2014) as a source for modest decreases or increases in snowfall at higher elevations, yet O'Gorman is focused on differences in the relative changes in mean snowfall versus extreme snow events rather than the elevational distribution of snow changes. [Government of United States of America, United States of America]	Taken into account - The sentence was edited for clarity and additional references are used to support the main statements.
8833	2	10	35	0		"lead" should be plural [Nina Hunter, South Africa]	Taken into accout. Text was checked and revised.
10445	2	10	35	10	35	so that annual precipitation incraese lead to snowfall increase - I think it is important to state all terminology correctly [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Correct terminology is critical ; in this case however, the term "annual" was not retained, because wintertime precipitation is concerned.
5469	2	10	39	11	9	In addition to wind speed, wind direction is also best to be investigated. [rashidian leila, Iran]	Taken into account - Wind direction is an important control overt the energy and mass balance of cryospheric elements, although there is not known literature addressing changes in wind direction. Material on wind speed is very scarce, and wind direction is even poorlier addressed in the literature.
5523	2	10	39	11	9	In addition to wind speed, wind direction is one of the most important meteorological parameters to evaluating climate change in mountain area. [Government of Iran, Iran]	Taken into account - Wind direction is an important control overt the energy and mass balance of cryospheric elements, although there is not known literature addressing changes in wind direction. Material on wind speed is very scarce, and wind direction is even poorlier addressed in the literature.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27417	2	10	39	0	43	The first paragraph of this section contains false statement; it says surface air temperature is one of the dominating variables for high mountain cryosphere changes [i.e. snow/ice ablation (melting+evaporation) or shrinkage snow/ice covered area]. Suuggestion to the first paragraph: Solar radiation radiation is the most dominating variable for snow / ice ablation in the high mountain cryosphere (e.g. Nepal Himalayas) as radiation contributes more than 85% of the melt energy, and more than 95% of ablation occurs during day time (Adhikary et al., 2002 and references therein). Also, absolute extreme values of solar radiation in Nepal Himalayas during fine weather conditions are quite high (i.e. close to solar constant: 1367 Wm-2) during pre-monsoon and monsoon seasons (Adhikary, 2012). (The contribution of sensible energy (air temperature) for snow/ice melt in the Himalayas is only about 10 %.) [Government of Nepal, Nepal]	Taken into account - Radiation is now given a more balanced position in the list of the drivers of the energy and mass balance of cryospheric components.
8835	2	10	41	0		Sentence is very long and slightly confusing. Suggest adding "namely" before "surface". [Nina Hunter, South Africa]	Accepted - The text was revised and shorter sentences are now used.
8837	2	10	42	0		"or" should be "and" [Nina Hunter, South Africa]	Accepted - The text was revised accordingly.
32935	2	10	42	10	43	The sentence, "Therefore, most simulation studies of cryospheric changes are mainly driven by temperature and precipitation" should be better supported. While it's likely that this is true, there are a number of studies using dynamical models to investigate changes in mountain snow, ice, and glaciers. [Government of United States of America, United States of America]	Accepted - The text was revised to better reflect the complexity of approaches used in the literature.
18553	2	10	45	10	47	On page 2-15, lines 18-19, we read that glacier mass loss in the Alps was excacerbated by increasing longwave radiation and latent heat flux (Thibert et al., 2018). Consider adding reference to Thibert et al. 2018 also here. [APECS Group Review, Germany]	Accepted - The text was revised to provide a more balanced representation of studies using variables beyond temperature and precipitation.
27411	2	10	45	0		what is long wave heat fluxes? I think this sentence is not correct. When we talk about latent then sensible or ground heat flux should come along ! [Government of Nepal, Nepal]	Rejected - Atmospheric moisture is responsible for latent (turbulent) fluxes and also influences incoming longwave (thermal) heat flux from the atmosphere. Atmospheric humidity is not directly connected to sensible and ground heat flux (see Armstrong and Brun, 2008).
8839	2	10	46	0		A definition of "ablation" would be useful in parentheses. [Nina Hunter, South Africa]	Rejected - The term "ablation" is defined in the Glossary.
1139	2	10	47	10	47	(1) The sentence has a break in its logics and needs to be split after "ice melt". (2) The correct wording would be "short-lied climate forgers" (not "forcings"), I believe. [Daniel Farinotti, Switzerland]	Accepted - The sentence was revised and the term "forcers" was used instead of "forcings".
2683	2	10	47	10	51	The attenuating effects of aerosols to incoming solar radiation in high mountains should generally be mininal? [Thian Yew Gan, Canada]	Accepted - The text was clarified.
30649	2	10	47	0		“forcers” instead of forcings [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Text revised accordingly.
9185	2	10	48	10	51	Philipona 2013: Aren't there more recent studies of Rolf that contradict that? [Luzi Bernhard, Switzerland]	Taken into account - There was no reference found, which contradict this statement.
3991	2	10	53	11	9	During melt conditions, the glacier boundary layer is typically decoupled from the general circulation and dominated by katabatic flow, and may not be as strongly affected by changes in larger-scale wind pattern. [Robert Moore, Canada]	Taken into account - The formulation in the document does not contradict that statement.
5311	2	10	53	10	53	also sublimation (not only melt) [Simone Schauwecker, Chile]	Accepted - Melt was replaced by ablation, which is more general and defined in the Gloassry.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5353	2	10	53	10	54	Wind also controls snow sublimation [Alvaro Ayala, Chile]	Accepted - Melt was replaced by ablation, which is more general and defined in the Gloassry.
22115	2	10	53	10	53	"...melt and sublimation rates..." [Joseph Shea, Canada]	Accepted - Melt was replaced by ablation, which is more general and defined in the Gloassry.
3339	2	10	54	11	2	Regarding the issue of wind speed in the Qinghai-Tibet Plateau, please refer to Yang et al., 2014 and Kuang and Jiao, 2016 and other papers to further clarify the time period. References just mentioned that the wind speed began to decrease since 1970s. Hence, there is s need of further explanation using the relevant data and literature about "when it stopped?" and "when it will tend to stabilize or increase?". Relevant documents need to be consulted for further clarification. [Peng CUI, China]	Taken into account - Given the low amount of evidence, text on wind speed changes was kept to a minimum.
10447	2	10	54	11	1	Could a numerical value be provided how much wind decreased over the Tibetian Plateau [Elzbieta Czyzowska-Wisniewski, United States of America]	Taken into account - Given the low amount of evidence, text on wind speed changes was kept to a minimum, and not quantitative figure could be given.
22117	2	11	0	11		It is critical to distinguish clearly between snow cover and snow depth/mass/volume throughout section 2.2.2. The former can be reliably obtained through remote sensing, but reliable spatially distributed estimates/observations of the latter remain a challenge. [Joseph Shea, Canada]	Accepted - The text was revised for better clarity.
27413	2	11	0	0		Norris et al. (2018) may contribute to discuss the contrasting trends of snow fall in Himalayas and Karakorum. There are few other studies (Cannnon et a...) which have high lighted how snowfall in Himalaya and Karakorum are changing in connection to changing track of western disturbances in recent decades. [Government of Nepal, Nepal]	Taken into account - This statement refers mostly to the influence of synotic weather patterns on the variability of precipitation, addressed in section 2.2.1.2. References were included in the assessment of relevant literature.
32937	2	11	1	11	9	Given the limited literature around changes in wind speed and direction in mountain environments, it would be worth looking at and referencing Luce et al. (2013), The missing mountain water: slower westerlies decrease orographic enhancement in the Pacific Northwest USA, Science. [Government of United States of America, United States of America]	Taken into account - This statement refers mostly to the influence of synotic weather patterns on the variability of precipitation, addressed in section 2.2.1.2. References were included in the assessment of relevant literature.
32939	2	11	2	11	2	Authors should clarify that the reference here is to 'near surface' wind speeds. Also line 6-9 doesn't seem to say much definitive about surface wind speeds other than they are not expected to change much in the little bit of literature available. [Government of United States of America, United States of America]	Accepted - "Near surface" was added where relevant, indeed the purpose of this paragraph is to address near surface wind speed.
32559	2	11	5	11	5	Chnage "Najac et al., 2011" to "Najac and Terray, 211" [John Diiwu, Canada]	Rejected - The three authors are Julien Najac, Christine Lac and Laurent Terray
1421	2	11	6	11	9	Delete, a very local case in Austria don't have much weight, and should not mentioned in a global report [Rene Forsberg, Denmark]	Accepted - This study was not retained in the FGD.
18555	2	11	6	11	7	"Hanzer et al. (2018) computed 21st century changes of wind speed for a high mountain catchment in Austria, finding increases in winter (on average from 0 to 0.2 m s-1) and decreases in summer (from 0 to 0.2 m s-1)". Changes in wind speeds provided here, i.e. "increases in winter on average from 0 to 2 m/s" and "decreases in summer from 0 to 0.2 m/s", are difficult to understand. Did you mean "by up to 0.2 m/s"? Please clarify. [APECS Group Review, Germany]	Accepted - Indeed changes up to 2 m s-1 (negative or positive) are reported here. The text was revised for better clarity.
26327	2	11	6	11	9	It would be useful to have a short explanation of the relationship between warming and wind speed here. [Ethan Pierce, United States of America]	Taken into account - Given the low amount of evidence, text on wind speed changes was kept to a minimum.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2261	2	11	11	12	12	Somewhere in the section on snow cover mention should be made of the fact that during the early snow season (fall) snow-cover formation primarily depends on precipitation (air temperatures being cold enough) but that in spring snow-cover vanishing primarily depends on temperature (melting). As a consequence, snow-cover duration under the influence of atmospheric warming tends to become shorter during springtime rather than during fall. [Wilfried Haeberli, Switzerland]	Accepted - The text was revised in order to clarify such statements
5475	2	11	12	14	3	some research studies have been accomplished in Iran (high land Area) about climate change which are presented below [rashidian leila, Iran]	Taken into account - More references for Iran were assessed and used in the FGD.
5529	2	11	12	14	3	some research studies have been accomplished in Iran (high land Area) about climate change which are presented below [Government of Iran, Iran]	Taken into account - More references for Iran were assessed and used in the FGD.
1973	2	11	13	11	13	Snow on the ground is a widespread (although globally not ubiquitous) component of the mountain cryosphere.' [Harald Pauli, Austria]	Accepted - "ubiquitous" replaced by "widespread"
2745	2	11	13	11	21	Better to include the information of mean, maximum, and minimum areas of snow cover during observation period. It is also welcome to clarify mountains where snow cover is more important than other regions as for water resource or recreation. [Shiyin Liu, China]	Taken into account - Regional studies are provided in the Supplement table. Impacts ofmountain snow for water resources and recreation are provided in the introduction of the chapter (and in Chapter 1 of SROCC).
32941	2	11	13	12	12	Section 2.2.2 does not appear to contain any major errors, but it is not as well supported from the literature as it could be. There are few references pointing to changes in North American mountain snowpack, a particularly well studied area. Notable papers that should probably be cited include Mote et al. (2018), Dramatic declines in snowpack in the western US; Klos et al. (2014), Extent of the rain-snow transition zone in the western US under historic and projecte climate; Fyfe et al. (2017), Large near-term projected snowpack loss over the western United States; and Pederson et al. (2011), The unusual nature of recent snowpack declines in the North American cordillera. [Government of United States of America, United States of America]	Accepted - Most references mentioned in the comment were already included in Supplementary Table 2.2. Additional references were considered for inclusion as part of the assessment process.
8841	2	11	14	0		"in" not "for" [Nina Hunter, South Africa]	Accepted - Text was revised accordingly.
28021	2	11	15	0		"key role": Are there other components playing a role in nourishing glaciers? [Frank Paul, Switzerland]	Accepted – text revised
28023	2	11	15	0		Although more lengthy, I would write 'glaciers in mountains' as a "mountain glacier" is a rather specific type of glacier (e.g. such as a valley glacier, cirque or ice cap) [Frank Paul, Switzerland]	Accepted – text revised
28215	2	11	15	11	16	'when present at the surface' is redundant [Martin Truffer, United States of America]	Accepted – text revised
3391	2	11	16	0	17	Perhaps add one or two references to the ecosystem impacts here? [Sven Lukas, Sweden]	Taken into account - The sentence was revised, and introductory material is now provided in the introductory section, to avoid redundancy. The section on snow cover focuses exclusively on assessment of past and future changes in snow cover.
28025	2	11	16	0		Maybe add the diverse role of snow cover falling in early autumn: keeping glaciers but warming permafrost? [Frank Paul, Switzerland]	Taken into account - space constraints make it difficult to convey such detailed information in the assessment (the information may be found in text books or review articles). The Chapter 1 of SROCC was revised to include more background information on snow cover.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27419	2	11	18	0	19	As appeared in the text: … (e.g. solid precipitation), and those responsible for its ablation and melt (e.g. air temperature, incoming radiation, deposition of light absorbing particles). Please rewrite it as; …… and those responsible for its ablation (e.g. air temperature, incoming solar radiation and deposition of light absorbing particles that strongly reduce snow surface albedo) (Adhikary et al., 2002).(Ablation = melting + evaporation. So no need to write ..ablation and melt) [Government of Nepal, Nepal]	Accepted - "and melt" was removed.
12705	2	11	19	11	21	In the short- and medium-term the aspect of seasonal snow distribution and changes will have important implications for areas around mean 0° elevation, and I agree strongly that particularly socio-economic development might be implicated heavily. [Thomas Dax, Austria]	Noted
26329	2	11	19	11	21	Include a citation for this claim. [Ethan Pierce, United States of America]	Taken into account - However, the text was revised and this claim is not anymore in the FGD.
8843	2	11	20	11	21	Suggest changing phrase "generating … reductions" to "with projected drastic reductions generating conern from multiple stakeholders" [Nina Hunter, South Africa]	Accepted – text revised
24523	2	11	20	11	20	Comment on a section within a chapter. Which is the high range that the authors use here to characterize as mid-elevation areas? Maybe it would be good to add some elevation, especially if they identified those areas as “particularly sensitive to climate change.” [Francisco Barraza, Chile]	Taken into account - The term "mean snowline elevation" was removed, and Box 2.1 explicitly introduces the relationships between elevation ranges (lower, higher) and rain/snow transition elevation.
14961	2	11	23	11	28	This text can be deleted. An explanation about snow cover and its variability due to decadal interannual variability seems redundant [Government of Germany, Germany]	Rejected - The interannual variability of snow conditions is a key, often misconceived, attribute of this cyrospheric component. Efforts were made to reduce text length.
28027	2	11	23	0		I suggest writing "by a very strong spatial and interannual variability" [Frank Paul, Switzerland]	Rejected - It is correct that the snow cover has a strong spatial variability, but this is not the purpose of this sentence, focusing on high resolution (annual) variability and long term trends.
8845	2	11	24	0		"similarly" should be "similar" [Nina Hunter, South Africa]	Accepted – text revised
30651	2	11	25	0		"sufficiently long": Could you define a minimum duration? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text was revised to indicate that several decades are necessary to assess past changes in snow cover. It is however not possible to give a "fixed" number.
22119	2	11	26	11	26	long term monitoring of snow is particularly absent in high mountain locations due to inaccessibility and logistics. [Joseph Shea, Canada]	Noted - This comment does not require a change in the text.
8847	2	11	27	0		"provide" should be "provides" [Nina Hunter, South Africa]	Accepted - text revised.
11073	2	11	27	11	27	Coupled with ground-based methodology, Satellite remote sensing provide new capabilities in monitoring snow cover at local to global scales (not only at regional scale), providing a synoptic view. [Charlotte Poussin, Switzerland]	Taken into account - Text was revised to emphase that the text deals with snow in mountains, hence with a clear regional focus.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11075	2	11	27	11	28	The problem of record length is not a big issue for optical remote sensing (widely used to identify snow cover extension) that start since 1984. But other issues are problematic such as cloud and vegetation. [Charlotte Poussin, Switzerland]	Taken into account - Records starting in 1984 are 35 years long, at best. This is just over the standard 30 years duration for establishing a climatological baseline, and thus too short to infer climatological trends on its own. Text was revised to mention difficulties induced by vegetation, clouds and complex topography. A recent publication (Bormann et al., 2018) was quoted in this pararaph, which contains up-to-date information about snow trends from space.
13823	2	11	27	11	28	The statements here clearly do not mirror the evidence presented in lines 10-12 for Japan, which appears to be the longest data set available, thus a stronger explanation is required. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - This comment refers to "line 10-12" and "Japan" ; no material was found corresponding to Japan and this line number.
28559	2	11	27	11	28	Suggestion : maybe add that the reliability of satellite products are unequal in forested environments that are often encountered in mountain regions. [Isabelle Gouttevin, France]	Accepted - Text was revised to refer to such issues, and a recent reference was added (Bormann et al., 2018, NCC).
32943	2	11	28	11	31	This statement is not rigorously supported by the data presented, and may not be correct: "Below the mean snowline elevation, there is high confidence that the mountain snow cover has declined since the middle of the 20th century, with regional variations." Table 3 in Appendix 2a is an amalgam of studies, most of which are small-scale in situ or GCM/RCMs. It is surprising that there is not a MODIS or Landsat compilation study that can be referenced, but there likely isn't one. The observational data are simply ambiguous on this point. There is no global trend in changes in mountain snow cover. Consequently, the sentence cannot be qualified as "high confidence". Maybe it could if applied only to very well-studied regions such as the U.S. West. The change probably needs to be described more accurately in the text: There may be no change in extent, but there may be earlier onset of melting. [Government of United States of America, United States of America]	Taken into account - The supplementary table indeed provides evidence from regional studies, which generally do not use the same indices and methods to assess past and future trends. This is a given, and this contrasts with the situation in other scientific domains where international harmonization has taken place (e.g. glacier mass balance). Efforts were taken to revise the text and highlight regions where the changes are better known. Last, it is correct that there is no global-scale remote-sensing study found on mountain snow cover trends (remote sensing time series are often too short, as mentioned in the text, in the revised version along with a synthesis paper on assessing snow cover trends from space - featuring a focus on mountain snow, Bormann et al., 2018, NCC)
1621	2	11	30	11	31	Why is "medium confidence" being used to describe "mean snowline elevation, snow cover trends are generally insignificant or unknown" when it is stated that these effects are unknown? Should this be "low confidence"? [Nora Richter, United States of America]	Taken into account - The text was revised for more clarity, and in particular the mean snowline elevation is not anymore referred to as such.
22121	2	11	30	11	30	remove “Well” (subjective, and not very informative) [Joseph Shea, Canada]	Accepted - text revised.
18557	2	11	31	11	31	"snow cover trends are generally insignificant or unknown (medium confidence)". Please move "(medium confidence)" just after "insignificant". As it is now, it appears there is medium confidence that trends are unknown. [APECS Group Review, Germany]	Accepted - Text was revised accordiingly.
24545	2	11	32	0		Add section 2.2.2.1 [Armand Hernández, Spain]	Rejected - Adding such level of granularity would be inconsistent with the rest of the chapter.
28029	2	11	33	0		I suggest writing "seasonal snow in mountain regions" as the term area is also used for size (e.g. area in square kilometre). [Frank Paul, Switzerland]	Accepted - text revised.
17033	2	11	34	11	36	I think that this statement needs a reference [Jorge Carrasco, Chile]	Accepted - The text was revised for better clarity and a reference is now provided in support to this statement (in a reformulated sentence).

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8849	2	11	36	0		Suggest inserting "to" before "increases" [Nina Hunter, South Africa]	Accepted - text revised.
27421	2	11	36	0		As appeared in the text: ..... precipitation (rain) below the mean snowline elevation and increases in melt rate at all elevations.(It says, below the mean snowline precipitation is mostly in liquid form (rain). It means above the mean snow line precipitation is in the form of snow. So, the statement ... 'increasing in melt rate at all elevations' is not logical.) The statement can be rewriten as ... precipitation (rain) below the mean snowline elevation and consequently increases in melt rate. The following references should be added to the report. 1. Adhikary, S., Yamaguchi Y. and Ogawa, K. (2002), Estimation of snow ablation under a dust layer covering a wide range of albedo: Hydrological Processes, 16, 2853-2865. 2. Adhikary, S. (2012), Seasonal and spatial variation of solar radiation in Nepal Himalayas: Journal of Hydrology and Meteorology, Vol. 8, Number 1, 1-9. [Government of Nepal, Nepal]	Rejected - Melt refers to the melt of snow on the ground. This thus concerns the snow cover both above and below the mean snowline. The only difference between above and below the mean snowline concerns the rain/snow partitioning during precipitation events, and not what happens when the snow cover melts.
22881	2	11	38	11	40	unclear, I suggest: Assessing the impact of the deposition of short-lived climate forcers on snow changes is an emerging issue. [Christoph Marty, Switzerland]	Accepted - text revised.
1141	2	11	40	11	40	The common wording is "light absorbing impurities", not "light absorbing particles" (note that the former is used later in the text, P. 28, L. 13-14) [Daniel Farinotti, Switzerland]	Taken into account - There is a shift a terminology that this report adopts. Light absorbing impurities can be abbreviated to LAI, which can be misunderstood as Leaf Area Index. Furthermore, "impurities" holds some judgement. We adopt here the term ligh absorbing particles, in line with the recent review article by Skiles et al. (2018, NCC).
11647	2	11	40	11	42	About this topic, according with Ontiveros, Delgado & Cortés (2015) there is a relation between volcanic activity and/or local air pollution sources with the glaciers retreat. https://www.redalyc.org/articulo.oa?id=56842730001 [Government of Mexico, Mexico]	Taken into account - The literature citation provided does not specifically discuss the role of light absorbing particles in changes of snow and glaciers.
14963	2	11	40	11	42	A literature citation would be helpful [Government of Germany, Germany]	Added a reference to the recent review paper by Skiles et al. (2018, NCC).
26331	2	11	44	11	50	Include more recent citations – the line above says this is an emerging issue. [Ethan Pierce, United States of America]	Taken in account - FOD references in this part of the text date back to 2014, 2015 and 2018. This does not contradict the fact that this is an emerging issue. A limited number of additional references (due to space contrasints) are added for FGD.
17035	2	11	45	11	50	What about black carbon in the southern Andes mountains? [Jorge Carrasco, Chile]	Accepted - A reference a statement for the Andes was added.
27039	2	11	45	11	45	Here some reference is needed. E.g.: Painter, T. H., Skiles, S. M., Deems, J. S., Brandt, W. T. and Dozier, J.: Variation in Rising Limb of Colorado River Snowmelt Runoff Hydrograph Controlled by Dust Radiative Forcing in Snow, Geophys. Res. Lett., 45 doi:10.1002/2017GL075826, 2018. [Biagio Di Mauro, Italy]	Accepted - rext revised.
1423	2	11	46	11	50	These statements should have a litterature reference [Rene Forsberg, Denmark]	Accepted - The section was revised and more literature references provided.
3131	2	11	46	11	50	Missing references to back up the statements [Fanny Brun, France]	Taken into account - The section was revised and more literature references provided.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14965	2	11	46	11	50	The increase in snow or ice melt is scarcely cited. I would recommend to cite J. Box, et al. 2012 (The Cryosphere, 6, 821-839. doi:10.5194/tc-6-821-2012) [Government of Germany, Germany]	Rejected - This literature suggestion refers to the Greenland Ice Sheet. Note however that additional references were added here.
15457	2	11	46	11	50	These statements should have a literature reference. [EUCE, Belgium]	Accepted - The section was revised and more literature references provided.
270	2	11	47	11	47	…, as identified in High Mountain Asia and in South America (e.g. Cereceda-Balic, F.; Palomo-Marín, M. R.; Bernalte, E.; Vidal, V.; Christie, J.; Fadic, X. et al. (2012): Impact of Santiago de Chile urban atmospheric pollution on anthropogenic trace elements enrichment in snow precipitation at Cerro Colorado, Central Andes. In: Atmospheric Environment 47, S. 51–57. DOI: 10.1016/j.atmosenv.2011.11.045.). [Sabine Baumann, Germany]	Taken into account - Note that the focus of the report is on long-term (climate timescales) changes of snow and glacier, so literature specifically discussing the impact of light absorbing particles was generally preferred.
24355	2	11	47	11	47	References are needed for "as identified in High Mountain Asia". See cryosphere and air pollution chapters HKH Assessment report published by Springer in Jan 2019. [Philippus Wester, Netherlands]	Taken into account - The text was revised to better account for regional-scale evidence.
27041	2	11	47	11	48	Here some reference is needed regarding the impact of impurities on snow cover in High Mountain Asia [Biagio Di Mauro, Italy]	Taken into account - The text was revised to better account for regional-scale evidence.
8851	2	11	48	11	49	Sentence difficult to understand - is it possible to rephrase to make more understandable? "are predominant over" could be improved upon. [Nina Hunter, South Africa]	Taken into account - The text was revised for better clarity.
22635	2	11	48	11	50	The Andes are missing in this list, see Molina et al., (2015) Molina, L. T., Gallardo, L., Andrade, M., Baumgardner, D., Bórquez, R., Casassa, G., … Schwarz, J. P. (2015). Pollution and its Impacts on the South American Cryosphere Earth ' s Future. Earth's Future, 3, 345–369. https://doi.org/10.1002/2015EF000311.Universitario [Lukas Arenson, Canada]	Accepted - A reference a statement for the Andes was added.
27043	2	11	48	11	48	This is a strong statement. References are needed regarding the increasing dust depositions. Recent ice coring of mountain glaciers can be used as archive for impurities depositions in the last century. [Biagio Di Mauro, Italy]	Taken into account - The text was revised for better clarity and consistency with recent and relevant literature.
24547	2	11	51	0		Add section 2.2.2.2 [Armand Hernández, Spain]	Rejected - Space constrains do not allow adding more subsections here, especially gievn that the projection part covers one paragraph.
12063	2	11	52	14	3	In Fig 2.3, it is specifically marked that Himalaya at an elevation of 4000-5000 m and 5000-6000 m registers a biggest increase in winter temperature (maximum projected warming>11℃), a (slight) increase in winter precipitation, while snow water equivalent decreases by more than 40%, and that Hindu-Kush at an elevation of 2000-3000 m registers a biggest increase in winter temperature, which indicates an increasing winter precipitation and a decreasing snow water equivalent that stands at 10-40%. This conclusion is inconsistent with the previous one (lines 7-8, page 12) that "…, well above the mean snowline elevation, projected reductions are smaller…". So it is suggested to check and assign the conclusion with a confidence level. [Government of China, China]	Taken into account - Changes in snow cover are generally lower at higher elevation, which is reflected in the figure and in the text.
8563	2	11	53	11	53	Are the terms "RCM" and "GCM" defined before? [Deborah Verfaillie, Spain]	Taken into account - GCM and RCM are introduced earlier in the FGD Chapter 2.
18521	2	11	53	11	53	Acronymn "GCM" and "RCM" have not been introduced at this point in this chapter. [APECS Group Review, Germany]	Accepted - The terms are now introduced earlier in the document.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24549	2	11	53	0		GCM and RCM should be defined because they have not been defined in this chapter. Moreover, these achronyms are used in a different way in the previous section. [Armand Hernández, Spain]	Accepted - The terms are now introduced earlier in the document.
24889	2	11	53	11	53	Please, insert the definitions of the acronyms GCM and RCM (because the former it is not explicitly defined until the page 16, and the later is not defined at all in this chapter). [Hernan Edgardo Sala, Argentina]	Accepted - The terms are now introduced earlier in the document.
9187	2	11	54	12	3	again CH2018 and Frei et al 2018. Future snowfall in the Alps: projections based on the EURO-CORDEX regional climate models. The Cryosphere 12, 1 - 24 [Luzi Bernhard, Switzerland]	Rejected - Frei et al. 2018 is relevant for snow precipitation (and referred to in Appendix 2.A.2), but not for snow on the ground.
32945	2	11	54	11	57	Should also cite Painter, Thomas H., Jeffrey S. Deems, Jayne Belnap, Alan F. Hamlet, Christopher C. Landry, and Bradley-Udall. "Response of Colorado River Runoff to Dust Radiative Forcing in Snow." Proceedings of the National Academy of Sciences, 107, no. 40 (2010): 17125-17130. [Government of United States of America, United States of America]	Rejected - This reference is Taken into account in the "observed changes part" above, but does not provide relevant information here for future changes.
24551	2	12	2	0		In my opinion, specific places from High Mountain Asia should not be mentioned here. [Armand Hernández, Spain]	Taken into account - Note, however, that many review comments on FOD and SOD encouraged providing more regional information. In the specific case of snow, this is conveyed both in the main text but also in the supplementary table.
32947	2	12	2	12	12	The discussion of future snow pack changes focuses appropriately on depth or mass, but it should increase its nearly absent coverage of the duration of the snow cover season. For example, below the mean snowline, it is expected that both mass and seasonal duration of snow cover will decrease, but at higher elevations it is possible, even likely, that the maximum mass of snow could increase even as the seasonal duration of snow cover decreases. Authors should consider adding a brief reference to snow cover seasonality. There is quite a bit of remote-sensing work historically that has focused on snow cover rather than mass or SWE. [Government of United States of America, United States of America]	Taken into account - The revised text assesses changes in snow cover duration where evidence is available - as shown in the supplementary tables Tables 5 and 6.
2685	2	12	3	12	5	I don't understand why below the mean snowline elevation, the snow cover (depth or mass) is projected to decline by 25%, between the recent past period (1986-2005) and the near future (2031-2050), regardless of the RCP climate scenario? [Thian Yew Gan, Canada]	Taken into account - The text was revised for clarity. The FGD contains a cross chapter box on scenarios, which highlights the fact that committed changes until 2050 do barely depend on the the emission scenario.
24553	2	12	5	0		Degree of confidence is required for this statement [Armand Hernández, Spain]	Taken into account - Likelihood statements are now explicitly provided in the text (likely range).
1623	2	12	7	12	8	In a previous part of this section, changes in snow cover at high elevations as insignificant or unknown with medium confidence. Why is this "high confidence"? Please clarify. [Nora Richter, United States of America]	Taken into account - Past changes at high elevation are known with a lower level of confidence than the confidence level of future changes at high elevation. Also the sentence states that there is high confidence that high elevation changes will be smaller than lower elevation changes.
24555	2	12	7	0	9	Reference needed [Armand Hernández, Spain]	Rejected - references are provided in Annex 2.A.3
22123	2	12	8	12	8	rephrase: "…projected reductions are smaller (high confidence), as temperature increases at higher elevations affect the ablation component of snow mass evolution, and not the onset and accumulation component." [Joseph Shea, Canada]	Accepted - Text revised accordingly.
22883	2	12	9	12	10	The projected increase snow accumulation may exceed the projected increase in melt, resulting in net increase in snow mass and duration during the winter half year. [Christoph Marty, Switzerland]	Accepted - This was Taken into account in the revised text, better highlighting the impact on reduced snow cover duration (annual scale) but potential increase in wintertime snow amount.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28031	2	12	9	0		I suggest writing "snow cover evolution, rather than ..." [Frank Paul, Switzerland]	Accepted - Text revised accordingly.
3357	2	12	11	12	12	The above discussion effectuates a contradiction to this statement. Again I suggest changing 'high confidence' to 'medium confidence' in line 12. [Divyesh Varade, India]	Rejected - Sustained variability is not contradictory with long term changes, which are both known with high confidence according to state-of-the-art literature.
32949	2	12	11	12	12	"All elevation levels and regions of the world are projected to exhibit sustained interannual variability of snow conditions throughout the 21st century (high confidence)." Without an explicit magnitude or direction, "snow conditions" may be too broad. It is correct to focus on variability as a current and continuing characteristic, but the way phrased this implies that interannual variability will be the same, which will likely not be the case. For example, variability in snow cover duration could increase substantially (some historically normal years, but more early melt years) but the variability in the amount of maximum SWE could stay quite similar. Authors should consider a caveat to the existing statement that acknowledges that "snow conditions" refers to multiple aspects whose variability may respond differently to warming. [Government of United States of America, United States of America]	Accepted - The text was revised, explicitly replacing "snow conditions" by "snow cover depth, mass and duration".
28033	2	12	14	0		I would add that in steep mountain topography, snow cover can well persist below the local snow line and nearly uneffected by increasing temperatures (as the snow might come from higher elevations or is otherwise protected from radiation). Trends derived from climate models will not capture such local deviations and ignore the related processes. Howevver, such permaent snow and/or ice bodies might be locally of high importance (see also artificial attempts described in Box 2.3) [Frank Paul, Switzerland]	Agreed, but space constraints do not make it possible to convey this type of statement with the required clarity. The text for FGD is rephrased to attempt to convey such information, though.
2419	2	12	41	0		My previous comment on FOD was unfortunately ignored. Therefore once again, you need to state that precipitation was subject to significant natural variation also in pre-industrial time during the past millennia. Otherwise readers might get the wrong impression that the precipitation changes of the past 100 years are unprecedented in the Holocene or even late Holocene context (see e.g. Ljungqvist et al. 2016, doi: doi:10.1038/nature17418; Lüning et al. 2018, doi: 10.1016/j.palaeo.2018.01.025). Ignoring climatic and precipitation changes in pre-Little-Ice-Age times is climatically shortsighted and leads to questions about the robustness of this chapter. [Sebastian Luening, Portugal]	Rejected - As indicated in the introduction to this chapter (and in the framing chapter 1), changes before pre-industrial periods are not covered in SROCC Chapter 2.
971	2	13	0	0		2.3 Should read Karakorum ? [Falk Huettmann, United States of America]	Rejected - written Karakoram
8569	2	13	0	13		Figure 2.3: Some of the text in the figure itself is too small to be read. Especially the legend on the right of panel b). [Deborah Verfaillie, Spain]	Accepted - The figure was amended to address this comment.
10489	2	13	0	13	0	Figure 2.3 has a lot of information but is very hard to decipher. Would line plots work better? [James Renwick, New Zealand]	Taken into account - The figure was amended for better clarity.
10891	2	13	0	0		2.3 Overcrowded and too complicated; even after several attempts I don't seem to be able to read it. [otto otto simonett, Switzerland]	Taken into account - The figure was amended for better clarity.
24557	2	13	0	0		Why the surface area is not quantified for b) and c)? Why are not displayed the horizontal lines for b) and c)? At least, the reasons should be explained in the caption. [Armand Hernández, Spain]	Accepted - The figure was amended to address this comment and provide results in the most possible harmonized way.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
26871	2	13	0	0		This figure is of limited value as drafted. Why limited to three high mountain areas? And only European Alps have info for all RCPs? Not sure it should be included if it is not more complete. [Ko Barrett, United States of America]	Taken into account - The figure was amended to address this comment, with additional regions covered.
27141	2	13	0	13		on Fig 2.3, it would be worth adding the winter 0°C elevation (solid line) also on panel b (Himalaya) and c (Hindu Kush Karakoram). Actually, in the central and eastern part of the Himalayas, the winter snow water equivalent change below 2000 m asl does not make sense because this elevation is almost never reached by snowfalls. Also these areas of the Himalayas are dry in winter, and the important variable to display is not winter snow cover but summer (monsoonal) snow cover cover. [Patrick Wagnon, France]	Taken into account - The figure was improved using this comment, keeping it altogether as simple and compact as possible.
100	2	13	1	13	1	Fig. 2.3: The lower axis labels should be repeated on the upper 2 rows of subpanels--it took me quite a while to understand what those numbers were under the upper rows. [Baylor Fox-Kemper, United States of America]	Taken into account - The figure was amended for better clarity.
1425	2	13	1	14	3	Figure convoluted and with too small font. Lack top indications of periods (1986-2005, 2031-2050, 2080-99). There is no explanation what the "Ensemble member" subtext and and associtated numbers refer to. [Rene Forsberg, Denmark]	Taken into account - The figure was amended for better clarity.
2687	2	13	1	13	10	I find this figure to be confusing, besides the variability of projected changes between ensemble members are so large that projected changes don't mean much to the readers. [Thian Yew Gan, Canada]	Taken into account - The figure was amended for better clarity.
15459	2	13	1	14	3	The Figure is convoluted and with too small font. There is a lack top indications of periods (1986-2005, 2031-2050, 2080-99). There is no explanation what the "Ensemble member" subtext and and associtated numbers refer to. [EUCE, Belgium]	Taken into account - The figure was amended for better clarity.
18559	2	13	1	14	3	Consider moving Figure 2.3 to Box 2.1 "Elevation-dependant warming". Otherwise, this graphic is not really necessary for the text, as there is no reference to Figure 2.3 anywhere in this chapter. If decided to leave the figure, please consider making it more readible and making the upper panels (the Alps) more similarly looking to panels b) and c), e.g. by removing the horizontal lines from a) or the right-most panel of hypsometry for a). There is also a mistake in figure caption in line 6: please change UPPER to LOWER. [APECS Group Review, Germany]	Taken into account - The figure was amended for better clarity.
31591	2	13	1	0		Figure 2.3. The captions referes to the number of available simulations for each panel, as being in the upper right corner - but the only number is in the lower panel - Is "ensemble members" the same as "number of simulations"? If so, it would be better to keep a single term for them. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The figure was amended for better clarity.
32951	2	13	1	13	1	The Himalaya and Hindu-Kush Karakoram are displayed as 1,000-m elevation classes rather than 500-m elevation classes. [Government of United States of America, United States of America]	Noted - Given the spatial resolution of the available simulations, it is not possible to provide results for the Himalaya and Hindu Kush Karakoram with a small elevation intervals than 1 km.
1145	2	13	2	13	2	(1) What is the meaning of the two numbers provided in the bottom right of each panel for the European Alps? (2) What is the meaning of the black arrows found in some panels? Is it because the bars are truncated?. For both (1) and (2), the legend should tell. [Daniel Farinotti, Switzerland]	Taken into account - The figure was amended for better clarity.
8565	2	13	2	13	3	Caption of Figure 2.3: for understandability, maybe specify columns in which temperature, precipitation and SWE are displayed, e.g., “Projected elevation-dependent change (1986-2005 to 2031-2050 and 2080-2099) of mean winter (December-May) air temperature (left column), precipitation (middle column) and snow water equivalent (right column)”. [Deborah Verfaillie, Spain]	Taken into account - The figure was amended for better clarity.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
14967	2	13	2	13	2	Figure 2.3 please add "left column/panels" after air temperature, middle after precipitation and right after snow water equivalent in figure caption to clarify the three columns [Government of Germany, Germany]	Taken into account - The figure was amended for better clarity.
28035	2	13	2	0		Apart from example b) (Himalaya) I cannot see a warming trend with elevation. Where is it? Maybe the related statements should be reworked? [Frank Paul, Switzerland]	Taken into account - The figure was amended for better clarity.
28037	2	13	2	0		How can climate models see a warming increase with elevation when they are not resolving the processes leading to it (see Box 2.1)? [Frank Paul, Switzerland]	Taken into account - The revised box provides explanations on why elevation dependent warming is visible in model output, even if they do not capture all relevant processes.
32953	2	13	2	13	10	Most of the other figures try to present information for a wider range of locations than this one does. It would be nice to see similar information summarized for the Western Hemisphere and perhaps even the Andes. [Government of United States of America, United States of America]	Taken into account - The revised figure includes plots for the Rocky Mountains and the Subtropical Central Andes.
32955	2	13	2	13	10	The horizontal lines are challenging to interpret; suggest explicitly stating that the bars show the range of projected changes with the middle white space depicting the average. One issue with showing the range (min/max) is that it is subject to outliers. One take away from the Alps example is that there is far more heterogeneity (or range) in temperature change above the 0°C level than below. [Government of United States of America, United States of America]	Taken into account - The figure was improved using this comment, keeping it altogether as simple and compact as possible.
24891	2	13	4	13	4	Please, check the correspondence of the order in the figure caption ("European Alps, Hindu-Kush Karakoram and Himalaya") with the figure itself. [Hernan Edgardo Sala, Argentina]	Accepted - The figure was amended for clarity.
28561	2	13	4	14	3	Suggestion : specify (if so) that no further downscaling or adaptation to relief was applied to the model outputs prior to producing these statistics graphs. [Isabelle Gouttevin, France]	Taken into account - The figure and the captions were edited for better clarity.
8567	2	13	5	13	6	Caption of Figure 2.3: “The numbers to the upper right of each panel” should be replaced by “The numbers to the lower right of each panel”. Also it could be specified what blue and red numbers mean (RCP2.6 and RCP 8.5?). [Deborah Verfaillie, Spain]	Accepted - The figure was amended for clarity.
18749	2	13	5	13	6	Figure 2.3: Caption - “The numbers to the upper bottom right of each panel reflect the number of available simulations” [APECS Group Review, Germany]	Accepted - The figure was amended for clarity.
1143	2	13	6	13	6	The text should read "bottom right" (not "upper right") I assume. [Daniel Farinotti, Switzerland]	Accepted - The figure was amended for clarity.
9189	2	13	6	13	6	Caption Fig 2.3: lower right of each panel (not upper) [Luzi Bernhard, Switzerland]	Accepted - The figure was amended for clarity.
17817	2	13	6	8	6	when it says "upper right of each panel" must say "lower right of each panel". [Lucas Ruiz, Argentina]	Accepted - The figure was amended for clarity.
18421	2	13	6	13	6	E1a: I think the authors refer to the numbers in the lower right (not the upper right). [APECS Group Review, Germany]	Accepted - The figure was amended for clarity.
24893	2	13	6	13	6	It seems that "upper right" should be replaced by "lower right". [Hernan Edgardo Sala, Argentina]	Accepted - The figure was amended for clarity.
28563	2	13	6	0		« upper right » : wouldn't it be « lower right » ? [Isabelle Gouttevin, France]	Accepted - The figure was amended for clarity.
8853	2	13	10	0		Insert "the" before "1986-2005" [Nina Hunter, South Africa]	Accepted - The figure was amended for clarity.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
22125	2	14	0	0		Sec 2.2.3.1: the recent combined studies of Dehecq et al (2018) and Brun et al (2017) point towards remotely sensed observations of glacier velocity as an additional means of estimating recent glacier mass changes (at individual or regional scales). [Joseph Shea, Canada]	Accepted - text revised
8571	2	14	6	17	6	Structure of Section 2.2.3: why is it that this section is divided in 2 sub-sections (2.2.3.1 Observed Changes and Attribution, and 2.2.3.2 Projections) when other sections are not (2.2.2, 2.2.4 and 2.2.5)? Please homogenise across sections. [Deborah Verfaillie, Spain]	Accepted - sections combined
3363	2	14	8	16	36	The entire section does not discuss about any of the glaciers in the Indo-Nepalese regions. I request the authors to kindly add details on the Gangotri glacier, since it is one of the significant glaciers in the Indian subcontinent. [Divyesh Varade, India]	Taken into account - Ch2 discusses changes in high mountain regions incuding High Mounain Asia but including details of individual glaciers is impossible due to space constraints
18423	2	14	8	14	9	E1a: Maybe I didn't come across it (and assuming other readers as well), but what is the reason not using the total glacier area in RGI 6.0? Given the total glacier area reported on p 65 in the technical note of RGI 6.0 (https://www.glims.org/RGI/00_rgi60_TechnicalNote.pdf), the glacier area considered in SROCC would sum up to 35% of RGI 6.0 [APECS Group Review, Germany]	Rejected - the Ch2 assesses recent and projected changes in 11 high mountains areas specified in introduction and Fig. 2.2
18435	2	14	8	14	10	30% of total global glacier area "excluding polar region" reads contradictory [APECS Group Review, Germany]	Accepted - sentence part dropped
18523	2	14	8	14	9	"~173,000 glaciers" as the tilde indicated a estimated or rounded number this should also be the case for the area value. [APECS Group Review, Germany]	Accepted
18563	2	14	8	14	18	Consider adding to this paragraph information about the volume of high-mountain glaciers or their sea-level equivalent, as well as that their meltwater contributes to sea-level rise, since the latter was mentioned only in Chapter 1. Otherwise, the later information about large sea-level contribution from Alaska might not be understandable for lay readers. [APECS Group Review, Germany]	Accepted - text revised
18721	2	14	8	16	15	General comments: Certainly the majority of the mountain glaciers are retreating and losing mass. Even the important progress in terms of knowledge about the glacier sensitivity to climate worldwide, there are regions where the glacier response to climate change is still poorly documented. An additional problem is the need to revisit the available glaciological mass balances series to assessing its representativeness in a corresponding region. I suggest that it has to be mentioned to stress the importance to intensify the monitoring activities. For example, in the Andes region where in situ monitoring programs are carrying out on few glaciers and dating back to the beginning of the 1990s. In this region remote sensing can provide an important source of data to adjust and extend glaciological mass balance series. [APECS Group Review, Germany]	Taken into account - policy-prescriptive recommendations are not made. We added several new studies that indicate a wealth of new data
1149	2	14	9	14	9	The information "not including the two ice sheets" is placed somewhat inconveniently, as it is unclear whether it refers to the sentence as a whole or to it's last part only - the meaning would be quite different. [Daniel Farinotti, Switzerland]	Accepted - sentence part dropped

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2029	2	14	9	14	10	The area from the RGI is the best estimate available to date. However, the area is not certain. I just want to recall that the glacier area from the GAMDAM inventory for high Asia and others differ by 10% or more for data based on similar time periods. The updated GAMDAM includes now much more ice area (see Sakai 2018, TCD). I recommend therefor to write “covering an area of about 250,000 km2”. In addition glacier area is subject to changes so I would also provide a time period for this estimate. Moreover, I suggest also to include the best estimate of ice volumes as they might have relatively less than the area, as glaciers are on average smaller and thinner than glaciers in the arctic. [Tobias Bolch, Germany]	Accepted
32957	2	14	9	14	10	"roughly 30% of the total global glacier area (not including the two ice sheets of Greenland and Antarctica)" Unclear if this is 30% of the total global glacier area, with 70% of non-ice sheet glaciers unaccounted for, or if 70% of the total global glacier mass is in the Greenland and Antarctic Ice Sheets and the remaining 30% is represented in the RGI. Suggest that authors clarify by explicitly stating that the RGI represents 30% of current global ice mass, with the remaining 70% in Greenland and the Antarctic. [Government of United States of America, United States of America]	Accepted - sentence part dropped
1147	2	14	10	14	10	The information that glaciers starting "from sea level" were considered is pretty surprising: Isn't the chapter focusing on "high mountain areas"? What is the meaning of "high" then? [Daniel Farinotti, Switzerland]	Rejected - for example Alaska has many glaciers spanning from sea-level to extreme elevations, e.g. elevation difference of >5000 m within a few tens of km from the coastline
32959	2	14	11	14	12	Authors should mention calving in drivers of mass budget. [Government of United States of America, United States of America]	Rejected - since this paragraph is about mountain glaciers and this component is very small in mountain regions, even in regions with marine-terminating fronts like Alaska (e.g. Alaska 4% of total ablation; 96% melt). It would be too much detail for this introductory paragraph.
9215	2	14	12	14	14	There is indeed a lag between the (full/final) response of glacier characteristics to an external forcing. While the full adjustment may take decades or more, some glacier characteristics start reacting immediately to a forcing (e.g. the glacier volume). This phrase may thus be a bit misleading in its actual formulation. Eventually consider rephrasing to something like: '…over time scales ranging to decades and more, and are thus a robust short- to medium-term…'. Otherwise it may sounds like the glacier (and the various characteristics that describe it) only start reacting after a decade. This would also be in better harmony with the next sentence, in which a reference is made to 'rapid changes of mountain glaciers'. [Harry Zekollari, Switzerland]	Taken into account - sentence deleted
18461	2	14	12	14	12	Aditionnaly to "melt", "sublimation" may also be stated here: sublimation is the main ablation process in the dry high tropics (where precipitation is lower than 200 mm/yr). [APECS Group Review, Germany]	Rejectd - too much detail for this introductory paragraph. Melt is clearly the main factor globally.
27143	2	14	12	14	14	better mentioning here that the mass balance (glacier-wide and point-scale) is the best indicator of climate change, much better than size or shape - see for instance the reference of Huss et al., New long-term mass balance series for the Swiss Alps, J Glaciol, 61, 227, 2015 [Patrick Wagnon, France]	Taken into account - sentence deleted
274	2	14	13	14	14	adjustment is size-dependent: some small glaciers respond in 1-2 years, not decades [Sabine Baumann, Germany]	Taken into account - sentence deleted

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8641	2	14	14	14	15	There are many uncertainties in this declaration. How many glacier need to serve as climate indicator? To which size of region the glacier driven climate indicators are related to? Besides, annual volume of accumulation on glaciers include avalanche feeding from surrounding slopes and volume of snow drift deposit on glacier surface. Both of these factors are not represent climate conditions outside of glacier basin. [Vladimir Konovalov, Russian Federation]	Taken into account - sentence deleted
12707	2	14	14	14	18	Figure 2 from paper McGinnis, M.D. and E. Ostrom 2014. Social-ecological system framework: initial changes and continuing challenges. Ecology and Society 19(2): 30. doi: org/10.5751/ES-06387-190230. might be a useful framework for addressing the multiple impacts for social-ecological systems. [Thomas Dax, Austria]	Noted
12709	2	14	14	14	18	The above mentioned Figure might be relevant not only for impacts from changes of glacier, but also for all changes related to the cryosphere. These would be relevant for ecological, social and economic development and habitability of mountain regions, and largely exert influences on future land management systems in the mountain regions. [Thomas Dax, Austria]	Noted
18463	2	14	14	14	14	State here that the glacier response time is controlled by the glacier's volume? [APECS Group Review, Germany]	Taken into account - sentence deleted
28039	2	14	14	0		What is a "medium term indicator"? [Frank Paul, Switzerland]	Taken into account - sentence deleted
8855	2	14	16	0		Comma should not be after "rivers" but rather after "hazards" [Nina Hunter, South Africa]	Accepted
11649	2	14	16	14	18	It is proposed make a vulnerability analysis due to the melting of mountain glaciers. [Government of Mexico, Mexico]	Taken into account - The chapter addresses many consequences of melting glaciers, under past and future climate conditions. For some sectors, vulnerability can be quantified and assessed, but not for all.
4035	2	14	18	14	18	Page 2-14 Line 18: suggest to add" Collapsing glaciers in the Third Pole is threatening Asia's water supplies, and communities need information to help them manage risks (Gao et al., 2019)." References: Gao et al., (2019) Collapsing glaciers threaten Asia's water supplies. Nature, 565, 19-21. [Fan Zhang, China]	Rejected - too much detail for this introductory paragraph.
2421	2	14	20	0		My previous comment on FOD was unfortunately ignored. Therefore once again, glaciers underwent significant changes also in pre-industrial times which needs to be acknowledged here. This represents important context information that should not be concealed to the readers. See e.g. Solomina et al. 2016 (doi: 10.1016/j.quascirev.2016.04.008) or Solomina et al. 2015 (doi: 10.1016/j.quascirev.2014.11.018). [Sebastian Luening, Portugal]	Taken into account - Short paragraph about past glacier variations was added for context, but it is emphasized the focus in response to the government approved outline is on the recent changes. Also made clearer that A6 will have a focus on that topic
2031	2	14	22	14	36	I do not know the details of the submitted paper by ZEMP et al. (subm.) and I think the best estimates by Gardner et al. (2013) and other studies are there also considered. If not please do so. [Tobias Bolch, Germany]	Taken into account - A number of new studies have come out since which we detail here. Gadner et al., 2013 data are used for comparison.Table of new regional mass loss estimates was added to the supplementary material and studies included in the figure

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2423	2	14	22	14	25	In the FOD you wrote "For Columbia Glacier, Alaska, the minimum extent is unprecedented in the last 900 years (Carlson et al., 2017)" (FOD 2-17, lines 47-48). I was happy to see that for a moment you were actually referring to the pre-industrial pre-Little Ice Age climate history. I suggested in my FOD review that you explain the palaeclimatic context with regards to the Medieval Climate Anomaly. Now I am shocked to see that you did the exact opposite in the SOD by simply deleting the sentence and reference to the past 900 years. The chapter authors' concept of systematically ignoring late Holocene and Holocene climate history is deeply flawed. By not providing this key contaxt information, readers are being misled and the modern glacier trends cannot be understood. Just imagine if a history book was to start only around 1800 CE and stays silent on ancient Greek, Roman and Sumer civilizations. This would be equally unacceptable. [Sebastian Luening, Portugal]	Taken into account - Short paragraph about past glacier variations was added for context, but it is emphasized the focus in response to the government approved outline is on the recent changes.
8643	2	14	22	14	24	Conclusion on "globally coherent picture" is not correct because of significant spatial and temporal inconsistency between [Vladimir Konovalov, Russian Federation]	Accepted - 'generally' added to indicate some deviations that are detailed later in the text.
8645	2	14	22	14	24	data in RGI 6 regions. See Tables 4-5 in the Supplement. [Vladimir Konovalov, Russian Federation]	Noted - incomplete sentence, unclear what it refers to
9217	2	14	22	14	24	For this sentence/statement a reference to the work of Gardner et al. (2013, Science) would be justified it seems (although being a 'AR5' reference, it still remains highly significant). [Harry Zekollari, Switzerland]	Taken into account - Gadner et al., 2013 data were used for comparison with more recent studies further in the text. Table of existing regional mass loss estimates was added to the supplimentary
9221	2	14	22	14	37	The discussion about the observed glacier changes is centred around the pioneering work by Zemp et al. (submitted), which makes sense. I was wondering whether it would however not make sense to refer to some of the recent important contributions on glacier change observations at regional scales, such as the work by Brun et al. (2017, Nature Geoscience) on High Mountain Asia and the work by Dussaillant et al. (2018, Frontiers in Earth Science) on the Northern Patagonian Icefield. [Harry Zekollari, Switzerland]	Taken into account - additional new studies were added. Table of existing regional mass loss estimates was added to the supplementary. Text was revised to include data from the other studies.
12065	2	14	22	15	10	It can be seen from Fig 2.4 that Ciraci and Wouters are quite different for their estimates made based on GRACE, which also differ from those made by Zemp and Gardner. Considering these differences, it is necessary to add a clarification that there is a significant uncertainty about the estimated glacier mass balance in this paragraph. Moreover, please supplement the method used for the figure to find out the possible reasons for the significant difference in mass balance estimation. [Government of China, China]	Taken into account - Text revised to mention these differences. Also the figure was largerly reviesed. We added a clarification on the used approach to create the figure.
25755	2	14	22	14	36	In this section the same results of Zemp et al, 2019, which are yet to be published are being quoted, and here also the overall figure of -190 kg/m2/yr is given for high mountain Asia in figure 2.4, which need to be given in three parts, covering Karakoram, North West Himalaya and East Himalaya separately, which can give better idea about level of glacier mass balance. [Praveen Kumar Thakur, India]	Taken into account - The suggested separation will increas complexity without changing the overal results. We dicuss the differences within HMA region in the text.
26873	2	14	22	0	24	This is compeling text about glaciers that is not adequately captured in the ES. Please elevate this to strengthen the glacier section of the ES. [Ko Barrett, United States of America]	Taken into account - ES reworded
18465	2	14	23	14	23	I wonder why this global glacier recession cannot be characterized by a likelihood (quantitative metric)? [APECS Group Review, Germany]	Taken into account - we use confidence language since we combined a number of studies with published uncertainties.

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28041	2	14	23	0		I suggest writing: "continued glacier mass loss and recession" [Frank Paul, Switzerland]	Accepted - text revised
32961	2	14	24	14	24	In addition to Zemp et al. (2015), several others papers should be cited here: Box et al. (accepted ERL, 2018) Global Sea-level contribution from Arctic Land Ice: 1971-2017; Bamber J L, Westaway R M, Marzeion B and Wouters B (2018), The land ice contribution to sea level during the satellite era (vol 13, 063008, 2018) Environmental Research Letters 13; Marzeion B, Leclercq P W, Cogley J G and Jarosch A H (2015), Brief Communication: Global reconstructions of glacier mass change during the 20th century are consistent Cryosphere 9 2399-404; Gardner A S, Moholdt G, Cogley J G, Wouters B, Arendt A A, Wahr J, Berthier E, Hock R, Pfeffer W T, Kaser G, Ligtenberg S R M, Bolch T, Sharp M J, Hagen J O, van den Broeke M R and Paul F (2013), A Reconciled Estimate of Glacier Contributions to Sea Level Rise: 2003 to 2009 Science 340 852-7. [Government of United States of America, United States of America]	Taken into account - Bamber added to text, and Box to the supplementary table (not mentioned here since their estimate is not globally complete)
9219	2	14	25	14	26	A reference is made to section 2.2.3.2. here, but that section treats projections and seems to not be referring to regional departures from a trend in the past. These are treated further in section 2.2.3.1 (on p.15 and first paragraph on p.16). Consider simply ommiting this reference. [Harry Zekollari, Switzerland]	Accepted - reference deleted
32963	2	14	25	14	25	In addition to Medwedeff and Roe, Larsen et al. (2015 GRL) should be cited for inter-regional variability. Also cite Ganey et al. 2017 Nat. Geos. [Government of United States of America, United States of America]	Taken into account - not mentioned here because this sentence is describing the significance of the global trend which was showed in Medwedeff and Roe 2015 paper. Suggested references are cited in other places of the Ch2.
1151	2	14	26	14	27	The statement "several new estimates […] have emerged" calls for at least three references. [Daniel Farinotti, Switzerland]	Accepted - references added
4119	2	14	26	14	29	Hirabayashi et al. (2016, Sec. Rep, DOI: 10.1038/srep29723) can be added as a reference for the fact that contributions of human-induced warming to the reductions in glaciers have been detected with considerable variations at the local scales. [Kumiko Takata, Japan]	Accepted - reference and sentence added
18561	2	14	26	14	26	I do not think the reference to section 2.2.3.2 is needed here, since you assess deviations from the general trend in the same section 2.2.3.1 [APECS Group Review, Germany]	Accepted - reference deleted
32965	2	14	26	14	26	Mentions several studies, but no citations. [Government of United States of America, United States of America]	Taken into account - A number of new studies have come out since which we detail here. Gadner et al., 2013 data are used for comparison.Table of new regional mass loss estimates was added to the supplementary material and studies included in the figure
18467	2	14	29	14	32	This summary of the Zemp et al paper is not clear. What is the difference between the "all mountain region" and the "estimated global average excluding polar regions" (for which there is no number…) [APECS Group Review, Germany]	Taken into account - statement deleted

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18565	2	14	29	14	30	I think the geodetic balance figures provided in these lines are very important for the whole chapter, so they deserve some additional comment. Firstly, please consider highlighting what the +- values really are, e.g. uncertainties or standard deviations? Secondly, in case the +- values refer to uncertainties, there is a chance that geodetic balances were comparable between the two analysed periods. Therefore, I suggest to use a milder statement, e.g. "mass losses increased from ... to ... (medium confidence)", or "mass losses probably increased from ... to ...", if supported only by the study by Zemp et al. (submitted). This comment also applies to the Executive Summary, p. 3, l. 24. [APECS Group Review, Germany]	Taken into account - text revised
25649	2	14	29	14	37	Mass loss mentioned for High Mountain Asia (-190kg m-2 yr-1) during 2006-2015 seems to be much lower than the many records of mass loss in Indian Himalaya. The geodetic mass balance of HK Himalaya for Western, Central, and Eastern Himalaya is typically 200 - 500 kg m-2 yr-1 around this period. Since the values reported in the current report are based on a manuscript that is still under review (Zemp et al. (submitted)), this needs further verification before incoporating in the document. [Government of India, India]	Taken into account - text revised. The mass losses reported here are for the whole region of High Mountain Asia. We dicuss the differences within HMA region in the text.
1427	2	14	30	14	37	It would be useful also to quote overall estimate in mm water eqiuvalent (as conventionally used in hydrology and ice sheets), as well as the overall GT loss (as used in GRACE results) - this would help readibility for non-experts; it's fine with the equivalent sea level rise numbers. [Rene Forsberg, Denmark]	Taken into account - text revised. We report mass losses also in sea-level equivalent and all regional/global mass changes are given in 3 different units in the supplementary material.
15461	2	14	30	14	37	It would be useful also to quote overall estimate in mm water equivalent (as conventionally used in hydrology and ice sheets), as well as the overall GT loss (as used in GRACE results) - this would help readibility for non-experts; it's fine with the equivalent sea level rise numbers. [EUCE, Belgium]	Taken into account - text revised. We report mass losses also in sea-level equivalent and all regional/global mass changes are given in 3 different units in the supplementary material.
32967	2	14	30	14	33	The Zemp numbers are reported as mass loss (positive numbers), and then the Southern Andes is reported as a mass budget (negative numbers). Note the Andes and HMA were reported as loss (positive numbers) in the executive summary at the start of the chapter. This really needs to be cleaned up to avoid confusion / misreporting. [Government of United States of America, United States of America]	Taken into account - text revised using term mass budget (negative for losses) instead of mass losses (positive for losses)
5509	2	14	31	14	31	what is "more" here? The mass loss or the increase in mass loss from on period to another? I was unsure. [Etienne Berthier, France]	Taken into account - sentence deleted
5215	2	14	32	14	34	These numbers provide mass budgets in different regions. It is worth providing total glacier area observed in these regions. [Saurabh Vijay, Denmark]	Taken into account - Areas are given in figure and table of existing regional mass loss estimates including the information about gacier area and volume was added to the supplimentary.
24525	2	14	33	14	33	Comment on a section within a chapter. The Andes mountain range is large from North to South, and it forms part of several countries. So, it is not accurate to mention the “southern Andes”, because the meaning of “South” will depend on several parameters, points of view, such as climate, geography or the country. A better statement could be “the Andes glacier at the south of latitude XXXXX”. [Francisco Barraza, Chile]	Rejected - boundaries of the Southern Andes region are defined in introduction and on Fig. 2.2. Region names and boundaries are largely taken from the Randolph Glacier Inventory which all global scale mass balance studies use.
8647	2	14	34	14	37	The term sea-level equivalent (SLE) used here and further, have no any relation to real change of sea level (more correct to say WOL), because of using false mass density 1000 kg/m3 at converting volume of snow and glacier. Besides, it is evident that duration of process transformation is very different in the cited regions (Alaska, Southern Andes, High mountain Asia). [Vladimir Konovalov, Russian Federation]	Taking into account - the term 'equivalent' is used instea of 'sea level rise'

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27145	2	14	34	14	34	Is Zemp et al (submitted) accepted? Actually, there is a clear omission of a key paper concerning high Mountain Asia mass balance changes, Brun et al., 2017. In this paper, the total mass change for HMA glaciers between 2000 and 2016 is -0.18 m w.e./yr - Brun F et al, A spatially resolved estimate of High Mountain Asia glacier mass balances from 2000 to 2016, Nature Geosciences, 2017, doi:10.1038/NGEO2999 [Patrick Wagnon, France]	Accepted - Zemp is published and Brun was added.
1975	2	14	36	14	36	... to sea-level rise...' [Harald Pauli, Austria]	Accepted
8857	2	14	36	0		Should "sea-level" not be replaced with "sea level rise"? [Nina Hunter, South Africa]	Accepted
272	2	15	0	15		Fig. 2.4: yellow line (Ciraci etal 2018) not well visible [Sabine Baumann, Germany]	Taken into account - The figure was largerly reviesed. We changed the color scheme.
973	2	15	0	0		2.4 Antarcticais missing, again [Falk Huettmann, United States of America]	Taken into account - added to caption this polar regions are considered in chapter 3.
8573	2	15	0	15		Figure 2.4: colours used to represent the different datasets could be improved. Especially yellow is not very visible. Are they suitable for colour-blind people? [Deborah Verfaillie, Spain]	Taken into account - The figure was largerly reviesed. We changed the color scheme.
10893	2	15	0	0		2.4 ditto see 2.2 plus different authors, suggest to decongest, separate the map from the graphs plus generalization.. [otto otto simonett, Switzerland]	Taken into account - The figure was largerly reviesed. We changed the color scheme.
22129	2	15	0	0		Figure 2.4: missing caption for western north America. Updated geodetic mass balance values for WNA (Menounos et al., in press) and High Mountain Asia (Brun et al., 2017) should be indicated here as well. Further, it is unclear how the mean values for mass budget and sea level rise, 2006-2015, are derived for each region. Is this a mean of glaciological, geodetic, and gravity-based measurements? [Joseph Shea, Canada]	Taken into account - The figure was largerly reviesed. We added regional estimates. We added a clarification on the used approach to create the figure.
23071	2	15	0	15		Not easy to see what are red and blue bards here [Valerie Masson-Delmotte, France]	Taken into account - The figure was largerly reviesed. We changed the color scheme.
24421	2	15	0	15		Figure 2.4 need to be revised. The addition of 3 time series to the Zemp 2019 model values of glacial mb make the mass data incomprehensible. Better to use and average data of the 3 other sources, or use a block average as is used fo the Gardner 2013 data. In understand the data is added to show the difference between the different data sets. This can though be stated in the text, such as other data sources show low correlation in high temporal resolution. [veijo pohjola, Sweden]	Taken into account - The figure was largerly reviesed. We added regional estimates. We added a clarification on the used approach to create the figure.
24559	2	15	0	0		Units from the caption must be reviewed. Too many references from unplished papers and they do not fit with the figure legend. Check, please. [Armand Hernández, Spain]	Taken into account - The figure was largerly reviesed.
24823	2	15	0	0		Fig 2.4: the title of insert figure for Western US/ Canada is missing. [Thomas Schuler, Norway]	Accepted
24825	2	15	0	0		Fig 2.4: how can the uncertainty range for all 11 regions together be smaller than those of the largest compenents? Alaska+Western US/Canada+Southern Andes+High Mountain Asia each have considerable larger uncertainty range than the total and account for 90% of the total glacierized area (87% of volume). [Thomas Schuler, Norway]	Taken into account - The figure was largerly reviesed.
26875	2	15	0	0		This needs a title so the reader doesn't need to go to the caption to understand it is a figure about glaciers. [Ko Barrett, United States of America]	Taken into account - Title added.

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27997	2	15	0	0		Insert a label for "Western U.S. and Canada" on the appropriate mass budget graph [Marcos Mendoza, United States of America]	Accepted
29347	2	15	0	15		Figure 2.4 - would be helpful to include data for the Canadian Arctic as Figure 3.8 indicates the Canadian Arctic as being one of the biggest contributors to global sea level rise. If not included because not in RGI Consorium (2017), it would be helpful for an inset map or caption to note key areas NOT included in that analysis. [Government of Canada, Canada]	Taken into account - Polar glaciers are discussed in Ch 3. The table summarising regional mass losses is included into supplementary.
546	2	15	1	15	10	Why are the esimates from Gardener et al used in AR5 so smooth compared to those using the newer estimates. [Jenna Pearson, United States of America]	Noted
1429	2	15	1	15	10	Figure fonts are too small. Difficult to see the different GRACE solutions - they should be combined into one solution, shown in a thicker line, and references to individual authors removed from the plot. [Rene Forsberg, Denmark]	Taken into account - The figure was largerly reviesed.
1615	2	15	1	15	10	Figure 2.4: Simplify this figure. The extra bar graphs on the map are unnecessary and hard to read. The graphs convey the necessary information. [Nora Richter, United States of America]	Taken into account - The figure was largerly reviesed.
3125	2	15	1	15	2	All the studies cited in the figure (except the Gardner et al. 2013) are under review and consequently not available to the reviewer. The use of the colors to represent the mass budget is not easy to read as the two colorscales (red and blue) systematically saturates for each individual region on the map. I suggest to use uniform color bars to simplify the representation. [Fanny Brun, France]	Taken into account - only studies published by May 2019 are included; color scheme adjusted
5355	2	15	1	15	1	No title in North America subplot [Alvaro Ayala, Chile]	Taken into account - The figure was largerly reviesed.
9191	2	15	1	15	1	No description of Western US/Canada graph [Luzi Bernhard, Switzerland]	Taken into account - The figure was largerly reviesed.
15463	2	15	1	15	10	Figure fonts are too small. Difficult to read the different GRACE solutions - they should be combined into one solution, shown in a thicker line, and references to individual authors removed from the plot. [EUCE, Belgium]	Taken into account - The figure was largerly reviesed.
24915	2	15	1	15	1	The second highest inset on the left-hand side does not have a title; it should probably read "Western Canada and USA" [Dirk Hoffmann, Germany]	Taken into account - The figure was largerly reviesed.
31593	2	15	1	0		Figure 2.4. There is a lot of information on this figure. A bit of rearrangement may help the reader to navigate through it better. For example, the dotted lines that connect the polygons with the sublabels could be avoided if you place letter codes to match the polygon with the graph (by the way, the caption need to mention what these polygons represent). This way, the main map can be placed on top, and below it you can rearrange the graphs nicely in three rows without repeating the Y-labels in order to make them slightly bigger and allow the reader to appreciate the differences between estimates, which are currently really hard to see. In case you do this, keep arrangement uniform across figures (e.g. 2.5). [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The figure was largerly reviesed.
31595	2	15	1	0		Figure 2.4. The 3D bars inside each circle have a color gradient, but it seems to be used only as decoration and with no embedded value, i.e. they are shrunk or enlarged without changing the gradient distribution - if this is the case, then a single color would be a better choice in order to reduce distractions. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The color scheme was ajusted.

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31597	2	15	1	0		Figure 2.4. Having the mass and SLE bars one next to the other tends to suggest that these two are somehow comparable. These information may be better appreciated if you remove the bars from the map, and make a separate panel with two bar graphs, one for mass and another for SLE - this will allow direct comparison amongst regions. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The figure was largerly reviesed.
1153	2	15	3	15	3	(1) It looks like the colour-graduation of the bars in the map has no meaning. It would therefore make sense to present each of the two bars in one single colour (red and blue, as the caption sais). (2) Why is the Ciraci-publication labelled with 2018? Shouldn't that be 2019, as for Zemp and Wouters? (all three publications are "submitted", and I take it that the year is a place-holder) [Daniel Farinotti, Switzerland]	Taken into account - The color scheme was ajusted.
2689	2	15	3	15	10	For South America, why a mass loss of 1200 kg m2 yr-1 will result in 0.95 mm of SLE per 10 years while 940 kg m2 yr-1 will only result in 0.05 mm of SLE per 10 years? Does that make sense? [Thian Yew Gan, Canada]	Noted - This is because of different glacier volume in different regions. With the same negative mass budget (kg m-2 yr-1) regions with higer glacier volume will contribute more to the sea lever rise.
5313	2	15	3	15	3	One title is missing (left, second from the top) [Simone Schauwecker, Chile]	Accepted
10491	2	15	3	15	10	Figure 2.4 needs better caption/explanation. By "random error" do you mean uncertainty in estimates? [James Renwick, New Zealand]	Taken into account - The figure was largerly reviesed. We added a clarification on the used approach to create the figure.
11849	2	15	3	15	3	When mentioned low latitudes is important to highlight what zone or countries is in this figure, may be in the text, it is relevant for stakeholders. [Isabel Ramos, Peru]	Taken into account - The figure was largerly reviesed. We added low latitudes region boundaries to the map.
24609	2	15	3	15	10	The figure is highly interesting and well drafted. Whereas the study by Zemp et al. Is described in the main text, providing additional background and details, the two GRACE studies are just mentioned in the caption and no details are given. Some discussion would however be relevant as the year-to-year variability indicated by the GRACE studies is extreme, lying much beyond the results by Zemp et al. that are based on direct mass balance observations. In this sense, I asked myself whether the two GRACE studies were able to actually correctly resolve year-to-year fluctuations in mass balance. If not, the figures would become much clearer if - like for Gardner et al 2013 - only average values over the considered period were shown, instead of annual values that hide the actual rates due to their unrealistic variability. [Matthias Huss, Switzerland]	Taken into account - The figure was largerly reviesed. We added a clarification on the used approach to create the figure.
28043	2	15	3	0		Fig. 2.4: The region name is missing in the left pane of the second rowl [Frank Paul, Switzerland]	Accepted
32969	2	15	3	15	10	Second box down on left most column is missing region label. The figure could be improved by removing redundant y-axis labels on plots as this takes up a fair bit of space. [Government of United States of America, United States of America]	Taken into account - The figure was largerly reviesed.
32971	2	15	3	15	10	The caption should provide clearer information about how to compare the values for V, provided in the line plots in mm SLE, to the mass budge values in blue on the map, provided in mm SLE per decade. For example, the Southern Andes line plot shows a change in volume of 16.9 mm SLE, whereas the blue number and bar shows a change in mass equivalent to 0.95 mm SLE/decade over roughly a decade. It's not immediately apparent whether these values (16.9 mm SLE over an unclear period and 0.95 mm SLE over 2006-2015) are comparable. If the figure continues to use blue and red bars, which don't really add anything over the red and blue numbers, the caption or legend should explain what the differences in shading along those bars mean. [Government of United States of America, United States of America]	Taken into account - The figure was largerly reviesed.

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18469	2	15	7	15	7	Caption of Fig2.4. It would be good to indicate the dates at which these areas (A) and volumes (V) were established. 2017? Morover, the volume V SLE should be defined more clearly: is it a total remaining glacier volume? SLE (Sea Level Equivalent): it seems to me that this acronym is not defined. [APECS Group Review, Germany]	Taken into account - The figure was largerly reviesed. References added.
8859	2	15	8	0		Bracket should be removed from before "RGI"and inserted in place of the comma after "consortium" [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
1921	2	15	13	15	13	Text says that it is 'virtually certain', which I would recommend changing to 'certain' [Kimberley Miner, United States of America]	Takenn into account - changes to 'very likely' (certain is not IPCC confidence language)
3359	2	15	13	15	15	The authors may mention here about the fact that the effect of solar variability is negligible on global warming in recent decades as discussed in the IPCC fifth assessment report to support the statement in lines 13-14. [Divyesh Varade, India]	Taken into account - sentence was deleted. Adding furter details is beyond the scope of this short glacier section
15187	2	15	13	16	15	I wonder if we should put in here some comments about recent (satellite era) glacier volume loss acceleration versus the long term (centennial, since Little Ice Age) trend...e.g. Carrivick et al. 2019. Geophysical Research Letters; e.g. Shiyin et al., (2003) Journal of Glaciology; e.g. Glasser et al., 2011 Nature Geoscience. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - outside of the scope of this chapter. Polar glaciers are discussed in Ch.3. Primarily we consider publications after 2014 for SROCC.
26877	2	15	13	0	14	While I'm sure this statement of global glacier loss is true, the figure indicates an increse trend between 1960-80 in several regions. This is not adequately addressed in the text. [Ko Barrett, United States of America]	Taken into account - text revised focusing on the last 3 decades. Previous periods were detailed in AR5
1431	2	15	14	15	16	Statement is political, there is no consensus on anthropogenic versus natural fractions. [Rene Forsberg, Denmark]	Taken into account - text does not claim that there is consensus but provides the details of the only paper on that matter. Details can be found in cited paper (Marzeion et al., 2014). Sentence slightly reformulated to make that clear.
18471	2	15	15	15	16	What are these uncertainties (35% and 24%)? How are they computed? One or two sigma level? Is there a spatial variability included in these values? [APECS Group Review, Germany]	Noted - Uncertainties correspond to one ensemble standard deviation. The detailes on this study can be found in cited paper
18473	2	15	15	15	16	"1851-1991" instead of "1851-2010". [APECS Group Review, Germany]	Rejected - This is exactly how the data are presented in the paper.
5511	2	15	16	15	16	Maybe I am wrong here but I thought the 2014 paper was the main attribution paper. And the 2015 paper an update on the total mass loss from different methods [Etienne Berthier, France]	Accepted - reference corrected
18425	2	15	16	15	16	E2: Marzeion et al. (2014) is the appropriate reference here: Marzeion, B., J. G. Cogley, K. Richter, and D. Parkes, 2014: Attribution of global glacier mass loss to anthropogenic and natural causes. Science, 345, 919–921, doi:10.1126/science.1254702. [APECS Group Review, Germany]	Accepted - reference corrected
18723	2	15	18	16	15	I did not find a description for glaciers in the Low Latitudes. For instance, a recent study based on aerial photos shows slight mass losses (-250 ± 30 kg m2 yr-1) on one of the most intensely surveyed tropical glacier (Antizana 15a) between 1995 to 2012 (Basantes-Serrano et al., 2016). This results suggests that the mass balance in the accumulation zone may have been significantly underestimated in previous studies. This is important to bear in mind because of the lack of glaciological and climatic data in this region. [APECS Group Review, Germany]	Rejected - detailing the mass changes of individual glaciers is beyond the scope of this section due to space constraints

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18475	2	15	19	15	19	A part of the observed increase in long-wave irradiance should also be due to the anthropic greenhouse gas increase. [APECS Group Review, Germany]	Taken into account - In this study the changes in long-wave irradiance and latent heat were attributed to increased air moisture.
18525	2	15	19	15	19	“exacerbated” carries a bit of a negative connotation in my opinion. Maybe better “intensified” [APECS Group Review, Germany]	Accepted
28565	2	15	19	0		The sentence here implicitely mentions an increase in latent heat. Imho, the reference for positive latent heat (atmosphere or snow/ice ?) should be specified as glaciologists and meteorologists do not have the same reference (as far as I know). Alternatively, « Latent heat » could be changed for «changes in latent heat exchange » or even « reduction in snow and ice sublimation » as meant by Thibert et al., 2018. [Isabelle Gouttevin, France]	Accepted - Text revised.
3361	2	15	20	15	20	Kindly change the sentence opening as "In the Tien Shan mountains, ..." or "In the Tien Shan mountain ranges,..." [Divyesh Varade, India]	Accepted - Text revised.
5217	2	15	22	15	24	The role of supraglacial debris, ice cliffs and lakes on ice melt and hence on glacier mass budget is very well known but has been underrepresented in the current form of the report. There are several scientific evidence highlighting the role of these supraglacial features based on both remote sensing and field observations. References: Vincent et al., 2016, Reduced melt on debris-covered glaciers: investigations from Changri Nup Glacier, Nepal, The Cryosphere, 10, 1845-1858, doi: 10.5194/tc-10-1845-2016; Vijay and Braun, 2016, Elevation change rates of glaciers in the Lahaul-Spiti (Western Himalaya, India) during 2000-2012 and 2012-2013, Remote Sensing, 8, 1038, doi:10.3390/rs8121038. [Saurabh Vijay, Denmark]	Accepted - sentence added
17505	2	15	22	15	26	Would it be useful to insert a statement linking these processes to similar occurrences and mechanisms on the Greenland Ice Sheet? [Kristin Campbell, United States of America]	Rejected - it is not clear if the mechanisms are the same.
17607	2	15	22	15	26	Would it be useful to insert a statement linking these processes to similar occurrences and mechanisms on the Greenland Ice Sheet? [Durwood Zaelke, United States of America]	Rejected - it is not clear if the mechanisms are the same.
18427	2	15	22	15	22	E1a: I suggest adding a sentence for tropical glaciers here: Physical based mass balance modelling on East African mountains (Kilimanjaro and Mt. Kenya) reveals that the observed glacier recession since the late 19th century is due to a decrease of precipitation in the range of 30% (annual) to 100% (seasonal) at the summit regions involving decreases in cloud cover fraction and surface albedo, with no changes in air temperatures required (Mölg et al. 2009; Prinz et al. 2016). Mölg, T., N. J. Cullen, D. R. Hardy, M. Winkler, and G. Kaser, 2009: Quantifying climate change in the tropical midtroposphere over East Africa from glacier shrinkage on Kilimanjaro. Journal of Climate, 22, 4162–4181, doi:10.1175/2009JCLI2954.1. Prinz, R., L. Nicholson, T. Mölg, W. Gurgiser, and G. Kaser, 2016: Climatic controls and climate proxy potential of Lewis Glacier, Mt. Kenya. The Cryosphere, 10, 133–148, doi:10.5194/tc-10-133-2016. [APECS Group Review, Germany]	Accepted - Sentence about African galciers added.

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208	2	15	25	15	25	No matching reference to the citation for Zhang et al., 2017. Perhaps it should read 2018 or 2015. [Scott Walker, United States of America]	Taken into account - we mean Zhang, Y., Kang, S., Cong, Z., Schmale, J., Sprenger, M., Li, C., et al. (2017). Light-absorbing impurities enhance glacier albedo reduction in the southeastern Tibetan plateau. J. Geophys. Res. 122, 6915–6933. doi:10.1002/2016JD026397.
3393	2	15	25	0	26	It would be beneficial (for increased transparency) to add a statement that the observation period and focus on black carbon etc. has perhaps been too short to assess its effects/impacts on medium to long-term melt rates. This is a recent development, and I think it would be good to make this clearer (along the lines of "More data are needed to assess whether there is a trend/correlation"). [Sven Lukas, Sweden]	Noted - We believe this is reflected by the statement that "there is limited evidence and low agreement that long-term changes in glacier mass are linked to these processes".
11985	2	15	26	15	26	After mentioning small scale effects from deposition of particles, algae and cryoconite holes, I suggest to also add a sentence about the effect of a continuous debris layer on glaciers (Östrem, GeogrA, 1959), touching e..g the following topics (there is a lot of recent literature about debris-covered glaciers): Scherler et al. (GRL, 2018) estimated that 4.4% of the global glacier area (excluding the ice sheets in Greeenland and Antarctica) is debris-covered, but reaching up to 25% in specific mountain regions, but at the same time debris-covered glaciers have not been included yet in global glacier mass balance estimates, despite their distinct effect on glacier ablation. Estimates about their behaviour are controversial as observed e.g. in High Mountain Asia (Kääb et al., Nat, 2012; Gardelle et al., TC, 2013) rising the term of a "debris-cover anomaly" (Pellicciotti et al., JG, 2015). [Pascal Buri, United States of America]	Accepted - sentence added
27045	2	15	26	15	26	Here it can be added that: "In the European Alps, it has been observed that the input of dust from lateral moraines can decrease bare ice albedo and promote the melting (Oerlemans et al. 2009). Reference: Oerlemans, J., Giesen, R. H., and Van Den Broeke, M. R.: Retreating alpine glaciers: increased melt rates due to accumulation of dust (Vadret da Morteratsch, Switzerland), J. Glaciol., 55, 729– 736, https://doi.org/10.3189/002214309789470969, 2009 [Biagio Di Mauro, Italy]	Rejected - This report focuses on new literature since AR5 (2013).
32249	2	15	26	15	26	"to these processes"? There are many discussed above and it is no longer clear to me, what exactly you mean here, notably since you "jump" from virtually certain to limited evidence and low agreement without giving an explicit rationale where the low agreement comes from or inasmuch the evidence is limited. Otherwise the paragraph is well structured with nice reasoning. [Andreas Fischlin, Switzerland]	Taken into account - Text revised. "those processes" changed to "light absorbing particles deposition".
5315	2	16	1	16	15	Start this paragraph with a summirizing sentence. Otherwise it is difficult to follow the idea of all the examples [Simone Schauwecker, Chile]	Taken into account - Sentence added.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18499	2	16	1	16	15	The chapter excludes the ice sheets from Antarctica and Greenland from the analysis (page 14, line 10), but there are some mountain regions in the polar regions which are not part of the ice sheets and should be included in the report. Over the last few decades, there have been glacier advances in some mountain glaciers and ice caps, such as in some areas of the Antarctic Peninsula since 1998. If this paragraph includes a list of areas where glacier advance has been reported, they should also be included. There are several recent articles on this topic: - Seehaus, Thorsten and Cook, Alison J. and Silva, Aline B. and Braun, Matthias (2018) 'Changes in glacier dynamics in the northern Antarctic Peninsula since 1985.', The cryosphere., 12 (2). pp. 577-594. - Engel, Z; Láska, K; Nývlt, D; Stachoň, Z. (2018). Surface mass balance of small glaciers on James Ross Island, north-eastern Antarctic Peninsula, during 2009–2015. Journal of Glaciology, vol. 64, issue 245, pp. 349-361. - Oliva, M.; Navarro, F.J.; Hrbáček, F.; Hernández, A.; Nývlt, D.; Pereira, P.; Ruiz-Fernández, J. & Trigo, R. (2017). Recent regional cooling of the Antarctic Peninsula and its impacts on the cryosphere. Science of the Total Environment, 580: 210-223. [APECS Group Review, Germany]	Noted - The list of mounain areas covered in this chapter is provided in the introduction. Glaciers located in Greenland and Antarctic periphery are discussed in Ch 3.
22637	2	16	1	16	15	It may be worth noting that in the Arid Andes, some glaciers had positive mass balances in the most recent year (data from WGMS, 2018), which is most likely related to the El Nino induced increase in snow fall. Most of these cold based glaciers are potentially more sensitive to precipitation than temperature, but there very little research studies available on this topic. This complexity supports the high uncertainty in the projected behaviour of the Low Latitude glaciers [Lukas Arenson, Canada]	Rejected - positive mass balances for individual years is not unusual in many regions. Detailing this further is beyond the scope of this section. The figure makes clear that there is large inter-annual variability.
24219	2	16	1	16	15	I appreciate the explanation provided for advancing glaciers, but seen in broader context it seems odd to have quite a substantial paragraph just on causes of advancing glaciers which are globally a very small fraction. This could generate the impression that advancing glaciers are an important feature in the world's mountains. If the text wants to be maintained I suggest that there is an intro sentence saying that here we look at causes for the small fraction [maybe provide % globally] of stagnating/advancing glacier, and a final concluding sentence to provide the context. [Christian Huggel, Switzerland]	Taken into account - An intoduction sentence was added.
32973	2	16	1	16	15	Given that vanishingly few glaciers are growing -- but nonetheless are -- shouldn't they be addressed with at least a line or two? Also, Larsen's 2015 paper on changes on how SMB changes now dominate mass loss in Alaska (instead of tidewater glacier calving) should be discussed. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015GL064349 [Government of United States of America, United States of America]	Taken into account - Causes for advancing glaciers are given. The dominant role of surface mass balance in Alaska was first shown by McNabb, JGR, however partitioning of mass balance components is outside the scope of this paragraph.
3389	2	16	4	0	6	Would it be worth highlighting that surging glaciers also operate independently of short- to medium-term climate change? It would make this sentence, and the overall statement, more solid as it would explain the behaviour of surging and tidewater glaciers in a similarly-clear way. [Sven Lukas, Sweden]	Taken into account - Text revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18567	2	16	4	16	15	These lines are used for summary of glacier advances in different regions of the world. This includes those resulting from surging, a phenomenon which should be briefly explained here, or at least a reference should be made to section 2.3.2.1.1 (see p. 31, lines 25-27). I think regions other than Karakoram should be mentioned here too, such as Iceland, Alaska or Tian Shan, where numerous surge advances occurred over the past decades. In such case, you might support such statement by the study by Sevestre and Benn, 2015 (Sevestre, H. and D. I. Benn, 2015: Climatic and geometric controls on the global distribution of surge-type glaciers: Implications for a unifying model of surging. Journal of Glaciology, 61 (228), 646-662, doi:10.3189/2015JoG14J136). [APECS Group Review, Germany]	Taken into account - Text revised. We refer to the section under hazards that deals more comprehensively with glacier surfaces and add the reference.
32975	2	16	4	16	4	Also cite Enderlin 2018 for calving retreat drivers. [Government of United States of America, United States of America]	Rejected - This study analyses the influence of geometry to dynamic of two tidewater galciers in Alaska. Too much detail to be included.
30225	2	16	5	16	5	Surge-type glacier behaviour is also a significant part of St. Elias Mountain glacier dynamics in Alaska and the Yukon Territory (e.g. Bevington and Copland, 2014; Abe and Furuya, 2015). [Christine Dow, Canada]	Accpeted - We added a referece to the Sevestre and Benn, 2015 paper which shows global distribution of surge-type glaciers, and mention a few regions specifically
276	2	16	6	16	10	missing verb in l10: … and leading to locally … [Sabine Baumann, Germany]	Accepted
2033	2	16	6	16	8	This sentence is not entirely clear and correct. I have here the following issues: [Tobias Bolch, Germany]	Accepted
2035	2	16	6	16	8	1. The review paper by Azam et al. is the only one who addresses the period since the 1970s and only for the Karakoram. However, similar little mass loss were also found for eastern Pamir since the 1970s. I suggest either to also consider the review by Bolch et al. (in press) who also include the Pamir but better the original work who showed that glaciers in Karakoram and Eastern Pamir lost also only little mass before 2000 (Bolch et al. 2017, TC, Zhou et al. 2017, J. Glac., Holzer et al. 2015, TC). [Tobias Bolch, Germany]	Accepted - References added.
2037	2	16	6	16	8	2. Moreover most of the mentioned regions showed slightly, though insignificant negative balances, but not positive ones. I suggest therefore slight rewording. [Tobias Bolch, Germany]	Accepted - Text revised.
2039	2	16	6	16	8	3. While studies agree with almost balanced conditions in eastern Pamir, there is no clear agreement for Western and Central. In contrast to Gardelle et al. (2013) as cited here Gardner et al. (2013) and also Brun et al. (2017) and Lin et al. (2017, Sci Rep. found negative ones (see also Bolch et al. (2018). This should also be reflected. I`d therefore also rather refer to the Brun et al. (2018) study which updates specifically Gardelle et al. (2013) and be again more careful with the wording. [Tobias Bolch, Germany]	Accepted - Text revised.
2747	2	16	6	16	11	Please include the paper by Lin et al (10.1038/s41598-017-07133-8). It is suggested that more attention should be given to “an increase in irrigation intensity which in turn affects the regional climate”. Only one reference is not enough to be the assessment basis. [Shiyin Liu, China]	Taken into account - Text revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9223	2	16	6	16	8	I would also expect a reference to the work by Brun et al. (2017, Nature Geoscience) here and potentially also to the recent work by Dehecq et al. (2019, Nature Geoscience). The work by Dehecq et al. also analysis surges and could therefore also be used as a reference for the previous sentence: it is noteworthy that this study suggests that surging glaciers do not affect the interpretation of velocity and mass changes, which contrasts a bit with a statement in chapter 3 (p. 51, l.36-38) for Arctic regions. Eventually the main message from Dehecq et al. (2019), i.e. an observed slowdown of glaciers in high-mountain Asia and its link to glacier mass loss., could also be included in the report as this is an important finding! [Harry Zekollari, Switzerland]	Taken into account - Text revised.
1433	2	16	8	16	9	What specific meteorological mechanisms? This is an important statement, should be explained [Rene Forsberg, Denmark]	Taken into account - Text revised.
5513	2	16	8	16	8	Gardelle et al. 2013 is affected by the issue of radar penetration. Brun et al. 2017 is better and more solid reference and cover a longer time interval. I have no problem stating this, as co-authors of both papers. [Etienne Berthier, France]	Taken into account - Text revised.
15465	2	16	8	16	9	What specific meteorological mechanisms? This is an important statement, should be explained [EUCE, Belgium]	Taken into account - Text revised.
27147	2	16	8	16	8	Brun et al, 2017 (reference above) should be mentioned: the Karakoram anomaly is in fact centrered over the western Kun Lun Shan and extends to Eastern Pamir and Eastern Karakoram [Patrick Wagnon, France]	Taken into account - Text revised.
5515	2	16	9	16	9	Sakai and Fujita, 2017 is a relevant reference but not on the meteorology side (more glacier sensitivity) but maybe there is no space to enter into such details? [Etienne Berthier, France]	Taken into account - Text revised.
1155	2	16	10	16	10	It is probably fair to say that the thesis by de Kok et al. (2018) is still controversial. A note of caution would probably be appropriate. [Daniel Farinotti, Switzerland]	Taken into account - Detailed evaluation of the various studies presenting causes for the anomalies is beyond the scope of this short glacier sections.
32977	2	16	10	16	10	Replace "...affects the regional climate..." with "...alters the moisture flux into the high mountains thereby altering precipitation amounts" [Government of United States of America, United States of America]	Taken into account - Text revised.
4037	2	16	11	16	11	Page 2-16 Line 11: suggest to add “The decline of Indian monsoon and enhancement of westerlies are considered to lead to inconsistent glacier variation across the Tibetan Plateau with the most intense glacier retreat occurred in the monsoon dominated region, less retreat in the transition region and the least retreat in the westerlies dominated region (Yao et al., 2012). References: Yao, T., Thompson, L., Yang, W., Yu, W., Gao, Y., Guo, X., ... & Pu, J. (2012). Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings. Nature climate change, 2(9), 663.”. [Fan Zhang, China]	Rejected - This report primarily considers publications published after 2014, and in this region a wealth of literature has been published since.
2041	2	16	15	16	16	I know the case of the glacier advance in Tien Shan well, but mining deposits are really and exception and cannot at all related to climate. However, this case shows evidence that large rock fall events could also trigger glaciers advances. This should be mentioned here. I am lacking time to lock into the literature, but I think some cases are described (please check studies by Kirkbride in New Zealand and Menounos et al. in British Columbia). [Tobias Bolch, Germany]	Taken into account - Mining case deleted here since treated in in section 'Mining and infrastructure'.Rock slide studies refer to holocene glacier fluctuations. No case linking a modern glacier advance to rock falls could be found

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27047	2	16	15	16	15	Here is not clear how volcanic activity and mining waste can result in glacier advances. I would expect the opposite since impurities are involved in the ice-albedo feedback. Instead, it should be stated that thick layers of dust particles can act as insulators. [Biagio Di Mauro, Italy]	Taken into account - Explanation added and mining case moved to section 'Mining and infrastructure
18527	2	16	17	16	36	Subsection 2.2.3.2 Projections: This paragraph makes a statement about potential enduring glacial recession even if “the current climate were [sic!] to remain constant (very high confidence)”. A paragraph on glacier equilibrium vs. Disequilibrium could be added that the response in retreat might not be instantaneous. So if the report states that in the future glaciers might exhibit continuing reduction due to present-day atmospheric forcing – there should be an additional statement on the likelihood that, at least in some cases, the observed glacial retreat today is attributable due to glacial disequilibrium. Otherwise this seems like a one-sided conclusion. [APECS Group Review, Germany]	Noted - not clear what reviewers mean, but detailed discussion on underlying physical processes for glacier retreat under constant climate is beyond the scope of this chapter
2691	2	16	19	16	36	I think there are large uncertainties associated with these projections of glacier mass losses, which could be somewhat reduced by increased winter precipitation in some glaciers? [Thian Yew Gan, Canada]	Noted
18477	2	16	19	16	22	It would be useful to provide here (and in Figure 2.4) a more quantitative estimate of the response time of these glaciers. [APECS Group Review, Germany]	Rejected - the concept of response times is complex with lack of information on a global scale, and beyond the scope of this section
18501	2	16	19	16	27	The substantial mass loss will lead to the disappearance of many glaciers, as well as perennial ice and snow patches. It would be good to highlight the fact that some glaciers will disappear. However, it should be also mentioned that some small glaciers are the most resilient to climate change, such as avalanche-fed glaciers, that can survive longer than others (Hughes et al., 2018). Hughes, P.D., 2018. Little Ice Age glaciers and climate in the Mediterranean mountains: a new analysis. Cuadernos de Investigación Geográfica, 44 (1), 15-45. The substantial mass loss will lead to the disappearance of many glaciers, as well as perennial ice and snow patches. It would be good to highlight the fact that some glaciers will disappear. However, it should be also mentioned that some small glaciers are the most resilient to climate change, such as avalanche-fed glaciers, that can survive longer than others (Hughes et al., 2018). Hughes, P.D., 2018. Little Ice Age glaciers and climate in the Mediterranean mountains: a new analysis. Cuadernos de Investigación Geográfica, 44 (1), 15-45. [APECS Group Review, Germany]	Rejected - the projection figure makes clear that substantial glacier volume survives. Further details on processes of individual glaciers is not considered here due to space limitations

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24423	2	16	19	16	36	Reading section 2.2.3.2. Projections I wonder if some caution should be taken to GC changes thar are known unknowns, ie. The complex feedback found on the troposhpere/stratosphere interactions, that offset the jet stream, export cold Arctic air and generate cold air excursions. It is suggested that these interaction may be driven by the decrease of the Arctic sea ice cover (see refs by Cohen given i Chapter 3). What if such events that today start to form occasionally, may be a norm decades ahead when the Artic sea ice likely is much less extensive than today. If the Rossby number change, the placement of the pressure change statistically from the present norm, will not this create a larger uncertainty of glacial mass balance? Earlier studies have shown that cyclonal/anticyclonal patterns are important for glacial massbalance, and a few more/less storms per year may bring different conditions ahead, not predicted by todays GCMs. A short sentence on this, refereing one of Cohen et al´s work (2014, 2015, 2018) cited in chapter 2 and 3 may at least give this uncertainty of unnown dynamical feedbacks in future predictions. Thsi phenomena is also discussed on page 10 in Chapter 3, to where a cross reference could be made. [veijo pohjola, Sweden]	Rejected - Further details on the many processes and feedback mechanisms at play are not considered here due to space limitations
32427	2	16	19	16	36	I would add that in som eregions as teh European Alps 'a significant fraction of glaciers is projected to disappear by the end of teh 21st century' [ROBERTO RANZI, Italy]	Rejected - the figure shows the substantial glacier mass loss in this region. Further text additions are not considered due to space constraints.
18479	2	16	24	16	24	What do these uncertainties (±7 % and ±10%) represent? Are they 1 or 2 sigma confidence intervals? Are they an estimate of the regional variability? [APECS Group Review, Germany]	Accpeted - it is mentioned what the uncertainties mean
32979	2	16	26	16	26	McGrath 2017 Earths Future also shows how small glaciers are dominant loss in Alaska and how this propagates into ecosystem. A regional model projection for Alaska should be included. Beamer 2017 WRR is starkly missing. [Government of United States of America, United States of America]	Taken into account - paper considered but does not provide comparable numbers, focus of paper is different
18569	2	16	27	16	27	Here you mention regions with the largest projected ice losses. I suggest to add west North America, which obviously falls to this same category, as evident from Figure 2.5. [APECS Group Review, Germany]	Rejected - this sentence refers to regions with little ice cover. With 14,000 km2 West Canada and US do not fall in this category
32561	2	16	27	16	27	Change "Low Latitude" to "Eastern Africa" Use this for consistency in refencing regions such as "Western North America", "Scandinavia", "Central Europe", "North Asia", etc. [John Diiwu, Canada]	Rejected - the data do refer to all glaciers in low latitudes and not just eastern Africa. We use consistent terminology for all considered regions as defined by RGI Consortium 2017. Figure 2.2 defines these regions and the region names.
11651	2	16	29	16	36	It is important establishment the probability total disappear of the tropical and mid-latitude glaciers. (Due to its important it would be advisable to determine the probability of the complete disapperance of tropical and mid-latitute glaciers). [Government of Mexico, Mexico]	Rejected - we report projected mass losses but studies quantifiying the probability of complete disappearance are missing.
26333	2	16	29	16	36	The discussion of regional scale changes is sparse, especially considering the following figure (Figure 2.5). Consider expanding with updated citations. [Ethan Pierce, United States of America]	Taking into account - projections moved to cross-chapter box including polar regions;
30653	2	16	29	16	32	It is difficult for the reader to compare the two estimates based on RCP8.5 relates to 1.5°C. Please clarify how RCP8.5 relates to 1.5°C [Hans-Otto Poertner and WGII TSU, Germany]	Taking into account - to avoid confusion the 1.5 scenario is removed.
30655	2	16	32	16	34	Does this study provide a scenario, i.e. at what projected temperature or GHG increase are these rates valid? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - scenario and range added

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8861	2	16	34	0		Move comma from after "loss" to after "2005" [Nina Hunter, South Africa]	Accepted
24221	2	16	35	16	36	It seems a bit odd to highlight here a study from a single glacier (Yakutat) rather than referring to other regions (such as the Alps, Andes). The policy relevance is certainly much higher when regions are mentioned rather than single glaciers. [Christian Huggel, Switzerland]	Accepted - sentence removed and more regional studies added
8863	2	16	36	0		Is "2110" referring to a year? It is not clear what it refers to. [Nina Hunter, South Africa]	Accepted - sentence was removed based on other comment
1157	2	16	37	16	37	Potentially, the text could also make reference to a new study for the European Alps: Zekollari et al. (submitted). Modelling the future evolution of glaciers in the European Alps under the EURO-CORDEX RCM ensemble. The Cryosphere. [Daniel Farinotti, Switzerland]	Accpeted
975	2	17	0	0		2.5 Antarctica is missing, again [Falk Huettmann, United States of America]	Taken into account - Antarctica is not part of the mountain chapter but the projections were combined with those from the polar regions in a new cross-chapter box
10895	2	17	0	0		2.5 Good, see that projections are of course easier to present than complex evidence but couln't 2.4 use a similar scheme? Also good for comparing [otto otto simonett, Switzerland]	Rejected - comment unclear. Similar to what?
32587	2	17	0	17		Change "Low Latitude" to "Eastern Africa" Use this for consistency in refencing regions such as "Western North America", "Scandinavia", "Central Europe", "North Asia", etc. [John Diiwu, Canada]	Rejected - Low latitudes includes also regions in the Andes and New Guinea. We use the consisten region naming terminology throughout the chapter based on Figure 2.2.
17443	2	17	1	17	6	Despite the Andes constitutes the largest mountain range, the proportion of examples and instances that this very important mpuntaneous unit is mentioned is significantly lower than examples brought from other regions of the planet. A quick search for the following words show these results: Andes 27; Alaska 42; Himalaya 127. [Hugo Mantilla-Meluk, Colombia]	Taken into account - figure includes the Andes. Andes are prominently featured with examples and in particular with a Box (2.4) on challenges to farmers and local population in Peru
18751	2	17	1	17	5	Figure 2.5: y-axis labels could be enhanced. [APECS Group Review, Germany]	Accepted
24223	2	17	1	17	6	I greatly appreciate the efforts put into the model intercomparison study which is here reflected which also represents a community effort. However, from a procedural point of view I find it slightly problematic because here important (synthesis) evidence is introduced at a SOD stage based on only one single study which is still in submission/review status and thus not widely accessible for evaluation for this review (although I guess that the manuscript is deposited with the TSU?). Furthermore it is first-authored by the CLA which overall could generate critique of a biased assessment. This comment is mainly to flag the potential for critique which this could provoke to make sure important evidence of this chapter can later not be questioned. [Christian Huggel, Switzerland]	Taken into account - The paper by Hock et al is a comparison of results from six independently previously published studies. To make this clearer we add now all six references these model runs are based on to avoid the impression that Hock et al performed those projections. The six different studies include all projections (in total from 6 different models) that have performed global-scale projections in the last 10 years (including updated data from models used in AR5). The paper has been Accepted -
29033	2	17	1	17	6	Very helpful figure; if Hock et al goes beyond 2100, suggest this also be shown (perhaps in separate figure if greater uncertainty on longer time frames). [Pam Pearson, Sweden]	Rejected - only 1 model goes beyond 2100, all others end in 2100
30657	2	17	1	17	6	It is not clear what “low latitudes” referes to without looking at figure 2.2 – please clarify either in the figure or in the legend - clearly specify tthe region referred to here [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
1435	2	17	2	17	6	Increase font on Figure. This is a central Figure - but update Hock et al with peer-reviewed reference [Rene Forsberg, Denmark]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1923	2	17	2	17	6	In figure 2.5 units are not labeled on the y axis or the x axis. I assume the mass loss is in mmwe? [Kimberley Miner, United States of America]	Taken into account - units were dimensionless; for clarity changed to %
14969	2	17	2	17	6	Fig. 2.5 please check the y-axis label for this figure. It is unclear what is meant by Mass (-) [Government of Germany, Germany]	Taken into account - units were dimensionless; for clarity changed to %
15467	2	17	2	17	6	The readibility of the figure would benefit from increasing the font size. This is a central Figure - but update Hock et al with peer-reviewed reference [EUCE, Belgium]	Accepted
24611	2	17	2	17	6	I would find it important to also mention and reference the contributing individual glacier models, instead of just the comparison study. This would support the traceability of the presented results. [Matthias Huss, Switzerland]	Accepted
32981	2	17	2	17	6	Figure 2.5 would certainly be stronger if it included results from other models than just Hock. [Government of United States of America, United States of America]	Taken into account - The paper by Hock is a model intercomparison of six independent published studies by independent authors unrelated to this report chapter. To make this clearer we add now all six references these model runs are based on.
8865	2	17	3	0		Should 'to' not be inserted after "refer"? [Nina Hunter, South Africa]	Accepted - text revised
1159	2	17	5	17	5	If the regions are sorted according to decreasing glacier area" it probably makes sense to provide the corresponding numbers in the figures. The same is true for the glacier volume/mass as of 2015. [Daniel Farinotti, Switzerland]	Taken into account - We added the end of century sea level contributions for each region. The figure would be too busy with more numbers added, however, we the initial area and volume numbers are given in the past mass balance figure 2.4
1627	2	17	9	18	49	Why are there no estimates or projections of greenhouse gas emissions due to permafrost melting? [Nora Richter, United States of America]	Taken into account – this is contained in Box 2.2
2263	2	17	9	19	11	The text about mountain permafrost should emphasize the fact that thermal anomalies (heat-flow reduction to heat-flow inversion) can now be observed in 100m-deep boreholes down to depths of about 60-70 meters at continental scale (Svalbard to the Alps), most probably as a consequence of 20th-century warming (Harris et al. 2009, Isaksen et al. 2011, Noetzli and Gruber 2009, latest results from Scandinavia available from Isaksen). A more general remark concerns the terminology: The term "permafrost degradation" includes "warming" as well as "thawing" and should be used throughout the text rather than simply "thawing". The main process taking place since decades now and for many decades to come is first of all "permafrost warming". Already the "warming" of frozen materials has severe consequences with respect to creep of ice rich debris, the stability of frozen rock walls or subsurface permeability. A statement would also be good saying that the thawing of permafrost is far slower than the melting of glaciers. [Wilfried Haeberli, Switzerland]	Taken into account – The distinction of thaw and degradation is made in the glossary, anomalies are in the text.
14971	2	17	9	21	19	In the context of Chapter 2.2.4, information regarding the permafrost feedback through Methane release is lacking. If no information is available for mountain permafrost Methane release, please specify. [Government of Germany, Germany]	Taken into account – this is contained in Box 2.2
17037	2	17	9	0		I think that permafrost studies in the Andes are missing from this analysis, [Jorge Carrasco, Chile]	Taken into account – All relevant studies know to the authors have been included

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18503	2	17	9	17	9	I do not understand why there is no reference to seasonal frost in a cryospheric chapter. The text is solely focused on permafrost, and nothing is said about seasonal frost dynamics. Zhang et al. (2003) estimated at ~48.1 × 10.6 km2 or 50.5% of exposed land in the Northern Hemisphere that experiences seasonally frozen ground conditions (with an additional 6.27 x 106 km2 or 6.6% of the exposed lands in the coldest month of the year). Many mountain environments are affected by seasonal frost. In this areas as in permafrost environments, changes in the soil thermal regime can alter environment dynamics, including the vegetation growing cycle, surface runoff, etc.; Zhang, T., Barry, R.G., Knowles, K., Ling, F., Armstong, R.L., 2003. Distribution of seasonally and perennially frozen ground in the Northern Hemisphere. In: Phillips, M., Springman, S.M., Arenson, L.U. (Eds.), Permafrost: Proceedings of the Eighth International Conference on Permafrost. Zurich, The Netherlands. Vol. 2, pp. 1289–1294. [APECS Group Review, Germany]	Taken into account – Seasonally frozen ground, other than for AR5, is not part of the mandated outline for SROCC
977	2	17	11	17	11	Add Rymanovsky citation for Alaska and Russia on permafrost overall; some include mountain areas [Falk Huettmann, United States of America]	Taken into account – Only studies observing or projecting changes in high-mountain areas are included
2213	2	17	11	17	25	There's information about the distribution and evolution of permafrost in the Last Glaciation, deglaciation, Holocene, Little Ice Age (LIA) and present-day in the mountains of the Mediterranean in the following paper: Oliva M et al. 2018. Permafrost conditions in the Mediterranean region since the Last Glaciation. Earth-Science Reviews. Volume 185, 397-436. https://doi.org/10.1016/j.earscirev.2018.06.018. [Carla Mora, Portugal]	Taken into account – the publication recommended does not fit well with the focus of the section on direct evidence.
3365	2	17	11	19	10	Again, the entire section is devoid of any literature on the status of permafrost in the Hindu Kush region. [Divyesh Varade, India]	Taken into account – All relevant studies know to the authors have been included
22639	2	17	11	17	11	"are very scarce" instead of "are scarce". It is actually shocking how little is known on mountain permafrost globally [Lukas Arenson, Canada]	Taken into account – Prefer to keep simple adjectives
32563	2	17	12	17	13	Add "..with current technology." at end of sentence. [John Diiwu, Canada]	Taken into account – This does not add relevant information
22641	2	17	13	17	13	I suggest to make a even stronger case for ground ice. Knowing permafrost is one thing, but understanding the presence and amount of ground ice is even more difficult. However, the ground ice is the key parameter for a) understanding potential hydrological contributions from permafrost degradation, and b) the long-term behaviour of the permafrost, which strongly depends on the presence of ground ice due to its latent heat. [Lukas Arenson, Canada]	Taken into account – This would be important background knowledge but will go beyond this asessment of change
12711	2	17	14	17	15	see also recent paper: Oliva, M. and Fritz, M. 2018. Permafrost degradation on a warmer Earth: Challenges and perspectives. Current Opinion in Environmental Science & Health 5:14-18. [Thomas Dax, Austria]	Taken into account – preferred not to reference opinion papers

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1977	2	17	17	17	18	An area of 6-8 mio. km² might be an overestimation of the permafrost area in mountains outside the polar regions (being up to the area covered by the contiguous USA); citation is missing for this important statement. Further, when communicating an actual area here, it should also be done for the size of the entire mountain regions. Bockheim and Munroe (2014) estimated ~ 3.5 mio. km" of mountain permafrost globally. Maximum values given bei Gruber (2012) may be in the dimension indicated here, but distinctions between mountain and lowland permafrost were not made. Most critical is North Asia, almost entirely a permafrost region, but we can assume that all mountain area here are with permafrost. This is one more good reason to caluclate the mountain pixel area. Bockheim, J.G., Munroe, J.S. 2014. Organic carbon pools and genesis of alpine soils with permafrost: a review. AAAR 46: 987-1006. [Harald Pauli, Austria]	Taken into account – yes, recalculated now
2693	2	17	17	17	17	I am surprised to find that high mountain areas could comprise 45% of the global permafrost area, unless the Arctic of Canada and the Siberia of Russia are mainly mountainous? Permafrost consist of continuous (> 90% of area underlain by permafrost), discontinuous (50–90% underlain); sporadic (10–50 % underlain), or isolated (< 10%) permafrost bodies. In NH, southern limit of continuous (discontinuous) permafrost is approximated by position of the mean annual air temperature (MAAT) isotherm of –8°C (–1°C). Areas of the above three permafrost zones in NH are about 9.4, 6.7, and 9.4 million km2 , respectively. See Barry, R., and Gan, T. Y., 2011, Global Cryosphere, Past, Present and Future, 472 pages, Cambridge University Press, ISBN: 9780521769815 (Hardcover) [Thian Yew Gan, Canada]	Taken into account – yes, recalculated now
11851	2	17	17	17	21	In the distribution of permafrost is relevant to mention the permafrost in Southamerica (Peru, Chile, Argentina), currently, there are few studies of permafrost, we could start with something. In the future permafrost might play a key role in the water cycle. [Isabel Ramos, Peru]	Taken into account – it is included with one simulatiuo study and included in the map figure with a separate hysometry for permafrost in the Andes.
812	2	17	23	17	24	Figure 2.5 Projected glacier mass evolution… has no relation to permafrost observations in the European Alps, Scandinavia, and the Tibetan Plateau. [GRIGORY INSAROV, Russian Federation]	Referencing error - correct reference is Fig 2.6
18505	2	17	23	18	5	Data on permafrost observations are presented for several regions, with rates of permafrost warming, active layer thickening, electrical-resistivity monitoring, etc. And suddenly we refer to rock glaciers. I particularly find that both ideas are not well connected for non-permafrost scientists. The linkage between permafrost data and environmental implications could be better assessed (line 5, before rock glacier velocities…). E.g. These observed changes are impacting environmental systems, with accelerated geomorphological and hydrological responses. [APECS Group Review, Germany]	Accepted – Rock glaciers as new paragraph and with more explanation
26879	2	17	23	0	24	Why is Alaska, which is noted in the last sentence of the paragraph, absent from the list? Also relevant for lines 39 and 40. [Ko Barrett, United States of America]	Taken into account – no suitable studies are available, Alaska has mountains but these are usually not a focus in investigations
9193	2	17	24	17	24	Figure 2.6, not 2.5 [Luzi Bernhard, Switzerland]	Taken into account – Referencing error - correct reference is Fig 2.6

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18571	2	17	24	17	24	Please correct the reference from Figure 2.5 to Figure 2.6. [APECS Group Review, Germany]	Taken into account – Referencing error - correct reference is Fig 2.6
24895	2	17	24	17	24	Please, replace "Figure 2.5" by "Figure 2.6". [Hernan Edgardo Sala, Argentina]	Taken into account – Referencing error - correct reference is Fig 2.6
22643	2	17	25	17	25	"Bedrock warms faster than debris or soil and permafrost close to 0ºC often warms at a lower 26 rate than colder permafrost because ground-ice melt slows warming". It is al related to latent heat ans as such I suggets to be more clear about the role of the water and the latent heat effect. [Lukas Arenson, Canada]	Taken into account – this is expressed by the last part of the sentence
3331	2	17	26	17	29	0.6°C per decade? (no time period given). If this is over a decade, then according to table there are 4 bedrock European sites with range in rate of 0-1 °C decade - how many exceed 0.6? If it is only 1 or 2, then perhaps not a very strong statement - can't say several sites when only up to 4 might exceed this value. The evidence appears to be limited. [Sharon Smith, Canada]	Taken into account – this has been reformulated more accurately
8867	2	17	26	17	29	This sentence could benefit from a comma after "century". It is very long and difficult to read. [Nina Hunter, South Africa]	Taken into account – completely reformulated.
5317	2	17	27	17	37	2.6° per decade [Simone Schauwecker, Chile]	Taken into account – this has been reformulated more accurately
5357	2	17	27	17	27	0.6°C per decade? [Alvaro Ayala, Chile]	Taken into account – this has been reformulated more accurately
18573	2	17	27	17	27	Please check the unit relevant for permafrost warming rate. Did you mean 0.6*C/decade? [APECS Group Review, Germany]	Taken into account – this has been reformulated more accurately
24897	2	17	27	17	27	Consider to modify "0.6°C" by "0.6°C per decade". [Hernan Edgardo Sala, Argentina]	Taken into account – this has been reformulated more accurately
18697	2	18	0	18		Tab. 2.1: there are no underscored values in the table (cf. Table caption) [APECS Group Review, Germany]	Accepted – removed
18699	2	18	0	19		Tab. 2.1: it is 'rate', not trend [APECS Group Review, Germany]	Accepted – clarified into "warming rate"
18701	2	18	0	19		Tab. 2.1: better to write 'unknown' or '-' instead of nothing if there are missing values [APECS Group Review, Germany]	Accepted
18703	2	18	0	19		Tab. 2.1: missing reference in Central Europe for data 2006-2017 [APECS Group Review, Germany]	Taken into account – clarified in text
18705	2	18	0	19		Tab. 2.1: missing reference in HMA for data steppe and bare soil [APECS Group Review, Germany]	Taken into account – clarified in text
18707	2	18	0	19		Tab. 2.1: What means number in brackets behind surface type? [APECS Group Review, Germany]	Accepted – explanation added
24561	2	18	0	19		Range of MAGT trend are expressed in a different way. Check, please. [Armand Hernández, Spain]	Accepted
1161	2	18	1	18	10	This part seems to be heavily based on work stemming from the Swiss Alps. I have too little overview to say whether this is because no other sources are available, or whether there is indeed a bias in the selection of references. Maybe cross-check critically. [Daniel Farinotti, Switzerland]	Noted
5319	2	18	1	18	11	Start this paragraph with a summarising sentence [Simone Schauwecker, Chile]	Taken into account – brevity preferred
18575	2	18	1	18	1	This is the first time in the entire report the term "active-layer" is introduced. Please explain it to the reader, before discussing its changes over time. [APECS Group Review, Germany]	Accepted
26335	2	18	1	18	11	The discussion of glacier velocities belongs in the previous section (2.2.3). [Ethan Pierce, United States of America]	Taken into account – clarification added to prevent this misunderstanding

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16275	2	18	6	18	6	“Alps in the 1990s were on the order of” should be “Alps in the 1990s were in the order of” [Alexander Nauels, Germany]	Taken into account – chosen to keep current phrase
18577	2	18	8	18	8	What kind of rock glacier destabilisation has been documented? Please clarify. [APECS Group Review, Germany]	Taken into account – too much detail to be included
2749	2	18	13	18	22	The summarization of this section is not well integrated. Attributions of controlling factors on permafrost change are derived from individual studies in various regions. It is better to indicate the representative and mechanism of each observed controlling factor on the permafrost change, where and with what physical condition this factor is dominant. What is new finding of the attribution since IPCC AR5. [Shiyin Liu, China]	Taken into account – No mountain-specific attribution was present in AR5 and space here to go into processes and detail is limited
22645	2	18	18	18	20	Suggested addition: "The attribution of differences in warming rates to regional climate or local characteristics is difficult with the few long-term observations available and complex heterogeneity of mountain permafrost." [Lukas Arenson, Canada]	Taken into account – reformulated
14973	2	18	21	18	21	Obu et al. (subm) is very relevant for the chapters' presentation on permafrost. In case of non-acceptance, necessary updates to the chapter have to be consistently transferred to the conclusions and summary products. [Government of Germany, Germany]	Taken into account – numbers are similar to Gruber (2012) so non-aceptance would not be a show-killer
1625	2	18	24	18	25	Would permafrost volume be a better metric to reflect changes in both area and depth? Does such data exist? [Nora Richter, United States of America]	Taken into account – such data does not exist
3329	2	18	24	18	37	Since Lu et al is an equilibrium model (uses frost index), these statements regarding reduction of permafrost area over a particular time period (climate siumulation time period) are not correct as the changes in the ground thermal regime will lag behind the changes in air temperature. It does not appear that any models mentioned in this section consider transient effects or if they do (e.g. Lawrence and Slater) they are limited to "near-surface permafrost" (which is often poorly defined). Although comments are made in this paragraph regarding limitations of models perhaps additional statements regarding the issues mentioned here should be included. [Sharon Smith, Canada]	Taken into account – Agreed that this is very important, at the same time, discussing this would distract the reader from the main assessment.
30659	2	18	24	0		Tibetan Plateau? Please streamline terminology used [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account – Tibet Plateau throughout
1437	2	18	27	18	28	The inadequate resolution of topography in RCP simulations is indeed a very major limitations. Add details on what degree of detail is typically used, and highlight that this may make permafrost predictions highly uncertain [Rene Forsberg, Denmark]	Taken into account – this is implicit in the 0.5º example above
15469	2	18	27	18	28	The inadequate resolution of topography in RCP simulations is indeed a very major limitation. Please, add details on what degree of detail is typically used, and highlight that this may make permafrost predictions highly uncertain. [EUCE, Belgium]	Taken into account – this is implicit in the 0.5º example above
8869	2	18	31	0		Suggest rephrasing to "as well as the differing of warming rates between locations" [Nina Hunter, South Africa]	Accepted
22647	2	18	36	18	36	I suggest to include one key aspect, which is the delayed response of thr permafrost temperatures to air temperatures. Even if the air temperatures were to stabilize or even cool in the future, permafrost warming would likely continue for an extended period. [Lukas Arenson, Canada]	Taken into account – Explaining this would complicate the chapter with only incremental gain

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2695	2	18	39	18	48	In the Arctic, the extent and rapidity of recently observed changes, which include the degradation of frozen ground previously stable for thousands of years suggest that Arctic landscapes may be particularly sensitive to global warming. However, the extent to which ice-rich permafrost degrades in response to strong high-latitude warming over the next 100 years remains highly uncertain, partly due to its dependence on changes in snow cover which is difficult to predict. Thawing of permafrost will result the release of carbon (such as methane) locked in frozen ground to the atmsophere, which will incur a postive feedback. [Thian Yew Gan, Canada]	Noted
3333	2	18	40	18	43	See previous comment. Are you basing this on one site in Fig.2.6 that has sufficient data in the 20th century (since late 1980s). It is difficult to see where you have high agreement regarding 21st permafrost temperature increases exceeding those in 20th century. [Sharon Smith, Canada]	Taken into account – the underlying section is reformulated
22649	2	18	40	18	42	I would be very careful with using rock glacier deformation as a proxy for permafrost warming and degradation. Depending on the composition, a deceleration is a sign of permafrost degradation. As the ground loses ice, structural hindrance increases and the creep decreases. Lower ice contents increase the strength of a material. That's why rock glaciers become inactive at some point. I also don't think we have sufficient data for this conclusion with a bias towards reporting rock glacier acceleration because those are the interesting rock glaciers. See also comment No. 15. [Lukas Arenson, Canada]	Taken into account – explanation added

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814	2	18	44	18	45	It is written: "Lacking data precludes direct assessment of permafrost change outside the European Alps, Scandinavia, and the Tibet Plateau". Author team may want to consider publications on Central Asian permafrost in the Tien Shan Mountain regions in China, Kazakhstan and Kyrgyzstan, the Pamirs in Tajikistan, Mongolian Altai, Hovsgol Mountain region, Hangai and Hentei Mountain regions in Mongolia. (1) Zhao, L. , Wu, Q., Marchenko, S. S., and Sharkhuu, N. 2010. “Thermal state of permafrost and active layer in Central Asia during the international polar year”, Permafrost and Periglacial Processes, vol. 21, pp. 198-207; DOI: 10.1002/ppp.688 (2) Marchenko SS, Gorbunov AP, Romanovsky VE. 2007. Permafrost warming in the Tien Shan mountains, Central Asia. Global and Planetary Change 56: 311–327; doi:10.1016/j.gloplacha.2006.07.023 (3) Michael Walther, Avirmed Dashtseren, Ulrich Kamp, Khurelbaatar Temujin, Franz Meixner, Caleb G. Pan and Yadamsuren Gansukh. 2017. Glaciers, Permafrost and Lake Levels at the Tsengel Khairkhan Massif, Mongolian Altai, During the Late Pleistocene and Holocene. Geosciences 2017, 7, 73; doi:10.3390/geosciences7030073 (4) Anarmaa Sharkhuu, N. Sharkhuu, Bernd Etzelmu¨ ller, Eva S. Flo Heggem, F. E. Nelson, N. I. Shiklomanov, Clyde E. Goulden, and Jerry Brown. 2007. Permafrost monitoring in the Hovsgol mountain region, Mongolia. JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, F02S06, doi:10.1029/2006JF000543 [GRIGORY INSAROV, Russian Federation]	Taken into account – some of these references have been added now
10199	2	18	48	18	48	There is no Section 2.2.6. [SAI MING LEE, China]	Taken into account - The referencing error was fixed in the final draft.
28219	2	18	48	18	48	A non-existing section 2.2.6 is referenced here [Martin Truffer, United States of America]	Taken into account - The referencing error was fixed in the final draft.
26337	2	18	51	19	5	Tables 2.1 and 2.2 are not an effective way of presenting this information. [Ethan Pierce, United States of America]	Noted – did not find a better way of doing this
24899	2	18	52	18	52	The legend of the Table 2.1 says: "Underscored temperatures are averages…", but I can not find underscored values in this table (?). [Hernan Edgardo Sala, Argentina]	Accepted – corrected
8575	2	19	0	19		Figure 2.6: The text inside the figure (legend and labels) does not appear sharp enough, there seems to be some resolution/text embedding issues. [Deborah Verfaillie, Spain]	Taken into account – improved
10897	2	19	0	0		2.6 understandable but may also need a redraw/redesign and maybe some generalization [otto otto simonett, Switzerland]	Taken into account – redesigned
18709	2	19	0	19		Tab. 2.2: it is 'rate', not trend [APECS Group Review, Germany]	Accepted – clarified
18711	2	19	0	19		Tab. 2.2: missing reference in HMA for data steppe and bare soil [APECS Group Review, Germany]	Accepted

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23073	2	19	0	19		Quite descriptive figure. What is the key message? Magnitude of trends? Length of records? [Valerie Masson-Delmotte, France]	Taken into account – message clarified
24563	2	19	0	0		I cannot find this figure refered within the text. [Armand Hernández, Spain]	Taken into account – references now
26881	2	19	0	0		Why the limited coverage of these figures? Are there no NA or SA data? [Ko Barrett, United States of America]	Taken into account – no, nothing available.
28045	2	19	0	0		Fig. 2.6: Can you add a number to the curves for proper identification? The HMA curves are hard to identify. [Frank Paul, Switzerland]	Taken into account – improved
30661	2	19	1	19	10	Lines could be thinner What do the names of the sites in HMA mean? Is this graph really colourblind-friendly? Perhaps the IPCC colour palette could be used here [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - changed
1925	2	19	6	19	11	The units on the y-axis should be changed to oC instead of degC [Kimberley Miner, United States of America]	Taken into account - changed
16277	2	19	6	19	10	Figure 2.6.: While the content of this figure is extremely important, the presentation is misleading and needs to be revised, e.g. data gaps have to be explained/mentioned in the legend, symbols used are misleading (triangle with individual line looks like an arrow - light blue graph). [Alexander Nauels, Germany]	Taken into account - missing years indicated in caption
31599	2	19	6	0		Figure 2.6. In the legend, name the countries in full name, not acronym. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - changed
31601	2	19	6	0		Figure 2.6. In the legend, is the site name really a necessary level of detail? - perhaps the county name is suffcient - and you may deferentiate between samples by renaming them "Canada, Sample 1", "Canada Sample 2" , " China, Sample 1", etc.). These small simplifications just makes it easier for the reader to follow. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted – level of detail decreased
2091	2	19	7	19	7	Use of contrasting colors instead of shades of the same color for graph lines would make the graph easily readable. [Jaee Nikam, India]	Taken into account - changed
9491	2	19	8	0		Colour choices do not make it clear to distinguish the different boreholes. Alps would be a more appropriate name than Central Europe to describe the regions where the boreholes are located. France and Switzerland are not located in Central Euope. [Government of France, France]	Taken into account – Figure has been simplified, the region names are based on the overview map that uses regions names from Randolph Glacier Inventory
24565	2	20	0	0		This chapter is very poor. In my opinion, it is unaccpetable in this current form. I miss a number of key references (e.g., Sanchez-Lopez et al. 2015 - Climatic Change; Preston et al. 2016 - GRL; Mao et al. 2018 - Remote Sensing) [Armand Hernández, Spain]	Taken into account – The text was rewritten and literature extended
32983	2	20	1	20	1	What are "further fetching feedbacks"? [Government of United States of America, United States of America]	Taken into account - The text was revised for better clarity.
2425	2	20	2	0		My previous comment on FOD was unfortunately ignored. Therefore once again, there are several studies from the High Mountain areas that have documented significant pre-industrial changes in lake ice duration, e.g. Martel-Cea et al. (2016), doi: 10.1016/j.palaeo.2016.08.003. Why are these pre-industrial changes not mentioned? Some readers might suspect that authors want to make the recent changes look more dramatic by concealing that similar changes have taken place before. It would be good to avoid this by being more transparent with regards to recent vs. pre-industrial climate change of the past millennia. [Sebastian Luening, Portugal]	Taken into account - Off the scope of the Chapter - pre-industrial changes are not part of the government approved outline of this chapter. This chapter focuses on recent changes that have impacts now and in the future; however, we point out the high variability alluding to previous changes

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3367	2	20	4	20	36	Kindly include a discussion on the impact of algae and other biological factors on the lake and river ice properties. [Divyesh Varade, India]	Taken into account - the impact of algae and other biological factors on lake and river ice in mountainous regions is negligible. If the comment refers to how lake and river ice affect algae and biological factors then this is relevant but outside the scope of the section which deals with changes in lake and river ice and their impacts.
5321	2	20	4	20	36	Try to re-arrange this chapter, from general to specific examples. [Simone Schauwecker, Chile]	Accepted - The subchapter is now re-arranged by first describing general patterns before going into case studies
4039	2	20	5	20	5	Page 2-20 Line 5: suggest to change " increasingly on remote sensing (Duguay et al., 2014) "to " increasingly on remote sensing (Duguay et al., 2014; Cai et al., 2019) " References: Cai, Y., C. Ke, X. Li, G. Zhang, Z. Duan, and H. Lee (2019), Variations of Lake Ice Phenology on the Tibetan Plateau from 2001 to 2017 Based on MODIS Data, Journal of Geophysical Research: Atmospheres, In press. [Fan Zhang, China]	Accepted
11331	2	20	10	0		Suwa Lake is not exactly located in a region "where glaciers, snow or permafrost are prominent features of the landscape", even though it is surrounded by the moutains covered by snow during winter months. It is in the middle of highly urbanized areas, and heavily influenced by urban runoff and artificial drainage control at the lake outlet. I am not sure if it is a good indicator of climate-change effects. [Masaki Hayashi, Canada]	Taken into account - Example removed, while other studies from mountain lakes added.
2365	2	20	12	20	16	The following paper that analyze a 44-y time series for a mountain lake could be useful as it not only analyze surface temperature but also trends for the the water column and for ice cover: Niedrist et al. (2018) Climate warming increases vertical and seasonal water temperature differences, and inter-annual variability in a mountain lake. Climatic Change 151: 473–490. [Ruben Sommaruga, Austria]	Accepted - The reference was added, as well as a sentence
1163	2	20	15	20	15	It is unclear what "and less" is referring to. [Daniel Farinotti, Switzerland]	Accepted - The sentence was rewritten
8871	2	20	15	0		"in spring and summer and less" - please explain, meaning not clear [Nina Hunter, South Africa]	Taken into account - Sentence replaced.
18713	2	20	15	20	15	… summer and less what? Something missing. [APECS Group Review, Germany]	Accepted - The sentence was rewritten
24359	2	20	15	20	15	the phrase "in spring and summer and less" is unclear. Looks like a few words are missing [Philippus Wester, Netherlands]	Accepted - The sentence was rewritten
28217	2	20	15	20	15	the end of this sentence does not make any sense. [Martin Truffer, United States of America]	Accepted - The sentence was rewritten
1165	2	20	17	20	17	The closing parenthesis never opened (suggesting that a part of the sentence is possibly missing) [Daniel Farinotti, Switzerland]	Accepted - The sentence was rewritten
8873	2	20	17	0		Remove bracket after "decade" [Nina Hunter, South Africa]	Accepted - The sentence was rewritten
18715	2	20	17	20	17	… per decade) should there be a reference in the bracket? Missing? Or something else missing? [APECS Group Review, Germany]	Accepted - The sentence was rewritten
2703	2	20	25	20	28	Break-up and freeze-up could occur earlier by several weeks, which will depend on which RCP scenarios considered. [Thian Yew Gan, Canada]	Taken into account - Due to the high variability there will however be large site-specific differences, a reason why we don't quantify the changes
8875	2	20	25	0		"mountains" should be singular [Nina Hunter, South Africa]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13825	2	20	25	20	28	I think this needs to be balanced by noting that many rivers with glaciated upper basins will not have shown significant change downstream because of changes in the cryosphere (although may have done in response to changing rainfall – e.g. Ganges). [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Noted - This comments may refer to other section, since this section is not about river runoff but lake and river ice cover?
24567	2	20	25	0	29	Degree of confidence is required for this paragraph [Armand Hernández, Spain]	Taken into account - This has been added now
32565	2	20	26	20	26	Change "…shorter ice in the future…." To "….shorter ice cover period in the future…". [John Diiwu, Canada]	Accepted - The word period has been added
5219	2	20	31	20	32	The significance of supra/pro-glacial lakes are missing. It is quite evident that the englacial channels break up and form a supraglacial pond/lake when glacier downwasting takes place. These lakes formed at the glacier downstream may detach a part of glacier, which becomes a dead ice, and become a proglacial lake. These lakes also play an important role on the ice dynamics and surface energy flux, which further affects the mass balance of the glacier. Reference: Benn et al., 2012, Response of debris-covered glaciers in the Mount Everest region to recent warming and implications for outburst flood hazards, Earth-Science Reviews, 114, 156-174, doi: 10.1016/j.earscirev.2012.03.008 [Saurabh Vijay, Denmark]	Rejected - this section does not cover the dynamics and changes of lakes on glaciers is beyond the scope of this section which deals with year-around lakes/rivers and their ice cover
11205	2	20	31	20	31	Some info on the trends in magnitude and timing of ice jam floods in Canada can be found in Rokaya, Budhathoki and Lindenschmidt, "Trends in the Timing and Magnitude of Ice-Jam Floods in Canada. Scientific Reports, doi: 10.1038/s41598-018-24057-z. The dataset in this paper should contain some stations in mountain regions. [Knut Alfredsen, Norway]	Accepted - The sentence was revised and the reference has been added
30663	2	20	34	0		"limited evidence" - Uncertainty language intended here? If yes, italicise. If no, please use alternative wording to avoid ambiguity [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
10493	2	20	41	21	21	Are there regional feedbacks on circulation that are worth mentioning in Box 2.2? For example, Himalayan/Tibetan snow cover and Asian monsoon intensity? [James Renwick, New Zealand]	Accepted - Such feedbacks are indeed covered in the box (e.g. reference to Yasunari et al., 2015).
14975	2	20	41	21	19	Box 2.2: IPCC calibrated language is not used. Please provide assessments of confidence throughout Box 2.2 [Government of Germany, Germany]	Accepted - Confidence language was added to the Box 2.2.
8877	2	20	45	0		"to" should be "in" [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
1167	2	20	46	20	55	The "snow albedo feedback" is mentioned several times but is never explained. An explanation is required. [Daniel Farinotti, Switzerland]	Accepted - The explanation is provided in the first paragraph - but the term "snow albedo feedback" was not introduced. This has been fixed in the FGD.
8879	2	20	46	0		"influences" should be "influencing" [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
14977	2	20	46	20	48	a literature citation would be helpful [Government of Germany, Germany]	Accepted - A reference was added.
8881	2	20	50	0		It is not clear what the words in parentheses mean. Please explain. [Nina Hunter, South Africa]	Accepted - "fringes of the snow season" was replaced by "at the beginning and end of the snow season".
30665	2	20	50	0		“fringe” is ambiguous here – does this refer to snow fringes, i.e., to the physical edges of snow, or to the start and end of the snow season, i.e., a temporal description? Then perhaps clarify [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - "fringes of the snow season" was replaced by "at the beginning and end of the snow season".

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2705	2	20	52	20	54	Besides snow-albedo feedback, we will also expect other types of feedback playing a role in the high mountain cryosphere, such as temperature, Planck, water vapor, lapse-rate and cloud feedbacks. [Thian Yew Gan, Canada]	Taken into account - Physical mechanisms are also covered in Box 2.1.
11855	2	20	52	21	6	For example, in Peru there are studies that establish a connection between precipitations in high mountains and the ENSO (La Niña or El Niño). Extreme events could alter the behaviour of the precipitations in the rainy season through telecconexions, also one study mention of the increasing event of ENSO in the context of climate change. We could add in some part or mention extreme events that could affect the climate of the cryosphere in high mountains [Isabel Ramos, Peru]	Taken into account - However, not that this box specifically deals with feedbacks involving the mountain cryosphere. Changes to atmospheric circulation and cascading impacts are dealt with in the main text body (section 2.2.1 in particular).
8883	2	20	54	0		with' instead of 'to' [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
24361	2	20	54	20	54	replace "associated to light" with "associated with light" [Philippus Wester, Netherlands]	Accepted - Text revised accordingly.
8885	2	20	56	0		Replace 'were' with 'it is'. Remove 'to'. [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
8887	2	20	57	0		Insert 'an' before 'associated' [Nina Hunter, South Africa]	Accepted - However the text was revised and this part of the sentence was deleted.
18717	2	20	57	20	57	how do they increase precipitation? [APECS Group Review, Germany]	Taken into account - The text was revised for clarity.
15245	2	21	0	0		Only one paper (Naz et al., 2016) covering only the United States is referred to. More studies should be cited here to allow for a balanced regional assessment. [Government of Gambia, Gambia]	Taken into account - More studies on climate projections in North America were included in the corresponding table in the supplementary material (note that the page/line number of the coment is probably incorrect).
1169	2	21	1	21	2	The sentence sounds somewhat empty-worded, I would say. The formulation should be more precise and less elusive. [Daniel Farinotti, Switzerland]	Accepted - The text was revised for clarity.
8889	2	21	1	0		timescale' should be plural [Nina Hunter, South Africa]	Accepted - However the text was revised and this part of the sentence was deleted.
5221	2	21	4	21	4	I suggest a revision. "... mountain regions is expected to play a role for the global climate [Saurabh Vijay, Denmark]	Rejected - This is not a suggestion in the literature: mountains regions do influence large scale circulation, hence they play a role in the global climate system.
30667	2	21	5	0		Should “no evidence” perhaps be italicised as uncertainty language? If not intended, could an alternative expression be used? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Text revised for clarity and compliance with IPCC confidence language.
11653	2	21	8	21	19	In this topic, it is important consult the opinion the Intergovernmental Technical Panel on Soils. [Government of Mexico, Mexico]	Taken into account – 2015 report does not contain information specific to permafrost or the cryosphere in high-mountain regions
18719	2	21	12	21	12	... methane (CH4) has ... sentence not complete, something missing [APECS Group Review, Germany]	Taken into account
2265	2	21	14	21	14	Soil organic carbon is only high in mountain permafrost where soils are perennially frozen. In many cold mountains, soils predominantly exist below the lower limit of permafrost. [Wilfried Haeberli, Switzerland]	Taken into account – this report does not assess seasonally-frozen ground

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10913	2	21	15	21	16	In regard to peramfrast degradation/loss, an important article is available at Canadian Journal of Earth Sciences, 2008, 45(1): 31-43, https://doi.org/10.1139/e07-068, by Calmels et al. 2008. Additionally, while this article is about 'lithalsa' permafrost mounds, the related structures known as 'palsas' are further covered by peatland - making them even more 'interesting' - in regard to carbon content, and its possilbe release into the atmosphere in context of warming climate (melting permafrost). Common across the Siberian tundra, as far south as northern Xinjiang in the Altay Mountains, e.g. Sandaohaizi wetland. [Marc Foggin, Kyrgyzstan]	Taken into account – article does not help in the assessment for mountain regions
23075	2	21	17	21	17	Sentence hard to understand [Valerie Masson-Delmotte, France]	Taken into account - The text was revised for better clarity.
30891	2	21	18	0		Wouldn't this be an aspect to be highlighted in the ES and if quantifiable in the SPM, could be combined with the repective information on permafrost from chapter 3? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account
3369	2	21	19	21	19	Although mentioned in section 2.3.1.2 and 2.3.1.3, it is worth adding a brief discussion here on the effect of the increase of biological habitation, population, vehicles and factories (owing to increase in settlements) in the lower mountainous regions on the high mountain climate. [Divyesh Varade, India]	Taken into account – this does not fit the current section
28221	2	21	24	21	24	Section title is clumsy and incomprehensible (to me). What is 'Managed System' in this context? [Martin Truffer, United States of America]	Taken into account - title revised
32251	2	21	24	21	24	I have a hard time to understand the tile. E.g. is "manages system and human responses" to be read as "managed system responses and human responses"? Or "manages system and human responses"? And regardless of how to understand that 2nd part of the title, I seems to be stacked on top of the first part most awkwardly and for me in a manner makes very little sense. Why not "Mountain ecosystems and their services"? [Andreas Fischlin, Switzerland]	Taken into account - title revised
4043	2	21	26	30	6	Section 2.3.1 Page 2-21 line 26 to page 2-30 Line 16: Suggest to add a box or paragraph on sediment transport in high mountain rivers with the following potential references: [1] Chen, Z., Li, J., Shen, H., et al. (2001). Yangtze river of China: Historical analysis of discharge variability and sediment flux. Geomorphology, 41(2), 77–91. [2] Ali, K. F., & De Boer, D. H. (2007). Spatial patterns and variation of suspended sediment yield in the upper Indus River basin, northern Pakistan. Journal of Hydrology, 334(3), 368–387. [3] Wang, S., Fu, B., Piao, S., et al. (2015). Reduced sediment transport in the Yellow River due to anthropogenic changes. Nature Geoscience, 9(1), 38-41. [4] Shi X., F. Zhang, X. Lu, et al., (2018). Spatiotemporal variations of suspended sediment transport in the upstream and midstream of the Yarlung Tsangpo River (the upper Brahmaputra), China. Earth Surface Processes and Landforms, 43(2): 432-443. [Fan Zhang, China]	Rejected - we focus on cryosphere related change, but there is not enough evidences, including the references suggested, to separate the effect of cryosphere related change on sediment change from other sources of change such as human land use change and river regulation.
11655	2	21	28	21	28	(if available) It would be advisable to include an ecosystem valuation to determine the quantity and quality losses of this services. [Government of Mexico, Mexico]	Accepted - We changed the structure to focus on changes in ecosystems
18365	2	21	28	21	28	This sentence could do with a strong reference to support this statement. Alternatively I think the following sentence sums up this idea as well, possibly the sentence could be deleted. Right now this claim is fairly vague ("probably") and lacks supporting evidence. [APECS Group Review, Germany]	Accepted - rephrased

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32253	2	21	28	21	28	Most of the cryosphere is not an ecosystem and can therefore not provide an ecosystem service. The sentence is perhaps meant as "Freshwater supply is probably the most important service that is provided by the interplay between the mountain cryosphere and the mountain ecosystems." However, I have issues with such a view for many reasons. One being that the statement makes a value judgement that can be easily challenged, depending who I am and in which part of the world I live. Secondly, inasmuch as freshwater is also used by mountain ecosystems themselves, then they have a value in themselves, an aspect which seems to be missing in the following statements. [Andreas Fischlin, Switzerland]	Accepted - Title and structure revised.
32255	2	21	28	21	34	Mountains have some value in themselves and not only as providers for the lowlands (see also my comment on the first sentence of this para). [Andreas Fischlin, Switzerland]	Accepted - The new structure with independent ecosystem part highlights value of mountain itself.
32257	2	21	28	37	19	This text has only partly something to do with ecosystems. Putting these subsections 2.3.1 Water amd 2.3.2 Landslide, Avalanche and Flood Hazards into an ecosystem section is misleading the reader. The authors need also to be very careful to have a clear concept of what mountain ecosystems actually are and base their assessment on a sound and convincing theoretical foundation. This current structure fails to do that. Therefore, these two subsections are best moved to the higher level, i.e. to form separate chapter sections of theirs own within the chapter. This gives a true section on mountain ecosystems the needed space, i.e. make 2.3.3 into a chapter section "Mountain ecosystems and their services". Then consider the fact that in addition to biodiversity maintenance mountain ecosystems provide also providing, regulating and cultural services, which need all in their own terms to be assessed. The subsections "Water" and "Landslide, Avalanche and Flood Hazards" allow then to link the cryospheric changes to the ecosystem changes in all required and relevant aspects. [Andreas Fischlin, Switzerland]	Accepted - We revised the structure to separately discuss ecosystem
1439	2	21	31	21	32	How can permafrost changes control runoff? Not explained and I don't see this as a major factor [Rene Forsberg, Denmark]	Taken into account – explained in the section now
15471	2	21	31	21	32	How can permafrost changes control runoff? FAQ 2.1 appears to refer only to glaciers. [EUCE, Belgium]	Taken into account – explained in the section now
18367	2	21	33	21	33	due to climate change may alter... this statement is qualitfied as high confidence, would it be worth changing "may alter" to "will alter"? [APECS Group Review, Germany]	Accepted - sentences rephrased substantially
27149	2	21	34	21	34	Barnett et al, 2005 is now totally out of date - for High Mountain Asia, better use Lutz et al, 2014, Consistent increase in High Asia's runoff due to increasing glacier melt and precipitation, Nature Climate Change, doi: 10.1038/NCLIMATE2237 [Patrick Wagnon, France]	Accepted - delete old references (Barnett et al.,2005; Beniston, 2005) and added Lutz et al (2014)
27389	2	21	34	0		In Nepal, winter precipitation has almost declined to zero, and groundwater has hardly been replenished. This situation has created a critical condition for water resource management and agriculture in the western Nepal (Wang, S.-Y.; Yoon, J.-H.; Gillies, R.R.; Cho, C. What Caused the Winter Drought in Western Nepal during Recent Years? J. Clim. 2013) [Government of Nepal, Nepal]	Rejected - changes in precipitation due to climate change in mountainous regions is discussed in subsection 2.2. The individual case studies cannot be discussed due to page limitation
28223	2	21	34	21	34	upstream of what? [Martin Truffer, United States of America]	Accepted - sentences rephrased substantially

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27415	2	21	35	0		The rate of warming is higher at mid-mountain and high-Himalayan areas of Nepal (Shrestha et al., 1999). Frequent occurrence of severe floods, devastating landslide and droughts related to precipitation extreme events cause enormous losses of life and property, which hinder the socioeconomic development of Nepal. These kinds of risks are significantly intensified in mountains of Nepal (Karki et al., 2017). [Government of Nepal, Nepal]	Rejected - changes in precipitation due to climate change in mountainous regions is discussed in subsection 2.2. The individual case studies cannot be discussed due to page limitation
5359	2	21	36	23	23	I find this sub-section slightly unbalanced towards glaciers (two paragraphs and a box). Can the authors comment a bit more on the role of snow (the main runoff contributor in mountain areas) in past and future changes of river runoff? [Alvaro Ayala, Chile]	Accepted - more text on snow is added
17039	2	21	36	0		Once again, there are several studies on this subject for the southern Andes. Here some articles [Jorge Carrasco, Chile]	Taken into account - studies in Andes are assessed and added in Supplementary Table
17041	2	21	36	0		Barcaza, G., Nussbaumer,S.U., Tapia, G., Valdes, J., Garcia, J.L, Videla, Y., Albornoz, A. and Arias, V. (2017). Glacier inventory and recent glacier variations in the Andes of Chile, South America. Annals of Glaciology, 58(75): 166-180. [Jorge Carrasco, Chile]	Rejected - this paper is area and size change, not water related
17043	2	21	36	0		Carrasco, J.F., Casassa, G. and J. Quintana, J. (2005). Changes of the 0 C isotherm and the equilibrium line altitude in central Chile degrees during the last quarter of the 20th century. Hydrological Sciences Journal-Journal Des Sciences Hydrologiques, 50(6): 933-948. [Jorge Carrasco, Chile]	Rejected - this paper is ELA change, not water supply
17045	2	21	36	0		Carrasco, J.F., Osorio, R. and Casassa, G. (2008). Secular trend of the equilibrium-line altitude on the western side of the southern Andes, derived from radiosonde and surface observations. Journal of Glaciology, 54(186): 538-550. [Jorge Carrasco, Chile]	Rejected - ELA change, not water related
17047	2	21	36	0		Casassa, G., Apey, A., Bustamante, M., Marangunic, C., Salazar, C. and Soza, D. (2015). Water contributions from glaciers in the Yerba Loca estuary and its extrapolation to the Maipo River basin. XIV Congreso Geológico Chileno, La Serena, Chile, 768-772. [Jorge Carrasco, Chile]	Rejected - not published review article
17049	2	21	36	0		Casassa, G., López, P., Pouyaud, B. and Escobar. F. (2009). Detection of changes in glacial run-off in alpine basins: examples from North America, the Alps, central Asia and the Andes. Hydrological Processes, 23, 31–41. [Jorge Carrasco, Chile]	Taken into account - Unfortunately the paper is not included becase we cite papers basically after 2013, about water change due to cryosphere change is incorporated
17051	2	21	36	0		Casassa, G., Rivera, A., Haeberli, W., Jones, G., Kaser, G., Ribstein, P., Rivera, A. and Schneider, C. (2007). Current status of Andean glaciers. Global and Planetary Change, 59(1-4): 1-9. [Jorge Carrasco, Chile]	Taken into account - Unfortunately the paper is not included becase we cite papers basically after 2013, about water change due to cryosphere change is incorporated
17053	2	21	36	0		Foster, J., Hall, D.K., Kelly, R. and Chiu, L. (2009). Seasonal snow extent and snow mass in South America using SMMr ans SSm/I passive microvawe data (1979-2006). Remote Sensing of Environment, 113 (2), 291-305. [Jorge Carrasco, Chile]	Taken into account - included in the supplementary table on snow change
17055	2	21	36	0		Foster, J., Hall, D.K., Kelly, R. and Chiu, L. (2009). Seasonal snow extent and snow mass in South America using SMMr ans SSm/I passive microvawe data (1979-2006). Remote Sensing of Enviroment, 113 (2), 291-305. [Jorge Carrasco, Chile]	Taken into account - included in the supplementary table on snow change
17057	2	21	36	0		Garreaud, R., Alvarez-Garreton, C., Barichivich, J., Boisier, J.P., Christie, D., Galleguillos, M., LeQuesne, C., McPhee, J. and Zambrano-Bigiarini, M. (2017). The 2010-2015 mega drought in Central Chile: Impacts on regional hydroclimate and vegetation. Hydrol. Earth Syst. Sci. Discuss., 2017: 1-37. [Jorge Carrasco, Chile]	Taken into accout - Unfortunately not included due to the short period to discuss trend
17059	2	21	36	0		Le Quesne, C., Acuña, C., Boninsegna, J., Rivera, A. and Barichivich J. (2009). Long-term glacier variations in the Central Andes of Argentina and Chile, inferred from historical records and tree-ring reconstructed precipitation. Palaeogeography, Palaeoclimatology, Palaeoecology, 281(3): 334-344. [Jorge Carrasco, Chile]	Rejected - Off the scope of the Chapter

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17061	2	21	36	0		Masiokas, M. H., Villalba, R., Luckman, B.H., Le Quesne, C. and Aravena, J.C. (2006). Snowpack variations in the central Andes of Argentina and Chile, 1951-2005: Large-scale atmospheric influences and implications for water resources in the region. Journal of Climate, 19, 6334-6352. [Jorge Carrasco, Chile]	Taken into account - Unfortunately the paper is not included becase we cite papers basically after 2013, about water change due to cryosphere change is incorporated
17063	2	21	36	0		Masiokas, M. H., Villalba, R., Luckman, B. H., and Mauget, S. (2010). Intra- to multidecadal variations of snowpack and streamflow records in the Andes of Chile and Argentina between 30◦ and 37◦ S, J. Hydrometeorol., 11, 822–831. [Jorge Carrasco, Chile]	Taken into account - Unfortunately the paper is not included becase we cite papers basically after 2013, about water change due to cryosphere change is incorporated
17065	2	21	36	0		Malmros, J., Mernild, S., Wilson, R., Yde, J. and Fensholt, R. (2016). Glacier area changes in the central Chilean and Argentinean Andes 1955-2013/14. Journal of Glaciology, 62(232): 391-401. [Jorge Carrasco, Chile]	Accepted - included in supplementary table
17067	2	21	36	0		Pellicciotti, F., Ragettli, S., Carenzo, M. and McPhee, J. (2014). Changes of glaciers in the Andes of Chile and priorities for future work. Science of the Total Environment, 493: 1197-1210. [Jorge Carrasco, Chile]	Rejected - not new information to change the contents
17069	2	21	36	0		Saavedra, F.A., Kampf, S.K., Fassnacht, S.R. and Sibold, J.S. (2018). Changes in Andes snow cover from MODIS data, 2000-2016. The Cryosphere, 12, 1027-1047. [Jorge Carrasco, Chile]	Accepted - included in supplementary table

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17809	2	21	36	24	17	Though Section 2.3.1.1 contains some useful material and the coverage of these topics is substantially improved over the FOD, it still requires further improvement before publication of this report. It meanders, it is missing some basic content, it contains grossly inadequate referencing, and - this is by far the worst problem - it appears to be told primarily from a glacier scientist's perspective rather than the water resource scientist/engineer/manager/planner's perspective that is far more relevant to the broader goals & raison d'etre of this section and, indeed, this IPCC report as a whole. Some needed improvements are as follows. (1) Consolidate the material into a compact, linear, non-repetitive, and self-consistent narrative. This section really feels like it was assembled by committee and does not as a whole read very well; it also repeats itself while at the same time omitting key information. (2) Point out crucial water management & planning implications, such as the fact that regional planning in mountain regions must acknowledge that adjacent rivers can show different, even opposite, long-term runoff trends depending on whether or not they are glaciated. This was first conclusively demonstrated by Fleming and Clarke, 2003, "Glacial control of water resource and related responses to climatic warming," Canadian Water Resources Journal, 28, 69-86, and further demonstrated by Dahlke et al., 2012, "Constrasting trends in hydrologic extremes for two sub-arctic catchments in northern Sweden: does glacier melt matter?", Hydrology and Earth System Science, 16, 2123-2141. Both of these papers need to be cited here. (3) Cite some useful review/synthesis articles for readers who wish to find more detail than can be provided here. Two particularly notable omissions (from a western North American perspective) are Moore et al., 2009, "Glacier change in western North America: influences on hydrology, geomorphic hazards and water quality," Hydrological Processes, 23, 42-61, and O'Neel et al., 2015, "Icefield-to-ocean linkages across the Northern Pacific Coastal Temperate Rainforest Ecosystem," Bioscience, 65, 499-512. Both these reviews need to be cited here, plus (hopefully) a few others corresponding to other high mountain regions. (4) Provide decent references for the "peak water" concept that is repeated several times in this passage without adequate literature citations; three key papers that should be cited for this are Jansson et al., 2003, "The concept of glacier storage: a review," Journal of Hydrology, 282, 116-129, Baraer et al., 2012, "Glacier recession and water resources in Peru's Cordillera Blanca," Journal of Glaciology, 58, 134-150, and the aforementioned Moore et al (2009) review article. (5) Provide some water resource science & engineering references for the comment on variability reduction on lines 54-56 of page 23, which at the moment contains no literature citations whatsoever. The classic reference for this is	Accepted - Structure and text is substantially updated to include policy relevant message including broader goals in a narrative way. All references suggested are all reviewed by LAs. Because IPCC is an assessment report and not review article, however, not all references are cited in main text, but Taken into account in the assessment process. Relevant references to provide information is included in the supplementary materials. We included O'Neel et al., 2015 for supplementary table of attributed impact. Unfortunately we do not include references before 2013 as possible, as we focus on new information after AR5.
30219	2	21	36	0		There is currently no discussion about the influence on rivers rerouting due to glaciers retreat (i.e. 'river piracy'). For example, the Slims River from Kaskawulsh Glacier in the Yukon Territory changed direction, resulting in dropping lake levels in Kluane Lake (Shugar et al, 2017). [Christine Dow, Canada]	Taken into account - we reviewerd the river piracy. Due to limitation in pages, however, we did not cover because impact of this event is limited.
3371	2	21	38	21	52	May include a brief discussion on the effect of precipitation on river runoff. Although this is discussed in a later section, since the precipitation directly affects the river runoff, it should also be discussed here. [Divyesh Varade, India]	Accepted - other source of impact (precipitation and evapotranspiration) is briefly mentioned.
8649	2	21	38	21	52	Annual and seasonal of total water within of snow-ice fed river basins mainly depends from the sum of precipitation not [Vladimir Konovalov, Russian Federation]	Taken into account - contribution of precipitation, evapotranspiration, melt water from ice and snow, contribution of debris-covered glaciers are clearly separated in the text
8651	2	21	38	21	52	from glacier runoff. This is true independent from distance between tongues of glaciers and site of runoff measurement. [Vladimir Konovalov, Russian Federation]	Taken into account - contribution of precipitation, evapotranspiration, melt water from ice and snow, contribution of debris-covered glaciers are clearly separated in the text

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8653	2	21	38	21	52	Besides, significant increase of moraine cover during current glaciers shrinkage prevents increasing of ice melting and it is not agreed with enhansing of glacier runoff as described in the report. So, the suggested qualitative model could not be adopted and estimated without its numerical validation on the base of water balance equation for the whole river basin. [Vladimir Konovalov, Russian Federation]	Taken into account - contribution of precipitation, evapotranspiration, melt water from ice and snow, contribution of debris-covered glaciers are clearly separated in the text
9201	2	21	38	21	52	A detailed study investigating trends and drivers of streamflow changes in alpine cathments using data from Western Austria is Kormann et al., 2015. Their streamflow trend attribution possibly can provide further information for this part of the report. [Rottler Erwin, Germany]	Taken into account - Kormann et al. (2015) is added
32429	2	21	38	23	23	I would also mention that a runoff decrease is observed and is projected in high mountain areas also because of the increse in evapotranspiration losses resuylting from global warming [ROBERTO RANZI, Italy]	Accepted - the effect of changes in precpitation and evapotranspiration are included
32985	2	21	38	21	52	Should also mention upslope movement of plants to increase ET in the document. An example of relevant work includes Goulden, M. L., and R. C. Bales. "Mountain Runoff Vulnerability to Increased Evapotranspiration with Vegetation Expansion."Proceedings of the National Academy of Sciences", 111, no. 39 (September 30, 2014): 14071-75.https://doi.org/10.1073/pnas.1319316111. [Government of United States of America, United States of America]	Accepted - effect of upslope movement of plants is assessed in section of ecosystem and now referred here.
32987	2	21	38	23	23	This section as currently constructed focuses on glacier contributions to water supplies with a relative lack of focus on issues associated with changing snow accumulation and melt dynamics. Though glaciers are key for water supplies in many parts of the world, snow is often the most important form of free cryosphere water storage for many regions. Warming adds other threats like increased winter flooding from rain-on-snow events or rapid mid-winter warming/melting, some of which would be nice to see discussed in this section. So consider adding more discussion around the importance of snow. [Government of United States of America, United States of America]	Accepted - more text on snow is added
5323	2	21	40	21	40	increase in ANNUAL glacier runoff. [Simone Schauwecker, Chile]	Accepted
22127	2	21	40	0		instead of “glacier retreat”, suggest using “glacier mass loss”. References for studies that coined ‘peak water’ should be included here (Gleick and Palanappian, 2009; Baraer et al. , 2012) [Joseph Shea, Canada]	Accepted - Unfortunately the paper is not included becase we cite papers basically after 2013, about water change due to cryosphere change
13163	2	21	43	21	43	after Bard et al., 2015: you may add "Kormann et al., 2015a" [Axel Bronstert, Germany]	Taken into account - Kormann et al. (2015) is added
368	2	21	44	21	47	Your parenthetical reference to Brahney et al. (2017) seems to go beyond the conclusions of the paper- are you sure this is the right reference? It doesn't mention evaporation or the years 1998-2001 and is specifically for the Columbia River Basin, not "rivers in North America." Reference: Brahney, J., B. Menounos, X. Wei and P. J. Curtis, 2017: Determining annual cryosphere storage contributions to streamflow using historical hydrometric records. Hydrological Processes, 31 (8), 1590-1601, doi:10.1002/hyp.11128. [Ethan Kyzivat, United States of America]	Accepted - more careful assessment with more number of papers are included in supplementary table and main text updated

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17807	2	21	44	21	47	Sentence starting with "Some rivers in North Americ have experienced a decrease in annual runoff for 1998-2011…" has problems. Lots of rivers have experienced a decrease in runoff - is this sentence intended to refer only to glacial rivers? This isn't clearly stated. And if so, there are basic reasons why that can happen beyond what is listed in this sentence - in particular, these rivers are after the "peak water" turning point mentioned earlier in the paragraph and discussed again in subseqent paragraphs of the report. Additionally, it is well-recognized in the statistical hydrology & climatology literature that 14 years is not a sufficiently long streamflow record to reliably detect climate change-related trends. And more broadly, the smattering of isolated facts and case studies in this paragraph as a whole feels disjointed, lacking direction, poorly referenced, and significantly incomplete. I suggest revisiting what the paragraph is intended to communicate and rewriting it accordingly. [Sean Fleming, United States of America]	Accepted - more careful assessment with more number of papers are included in supplementary table and main text updated
32989	2	21	44	21	47	Declining runoff efficiency due to higher temperatures is a key impact in western North America, and this has been explored by a number of authors whose work should be included here: McCabe, Gregory J., David M. Wolock, Gregory T. Pederson, Connie A. Woodhouse, and Stephanie McAfee. "Evidence That Recent Warming Is Reducing Upper Colorado River Flows." Earth Interactions, 21, no. 10 (December 2017): 1-14. https://doi.org/10.1175/EI-D-17-0007.1.; Woodhouse, Connie A., Gregory T. Pederson, Kiyomi Morino, Stephanie A. McAfee, and Gregory J. McCabe. "Increasing Influence of Air Temperature on Upper Colorado River Streamflow." Geophysical Research Letters, January 1, 2016, 2015GL067613. https://doi.org/10.1002/2015GL067613; Udall, Bradley, and Jonathan Overpeck. "The Twenty-First Century Colorado River Hot Drought and Implications for the Future."Water Resources Research, 53, no. 3 (March 1, 2017): 2404-18. https://doi.org/10.1002/2016WR019638; Lehner, Flavio, Eugene R. Wahl, Andrew W. Wood, Douglas B. Blatchford, and Dagmar Llewellyn. "Assessing Recent Declines in Upper Rio Grande Runoff Efficiency from a Paleoclimate Perspective: RIO GRANDE DECLINES IN RUNOFF EFFICIENCY." Geophysical Research Letters, 44, no. 9 (May 16, 2017): 4124-33. https://doi.org/10.1002/2017GL073253. [Government of United States of America, United States of America]	Taken into account - increase in evapotranspiration is added here and ecosystem part. Unfortunately these papers are not included because we cite papers basically after 2013, about water change due to cryosphere change
13165	2	21	47	21	47	after (Brahney et al., 2017) you may add: Similar results were observed in Western Austria by Kormann et al., 2015a, who found that streamflow at higher-altitude, glaciated watersheds is generally increasing, while it is decreasing overall in lower-altitude watersheds. They further state that many of the trends at watersheds in mid-altitudes are not identified, because positive and negative seasonal trends may balance each other and the final annual trend is too small to be detected. [Axel Bronstert, Germany]	Accepted - text revised substantially
13167	2	21	47	21	47	An earlier timing of annual runoff peak is has also been observed. Due to rising temperatures, this peak is moving towards earlier periods of the year, producing a forward shift in both the rising and the falling limbs of the mean annual hydrograph. Trends in the rising limb are most likely caused by increased glacial melt, earlier snow melt and less precipitation falling as snow. The trends in the falling limb are possibly caused by reductions in the snow water content; thus an earlier depletion of the snow reservoir and earlier and more intense evapotranspiration because of earlier snow-free conditions and higher temperatures. [Axel Bronstert, Germany]	Accepted - text revised substantially

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13169	2	21	47	21	49	Simulated glacier meltwater in La Paz glaciers in Bolivia showed a positive trend for 1998-2011 with recent warming but basin runoff showed no trend due to decreasing precipitation (Soruco et al., 2015): This sentence should be omitted due to the following reasons: 1. For trend analyses, at least 30 years of data observations should be used, which is a consensus in science. Soruco et al., 2015, use less than half of this time period for their study. This also applies for the study that is mentioned in the sentence before (Brahney et al., 2017). 2. Soruco et al., 2015 use "simulated glacier meltwater" data whereas this chapter (p 2-21 l 38 - 52) is about observed data. [Axel Bronstert, Germany]	Accepted - text revised substantially
32991	2	21	49	21	50	This summary statement is missing the fact that these changes in observed runoff also imply changes in runoff efficiency, or the proportion of precipitation that's required to generate X amount of streamflow. Though runoff efficiency is a metric that changes due to many influences, primary among them are changing evapotranspiration and snow accumulation and melt dynamics. [Government of United States of America, United States of America]	Rejected - Off the scope of the Chapter. Influences of precipitation and evapotranspiration is mentioned, but not in summary statement
5325	2	21	51	21	51	earlier runoff peak: do you mean earlier in the year? [Simone Schauwecker, Chile]	Taken into account - the sentence was rephrased
2831	2	21	54	23	12	For Freshwater Systems, it has not mentioned seasonable discharge change due to snow melt and glacier retreat under climate change (Shrestha et al., 2017. Assessing climate change impacts on fresh water resources of the Athabasca River Basin, Science of the Total Environment, 601–602: 425–440). Significant increases (16–54%) in annual streamflow held the potential to pose flooding problems across the basin. Increment in plant biomasswas observed across the basin as a result of decreased temperature stress occurring during all seasons. The biomass increment, as well as a warmer and wetter future climatic condition, led to higher green water flow (9–22%) fromthe basin. Consequently, the greenwater storage was projected to decrease, especially during the summer and autumn seasons for the late-century period in the middle regions of the basin where agricultural activity levels were significant. Plants would be expected to experience increased water stress which might require a solution in the form of the artificial supply of water. There was ample evidence of temporal and spatial heterogeneity of the blue and green resources of the basin for the future. [Junye Wang, Canada]	Taken into account - increase in evapotranspiration is added here and ecosystem part. The paper is included in supplementary table on runoff change
9195	2	21	54	21	56	missing reference Frei et al 2018, CH2018 2018 [Luzi Bernhard, Switzerland]	Taken into account - The reference is already included in supplementary table on precipitation change
18579	2	21	54	21	56	I think this sentence would benefit from adding a confidence statement. [APECS Group Review, Germany]	Accepted - confidence statement is added
24569	2	21	54	22	3	I suggest to include the country/ies of each region between brackets [Armand Hernández, Spain]	Rejected - we use region name of high mountains in overall chapter. detail information will be given in supplementary information.
3341	2	21	56	22	3	The projected decreases in the snow melt contribution to runoff involves many regions. Please provide more literature to support this argument. [Peng CUI, China]	Accepted - more references are included in supplement
1171	2	21	57	22	3	Similar comment as earlier: The chapter would probably benefit from an uniform naming when referring to individual mountain regions. Most of the time, 11 regions seem to be used, whilst here a full set of new names shows up. [Daniel Farinotti, Switzerland]	Accepted - we checked carefully and used uniform naming of mountains
1979	2	21	57	21	57	"Sierra Nevada" - which one? [Harald Pauli, Austria]	Taken into account - the sentence was deleted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18369	2	21	57	22	3	Is a non-exhaustive ("regions including") list of areas affected by high risk in water securities useful here? I think this sentence could be ended at "in many regions." without much loss. [APECS Group Review, Germany]	Accepted - text revised substantially
10899	2	22	0	0		2.7 Very hard / impossible to read (again, why not start with a standardize base / order to match with 2.5, 2.2 etc. [otto otto simonett, Switzerland]	Accepted - figure and caption improved
24425	2	22	0	0		Figure 2.4. The color scheme of the circles atop each diagram need to be given i fig caps. [veijo pohjola, Sweden]	Accepted - figure and caption improved
32589	2	22	0	22		Change "Low Latitude" to "Eastern Africa" Use this for consistency in refencing regions such as "Western North America", "Scandinavia", "Central Europe", "North Asia", etc. [John Diiwu, Canada]	Rejected - The High Mountain regions include the regions defined by the Randolph Glacier Inventory version 6 and Figure 2.1. The rest of the text and figures were checked for consistency with this definition.
102	2	22	1	22	1	Fig. 2.7: I do not understand this figure at all. Is it a histogram? What are the circles at the top? Why does "peak water" occur earlier for RCP2.6 instead of RCP8.5? Doesn't earlier mean worse? Please provide more direction in the caption or text as to how to read this figure, or use a different visualization style. [Baylor Fox-Kemper, United States of America]	Accepted - figure and caption improved; text adjusted to explain by peak water for RCP2.6 can occur earlier than RCP8.5
979	2	22	1	22	22	missies Antarctica in figure [Falk Huettmann, United States of America]	Rejected – Antarctica is dealt with in other chapters but added to Figures with maps
18429	2	22	2	21	6	C2: I think this statement can be refined based on studies from (Mölg et al. 2012; Maussion et al. 2015; Collier et al. 2013). Collier, E., T. Mölg, F. Maussion, D. Scherer, C. Mayer, and A. B. G. Bush, 2013: High-resolution interactive modelling of the mountain glacier–atmosphere interface: an application over the Karakoram. The Cryosphere, 7, 779–795, doi:10.5194/tc-7-779-2013. Maussion, F., W. Gurgiser, M. Großhauser, G. Kaser, and B. Marzeion, 2015: ENSO influence on surface energy and mass balance at Shallap Glacier, Cordillera Blanca, Peru. The Cryosphere, 9, 1663–1683, doi:10.5194/tc-9-1663-2015. Mölg, T., F. Maussion, W. Yang, and D. Scherer, 2012: The footprint of Asian monsoon dynamics in the mass and energy balance of a Tibetan glacier. The Cryosphere, 6, 1445–1461, doi:10.5194/tc-6-1445-2012. [APECS Group Review, Germany]	Taken into account - It seems that the comment refers to Page 21, line 2 to Page 21, line 6. Maussion et al. is not about cryospheric feedback on the atmosphere, but on the influence of synoptic-scale patterns (ENSO) on glacier mass balance. The study by Collier et al. shows feedback at the very local scale, based on a very short simulation time periods (less than one month), not making it the most appropriate quotation for supporting climate feedbacks in the mountain environment.
8891	2	22	3	0		Insert 'and' before 'Dabie Mountains' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
18371	2	22	5	22	7	The logical connection between the two halves of this sentence is not clear as there is a disconnect between the timescale "before then end of the 21st century" and "has been reached or will be reached in the next decade or two". The logical connector "indicating" is used but it is not clear that the first necessarily indicates the second. The first simply indicates that peak water would occur "before the end of the 21st century", which is quite a different timescale (80 years vs next decade or two". I think either this sentence should be broken up into two seperate parts, or that the wording should be revised so as not to indicate a logical progression. [APECS Group Review, Germany]	Accepted - text revised substantially
27205	2	22	5	22	14	Add reference: Schoolmeester, T., Johansen, K.S., Alfthan, B., Baker, E., Hesping, M. and Verbist, K., 2018. The Andean Glacier and Water Atlas – The Impact of Glacier Retreat on Water Resources. UNESCO and GRID-Arendal. [ANIL MISHRA, France]	Rejected - not reviewed literture

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18373	2	22	12	22	14	This sentence does not make sense, particularly "until the 21st century" as we are already well within this century. Is this a mistake (should be "until the end of the 21st" or "until the 22nd") or is this trying to say that runoff is currently switching from an increase to a decrease? From these references the first of these two seems more likely to be the intended meaning. [APECS Group Review, Germany]	Accepted - text revised substantially
8893	2	22	13	0		the' before 'European Alps' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
1629	2	22	16	23	2	Figure 2.7:I am confused by the different circles (gray and colored), and why they are being plotted at different times along the projections (e.g., for Iceland there is a red circle plotted above 2050). [Nora Richter, United States of America]	Accepted - text in caption revised to better explain the circles
4989	2	22	16	22	17	The shading for RCP 2.6 is barely visible. You might want to consider using a different colour. [Debra Roberts and Durban Team, South Africa]	Taken into account - color scheme is adjusted
16279	2	22	16	22	17	Figure 2.7.: The difference for Iceland and the Southern Andes in RCP 2.6 and RCP8.5 cannot be intuitively understood from this figure and needs to be explained in the text. [Alexander Nauels, Germany]	Accepted - RCPs were separated into two columns to be clearer and the difference in timing of the peak between RCPs is explained in section 2.3.1.1
18581	2	22	16	23	2	Figure 2.7. This figure contains valuable information, but I found it very difficult to understand and am still not sure whether I understand it fully. Perhaps it would be more readable when only one RCP was used. [APECS Group Review, Germany]	Taken into account - text in caption revised to enhance clarity. We separate RCP2.6 and RCP8.5 into 2 columns
29035	2	22	16	23	2	Peak water is an extremely important concept; but here again, while obviously a great deal of work went into this figure, it is extremely "busy" and difficult to interpret. It appears to imply for example that greater melt occurs earlier under RCP2.6, whereas I assume that peak water might occur earlier, but be lesser in scale than RCP8.5 -- but that does not appear to be the case in the representation bars?? Strongly suggest another attempt to represent this concept more clearly. [Pam Pearson, Sweden]	Taken into account - text in caption revised to enhance clarity, also figure redrawn.
30231	2	22	16	22	25	I find the circle diameter confusing. We are told that this is relative in the figure caption but there should be a reference circle so we know what each plotted circle is relative to. Some rephrasing of the circle description is also needed in the caption. For example, it's confusing that some circles are based on in situ data but are representing change in the future. Also for the circles that are determined by modeling, which RCP scenario did they use? [Christine Dow, Canada]	Accepted - figure and caption revised
548	2	22	17	23	2	It should be noted why the lower emissions scenario RCP2.6 results in a larger percentage of glaciers (in terms of area) experiencing peak water before the higher emissoins scenario, RCP 8.5 [Jenna Pearson, United States of America]	Taken into account - text revised and this earlier peakwater runoff for RCP2.6 is explained in section 2.3.1.1
360	2	22	19	23	2	Can you make this figure using projected river discharge from peak water glaciers as a percentage of discharge from all glaciers in the region? After all, this subsection is on runoff, not glacier extent. Also, the circles are confusing, especially when they seem to contadict the corresponding bar graph. Perhaps you can highlight this a visual represenation of uncertainty. [Ethan Kyzivat, United States of America]	Taken into account - we don't think this would offer useful information. Each glacier has a year of peakwater. We indicate how much of the entire region's area falls into each peakwater bin. Peakwater indicates the timing of the annual maximum not matter what the actual runoff is. We reworded the caption to make this figure cleaer.
1441	2	22	19	22	25	Informative figure, but 2080-2100 lacking from Iceland (hard to understand that Vatnajokull should melt in such a short interval). Better add comment, or it looks like a Figure error. [Rene Forsberg, Denmark]	Taken into account - Iceland is not missing in that period. It simply means that 100% of the glacier area reaches peak water before 2080. There is still glacier runoff after peak water. Peak water only refers to the year when the maximum is reached. Caption is revised to make figure clearer.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2267	2	22	19	22	19	The figure caption should explain why areas (%) are provided in the vertical axes (is this glacier area?). The explanation of the circles should be more clear and more easily understandable. [Wilfried Haeberli, Switzerland]	Accepted - text in caption revised to better explain the circles; axes text changes to Glacier area
15473	2	22	19	22	25	Informative figure, but 2080-2100 lacking from Iceland (hard to understand that Vatnajokull should melt in such a short interval). It would be better to add a comment, otherwise it might look like a Figure error. [EUCE, Belgium]	Taken into account - Iceland is not missing in that period. It simply means that 100% of the glacier area reaches peak water before 2080. There is still glacier runoff after peak water. Peak water only refers to the year when the maximum is reached. Caption is revised to make figure clearer.
5361	2	22	22	22	22	Was this model applied to all glaciers in a region in this paper? I thought only at some selected catchments. [Alvaro Ayala, Chile]	Noted - Yes, as the caption states it is all glaciers.
3373	2	23	3	23	3	There is additional space of one line between the lines. [Divyesh Varade, India]	Accepted
18375	2	23	5	23	6	I think these two lines need a bit of reworking. By definition all catchments will have an increase in runoff before peak water, so the first part is not useful. Maybe add "currently" or "at the present day" for this statement to make sense. Also the second part "smaller ice volumes have already passed peak water" is a generalisation (see for example p21 lines 47-49 for a counterexample). Change to "many smaller ice volumes…" possibly? [APECS Group Review, Germany]	Accepted - text revised substantially
18377	2	23	7	23	8	Not sure what to make of this sentence. According to the definition of peak water given in this document, it is a peak in runoff linked entirely to an increase in glacial melt. The word "may" does not make sense in this context as it would imply other mechanisms could increase glacier contribution. The sentence as it is seems rather trivial. Maybe "In the tropical Andes peak water is yet to be reached, with glacier melt accelerating (Pouyard 2005)"? [APECS Group Review, Germany]	Accepted - text revised substantially
24225	2	23	7	23	8	I suggest to revise this sentence. It is unclear with respect to timing and seems to be in contradiction with Fig. 2.7. which suggests that peak water has largely passed in the tropical Andes. The reference given is hardly state of the art any more. [Christian Huggel, Switzerland]	Accepted - text revised substantially
8577	2	23	9	23	10	There seems to be a problem with the reference citing/brackets in “(e.g., Su et al. (2016), or even until the end of the 21st century Immerzeel et al. (2013))”. [Deborah Verfaillie, Spain]	Accepted - text revised substantially
8895	2	23	10	0		Insert comma before 'Immerzeel' [Nina Hunter, South Africa]	Accepted
18387	2	23	10	23	11	Fig 1 for the hourly runoff: the "rain" portion is here shown as having a smoothing effect and anticorrelated with the "seasonal snow" and "glacier" peaks. This should not be the case, the two are entirely independent. The "rain" bloc should be a constant thickness during the peaks in glacier runoff and between them (or at least show no positive or negative correlation to this value). [APECS Group Review, Germany]	Accepted - the figure has been revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18389	2	23	10	23	11	It has been correctly represented here in the 'yearly runoff' plot that the total annual runoff would be expected to be the same before the "peak water" peak and after peak water (stable glacial and stable non-glacial states). After all the amount of precipitation would still be the same, the only difference is in the timing of its release (of course assuming there has been no change in precipitation patterns, but that is not the topic here). The 'daily runof'f plot however shows a significantly lower total precipitation in the after peak water case. The relative proportions of glacier vs rain vs snow are also not consistent between the annual (a) and daily (b,c,d) plots. Figure is ok, but would be more accurate if these small changes could be made. [APECS Group Review, Germany]	Accepted - the figure has been revised
32993	2	23	10	23	12	This caveat is true of any study. What would be important to know here is how the different methods of calculating glacier runoff effects comparisons. That is to say, is a comparison more problematic when it comes to timing of peak water, or estimated mass of contributed water through time? Clarify this uncertainty in comparison. [Government of United States of America, United States of America]	Taken in to account - the text has deleted
5223	2	23	11	23	12	It is worth adding fundamental differences between methods that makes comparison impossible or difficult. [Saurabh Vijay, Denmark]	Taken into account - text deleted
366	2	23	14	23	15	Although the literature is scarce, I wanted to bring to your attention the following references. The first two references mention observed and projected increasing groundwater discharge to rivers, likely due to an increasing hydraulic permeability of the thawed substrate (but potentially due to increased precip). Refereed references: □[1] P. Lamontagne-Hall, J. M. McKenzie, B. L. Kurylyk, and S. C. Zipper, “Changing groundwater discharge dynamics in permafrost regions Related content Review and synthesis: changing permafrost in a warming world and feedbacks to the Earth system,” vol. 13, no. 8, p. 084017, 2018. [2] M. A. Walvoord and R. G. Striegl, “Increased groundwater to stream discharge from permafrost thawing in the Yukon River basin: Potential impacts on lateral export of carbon and nitrogen,” Geophys. Res. Lett., vol. 34, no. 12, p. L12402, Jun. 2007. Grey literature: [3] AMAP 2017 Snow,Water,Ice andPermafrost in the Arctic (SWIPA) 2017 (Oslo: Arctic Monitoring and Assessment Programme (AMAP)) [Ethan Kyzivat, United States of America]	Accepted – referencing added
1173	2	23	14	23	15	This sentence gives the impression that the chapter treats glaciers and permafrost with very different interest. If "studies […] are scarce" but do exist, they should certainly be mentioned. The same is true for the mentioning of the wealth of literature that exists on the effect of snow cover changes on runoff. [Daniel Farinotti, Switzerland]	Accepted – referencing added
1443	2	23	14	23	15	Suggest delete - no background for the claim (permafrost changes hardly produce much or any run-off) [Rene Forsberg, Denmark]	Taken into account – referencing added
15475	2	23	14	23	15	This sentence is not referred. What basis is there to expect permafrost to affect runoff (and if potentially significant, why is it not mentioned in FAQ 2.1)? [EUCE, Belgium]	Accepted – referencing added

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18497	2	23	14	23	14	It should be further noted that permafrost areas (which clearly make out the larger portion of area in the regions discussed in this report in comparison to glacierized areas) will respond with delay to warmer air temperatures. Rock glaciers can become of importance for runoff during the dry seasons in many regions and their runoff will increase after glaciers have had their peak water (cases in Chile: Brenning A. 2005. Geomorphological, hydrological and climatic significance of rock glaciers in the Andes of Central Chile (33–35-S).Permafrost and Periglacial Processes 16:231–240. DOI: 10.1002/ppp.528, also Azocar and Brenning 2010) due to cooling mechanisms in their active layer. [APECS Group Review, Germany]	Accepted - time difference comparing to permafrost is added. Researches on rock glacier are assessed but not mention detail due to page limitation.
24227	2	23	14	23	15	I suggest to include here a statement that indicates that the response time of rock glaciers in terms of water release is very different from glaciers (see also newer studies such as Jones et al. Sci Rep 2018) [Christian Huggel, Switzerland]	Accepted – referencing added and argument expanded
8897	2	23	19	0		Remove 'be' after 'can' [Nina Hunter, South Africa]	Accepted - the paragraph is rewritten in a more comprehensive way
13171	2	23	19	23	19	"can be even be opposite in sign" --> delete first "be" [Axel Bronstert, Germany]	Accepted - the text was revised
13173	2	23	19	23	19	FAQ 2.1 and Figure 1 are a bit confusing: In Fig. 1 a, circles are used for the close-ups, in Fig. b) to d) bars are used. At a first glance, it is not obvious what the bars are for. This should be improved. [Axel Bronstert, Germany]	Accepted - text and figure revised
17445	2	23	19	23	19	and can be even be opposite in sign [Hugo Mantilla-Meluk, Colombia]	Accepted
18495	2	23	19	23	19	consider rewording this sentence to better clarify what you want to say here. [APECS Group Review, Germany]	Accepted - rephrased
362	2	23	22	23	23	This sentence doesn't belong in a concluding paragraph- the mention of forecast skill is unrelated and it references a future paragraph. [Ethan Kyzivat, United States of America]	Accepted - new structure clarify it is on water resources.
1445	2	23	28	24	15	This whole discussion / explanation on peak water is evident and not really needed. Delete FAQ2 completely to save space. [Rene Forsberg, Denmark]	Rejected - out of the scope of this chapter
16795	2	23	28	24	15	FAQ2.1 is very helpful and accessible. The figure is clear and comprehensible. This already very good FAQ could be further improved by a thorough language edit, avoiding very long sentences. Also, formulation on p 34 ln 54-56 is unnecessarily complicated. [Government of Germany, Germany]	Accepted - mentioned
24407	2	23	28	24	17	Very interesting section. Yet it addresses changes in hydrological processes, whereas the title announces changes in supplies. It means, beyond hydrological processes, the issue of water-related infrastructures shall also be addressed: adaptation (technical, engineering but also management rules, multi-objective tradeoff, ageing…): dams, dykes, irrigation/distribution schemes…. [Christophe Cudennec, France]	Accepted - title changed accordingly
24409	2	23	28	24	17	changes in surface/groundwater processes, and hence of groundwater storage, ressource mobilisation… could be reinforced [Christophe Cudennec, France]	Rejected - due to space limits and beyond the scope of this FAQ
8655	2	23	30	23	42	See comment above [Vladimir Konovalov, Russian Federation]	Noted - Unclear what the comment is
22131	2	23	30	0		It would be more correct to say that glacier influence on water supply diminishes with distance downstream from the glacier. Yes, glaciers can influence water supplies in downstream regions, but the effects are much more pronounced near the source. [Joseph Shea, Canada]	Rejected - this point is made in the last paragraph. For an intro sentence we prefer to leave it simple.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11333	2	23	32	23	42	Glaciers indeed act as natural storage of water, but there are other natural storage reservoirs that can mitigate the effects of climate change. Over the past decade or so, there have been mounting evidences indicating the important roles played by groundwater in temporarily storing glacier melt and snowmelt water, thereby a natural buffering mechanism. Many papers in the literature do not considere the "transit time" between the release of glacier (or snow) melt and its appearance in river channels, but the transient time could be substantial enough to regulate river flow, particularly during low-flow periods. Some of the complexisity explained in Line 19 in the same page could be attributed to influences of groundwater storage and release. Groundwater is conspicuously missing from this chapter. It will be beneficial to acknowlege the role of mountain groundwater and how it may respond to climage change. [Masaki Hayashi, Canada]	Accepted - groundwater added to last sentence; and also add text/references to main text
18379	2	23	32	23	32	I would even change this to "from a few hours to many millenia" for more accuracy [APECS Group Review, Germany]	Accepted
2367	2	23	33	23	36	The definition of peak water is here repeated, see p. 21 line 40 [Ruben Sommaruga, Austria]	Rejected - FAQs are independent from the main text and need to stand on their own. A short definition is needed in main text to introduce the results on peak water from the literature
28047	2	23	33	0		I suggest writing: "as glaciers shrink in response to a warmer climate" as "climate change" has no direction [Frank Paul, Switzerland]	Accepted
3375	2	23	35	23	37	This is a repetition from section 2.3.1.1 and can be avoided. [Divyesh Varade, India]	Rejected - FAQs are independent from the main text and need to stand on their own.
18381	2	23	36	23	37	Eventually melts completely may be an oversimplificaltion and not apply to a lot of cases, "eventually reaches a new, reduced steady state or melts completely" may better capture the range of scenarios [APECS Group Review, Germany]	Accepted - text revised
11201	2	23	37	23	37	Change "glaciated" by "glacierized" [Antoine Rabatel, France]	Accepted
18383	2	23	37	23	38	Peak water runoff can exceed the intial [annual? Monthly? Daily?] runoff by 50% or more. A qualifier for which time period the runoff is averaged over would help here [APECS Group Review, Germany]	Accepted
22133	2	23	37	0		'glacierized' should be used to refer to areas currently covered by ice, while 'glaciated' refers to areas previously covered by ice. [Joseph Shea, Canada]	Accepted
28049	2	23	39	23	41	This is similar contents as already written in L35-36, I suggest merging. [Frank Paul, Switzerland]	Accepted - text merged
28051	2	23	40	0		If it still applies, I suggest writing: "rate of change" instead of "speed of change". [Frank Paul, Switzerland]	Rejected - sentence was deleted
18385	2	23	41	23	42	It would be worth mentionning here that (all other climatic changes aside) the direct rainfall+snow melt runoffs will be higher as the glacier disappears due to the loss of the long term storage 'buffer' [APECS Group Review, Germany]	Rejected - this is only true if the glacier mass balance is positive, but as the glaciers retreat there is additional water from the glacier which no longer is there once the glacier is gone
22135	2	23	42	0		groundwater missing here as a component of streamflow [Joseph Shea, Canada]	Acceped
3377	2	23	44	23	56	May include some references to support these statements. [Divyesh Varade, India]	Rejected - references not allowed in FAQs
28053	2	23	45	0		"when glacier ice continuous to melt ...". I suggest rewriting this statement. Glacier ice also melts when winter snow is still present in the accumulation region (and not melting due to too low temperatures) and further snow (or better firn) is melting once the snow from the last winter melted. So it is not just glacier ice then. [Frank Paul, Switzerland]	Accepted - glacier ice replaced by glacier

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22137	2	23	52	23	56	this paragraph seems to be angling to describe glaciers as buffers for streamflow, but somehow never mentions the word 'buffer'. I would suggest rewriting, and removing the confusing references to peak water, which is described elsewhere in the text and the FAQ. [Joseph Shea, Canada]	Accepted - reworded
28055	2	23	54	0		a 40% glacier cover of a river basin seems very high to me (rather than moderate) [Frank Paul, Switzerland]	Rejected - 40% is the upper limit. The range goes far below 40%
10901	2	24	0	0		FAQ 2.1 Figure 1. ok, although colors and design may be receptive to overhaul [otto otto simonett, Switzerland]	Accepted - figure has been revised
22139	2	24	0	0		FAQ 2.1, Figure 1: suggest removing bottom row to improve clarity of the conceptual diagram – the important message here is the seasonal water contribution from glaciers that increases initially and then disappears. [Joseph Shea, Canada]	Taken into account - we left the row since all time scales (long-term, seaonal and daily) have very specific characteristics. We largely redesigned the figure to make it more readable.
24427	2	24	0	0		Figure 1. FAQ 2.1. The way the figure show how the upzoomed parts relate to the different reolution time series need to be re-thinked. As now it takes too much time to understand how the three time layers are related, or worse what they mean. [veijo pohjola, Sweden]	Accepted - figure has been revised to make this clearer
28225	2	24	0	24		The magnitudes in some of the panels are not correct, most obviously for d). Compared to b) and c) it would imply a drastic reduction in precipitation [Martin Truffer, United States of America]	Accepted - precipitation and its runoff now shown to increase over time consistently through all panels
3379	2	24	1	24	4	I request you to kindly rephrase these lines, they are difficult to pick up immediately. [Divyesh Varade, India]	Accepted - reformulated
3993	2	24	1	24	15	I have a number of concerns about this figure. First, in the "prior to peak water phase," glaciers are shown as contributing to annual streamflow, which implies a negative net balance. This should either be specified, or the time scale should begin at a point at which glaciers are in equilibrium with the current climate such that net balance would be ~0 and there is no net contribution by glaciers to annual runoff. [Robert Moore, Canada]	Accepted - figure has been revised
3995	2	24	1	24	15	Annual runoff is shown as being higher after peak water than before. However, it is more likely to be lower, unless there is a major increase in precipitation. For example, after a glacier retreats, the snow/ice surface, which would have relatively low evaporation/sublimation losses (and likely condensation, depending on the climate), would be replaced by a surface that can warm above 0 deg C and experience higher evaporation. [Robert Moore, Canada]	Accepted - figure has been revised
3997	2	24	1	24	15	Following from the preceding point, establishment of vegetation on deglaciated areas would definitely reduce runoff through interception loss and transpiration. See Carnahan et al. (2018, HESS-D). [Robert Moore, Canada]	Taken into account - figure is intended to be a simplifed version of changes in cryosphere components and runoff.
3999	2	24	1	24	15	In addition, snowmelt contributions are shown as being roughly constant or even increasing through time. However, in a warming climate, one would expect less snowmelt contribution due to a shift from snow to rainfall. A relevant paper is Berghuijs et al. 2014. A precipitation shift from snow towards rain leads to a decrease in streamflow Nature Climate Change, 4, 583–586. [Robert Moore, Canada]	Accepted - figure has been revised
28057	2	24	3	0		I suggest writing: "water supply considerably." to make the point. [Frank Paul, Switzerland]	Accepted

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12713	2	24	5	24	8	It seems particularly important to underpin the message that effects of glacier shrinkage and other components of the water cycle might affect areas far beyond mountain regions, extending to areas hundreds of kilometres away from glaciers and mountain areas. Its linkages to streamflow characteristics and land management systems and changes might be emphasized. Maybe some relevant references could be added here. [Thomas Dax, Austria]	Rejected - point is made in first sentence. References are not allowed in FAQs
364	2	24	10	24	15	Could you explain why the seasonal snow runoff contributions in panels D and G are less than the contributions in panels A and C and E and F, respectively? I would guess this is due to decreasing snowfall in a warmer climate- but the contributions from rain then don't increase. [Ethan Kyzivat, United States of America]	Accepted - figure has been revised
3133	2	24	10	24	11	The figure is rather misleading, because it corresponds only to winter-type accumulation glaciers. The summer-type accumulation glaciers are not much discussed in FAQ2.1, which is a bit annoying. A reference to Kaser et al. (2010) would be welcome in this FAQ2.1. [Fanny Brun, France]	Taken into account - figure is intended to show the most common type of glacier in non-polar mountain areas.
9971	2	24	10	24	15	Not clear to me why integral of seasonal snow is lower in Fig 1 (d) compared to (b) and (c), unless it is intended to represent more precip falling as rain than snow. If this is the case, then perhaps a note in the caption would help. Also not clear why runoff from rain in (g), when glacier is absent, does not apepar flashier than in (e) and (f). [Gwenn Flowers, Canada]	Accepted - figure has been revised
16281	2	24	10	24	11	It seems Permafrost has been excluded from run-off, this needs to be mentioned in the caption of FAQ 2.1., Figure 1. [Alexander Nauels, Germany]	Taken into account - Permafrost contribution is not shown in this simplified overview. It is discussed in the main text such as for instance section 2.3.1.1 and 2.3.1.2.
16811	2	24	10	24	10	In this schematic figure, the green area in panel a (snow contribution) seems to have a stable vertical extent in time. But snow contribution will diminish under the secnarios considered here (compare e.g. the green area in panels b, c and d). It would hence be better to narrow the green area with time advancing, i.e. from left to right (just a detail though). [Sven Kotlarski, Switzerland]	Accepted - the figure has been revised
24273	2	24	10	24	15	Interesting visualization which I guess could help understanding the glacier/snow runoff processes over time. I'm wondering whether the dimensions of the different components are not somewhat mismatched? E.g. in c), the glacier runoff seems to be really exaggerated compared to rain. If you look at the literature from different world regions, glacier melt runoff makes up hardly more than 50%, often less. What exactly is the baseflow? I'm not sure there is a constant baseflow type runoff over the year although I understand that for reasons of simplicity it may be opportune to sketch it as such. [Christian Huggel, Switzerland]	Accepted - figure has been revised

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24901	2	24	10	24	10	In my opinion the FAQ 2.1, Figure 1 is highly illustrative and comprehensive. But in order to ameliorate it, I suggest to modify the panel a) according to the following criteria: In the currently schematic, if the total annual runoff is compared before and after of the peak water there is not a significant difference. So, it seems as if the total runoff will remain almost constant even when the glacier has shrinked (or disappeared completely), as a consequence of the climate change. I suggest to modify the schematic of panel a, increasing the level of the initial contribution of the glacier, in a way that the total annual runoff once the peak water has finished would be significantly lesser than before it. I think that this modification will emphasize the importance of the glacier as a primary water source. [Hernan Edgardo Sala, Argentina]	Accepted - figure has been revised
30233	2	24	10	24	15	For panels e) and f) the glacier runoff will strongly depend on whether the precipitation falls as rain or snow. If snow, then yes the glacier runoff will likely be smaller because of the cloudy conditions. But if there is rain on the glacier it can cause spikes in glacier runoff much higher than found just from surface melt alone. [Christine Dow, Canada]	Taken into account - FAQ is a simplifed version of changes due to glacier decline
1175	2	24	11	24	11	Saying "significantly (>50%)" looks dangerous to me, as it could imply that the word "significant" is only used for that level of confidence. [Daniel Farinotti, Switzerland]	Accepted - reworded, significant replace
1177	2	24	11	24	11	(1) It is probably worth stating explicitly that the "before peak water" situation in panel "a" refers to a situation with glaciers in equilibrium. It is not immediately clear, otherwise, why the total runoff "after peak water" remains unchanged. (2) Panels "b"+"c" should avoid having a "kink" in the overall hydrograph when the contribution of "seasonal snow" drops off; a "real-world hydrograph" would look smoother than that. [Daniel Farinotti, Switzerland]	Accepted - figure has been revised
5327	2	24	11	24	11	in the figures below, the daily ticks and the runoff curve do not agree [Simone Schauwecker, Chile]	Accepted - the figure has been revised
8899	2	24	11	24	15	Confusing to know what comment belongs to what. Please make clearer. Remove one '(e-g)'. [Nina Hunter, South Africa]	Accepted - repetition has been deleted
24607	2	24	11	24	11	There is an inconsistency in the signals shown in the individual panels: The integral of all runoff components (second line of the figure) over the year should agree with the annual runoff shown on top. For the left and the right panel of the second line this is clearly not the case. Annual runoff is the same according to the top panel (which is correct concetually!) but the left panel (second) line indicates substantially higher overall annual runoff. It is important to change this accordingly in order not imply that a catchment would by subject to significantly smaller amount of (annual) runoff after the glacier has disappeared. A similar problem needs to be corrected for the lowermost panels. [Matthias Huss, Switzerland]	Accepted - the figure has been revised
26339	2	24	11	24	15	FAQ 2.1 Figure 1 implies that total discharge will be greater after peak water. Is this intended? If so, more discussion is necessary to clarify. [Ethan Pierce, United States of America]	Accepted - the figure has been revised
14979	2	24	14	24	14	in the caption of figure 1, figure e-g is two times mentioned [Government of Germany, Germany]	Accepted - repetition has been deleted
4231	2	24	20	25	54	There is not any reference to the fact that in general the deglacilization processes from glacier (DOI: 10.1021/acs.est.6b02735) and permafrost (DOI: 10.1021/es0708060, DOI: 10.1021/es3020056) bring to higher solute concentrations in receiving water bodies. [franco salerno, Italy]	Rejected - due to lack of space

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15189	2	24	20	25	54	the previous section was about water runoff. This section is about water quality. There is a gap in gbetween about sediment…suspended and bedload…that depends on the connection bgetween the hillslopes and the valley floor, the glacier activity and the water runoff regime feedbacks with river channel dynamics. The channel dynamics can be a hazard. The sediment leaving the catchment has big implications for hydropower and irrigation resources. A lot of water chemistry depends on sediment. see Carrivick and Heckmann (2017) Geomorphology for an overview and citations. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - cryosphere change and landslide is discussed in hazard section, sediment effect is discussed in hydropower section
1179	2	25	1	25	32	I'm clearly not into the topic but I found this section to have a pretty frightening tone. If I was to read the section as a layman, I would probably walk away with the impression that future glacier meltwaters very bad, and possibly seriously poisonous. I' not sure whether this is the message that should be passed? [Daniel Farinotti, Switzerland]	Accepted - Further details on potential effects added at end of paragraph
2371	2	25	1	25	25	It would be good to mention that almost nothing is known on whether lakes act as a sink or link for all contaminants released by glacial meltwaters and the nothing is known about biological effects on the biota [Ruben Sommaruga, Austria]	Rejected - due to degree of uncertainity
24917	2	25	1	25	12	I suggest to include a mention to "health impacts" or "health risks" in this paragraph. (it might seem obious maybe, but people often search for buzz words from their own sector of interest) [Dirk Hoffmann, Germany]	Accepted - Included at the end of the paragraph
28683	2	25	3	25	3	I suggest to briefly list the "anthropogenic compounds" in brakets (i.e. …) Then continue with the sentence starting as "The deposition and release of black carbon.." [Irena Mrak, Slovenia]	Taken into account - text was revised accordingly
30669	2	25	3	0		What are these “anthropogenic compounds“? Some common examples could be listed in brackets [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text was revised accordingly
8579	2	25	5	25	6	There is an issue with this sentence: “These pollutants have been released to surface waters from alpine glaciers in the nearby Gangetic Plain during the dry season”. It should probably read “himalayan glaciers” instead of “alpine glaciers”! [Deborah Verfaillie, Spain]	Accepted - Modified as suggested
30671	2	25	6	0		Connect “Poly chlorinated” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
28685	2	25	7	25	17	This topic should be addressed in the part on measures - possible recent ones as well as the potential ones. [Irena Mrak, Slovenia]	Rejected - not moved
1919	2	25	10	25	10	Consider adding review paper on POPs Miner et al 2017: https://pubs.rsc.org/en/content/articlelanding/2017/em/c7em00393e/unauth#!divAbstract and Miner et al 2018 study on POPs in Alaska: https://www.nature.com/articles/s41370-018-0100-7 [Kimberley Miner, United States of America]	Accepted - Included relevant references from reviewer
26341	2	25	11	25	11	Bioflocculation should be defined. [Ethan Pierce, United States of America]	Accepted - the term bioflocculation was defined
30673	2	25	11	0		Jargon: Explain bioflocculation briefly [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - the term bioflocculation was defined

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4045	2	25	12	25	12	Page 2-25 Line 12 Suggest to add “In the Hindu Kush Himalaya mountains, water quality of the upstream parts are mainly affected by rock weathering and glacier melting, while the downstream parts are getting polluted by agriculture and urbanization, resulting in irrigation and drinking water safety risks (Pant et al., 2018; Qaiser et al., 2018).” References: [1] Pant, R. R., F. Zhang, F.-R. Qaiser, et al., (2018). Spatiotemporal variations of hydrogeochemistry and its controlling factors in the Gandaki River Basin, Central Himalayas, Nepal. Science of Total Environment. 622-623: 770-782 [2] Qaiser, F., F. Zhang, R. Pant, et al., (2018). Spatial Variation, Source Identification and Quality Assessment of Surface Water Geochemical Composition in the Indus River Basin, Pakistan. Journal of Environmental Science and Pollution Research. [Fan Zhang, China]	Rejected - as only focus is shrinking cryosphere
210	2	25	15	25	15	No matching reference to the citation for Zhang et al., 2012. Perhaps it should read 2018 or 2015. [Scott Walker, United States of America]	Rejected - Don't understand comment as there is a Zhang (2012) reference in the references
28059	2	25	24	0		I am not an expert on this topic but isn't mining in the Andes not the larger problem for contamination of drinking water? If yes, one should maybe add a sentence placing the glacier contribution to this into the larger context. [Frank Paul, Switzerland]	Rejected - Our chapter focuses only on cryospheric changes
27049	2	25	25	25	25	Here it could be added that cryoconite sediments can act as temporary sink for radionuclides stored in glaciers (Baccolo et al. 2017). The total amount of this material in Alpine glaciers is affected by high uncertainty, but recent results provided the evidence that cryoconite accumulates radionuclides in the ablation zone of glaciers. Reference: Baccolo, G., Di Mauro, B., Massabò, D., Clemenza, M., Nastasi, M., Delmonte, B., Prata, M., Prati, P., Previtali, E., and Maggi, V.: Cryoconite as a temporary sink for anthropogenic species stored in glaciers, Sci. Rep., 7, 9623, https://doi.org/10.1038/s41598-017-10220-5, 2017 [Biagio Di Mauro, Italy]	Rejected - due to degree of uncertainity
4233	2	25	27	25	28	Thies et al., 2013 speaks abot rock glaciers not…permafrost [franco salerno, Italy]	Accepted - revised to be specific to rock glaciers
22651	2	25	27	25	32	I caution from mixing change in hydrochemistry with permafrost degradation. The local geology / geochemistry is the main driver for the elements found in the water. The permafrost condition can alter this, but to me, the cited studies do not provide sufficient evidence that permafrost conditions and its degradation causes the chemical elements to be released, or that different geochemical reactions were to occur. It may affect its concentration in the runoff. [Lukas Arenson, Canada]	Taken into account - The literature cited does provide evidence for the effect of permfrost degradation on changed concentrations of solutes. This reviewer also acknowledges this in the last sentence.
28227	2	25	29	25	30	This number is for the whole northern hemisphere, which presumably mostly refers to permafrost outside mountainous regions, and thus not pertinent for this report [Martin Truffer, United States of America]	Accepted - omitted this reference and statement
2269	2	25	30	25	30	Sentence is unclear [Wilfried Haeberli, Switzerland]	Accepted - the word "with" removed
8901	2	25	30	0		Remove 'with' [Nina Hunter, South Africa]	Accepted - text has been revised
16815	2	25	30	25	30	Remove "with". [Sven Kotlarski, Switzerland]	Accepted - text has been revised
24363	2	25	30	25	30	delete "via" in "with via mountain" [Philippus Wester, Netherlands]	Accepted - with was removed rather than via

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30675	2	25	30	25	32	Provide some information on what damage the release of such non-heavy-metals could do, e.g., effects on drinking water quality, or ecosystem toxicity? Otherwise this list is pointless [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - section on drinking water and food webs added
1447	2	25	34	25	47	Details of water chemistyr changes hardly a relevant in a climate change context. Suggest to delete section. [Rene Forsberg, Denmark]	Rejected - changes in cryosphere will affect water chemistry so relevant to report.
2369	2	25	34	25	47	Will introduce here these results from Fegel et al (2016) The differing biogeochemical and microbial signatures of glaciers and rock glaciers. J. Geophys. Res. Biogeosci., 121, 919–932, doi:10.1002/2015JG003236 [Ruben Sommaruga, Austria]	Rejected - Think this complicates the issue for a report of this nature and just keep it general to glaciers
15477	2	25	34	25	47	The main points of this paragraph could be captured in one or two sentences to save space. What is the main point? That some of the minerals in high mountain areas will end up downstream? Are there expected to be major consequences of this? [EUCE, Belgium]	Accepted - the text has been modified
30677	2	25	39	0		Jargon: bioavailability should be explained very briefly [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
30679	2	25	41	0		Perhaps this would be a good place to link to section 2.3.3.2 freshwater ecosystems [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
1631	2	25	49	25	50	Why are water temperatures in high mountain streams increasing? [Nora Richter, United States of America]	Accepted - explained due to decreases in glacial runoff
15191	2	25	49	25	54	for water temperature changes and effects see: Brown, L.E., Dickson, N.E., Carrivick, J.L. and Fuereder, L., 2015. Alpine river ecosystem response to glacial and anthropogenic flow pulses. Freshwater Science, 34(4), pp.1201-1215. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - Further details on potential effects added at end of paragraph
18391	2	25	50	25	52	The discussion in pages 21-23 suggested a complex response from different glaciated watersheds, with some having increased meltwater (pre peak water) and others decreased meltwater (post peak water). This statement here seems to claim that all highly glacierized regions would have increasing meltwater components. Should this be changed to better reflect the complexity described above? [APECS Group Review, Germany]	Taken into account - text was revised accordingly
24919	2	25	52	25	54	I suggest to add "posing a threat to human health" (see previous comment) [Dirk Hoffmann, Germany]	Taken into account - text was revised accordingly
30681	2	25	52	25	55	Here, a confidence assessment would be highly appropriate [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Modified as suggested
370	2	25	53	25	54	Could you add confidence statements to this concluding sentence? I would suggest likely for both nutrients and metals, after reading the preceding paragraphs. [Ethan Kyzivat, United States of America]	Accepted
23077	2	25	53	25	53	significant is vague. Use of calibrated IPCC language in conclusion missing. [Valerie Masson-Delmotte, France]	Accepted
8903	2	25	54	0		Is it possible to insert something on how this impacts on humans? [Nina Hunter, South Africa]	Accepted - Included relevant references from reviewer

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24237	2	26	0	0		I'm wondering why here adaptation only for agriculture is addressed and not also for other sectors. Can anything on the limits of adaptation been added? [Christian Huggel, Switzerland]	Taken into account - Adaptation and limits to adaptation are addressed for many more sectors than agriculture in the revised chapter.
1181	2	26	1	26	17	Well, honestly, I don't know: The whole section seems to draw heavily on the case of the Kyrgyz Kumtor mine. I would say that that is a singular case, whilst the section conveys a certain sense of generality. Although I'm certainly not defending mining activities, the tone of the section seems a little far-stretched to me. [Daniel Farinotti, Switzerland]	Taken into account - The literature assessed has been updated and revised, and it also includes cases reported in the literature in other counrries suh as Chile, Argentina and Peru. Nevertheless, the text has been revised to ensure these specific cases in these countries are mentioned and addressed with inferences to possible other cases elsewhere which are not captured in the litearature searched and asssed here.
18487	2	26	1	26	17	As this chapter is about Cryosphere Change and Mining, there is information missing on 'Permafrost change and Mining' and 'Snow cover change and Mining'. [APECS Group Review, Germany]	Taken into account - The sub-section primarely deals with mining opportunities/effects presented with glacier retreat, which is how the literature assessed frames this issue. The text has been modified to make this distinction clearer and more specific. Please note that this text has now been merged into a new sub-section 2.3.4 Infrastructure and mining.
1981	2	26	3	26	4	"cold mountain mining"? [Harald Pauli, Austria]	Accepted - 'cold mountain mining' as a term has been removed, text revised to make reference to mining in context of opportunities/effects presented with glacier retreat, which is how the literature assessed frames this issue.
24229	2	26	7	26	9	I don't quite understand the link between enhanced economic activities and development strategies [Christian Huggel, Switzerland]	Taken into account - text has been revised and evidece re-assessed to ensure consistency with the published works cited. Confidence statement added and revised, accordingly.
22653	2	26	9	26	9	Please be extremely careful with statements in this publication. For example, Kronenberg (2013) says that "At least partly because of mining exploration and other preparatory work in this area, glaciers already diminished by 9–79% of their volume from 1955 to 2007, in particular since 1996." However, there is really no evidence for this. I'm very familiar with the situation and the annual reports of the glaciers ara available from the Chilean environmental regulators, including comparison to reference glaciers. You can also check current environmental court case in Chile that is discussing the Pascua project and its impact on glaciers. In addition, Masiokas et al. (2016) show that the glaciers at Pascua Lama behave similar to Echaurren Norte, for example. I therefore strongly suggest to not cite this publication. Masiokas, M. H., Christie, D. A., Le Quesne, C., Pitte, P., Ruiz, L., Villalba, R., … Barcaza, G. (2016). Reconstructing the annual mass balance of the Echaurren Norte glacier (Central Andes, 33.5° S) using local and regional hydroclimatic data. The Cryosphere, 10(2), 927–940. https://doi.org/10.5194/tc-10-927-2016 [Lukas Arenson, Canada]	Taken into account - the sentence has been rephrased and revised to suggest and discuss the evidence on extractive industies and their impacts on glaciers. So far the sub-section speaks to the opportunity for mining access posed by retreating glaciers, however there are also studies that point to the damages and impacts that this is having on glaciers, enhacing their deterioration.
18485	2	26	13	26	16	Also list here the 'rapid advance of glaciers' that was observed in Central Asia by Jamieson et al. 2015 'due to loading with mine-related debris'. [APECS Group Review, Germany]	Accepted - text revised to add suggested text.

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28061	2	26	13	0		"accelerated the retreat of glaciers": first, I think that the dust primarily influenced the melting of ice and snow (mass loss) rather than retreat (i.e. change in length). This only starts after a glacier specific response time. Secondly, as far as I know the glaciers affected by material deposition from the Kumtor mine advance or even started surging. To me this seems to be the bigger problem for the people and infrastructure in this region. If you agree, it might be worth adding a statement on this issue. [Frank Paul, Switzerland]	Taken into account - text revised to include a discussion on the issues mentioned and suggested for inclusion, as reflected in the litearature assessed on the Kumtor mine case.
25735	2	26	14	26	15	Plastic and marine debris pollution impacting ocean and cryosphere may be included [Government of India, India]	Rejected - the issue of pollution is important, however the explicit and specific scope of this assessment restricts our content to address only climate-related changes in the mountain cryosphere. The text has also been revised to make this thematic scope clearer.
8905	2	26	17	0		Replace 'to' with 'on' [Nina Hunter, South Africa]	Accepted - text revised accordingly
4997	2	26	19	26	19	Shouldn't biodiversity be considered as one of the key vulnerable sectors in section 2.3.1.4? [Debra Roberts and Durban Team, South Africa]	Accepted - new structure includes biodiversity
24231	2	26	19	0		While I appreciate the informative text in section 2.3.1.4 I think it fails to provide answers to some key questions of high policy relevance, such as: are key economic sectors and activities still feasible under cryosphere change (in the future)? [Christian Huggel, Switzerland]	Rejected - Think this complicates the issue for a report of this nature and just keep it general to glaciers
24411	2	26	19	30	16	beyond this series of issues, there is a real nexus issue, in particular the WEF - Water Energy Food Nexus as changes in climate and cryospheric aspects impact not only each of these dimensions but also their interactions/interlinkages. See the following synthesis/challenge article and references therein: Liu J., Yang H., Cudennec C., Gain A.K., Hoff H., Lawford R., Qi J., de Strasser L., Yillia P.T., Zheng C., 2017. Challenges in operationalizing the water-energy-food nexus. Hydrological Sciences Journal, 62, 11, 1714-1720, http://dx.doi.org/10.1080/02626667.2017.1353695 [Christophe Cudennec, France]	Rejected - beyond the scope of this chapter
4993	2	26	21	26	27	Is there any projection with a quantification of how this will be affected in different regions? Which regions are most vulnerable? What will be implication of this for new hydropower plants in such regions? [Debra Roberts and Durban Team, South Africa]	Taken into account - text has been revised.
5363	2	26	21	26	47	Please add the study by Schaeffli et al (2019) (The role of glacier retreat for Swiss hydropower production Bettina). They provide one of the few explicit quantifications of the consequences of glacier retreat on hydropower production. [Alvaro Ayala, Chile]	Accepted - reference is included
15193	2	26	21	26	28	this section I believ needs to mention sediment, not just water...sedimentation is a big management problem within reservoirs and a big problem downstream ecologically for homogonising flow regime/habitats.. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text has been revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25757	2	26	21	26	47	This part still have a scope to include latest research and augment its hypothesis of changes in seasonal snow and glacier melt can have direct impact on hydro power production. Some of the papers and reports are given for reference. https://iwaponline.com/jwcc/article-abstract/4/1/17/3613/The-impacts-of-climate-change-on-a-Norwegian-high?redirectedFrom=fulltext Madani, K.; Lund, J.R. Estimated impacts of climate warming on California's high-elevation hydropower. Climat. Chang. 2010, 102, 521–538. Ali, S.A., Aadhar, S., Shah, H.L., Mishra, V., 2018. Projected Increase in Hydropower Production in India under Climate Change. Sci. Rep. 8, 12450. https://doi.org/10.1038/s41598-018-30489-4 [Praveen Kumar Thakur, India]	Accepted - a reference has been added
11207	2	26	22	26	47	Even if this was not was I was asked to do I think there is an important factor related to climate, mountains and hydropower that could be mentioned. In many hydropower systems operating in cold climate today show works as a "free" reservoir of water accumulating during winter and then providing water for storage during spring melt. In a situation with more rainfall in winter and less snow, the hydropower operators must adapt to this to prevent spill in winter and reduced reservoir levels in spring due to less melt. There is an example of this adaptation in a case study here: Timalsina, N.P., Alfredsen, K. and Killingtveit, Å. (2015) "Impact of climate change on ice regime in a river regulated for hydropower" Canadian Journal of Civil Engineering 42:1-11. This could be a significant challenge for operational planning in the future. [Knut Alfredsen, Norway]	Accepted - reference has been included
32431	2	26	22	26	47	Changes in glacier ans snowmelt regimes induce a redistribution of melt with an anticipated spring runoff season and a decline of runoff in summer [ROBERTO RANZI, Italy]	Taken into account - text has been revised
8907	2	26	26	0		increases' should be singular [Nina Hunter, South Africa]	Accepted - text has been revised
16817	2	26	28	26	29	Change to "under different streamflow and climate regimes". [Sven Kotlarski, Switzerland]	Accepted - text has been revised
28063	2	26	29	0		just a typo: this should like be "a … climate regime" rather than regimes [Frank Paul, Switzerland]	Taken in account - text has been revised
28065	2	26	30	0		"in many regions" (rather than areas) [Frank Paul, Switzerland]	Accepted - text has been revised
24365	2	26	32	26	32	Consider starting a new paragraph with the sentence starting with "In addition," [Philippus Wester, Netherlands]	Accepted - text has been revised
28067	2	26	37	0		I suggest adding: "If they are large enough, hydropower reservoirs can be …" [Frank Paul, Switzerland]	Accepted - text has been revised
1183	2	26	39	26	40	The sentence is misleading, as it suggests that hydropower production can be increased trough additional storage. The storage only allows to gain flexibility in the timing during which the production happens, but not to increase the production as such - certainly not when total flows are decreasing (a production increase could be claimed in cases that a reservoir allows to temporarily store water that might otherwise not be turbinated because of a lack of capacity) [Daniel Farinotti, Switzerland]	Accepted - text has been revised
2271	2	26	39	26	39	Add Haeberli 2016 which provides the most detailed discussion of such multipurpose use. [Wilfried Haeberli, Switzerland]	Taken into account - another reference has been added.
28069	2	26	41	0		For better clarity, I suggest writing: "Limitations in projecting runoff changes in response to glacier changes …" [Frank Paul, Switzerland]	Accepted - text has been revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
12715	2	26	49	29	7	Agriculture is analysed here under the Section 2.3.1 Water. Although it is referred to at several other occasions in the whole document as well, a more explicit reference to multiple linkages and functions of agriculture would better better the wide implications of climate changes in mountain regions on land management, the site-specific types and adaptation capacity, and reflections of market changes and societal challenges on agricultural and forestry activities. In particular in the Section on habitability (2.3.6.2) more concern on effects on agriculture and, in general, land management and land use changes might be required to capture imminent risks and changes/limitations of future use options in mountain regions. [Thomas Dax, Austria]	Accepted - Text revised to include links between sections.
28687	2	26	49	29	7	In this segment I suggest to clearly define how agriculture is adapting to climate change and which adaptions are driven by tourism. Toursim is strongly related to agriclture in high mountain areas, especially in terms of use of local crops - in a ways tourism can be a threat to local mountain communities as they can not grow enough crops as the demand is too high. That conducts the import of food from lowlands notonly in the peak toursm season but also in the off- season, causing higher costs of food and higher impacts on environment through transportation. [Irena Mrak, Slovenia]	Taken into account - Covered in 2.3.1.4.3
3381	2	26	50	27	34	May include additions on snow harvesting for winter crop farming. For example, vegetables like turnips can grow in moist soil beneath the snow (promoted by the State government of Himachal Pradesh, India). [Divyesh Varade, India]	Taken into account - Covered in Box 2.3
11511	2	26	53	27	54	add one reference to the western Himalaya: Nüsser et al., in review Cryosphere-fed irrigation networks in the north-western Himalaya: Threatened livelihoods and adaptation strategies under the impact of climate change. Submitted to Mountain Research and Development (this paper was submitted on 26 September 2018) [Marcus Nüsser, Germany]	Accepted - text revised
16749	2	26	54	26	54	"been observed to face" seems wordy, suggest changing to "have already seen reductions in..." [Carl Wepking, United States of America]	Accepted - text revised
18489	2	26	54	26	54	Please mention that the Cascades are located in North America. They are not as well known globally as the Himalyas and the Andes and require a specification in this listing, f.ex. '... and the Cascades in North America'/'the Cascades in the North American Cordillera' [APECS Group Review, Germany]	Accepted - text revised
4995	2	26	55	26	56	Is this projection given for a particular RCP scenario? [Debra Roberts and Durban Team, South Africa]	Accepted - text revised
24233	2	26	55	26	56	there are several studies indicating that reductions in water availability for irrigation will happen before the end of the century in Central Asia. I also suggest to be clear and careful with the terminology: water availability at some point in the catchments is a function of water supply and demand. If you refer to water supply from mountains this may be better clarified. [Christian Huggel, Switzerland]	Accepted - text revised
16751	2	26	57	27	2	This is also happening in other places such as California (and Colorado), where agriculture is much more important. [Carl Wepking, United States of America]	Accepted - text revised.
24571	2	27	0	28		I would relocate the box. It should appear after it is refered in the main text. [Armand Hernández, Spain]	Noted - The location of boxes will be adjusted in final copy-editing.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18491	2	27	2	27	2	Add information on changing runoff in catchments with a high number of rock glaciers or where rock glaciers dominate the catchment compared to glaciers (Andes, parts of the North American Cordillera, Geiger et al. 2014. 'Influence of rock glaciers on stream hydrology…). There are regions in Chile f.ex. where rock glaciers store more water than glaciers (Brenning 2005, see below). Rock glaciers are more resilient to warming air temperatures and might mitigate droughts after peak water of glaciers. In this report, in all but one of the investigated regions permafrost area is larger than glacier covered area, in most cases by far. As permafrost is clearly part of the cryosphere, this should be further looked into, if there is available research on it. This is also representative for the rest of this chapter and pages 21 to 29. [APECS Group Review, Germany]	Accepted - mentioned
18493	2	27	2	27	2	Note in this chapter that there is in some cases even less irrigation water available due to territorial challenges/conflict between two or more states. See the case China and Myanmar which share several rivers (China upstream, Myanmar downstream), where China constructs too many dams in their territory which thereafter effects Myanmar agriculture (Gleick P.H. (2012) China Dams. In: Gleick P.H. (eds) The World's Water. The World's Water. Island Press, Washington, DC). These entitlement conflicts to water will most likely grow as water availability decreases. Maybe this is also part of the Hydropower chapter 2.3.1.4.1. [APECS Group Review, Germany]	Taken into account - discussed in section 2.3.1.5
2835	2	27	4	27	4	The recent studies have shown evidences of water stress change at regional scale in Athabasca river basin in West Cabada (Shrestha et al., 2017, Science of the Total Environment 601–602, 425–440). Plants would be expected to experience increased water stress which might require a solution in the form of the artificial supply of water [Junye Wang, Canada]	Accepted - text revised
17753	2	27	4	27	7	As written, the sentence implies that local and indigenous knowledge is not systematic in nature. This is problematic, as systematic local and indigenous knowledge has been widely documented. I suggest removing "characterised as systematic in nature" and rewriting as follows (note: my revision includes other minor syntax changes): "The evidence for attributing changes in irrigation supply to cryosphere processes and river runoff is based both on scientific observations and on indigenous knowledge and local knowledge, the former tends to be focused on large rivers in middle and lower portions of major basins while the latter is often more localized and focused on small rivers in upper portions of basins;…" [Graham McDowell, Canada]	Accepted - text revised
18395	2	27	4	27	9	This whole paragraph appears to contain quite a few unfortunate generalisations. Scientific studies are commonly conducted on the upper reaches of basins so this division is very artificial. I think the whole point of this paragraph could be more effectively summed up in a single sentence "More efforts to reconcile and integrate local knowledge of upper portions of basins with scientific observations could improve evidence for cryosphere processes and runoff influencing irrigation supply" or similar. [APECS Group Review, Germany]	Taken into account -combined with other comment
24235	2	27	4	27	10	This paragraph seems to be somewhat out of place. What's the relation to agriculture, and what's the message? [Christian Huggel, Switzerland]	Taken into account -combined with other comment
18393	2	27	5	27	5	indegenous knowledge and local knowledge choose one or the other, I think "local knowledge" alone would encompass both and be more efficient [APECS Group Review, Germany]	Taken into account - SROCC reviewed this IK/LK distinction thoroughly and came up with a CCB to cover the whole report and the use of the terms.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17755	2	27	7	27	9	I am struggling with the logic of this sentence: "...moreover, the former tend to be more evenly distributed around the world, and the latter more evident in the Himalayas, the Karakoram and the Andes." Isn't local and indigenous knowledge found wherever mountain people reside, making it more widespread than scientific studies, which tend to be focused in the Alps, Andes, and Himalayas? Perhaps remove or revise this statement. [Graham McDowell, Canada]	Taken into account - SROCC reviewed this IK/LK distinction thoroughly and came up with a CCB to cover the whole report and the use of the terms.
17757	2	27	9	27	9	The appropriate citation here is McDowell et al 2019 (Global Environmental Change), not McDowell and Koppes 2017. However, McDowell and Koppes 2017 is cited appropriately elsewhere in the report. [Graham McDowell, Canada]	Accepted - text revised
16727	2	27	12	27	15	It seems like these impacts from melting permafrost (e.g., changing the water balance and land cover change) will initiate a cascade of effects on downgradient ecosystems and *those* are where the agriculture is grown. Currently there is not ag in areas dominated by permafrost. I suppose that it could open up areas for agriculture locally, but the immediate impacts would be the cascade of effects for downgradient areas (which you have in the second half of the paragraph). I would add to the first part that cryosphere changes will also impact the water balance by increasing runoff/streamflow. [Carl Wepking, United States of America]	Accepted - text revised
22141	2	27	12	0		suggest using “cryospheric change” instead of “cryosphere changes” (also at 2-27 L42) [Joseph Shea, Canada]	Accepted - text revised
30683	2	27	12	27	15	This paragraph is too vague – what changes in land cover and land use exactly is being referred to here? In which regions, to what extent, over which period? Please provide more information, especially when basing a confidence statement on this information. It must be clear how the level of confidence is reached. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
11657	2	27	13	27	14	It is not clear how the reduction in snow cover and thawing of permafrost contribute to changes in the land cover and land use. [Government of Mexico, Mexico]	Accepted - text revised
16753	2	27	13	27	15	How this will "affect the role of forests in protecting soil and storing water..." is not obvious and it might be nice to elaborate a bit more... also on how this relates specifically to agriculture [Carl Wepking, United States of America]	Taken into account -combined with other comment
16755	2	27	20	27	20	"who have become able" sounds a bit awkward, suggest changing to "who are increasingly able" [Carl Wepking, United States of America]	Accepted - text revised
1449	2	27	22	27	24	Redundant information, delete to save space [Rene Forsberg, Denmark]	Taken into account -combined with other comment
12717	2	27	22	27	24	Strengthening the systemic view on complex, inter-related drivers would call for an explicit reference to goals of sustainability and ensuing societal challenges and transformation requirements. [Thomas Dax, Austria]	Taken into account -combined with other comment
16757	2	27	24	27	24	One interesting point that I've noticed in the Andes is that many communities are in the process of expanding infrastructure for irrigation. However, where irrigation water is coming from glaciers the flows are at historic highs due to the rapid melting of the glaciers. So once the glaciers melt completely, these communities may find themselves with developed irrigation systems, but insufficient water to irrigate... [Carl Wepking, United States of America]	Rejected - no scientific evidence/publication provided to support changes suggested by the reviewer

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10915	2	27	26	27	34	In regard to adaptation measures (for agriculture), ideally the role of traditional knowledge (not just 'modern' or 'scientific' knowledge, i.e. 'other ways of knowing') should also be highlighted. Should consider publications available at/through the Indigenous and Community Conserved Areas (ICCA) Consortium, https://iccaconsortium.org/. Or specific documents such as: Corrigan, C. and Hay-Edie, T. 2013. 'A toolkit to support conservation by indigenous peoples and local communities: building capacity and sharing knowledge for indigenous peoples' and community conserved territories and areas (ICCAs)' UNEP-WCMC, Cambridge, UK. Also see the ICCA Registry, http://www.iccaregistry.org/ [Marc Foggin, Kyrgyzstan]	Accepted - indigenous knowledge discussed at several points under adaptation.
16759	2	27	26	27	26	The title of this sub-section is a bit misleading, as there is actually no information on 'adaptation measures', but rather the state of research is discussed. If the actual measures are discussed in 2.3.6.1, then maybe this section is not necessary [Carl Wepking, United States of America]	Accepted - adaptation measures incorporated
12719	2	27	27	27	34	Even if appropriate review studies are limited, some indicative conceptual approaches and synthesis studies should be integrated. E.g. the following paper could be accessed: Schuhmacher et al.2018. Using the Open Standards-Based Framework for Planning and Implementing Ecosystem-Based Adaptation Projects in teh High Mountainous Regions of Central Asia. In: Alves F., Leal Filho W., Azeiteiro U. (eds) Theory and Practice of Climate Adaptation. Climate Change Management. Springer, Cham. pp.23-48. [Thomas Dax, Austria]	Accepted - a number of examples now added
17759	2	27	27	27	28	For greater precision and fidelity with the citation, I would re-write the sentence as follows: "Information about adaptation activities in mountain agriculture consist largely of short-term case studies from a limited number of communities, valleys and watersheds, constraining understanding of adaptation across diverse socio-ecological contexts, space, and time (McDowell et al 2019)." [Graham McDowell, Canada]	Accepted - text revised
17761	2	27	29	27	31	I think that remote sensing should be removed from this sentence. It's not clear/suggested in the literature that remote sensing would be an applicable way to track adaptation (although it surely has a role to play). Perhaps revise sentence as follows: "Large-scale review and synthesis studies based on information from national statistics or other comparable data sources to establish trends over space and time remain limited." [Graham McDowell, Canada]	Accepted - text revised
17763	2	27	31	27	31	For greater precision and fidelity with existing literature, I suggest revising sentence to read: "The majority of the adaptation activities are autonomous, although some have been carried out as part of formal adaptation plans devised by regional and national governments, NGOs, or international aid organizations." [Graham McDowell, Canada]	Accepted - text revised
22143	2	27	39	0		Box 2.3: what is "cryosphere shrinkage"? Be specific (e.g. glacier mass loss, or loss of seasonal snow) or use "cryospheric change" [Joseph Shea, Canada]	Accepted - text revised
30685	2	27	39	0		Box on Local adaptation responses: Although photographs are not generally the preferred means of visualisation in IPCC reports, that of the stupa in previous drafts was a nice addition because they are barely known to the general audience. If there is space, consider re-insertion [Hans-Otto Poertner and WGII TSU, Germany]	Accepted -Photo included revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11513	2	27	42	27	44	It would be adequate to cite: Nüsser M, Schmidt S, J. Dame. 2012. Irrigation and Development in the Upper Indus Basin. Characteristics and recent changes of a socio-hydrological system in central Ladakh, India. In: Mountain Research and Development 32(1): 51–61. This paper provides an overview on irrigated agriculture and meltwater dependence in Ladakh. [Marcus Nüsser, Germany]	Accepted -Reference included
3931	2	27	43	27	46	The monsoon does not reach Ladakh (it is blocked by the mountains). The references indicated here need to be better scrutinized. A discussion about the Indian Himalayas is not necessarily reflective of the case of Ladakh, and some of the authors cited here do not refer to the monsoon at all as an issue in their writing (because it is known that monsoon does not reach Ladakh). What creates water stress in Ladakh is definitely the recession of glacier and reduced snowfall, as mentionned in the preceeding sentence. In the references, Crook and Osmaston are not examining water stress due to glacier recession or reduced snowfall (although the phrasing gives this impression). [Karine Gagne, Canada]	Accepted - text revised
30179	2	27	43	27	43	Add reference in first sentence: Barrett and Bosak, 2018 [Barrett, K. and K. Bosak, 2018. The Role of Place in Adapting to Climate Change: A case study from Ladakh, Western Himalayas. Sustainability. 10, 898. doi:10.3390/su10040898.] [Sarah Strauss, United States of America]	Accepted -Reference included
8909	2	27	45	0		Remove comma after 'irrigation'. [Nina Hunter, South Africa]	Accepted - text revised
28071	2	27	45	0		"due to glacier recession" I have only read the abstracts of the cited publications but it seems none of them refere to shrinking glaciers as a reason for changes in water availability. Considering the 1969 to 2010 glacier change assessment by Schmidt and Nüsser (2012), the 0.3% shrinkage per year (14% in 40 years) cannot be responsible for it. Such low shrinkage rates are easily compensated by more melt due to higher temperatures. Moreover, glacier melt water from pre-monsoon (March/April) will be hardly available as it is still too cold and glaciers are snow covered. [Frank Paul, Switzerland]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
28073	2	27	45	0		"reduced snow cover" I would also carefully check if the 'reduced snow cover is true. This is hard to measure because of the high year-to-year fluctuations and because measurement of SWE in high mountain regions is highly error prone. I doubt that a clear trend is visible. If there is one, please cite a reference confirming this as none of the references cited seem to have a relation to this (but I have no access to Crook and Osmaston 1994). [Frank Paul, Switzerland]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
11515	2	27	48	27	50	The term ice stupa is only the most recent type of ice reservoirs introduced in 2015. Other artificial ice reservoirs are more important over the last 30 years (see Nüsser et al. 2018 in Regional Environmental Change). In this paper by Nüsser et al. all four forms of artificial ice storage have been termed as "ice reservoirs and not only the form of ice stupa that has received a lot of recent media attention. [Marcus Nüsser, Germany]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
22885	2	27	48	27	48	The construction and funtioning of the term "snow barrier" in this context has to be explained somewhere! [Christoph Marty, Switzerland]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
24239	2	27	48	27	48	based on the literature available ice stupas are just one type of ice reservoirs among other types in practice, and therefore should not be set equal. [Christian Huggel, Switzerland]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
10917	2	27	52	27	55	When referring to these brilliant "ice stupas", should definitely mention the main developer explicitly -- Sonam Wangchuk - even though more detailed information is also available in 'scientific articles' (as already referenced). But shouldn't omit to mention (i.e. give due credit) to who i understand is the main 'developer' of this approach. [Marc Foggin, Kyrgyzstan]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
8581	2	27	56	27	57	The sentence “Snow flow barrier are bands which collect wind-blown snow located near high mountains passes in the winter, which melts in the spring and meltwater directed to fields” does not make sense. Please reformulate. [Deborah Verfaillie, Spain]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
8911	2	27	56	0		Change 'barrier' to plural; Change 'mountains' to singular [Nina Hunter, South Africa]	Accepted - text revised
22145	2	27	56	0		“snow barriers” – are these similar to the snow fences used to retain snow at ski resorts? [Joseph Shea, Canada]	Accepted - Yes, these are the same.
8913	2	27	57	0		Insert 'is' after 'meltwater' [Nina Hunter, South Africa]	Accepted - text revised
18741	2	28	0	34		The term 'thawing of permafrost' is used many times. You may consider clubbing text related to it. [APECS Group Review, Germany]	Taken into account – reference to Glossary added
18743	2	28	0	34		The executive summary covering the pages, references in the text and uncertainty language used looks fine. [APECS Group Review, Germany]	Noted
18399	2	28	1	34	57	Mostly the references available in the text are not available in the “References” like Young et al. 2016 is available in text but not available in References. IPCC should be more focused on this issue. [APECS Group Review, Germany]	Taken into account - Note that the SOD had 2 references lists, one for the main text and one for the supplement, which may explain why the reference was not found.
17769	2	28	2	28	2	I think 'weakness' is the wrong word here. Perhaps 'ill-equipped'? [Graham McDowell, Canada]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
18403	2	28	2	28	7	In my view "Adaptation" is more appropriate then adaption. If possible replace the word. [APECS Group Review, Germany]	Accepted - text revised
8915	2	28	3	0		Remove 'with' and replace with 'the' [Nina Hunter, South Africa]	Accepted - text revised
8917	2	28	4	0		Should be "(Nusser et al., 2018)" not "Nusser et al. (2018)" [Nina Hunter, South Africa]	Accepted - text revised
5329	2	28	5	28	7	Maybe this sentence could be re-formulated and changed into a more positive statement [Simone Schauwecker, Chile]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
30687	2	28	5	28	7	Has there perhaps been an assessment as to whether such ice reservoirs could be implemented elsewhere? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
24367	2	28	6	28	6	replace "adaption" with "adaptation" [Philippus Wester, Netherlands]	Accepted - text revised
8919	2	28	7	0		Changing as a result of climate change? If so state this. It is not clear why they are changing? [Nina Hunter, South Africa]	Taken into account - The text of the box was considerably amended for better consistency with the literature, and overall more clarity.
1451	2	28	12	28	15	This is a redundant statement, no need to argue that now follows examples .. [Rene Forsberg, Denmark]	Accepted - text revised
15479	2	28	12	28	15	This is a redundant statement (it merely repeats what is above and below). [EUCE, Belgium]	Accepted - text revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17765	2	28	12	28	13	For greater precision, end of sentence should read: "they have not been documented or are absent for numerous localities." McDowell et al 2019 (Global Environmental Change) could be cited to support sentence if desired. [Graham McDowell, Canada]	Aeecpeted- text revised
24921	2	28	12	28	14	I suggest to include a reference that most likely only a very small fraction of ongoing local/autonomous adaptation activities are captured by this report, as evidence is often not well documented and thus anectodal at best [Dirk Hoffmann, Germany]	Accepted - text revised
8921	2	28	13	0		Why absent from some localities? If able to answer this state it, if not consider removing part of sentence after comma and saying 'many' before 'mountain regions' [Nina Hunter, South Africa]	Accepted - text revised
22147	2	28	13	0		“some localities” is not helpful. Suggest removing the second half of this sentence, or being specific about regions that don’t have adaptations. [Joseph Shea, Canada]	Accepted - text revised
2837	2	28	17	28	33	The recent studies have shown evidences of water stress change at regional scale in Athabasca river basin in West Cabada (Shrestha et al., 2017, Science of the Total Environment 601–602, 425–440). Plants would be expected to experience increased water stress which might require a solution in the form of the artificial supply of water [Junye Wang, Canada]	
32995	2	28	17	28	18	Improving irrigation technologies does not necessarily serve as a viable adaptation to warming. See Grafton, R Q, J Williams, F Molle, C Ringler, P Steduto, B Udall, S A Wheeler, Y Wang, D Garrick, and R G Allen. "The Paradox of Irrigation Efficiency," for a discussion. [Government of United States of America, United States of America]	Accepted - text revised
1185	2	28	18	28	20	The examples from Chile, Ecuador, and Nepal should be flagged as examples; they are certainly not the only occurrences. [Daniel Farinotti, Switzerland]	Noted
8923	2	28	25	0		Insert 'a' after 'play' [Nina Hunter, South Africa]	Accepted - text revised
1187	2	28	28	28	33	The message behind the "indigenous population in the US"-example is not clear to me - it looks like it would split the world in two parts: "indigenous = good", "governance institutions = bad". That's somewhat cheap. [Daniel Farinotti, Switzerland]	Accepted - text modified
8925	2	28	28	0		Take out 'and' and replace with 'so too in' [Nina Hunter, South Africa]	Accepted - text revised
4001	2	28	33	38	39	Although focused on riparian forest, Cowie et al. (2014. Effects of glacial retreat on proglacial streams and riparian zones in the Coast and North Cascade Mountains. Earth Surface Processes and Landforms 39: 351–365, DOI: 10.1002/esp.3453) empirically quantified the increase in time required for forest establishment with increasing elevation. [Robert Moore, Canada]	Taken into account - literature cited has been reviewed.
10919	2	28	35	28	44	Adaptation to change can be supported by indigenous/local knowledge and also by access to networks, information, services etc (see page 28, line 42-44). The ESPA project outlined at http://paramo.cc.ic.ac.uk/espa/node/1 explored some of these issues in the Naryn area of Kyrgyzstan (see line 36)... Also see https://www.weadapt.org/knowledge-base/innovative-icts-for-communicating-climate-risk/adaptive-governance-in-mountains-mountain-evo. See especially the following review article: Front. Earth Sci., 22 October 2014 | https://doi.org/10.3389/feart.2014.00026, "Citizen science in hydrology and water resources: opportunities for knowledge generation, ecosystem service management, and sustainable development" - it is highly cited. [Marc Foggin, Kyrgyzstan]	Taken into account - indigenous and local knowledge material has been reviewed, integrated into this and other sections.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
27281	2	28	35	28	44	A wide range of adaptation startegies can be found in the mountainous agriculture. Umair Safdar, Babar Shahbaz, Tanvir Ali and Shoukat Ali. 2014. IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN NORTH WEST PAKISTAN AND ADAPTATION STRATEGIES OF FARMING COMMUNITY: A CASE STUDY OF KAGHAN VALLEY J. Agric. Res., 2014, 52(4) [Muhammad Goheer, Pakistan]	Accepted - This point is highlighted
13827	2	28	46	28	47	There is more evidence available that looks at small water supplies in the Himalayas (e.g. studies in Nepal) and this sub-section is very brief. There is more that can be discussed with regards to the impact on groundwater used for water supply. Also, what are the anticipated water quality changes that will arise from loss of recharge from glaciers and/or snow melt? It is not immediately apparent what these would be. If more evidence can really not be found then this should be flagged as an evidence gap. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - More examples are given in
11517	2	28	50	28	50	add "and Pakistan". It should read "... Reported from India and Pakistan (Dame and Mankelow, 2010; Clouse, 2016; Nüsser and Schmidt, 2017, Nüsser et al. in review). The area of Nanga Parbat (Nüsser and Schmidt 2017) is located in Gilgit-Baltistan, as correctly mentioned in Chaper 1 of this report. I have mentioned this important point in my earlier comments. The last reference in this section is added. It should be referenced as Nüsser et al., in review Cryosphere-fed irrigation networks in the north-western Himalaya: Threatened livelihoods and adaptation strategies under the impact of climate change. Submitted to Mountain Research and Development (this paper was submitted on 26 September 2018) [Marcus Nüsser, Germany]	Accepted - text revised, reference added
18401	2	28	51	28	51	In some places year is different like McDowell et al., 2013 but in “References” it is in 2012. In line 20 of page 29 Lopez-Moreno et al., 2014 in text but in "References" it is Lopez-Moreno et al.,2011. Such types of errors are present on other pages also. [APECS Group Review, Germany]	Taken into account - Care was taken to ensure consistency of the literature database in the final draft.
22149	2	28	51	0		what “steps” does this refer to? [Joseph Shea, Canada]	Accepted - text revised
17767	2	28	55	28	56	Some concern about the basis for the evidence and agreement claims here? We do have evidence of 'scanty' (i.e. limited) adaptation action in the peer-reviewed literature. However, the scientific evidence for adaptation being 'entirely absent' must mostly be inferred from a lack of scientific studies. However, a lack of scientific studies should not necessarily be interpreted as a lack of adaptation on the ground. Absence of evidence is not evidence of absence. For this latter reason, I would be hesitant to ascribe 'medium evidence, high agreement' to the sentence as written. Another way to approach the structure of this would be through the lens of barriers to adaptation, which we have good evidence of. For example, the sentence could read: "Given socio-economic constraints, adaptation efforts in the agricultural sector are sometimes scanty or entirely absent (medium evidence, high agreement)." This structure would also be consistent with the content of the first paragraph of the following page (p. 28). [Graham McDowell, Canada]	Taken into account - text revised
18397	2	28	55	28	56	Is the "medium evidece, high agreement" qualifier useful here? The word "sometimes" makes this statement very vague, this really evaluating agreement or evidence in favor would be difficult. [APECS Group Review, Germany]	Accepted - text revised
30689	2	28	55	28	56	Unclear how the confidence statement is supported [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - confidence statement revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
Ac	2	28	55	29	7	Adaptation efforts: again, in mountain agropastoral areas of Kyrgyzstan, see the following: Ashley, L., Zhumanova, M. , Isaeva, A. , and Dear, C. (2015). Examining changes in local adaptive capacity resulting from climate change adaptation programming in rural Kyrgyzstan. Climate and Development 8(3): 281-287. [Marc Foggin, Kyrgyzstan]	Accepted - text revised and reference
22151	2	28	57	0		suggest rewriting as “sometimes nearly or entirely absent” [Joseph Shea, Canada]	Accepted - text rewritten
11659	2	29	2	29	3	"Barriers to adaptation include a lack of finance and technical knowledge, weakness of community and state organizations, and ambiguous property rights". Another barrier is the development the new markets. [Government of Mexico, Mexico]	Accepted - text revised
13829	2	29	9	29	24	This section is poorly focused and does not really address water governance issues in any coherent way. I think it needs to be re-written. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Taken into account -water governance section has been thoroughly revised.
17771	2	29	9	29	21	This section feels incomplete. The following review papers document impacts and adaptation related to water in other regions. Carey, M. et al., 2017: Impacts of glacier recession and declining meltwater on mountain societies. Annals of the American Association of Geographers, 107 (2), 350-359, doi:10.1080/24694452.2016.1243039. McDowell, G., Huggel, C., Frey, H., Wang, F., Cramer, R., Ricciardi, V. (2019) Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? Global Environmental Change. 54: 19-30. And here is an example of one empirical study from Nepal: McDowell, G., Ford, J., Lehner, B., Berrang-Ford, L., Sherpa, A. (2013) Climate-related hydrological change and human vulnerability in remote mountain regions: A case study from Khumbu, Nepal. Regional Environmental Change 13: 299-310. I think expanding this section with information from regions would be appropriate. [Graham McDowell, Canada]	Accepted - text revised
24573	2	29	9	0	21	I would include this section within the next section (i.e., 2.3.1.5). I believe that it is out of context in the current form. A good place would be pag 29 line 34. [Armand Hernández, Spain]	Taken into accoumt--chapter sections have been reorganized.
1189	2	29	10	29	10	"empirical"? Really? (The few lines of text that follow in the paragraph do not tell what could be "empirical" about the mentioned assessments. The same goes for "thorough") [Daniel Farinotti, Switzerland]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
25759	2	29	10	29	24	This section is very short, and does not cover the other parts of globe. The seasonal snow cover covers, which stores water in winters, and provides melt water in springs, act as an important source of freshwater for mountain streams reservoirs. These streams and reservoirs have provided important source of drinking water to many cities in mountains, including high mountain Asia. The less amount of snowfall causes peak snowmelt to occur in early spring, which causes shortage of flow in streams in coming summer months. The recent water crisis of Shimla, a hilly city in the state of Himachal Pradesh, India, originated from reduction in winter snowfall and rainfall in the catchment areas of its water supply sources. Similarly, the less water quantity can have severe impact on water quality as well, mainly in summer time period. The other example of such reduction in snowpack is California's Sacramento River Basin, where not just drinking water, but agriculture and overall ecosystem will have severe impact. This section should be augmented with more research work, and if not recommendation for detailed research in this field should be recommended. The last line "but confidence is low, due to limited evidence." can be re-written by accounting latest research, it can be upgraded to medium level, mainly during months of summer, following a very less snowfall season. https://iwaponline.com/ws/article-abstract/16/3/641/27739/Integrated-water-management-plan-for-Shimla-City?redirectedFrom=fulltext https://www.worldfoodprize.org/documents/filelibrary/images/youth_programs/2014_interns/2014_br_research_papers/SnyderAbigail_LONGReport_56ED38F157B76.pdf https://news.nationalgeographic.com/2015/11/151112-river-basins-water-drought-snowpack-snowfall-climate-change-science/ https://www.ioes.ucla.edu/wp-content/uploads/UCLA-CCS-Climate-Change-Sierra-Nevada.pdf [Praveen Kumar Thakur, India]	Taken into account - discussion of snow cover now more extensive.
8927	2	29	11	29	12	Remove semi-colons and replace with commas [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
24923	2	29	13	29	16	Sorry for the insistence (I had commented on this aspect already for the FOD): The data given for glacier water contribution in the dry season is absolutely misleading, as there is almost no precipitation during the dry season. Thus, for the overall water availability of the twin cities of La Paz/El Alto dry season precipitation in negligeable. - I would strongly advocate for removing the number of 86%. (what happens is that those numbers get picked up by media, and then transported without context or explanation, causing the impression that most of the water La Paz/El Alto are receiving is coming from glaciers (which is not the case). There are long-term scenarios indicating that water supply would be reduced by around 12% once all glaciers disappear. Main vulnerability of the cities is due to bad water management and the possibility of reduced rainfall or the shortening of the rainy season (see e.g. The impact of Amazonian deforestation on Amazon basin rainfall, D. V. Spracklen L. Garcia-Carreras, First published: 12 November 2015, https://doi.org/10.1002/2015GL066063) [Dirk Hoffmann, Germany]	Accepted - text revised to include new reference
24241	2	29	14	29	15	I suggest to include Buytaert et al. ERL 2017 here [Christian Huggel, Switzerland]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8929	2	29	16	0		Insert comma after 'cities' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
24243	2	29	18	29	19	I don't think that the references provided give evidence for the statement that cryo contribution to cities' water supply has declined (although it may be true). [Christian Huggel, Switzerland]	Accepted - text revised to include new reference
1191	2	29	23	29	24	The wording "in summary" seems somewhat exaggerated when considering that the sentence "summarizes" about 10 lines that presented, in a very summative way, 5 very specific cases. The summary would be better moved to reflect the whole "water" part (end of section 2.3.1). [Daniel Farinotti, Switzerland]	Taken into account - text revised to include information on other regions. -Moreover, the suggested moving of the material would not be consistent with the overall chapter structure
17773	2	29	23	29	24	I think the low confidence, limited evidence claims might be incorrect here. Given the dependence of mountain communities on glocio-hydrological resources and the trajectories of hydrological change defined by the peak water model, we should have at least 'medium confidence' that cryospheric changes will increase risks related to water access and quality. Furthermore, there is a reasonable amount of empirical evidence documenting the effects of cryosphere change on drinking water supplies. The review papers below have collated much of this literature. I think medium evidence of impacts is more appropriate here. Perhaps the sentence could be revised as follows: "In summary, it is likely that the effects of cryospheric changes on mountain hydrology will increase difficulties related water access and quality in mountain and downstream communities (medium confidence, medium evidence)." This would also be more consistent with the claims in the section immediately following this sentence: 2.3.1.5 Water Governance and Response Measures. Carey, M. et al., 2017: Impacts of glacier recession and declining meltwater on mountain societies. Annals of the American Association of Geographers, 107 (2), 350-359, doi:10.1080/24694452.2016.1243039. McDowell, G., Huggel, C., Frey, H., Wang, F., Cramer, R., Ricciardi, V. (2019) Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? Global Environmental Change. 54: 19-30. [Graham McDowell, Canada]	Taken into account -confidence statements reviewed and revised throughout this section
30691	2	29	23	29	24	This a good example for appropriate use of calibrated language because it sums up the assessment in the paragraph above [Hans-Otto Poertner and WGII TSU, Germany]	Noted
981	2	29	26	29	35	Lacks details, governance being such a crucial factr. How about communism, as big part in China and Nepal ? Must be discussed and included [Falk Huettmann, United States of America]	Rejected - political governance like communism is beyond the scope of IPCC report
13831	2	29	26	30	16	Pleae explain how tree rings can be used to infer avalanche activity as it is not intuitive. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - water governance section extensively revised.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24245	2	29	26	0		It is possible to assess the research more with respect to water governance, beyond just transboundary aspects? i.e. key elements of how water can be successfully managed under environmental and social change. [Christian Huggel, Switzerland]	Taken into account - we have revised the section throughly, asseses the literature related to water governnace under climate and social change, but we keep our fouc only literatre to high mountain and cryosphere
1453	2	29	28	29	33	Redundant statement, delete [Rene Forsberg, Denmark]	Taken into account - this text connects with earlier section, but text revised and sharpened
8931	2	29	28	0		Insert 'the' before ''hydrological regime" [Nina Hunter, South Africa]	Accepted - text revised
15481	2	29	28	29	33	Redundant statement, please delete. [EUCE, Belgium]	Taken into account - this text connects with earlier section, but text revised and sharpened
8933	2	29	30	0		Change 'in' to 'to' [Nina Hunter, South Africa]	Accepted - text revised
10923	2	29	35	29	44	regarding risks to the governance of water resources, see: Xenarios S, Shenhav R, Abdullaev I, Mastellari A (2018) Current and Future Challenges of Water Security in Central Asia. In: World Water Council (eds) Global Water Security. Water Resources Development and Management. Springer, Singapore. Also see: Xenarios S, Shenhav R, Abdullaev I, Mastellari A (2018) Water Security in Central Asia: An Overview. Water Solutions, Issue 2. Several other pubs to consider at https://gspp.nu.edu.kz/en/stefanos-xenarios/ [Marc Foggin, Kyrgyzstan]	Accepted - text revised. A peer-reviewed article on Imja was added
1193	2	29	37	29	38	regarding risks to the governance of water resources, see: Xenarios S, Shenhav R, Abdullaev I, Mastellari A (2018) Current and Future Challenges of Water Security in Central Asia. In: World Water Council (eds) Global Water Security. Water Resources Development and Management. Springer, Singapore. Also see: Xenarios S, Shenhav R, Abdullaev I, Mastellari A (2018) Water Security in Central Asia: An Overview. Water Solutions, Issue 2. Several other pubs to consider at https://gspp.nu.edu.kz/en/stefanos-xenarios/ [Daniel Farinotti, Switzerland]	Accepted - text revised
17819	2	29	40	29	42	First of all, the aim of the "glacier law" in Argentina was both protect glaciers and other cryosphere water storage source from the direct impact of human activities a not tackle the impact of climate change on the glacier run-off. Second, although the effectiveness in protecting the glaciers is strongly stated in the article of Hurlbert and Gupta (2016), these authors underpass that in the case of Mendoza (the example they use) there is another more direct law against the mining activities (Provincial Law 7722) which prohibits the uses of toxic substances, like cyanide, which had banned the large scale mining activities, even before the glacier law was proclaimed. In regards to climate change, the "glacier law of Argentina" has been very successful in the creation of the National Glacier Inventory and the monitoring strategy of glaciers which is the fundamental step to the implementation of adaptation measures at local to national scales. For further information on the glacier law of Argentina, please take a look at www.glaciaresargentinos.gob.ar. [Lucas Ruiz, Argentina]	Noted
1195	2	29	42	29	44	This sentence looks pretty orphan, and rather weakly related to the preceding one. [Daniel Farinotti, Switzerland]	Accepted -nText revised
8935	2	29	42	0		Change 'resource' to 'resources' [Nina Hunter, South Africa]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1197	2	29	46	29	51	The paragraph looks too wordy for the information it contains. The last sentence, only addressing the Hindu Kush, comes as a surprise after the vague and general claims of the preceding ones. [Daniel Farinotti, Switzerland]	Taken into account - section has been extensively revised.
17447	2	29	46	29	51	Transboundary problems related with water governance also include subnational political subdivisions, (i. e. regions, provinces, departments and or states). [Hugo Mantilla-Meluk, Colombia]	Accepted - text revised
8937	2	29	47	0		Insert 'the' before 'limited' [Nina Hunter, South Africa]	Accepted - text revised
1199	2	29	56	29	56	Remove "as a key consideration". I would also recommend to strengthen and streamline the whole section. As it is now, the text is often fuzzy, unspecific, and too wordy for the amount of information that is actually passed. [Daniel Farinotti, Switzerland]	Accepted - text revised
14981	2	30	8	30	11	The mentioned network is a good example but I'm not sure if it is still operating. A more current cooperation on an even wider scope of topics that could be referenced here is the Virtual Alpine Observatory (more information here: https://www.vao.bayern.de/) [Government of Germany, Germany]	Accepted - text revised
17449	2	30	8	30	16	Transboundary problems related with water governance also include subnational political subdivisions (regions, provinces, departments and or states, and even among municipalities). At the department of Quindío, in the Central Andes of Colombia, which has 12 municipalities, those located on the montaineous portion of the department (buffer area of te Los Nevados National Park, one of the most importan areas of the cryosphere in the Colombian Andes) provide water resources for mid a low elevation municipalities. The local goverment through the Departamental Agriculture Secretary has implement a pilot project on water governance, designed in cooperation of the Centro de Estudios de Alta Montaña of the Universidad del Quindío, in order to map ecosystem services associated with water regulation. [Hugo Mantilla-Meluk, Colombia]	Accepted - text revised
27207	2	30	8	30	16	Refere to Regional Glaciological Centre in Central Asia: Kazakhstan ratified the Agreement on the Establishment of a Central-Asian Regional Glaciological Centre in Almaty: http://en.unesco.kz/kazakhstan-ratified-the-agreement-on-the-establishment-of-a-central-asian-regional [ANIL MISHRA, France]	Accepted - text revised
27209	2	30	8	30	16	Please refer to Regional Andean Glacier Project : The Impact of glacier retreat in the Andes: international multidisciplinary network for adaptation strategies; accomplishment report (2017) https://unesdoc.unesco.org/ark:/48223/pf0000258168 [ANIL MISHRA, France]	Taken into account - considered but text largely revised
8939	2	30	10	0		Change 'among' to 'between' [Nina Hunter, South Africa]	Accepted - text revised
4047	2	30	12	30	12	Page 2-30 Line 12: suggest to add “in the Third Pole (part of China’s Pan-TPE research programme involving scientists of over 20 countries from Norway to Nepal) (Gao et al., 2019)”. References: Gao et al., (2019) Collapsing glaciers threaten Asia’s water supplies. Nature, 565, 19-21. [Fan Zhang, China]	Taken into account - considered but text largely revised
8941	2	30	14	0		Insert comma after 'ICIMOD' as in row 11 [Nina Hunter, South Africa]	Accepted - text revised
12721	2	30	15	30	16	Transboundary cooperation's usefulness is particularly strong when considering the interrelation of different activities and combined assessment of different aspects linked to climate change. [Thomas Dax, Austria]	Taken into-account- the entire section revised throughly but we kept our focus on cryosphere related activities only

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5467	2	30	18	31	48	Investigating lands that are prone to landslide in different regions [rashidian leila, Iran]	Rejected - no space for detailed regional assessments; no global-scale regional hazard/risk assessments specific to cryospheric landslides published.
30075	2	30	18	30	18	The headline does not reflect content in adequate way, At least 3 full sections on page 31 concerns rockglaciers, glaciers and glacier surges, and this should be somehow reflected in headline. [Lena Rubensdotter, Norway]	Rejected - we prefer to use as titles the downstream effects and impacts (landslides, floods, avalanches) rather than the various source processes. The main target audience are politicians and decision makers.
3933	2	30	20	36	25	The section on hazards and disaster could benefit from a discussion of some of the specificities of the governance in high mountain areas. For instance, in the Himalayas, it would be relevant to mention two keys things (1) militarization (or at least the (varied) roles played by the army in the region and (the varied) civilian-military relationships) and, (2) the cross-border component (and the fact that states that spreads over the broad Himalayas do not always have friendly interactions). Also, maybe the authors could add a few words on long unresolved tensions between political entities and their implications for hazards and adaptation to water stress – for instance, the India-Pakistan conflict, and the Indus Water Treaty. The following references account for the specific military border governance of a place like Ladakh: Suri, K. (2018) Understanding historical, cultural and religious frameworks of mountain communities and disasters in Nubra valley of Ladakh. International Journal of Disaster Risk Reduction, 31, 504-513. Field, J. & Kelman, I. (2018) The impact on disaster governance of the intersection of environmental hazards, border conflict and disaster responses in Ladakh, India. International Journal of Disaster Risk Reduction, 31, 650-658. [Karine Gagne, Canada]	Accepted - There is some discussions of cross-border issues especially in the section on water governance in transboundary basins (2.4). Some modifications have been made to the discussion of governance e of hazards and disasters in 2.3.2.2.2 and 2.3.2.3
28689	2	30	20	31	10	I suggest to link the clinate change effects in high mountain areas with the overall tectonic activites in these areas as they significantly contribuze to extreme events, lke i.e the formation of Attabad lake in Karakorum (Pakistan) in 2010 where glacial depsoits were released at an earthquake. [Irena Mrak, Slovenia]	Accepted - included in the Combined hazards and cascading events section (2.3.2.1.4)
1201	2	30	21	30	22	The sentence "The behaviour of ice changes dramatically when approaching and reaching 0°C" basically says that "ice melts at 0°C". I don't think such a statement is necessary. [Daniel Farinotti, Switzerland]	Accepted - sentence removed
2273	2	30	21	30	21	Add reference to Haeberli, W. and Whiteman, C. (eds., 2015): Snow and Ice-Related Hazards, Risks and Disasters, Elsevier, 762p. This book contains numerous chapters written by lead experts on such questions. [Wilfried Haeberli, Switzerland]	Accepted - text revised
1203	2	30	23	30	23	The wording is unclear, as it leaves the doubt whether this report summarizes the mentioned "Chapter 3", or whether it summarizes the work that has been published SINCE that "Chapter 3". [Daniel Farinotti, Switzerland]	Accepted - text revised
30693	2	30	23	30	24	SREX – acronym should be included for clarity [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
8943	2	30	28	0		It should read 'hundreds of kilometres' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
24841	2	30	29	30	31	Recommended text: These characteristics require that assessments of change are based not only on direct evidence, but also on laboratory experiments, calculations, theoretical considerations, and numerical modelling. [Government of Hungary, Hungary]	Accepted - text revised
2275	2	30	36	30	36	Write "Permafrost degradation (warming and thaw) … [Wilfried Haeberli, Switzerland]	Accepted - text revised
26343	2	30	36	30	42	In addition to permafrost thaw, subglacial discharge can also cause basal lubrication, and thus overall acceleration. [Ethan Pierce, United States of America]	Accepted - text revised
25183	2	30	44	30	45	I would cite also Fisher et al. 2012 here to cover a wider area of the European Alps ([Fischer L, Purves RS, Huggel C, Noetzli J, Haeberli W. On the influence of topographic, geological and cryospheric factors on rock avalanches and rockfalls in high-mountain areas. Nat Hazards Earth Syst Sci 2012;12:241–54.) [Simon Allen, Switzerland]	Accepted - text revised
30071	2	30	44	30	47	The two sentences in the beginning of the section are partly overlapping in meaning and becomes confusing. It is mentioned "ricks detatching and fallin" in first sentence (which is the same as rock fall) , and the second sentence seem to mention something else, using the work "also", but refers to rock fall (and rock avalanches). Hence both sentences explain the same well established relation between rock fall (of all sizes) and thawing permafrost, but as written now seem to talk about two different processes. [Lena Rubensdotter, Norway]	Accepted - text revised
30695	2	30	44	30	45	Where? Please provide location, e.g., “zones of thawing permafrost across the globe” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
2277	2	30	45	30	45	Write " … within zones of degrading (warming and thawing) permafrost …" [Wilfried Haeberli, Switzerland]	Accepted - text revised
1205	2	30	46	30	46	The meaning of "in theory" is unclear. [Daniel Farinotti, Switzerland]	Accepted - text revised
11853	2	30	49	30	53	In the text it is mentioned the different factors that could trigger slope instability, we could add one diagram/figure to show that factors. It is important for the warning system. [Isabel Ramos, Peru]	Rejected - there is not enough space allowance for such diagramme, but we improved Fig. 2.8 accordingly
30697	2	30	50	30	51	What are these considerations / what does the paper report? Jargon: Frozen fractures might need to be briefly explained [Hans-Otto Poertner and WGII TSU, Germany]	Accepted – clarified

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3395	2	30	56	0	58	It is interesting that a fairly old general study is used in support of the stability of large lateral moraines when several recent studies actually treat these processes in much more depth. Maybe consider replacing and/or inserting the following more recent studies here to bring this in line with the up-to-date nature of the rest of the report: Eichel, J., Draebing, D., Meyer, N., 2018. From active to stable: Paraglacial transition of Alpine lateral moraine slopes. Land Degradation and Development, 29 (11), pp. 4158-4172. DOI: 10.1002/ldr.3140; Curry, A.M., Cleasby, V., Zukowskyj, P., 2006. Paraglacial response of steep, sediment-mantled slopes to post-'Little Ice Age' glacier recession in the central Swiss Alps. Journal of Quaternary Science, 21 (3), pp. 211-225. DOI: 10.1002/jqs.954; Lukas, S., Graf, A., Coray, S., Schlüchter, C., 2012. Genesis, stability and preservation potential of large lateral moraines of Alpine valley glaciers - towards a unifying theory based on Findelengletscher, Switzerland. Quaternary Science Reviews, 38, pp. 27-48. DOI: 10.1016/j.quascirev.2012.01.022. Also note that the nature of the "debris" in glacial systems and whether buried ice is incorporated in glacial landforms (cf. Lukas, S., 2011: Ice-cored moraines. Encyclopedia of Earth Sciences Series, Part 3, pp. 616-619. DOI: 10.1007/978-90-481-2642-2_666) determines landform stability/erodibility a lot, and that not all moraines are typically over-steepened as claimed in line 56 (see Lukas et al., 2012, for a review of the details). The granulometry of glacial sediments also has implications for the stability of moraine dams (see page 32; GLOFs), although I am unaware of a study to recommend that looks at this aspect in particular. [Sven Lukas, Sweden]	Accepted - text revised
25185	2	30	57	31	1	Its and old paper, but to give a bit more reginal flavour you could cite: Blair Jr. RW. Moraine and valley wall collapse due to rapid deglaciation in Mount Cook National Park, New Zealand. Mt Res Dev 1994;14:347–58. [Simon Allen, Switzerland]	Accepted - text revised
11341	2	31	0	32		General comment: The text on snow avalanches is generally a bit rough, some of the wording is a bit unusual, for example, line 52: "following wet snow conditions conducive to wet-snow avlaanches", and there is too much emphasis on wet-snow conditions in general. The view that overall warming will contribute to an increase in wet-snow avalanche activity is oversimplified. Finally, given the lack of studies on future snow avalanche activity, I am only aware of a single one by Castebrunet et al., I cannot see how trends can be described with "high confidence". [Juerg Schweizer, Switzerland]	Taken into account - The text on avalanches was revised for clarity and in order to avoid misunderstandings.
8583	2	31	3	31	4	The sentence “Increased landslide activity in recently deglacierized zones has received increased attention” has twice the word “increased”. It could be changed to something like “Intensified/Stronger landslide activity in recently deglacierized zones has received increased attention”. [Deborah Verfaillie, Spain]	Accepted - text revised
8947	2	31	4	0		Has this increased attention had anything to do with loss of human life as a result of landslide activity? [Nina Hunter, South Africa]	Noted - to our knowledge there is no scientific study on that. Could well be, together with better availability of information and increased human activities/infrastructure (see later in this chapter).
30073	2	31	6	31	6	The concept og "Little-Ice-age" is coming very abruptly and without reference or even explanatino whitng period in thime this is related to. Again I do not believe people outside the field will grasp this sentence without further explanation of the Little-Ice-Age, what it means inclimatic terms and relation to glacial variations. [Lena Rubensdotter, Norway]	Accepted - text revised; Little Ice Age term replaced by 'from mid-19th century on'.

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8945	2	31	7	0		Insert space between 'movements' and '(Olivia' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
15441	2	31	9	31	10	In the paragraph it is stated that 'Overall, there is high confidence that glacier retreat in general destabilizes adjacent debirs and rock slopes, but knowledge of trends remains incomplete due to scarce observations'. This statement should be lifted in the key messages. It carries an important warning even if observations are scarce to date. Once there are numerous observations it will be too late to act. [EUCE, Belgium]	Noted - weakens and distracts from main messages in the Executive Summary; not done.
24575	2	31	9	0		This high confidence based on low evidences (scarce observations) sounds rare. I suggest to quantify the evidences or better justify this high confidence. [Armand Hernández, Spain]	Accepted - text revised
4991	2	31	12	31	15	What is the implication of this for human and natural systems down the mountain? [Debra Roberts and Durban Team, South Africa]	Accepted - text revised
8585	2	31	12	31	14	This sentence again has three forms of the word “increase” in it: “The acceleration of rock glaciers (frozen debris slopes slowly deforming under gravity), which is in principle their expected response to increases in ground temperatures (Kääb et al., 2007), can contribute to increased debris-flow activity by increasing material supply to debris-flow starting zones”. Please consider replacing at least one of them. [Deborah Verfaillie, Spain]	Accepted - text revised
12067	2	31	12	31	15	Landslide and debris-flow related to the melting glacier are important types of mountain disasters. So it is suggested to make relevant additions. [Government of China, China]	Rejected - outside mandate
22655	2	31	12	31	12	As the ice content decreases, the strength increases and creep is hindered, which then results in the inactive phase of a rock glacier. Arenson and Springman (2005) and Arenson et al., (2014) show creep and strength parameters of rock glacier material in function of volumetric ice content. Arenson, L. U., & Springman, S. M. (2005). Mathematical descriptions for the behaviour of ice-rich frozen soils at temperatures close to 0 °C. Canadian Geotechnical Journal, 42(2), 431–442. https://doi.org/10.1139/t04-109 Arenson, L. U., Colgan, W., & Marshall, H. P. (2014). Physical, Thermal, and Mechanical Properties of Snow, Ice, and Permafrost. In W. Haeberli & C. Whiteman (Eds.), Snow and Ice-Related Hazards, Risks, and Disasters (1st ed., pp. 35–75). Elsevier Inc. https://doi.org/10.1016/B978-0-12-394849-6.00002-0 [Lukas Arenson, Canada]	Accepted - text revised
25637	2	31	12	31	15	Increased material supply may also lead to debris flows of greater magnitudes (Stoffel, M., Mendlik, T., Schneuwly-Bollschweiler, M., Gobiet, A., 2014b. Possible impacts of climate change on debris-flow activity in the Swiss alps. Clim. Chang. 122, 141–155.) - As debris flow triggering does not only depend on sediment availability but also on sediment transport (availability of meltwater, changes in seasonality, frequency and intensity of precipitation). The response of debris flow frequency and magnitude is not univocal as at lower altitudes the reduction in the number of freezing days will reduce the surface affected by weathering and may thus result in a reduction of debris-flow activity (Jomelli, V., Brunstein, D., Déqué, M., Vrac, M., Grancher, D., 2009. Impacts offuture climat- ic change (2070–2099) on the potential occurrence of debris flows: a case study in the Massif Des Ecrins (French Alps). Clim. Chang. 97, 171–191.) [Floortje van den Heuvel, Switzerland]	Accepted - text revised

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30077	2	31	12	12	15	This short section consists of only one, very long, sentence. It is not clear what relation rock-glciers have to debris starting zones, and the sentence should be divided and preferable slighly extended or illustrated/referenced to figure to convey the meaning to readers. [Lena Rubensdotter, Norway]	Accepted - paragraph moved and rewritten
30699	2	31	12	0		Acceleration of rock glacier movement? Or of rock glacier melt? Please specify here and later on to avoid ambiguity [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
30079	2	31	17	31	17	The word "often" in mid line seems out of place and unnecessary. Could be removed. Creates some confusion as it is. [Lena Rubensdotter, Norway]	Accepted - text revised
30081	2	31	21	31	23	This last sentence in the section seems to refute the previous sentences! Needs refrasing! [Lena Rubensdotter, Norway]	Accepted - text revised
30701	2	31	21	31	23	High agreement but only 1 study cited? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
2043	2	31	25	31	39	I was surprised to find the topic about glaciers surges in the chapter about unstable slopes and landslides. It does not really fit here. In case there is no better fit elsewhere I`d at least add "and glacial hazards" or similar to the title. [Tobias Bolch, Germany]	Taken into account - text partially revised. Main focus is on impacts (=floods, landslides)
9973	2	31	25	31	26	Citing a more fundamental reference about surging seems appropriate. See earlier work by Meier, Post, Kamb, Raymond (1987 review), Clarke. Perhaps replace Sevestre and Benn here, as it applies more directly to the connection between surging and climate where it is cited again. [Gwenn Flowers, Canada]	Rejected - we have a limted number of references available and try to avoid older textbook-type references
1207	2	31	28	31	28	The word "hazards" should be removed. [Daniel Farinotti, Switzerland]	Accepted - text revised
3397	2	31	30	0		It would perhaps be clearer here to separate the terms climate change and climatic envelope: surging glaciers operate under a broader climatic envelope (see Sevestre and Benn, 2015), and if this envelope shifts, surging activity may be switched on or off, first for individual glaciers and then, perhaps in the longer term, for entire regions that are current surging clusters. This is not the same as implying that surging glaciers being driven by climate change (as the text suggests to me in its current form) - the mechanisms are a little more complex due to the modulation via the mass balance instabilities that characterise surging systems. [Sven Lukas, Sweden]	Accepted - text revised
9977	2	31	31	31	32	Hewitt (2007) (https://www.cambridge.org/core/journals/journal-of-glaciology/article/tributary-glacier-surges-an-exceptional-concentration-at-panmah-glacier-karakoram-himalaya/0C1AF48FDAEC3B283EC61FE9093028E9) would be a good reference to follow "and thus change with climate" where there is now no citation. [Gwenn Flowers, Canada]	Accepted - text revised
30703	2	31	32	31	34	i.e., does that mean that flood/surge hazard will be reduced in future compared to now? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
9975	2	31	33	31	34	Cessation of surges due to mass balance deficits (or ability for glacier to surge only is certain MB regime) also suggested by Hoinkes (1969) (Hoinkes, H. C.: Surges of the Vernagtferner in the O¨ tztal Alps since 1599, Can. J. Earth Sci., 6, 853–861, 1969.), Frappe and Clarke (2007) (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2006JF000607), De Paoli and Flowers (2009) (https://www.cambridge.org/core/journals/journal-of-glaciology/article/dynamics-of-a-small-surgetype-glacier-using-onedimensional-geophysical-inversion/12E833C0B239E453DD9A59620FCE555A) [Gwenn Flowers, Canada]	Accepted - text revised; though, not at all references incøluded due to strong space limitations

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2045	2	31	34	31	36	I agree that western Tibetan Plateau or more specific western Kunlun has positive mass balances and increased surge activity. However, none of the cited references addresses positive mass balances in this region (western Kunlun) or real surges. Kääb et al. (2018) describes an ice collapse, which is a sudden glacier collapse, and differs from a surge as commonly defined. The authors need also to be a bit more careful with the general statement of positive mass balances as western and Central Pamir which is also known for many surges exhibited slightly negative mass balances and also most studies show on average slight, though insignificant negative balances. The best study to date which shows these differences is Brun et al. (2017). I also ask the authors to cite a study which really addresses the surges in Western Kunlun. [Tobias Bolch, Germany]	Accepted - text revised
8949	2	31	34	0		on the' to replace 'in' [Nina Hunter, South Africa]	Accepted - text revised
1455	2	31	36	31	37	Polythermal glacier definition incomplete/un-understandable; need to add geothermal heating effect [Rene Forsberg, Denmark]	Taken into account - text revised but not much extended as more relevant for the Arctic not this chapter.
15483	2	31	36	31	37	the Polythermal glacier definition is incomplete and unclear. The geothermal heating effect should be added. [EUCE, Belgium]	Taken into account - text revised but not much extended as more relevant for the Arctic not this chapter.
30083	2	31	36	31	37	The last sentence is generally not well frased for explaining the complex mechanisms, and also the term "poly-thermal" needs some further explanation for all readers outside glaciology. Since poly-thermal glaciers are complex in themselves and has nomerous sub-types as concering the thermal pattern, this needs to be somehow explained before referred to. [Lena Rubensdotter, Norway]	Taken into account - text revised but not much extended as more relevant for the Arctic not this chapter.
30705	2	31	37	0		0°C as opposed to…? Perhaps clearer to say “that contain ice of different temperatures” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
1209	2	31	38	31	39	This sentence is based on a singular event. It should at least be flagged as such (at the moment it suggests a generality that seems difficult to defend) [Daniel Farinotti, Switzerland]	Accepted - removed
2047	2	31	38	31	39	This statement is almost a repetition of page 16, line 15f. See my comment no. 7: I know the case of the glacier advance in Tien Shan well, but mining deposits are really and exception and cannot at all related to climate. However, this case shows evidence that large rock fall events could also trigger glaciers advances. This should be mentioned here. I am lacking time to lock into the literature, but I think some cases are described (please check studies by Kirkbride in New Zealand and Menounos et al. in British Columbia). [Tobias Bolch, Germany]	Accepted - text revised in the section on combined hazards and cascading events
1211	2	31	43	21	43	The statement "for only three cases" is no longer valid: Similar events have been reported for the Central Andes of Argentina (https://doi.org/10.5194/tc-2018-201) and the Wrangell-St. Elias National Park in Alaska (https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/452562) [Daniel Farinotti, Switzerland]	Accepted - text revised
8953	2	31	43	31	44	Did these collapses result in human impacts? [Nina Hunter, South Africa]	Accepted - text revised
8951	2	31	44	0		Replace comma before 'Tibet' with 'in' [Nina Hunter, South Africa]	Accepted - text revised
30707	2	31	44	0		Perhaps clearer to say “twin glacier collapse of the Aru range, Tibet” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30085	2	31	50	32	35	The whole chapter about snow avalanches shows a lack of mentioning and discussion of dry snow avalanches in the norhtern (colder) parts of the northern hemisphere. The impression given is that there is only a potential increase in wet snow avalanches, but in cold, but maritime areas (such as almost whole of Norway) there is also a high occurence, and possibly increase of, dry snow avalanches due to warmer oceans during winter increasing snow precipitation. Also the section does not mention the cause of snow-avalanches due to weak layers deeper down in snow stratigraphy that develope during winter warm spells or precipitation as rain, which later in the season acts as sliding layers for avalanches. The text imlies water content in snow is only/deciding factor for avalanche release, which is not the whole truth. [Lena Rubensdotter, Norway]	Taken into account - We are not aware of literature describing past changes in triggering factors for dry snow avalanches. The text was revised for better clarity, and putting less emphasis on changes in wet snow avalanches, consistent with literature findings and concistent with feedback from other reviewers.
32997	2	31	50	31	50	There is no mention of rain-on-snow events and avalanches in this section. Coordination should be sought between this section and Section 2.3.2.1.3 Floods, P2-33, Line 6-20. [Government of United States of America, United States of America]	Accepted - Rain-on-snow events are now mentioned in this section (as one potential triggering factor for wet snow avalanches), but past and future changes in rain-on-snow events remain provided in the corresponding section.
3383	2	31	51	32	35	Two of the critical factors for avalanche studies are snowpack susceptibility and slope stability. The text in section 2.3.2.1.2 can be improved to incorporate a discussion on snowpack susceptibility. There is a significant linkage between the mountain slop aspect and the scale of avalanche mass flow. This should also be discussed in this section. [Divyesh Varade, India]	Taken into account - The emphasis is placed in this report on past and future changes. Because of text length limitations, we cannot provide details on avalanche triggering mechanisms in general.
11343	2	31	51	31	54	I suggest to replace the first sentence: Snow avalanches can occur either spontaneously due meteorological conditions such as loading by precipitation or melt water infiltration, or can be triggered artificially by the passage of a skier, the impact of falling ice or rocks, or by explosives (for avalanche control purposes) (Schweizer et al., 2003). [Juerg Schweizer, Switzerland]	Accepted - Text was revised accordingly, with slight edits to remain as complete as possible.
15165	2	31	52	31	52	I think that the snow gliding and the related glide-avalanches should be mentioned. See for example Ancey C and Bain V (2015) Dynamics of glide avalanches and snow gliding, Reviews of geophysics. 10.1002/2015RG000491 [Michele Freppaz, Italy]	Taken into account - The reference to Ancey and Bain was already provided in the SOD, and has been kept in FGD.
11345	2	31	54	31	55	I suggest to replace the second sentence: Changes in snow cover characteristics are expect to induce changes in natural rather than artificially triggered avalanche activity by e.g. changes in flow regime (Naaim et al., 2013; Köhler et al. 2018). I suggest to explicitly mention that we expect natural but not artifically triggered avalanche activity to change, and to replace the reference Steinkogler, by a recent study that explicitly addresses the different flow regimes: Köhler, A., Fischer, J.T., Scandroglio, R., Bavay, M., McElwaine, J. and Sovilla, B., 2018. Cold-to-warm flow regime transition in snow avalanches. The Cryosphere, 12(12): 3759-3774. [Juerg Schweizer, Switzerland]	Taken into account - The references were updated according to the suggestion. That there is no evidence of changes in accidental avalanches is now provided upfront in the first paragraph, thereby clarifying that all remaining statements apply to spontaneous avalanches. Statements on accidental avalanches were provided at the bottom of the avalanche subsection in SOD.
32999	2	31	54	31	55	These papers suggest that warmer snow temperatures change flow dynamics and influence the friction coefficient. It is possible to extend this to mean that warmer snow temperatures will affect avalanche behavior, and the referenced work supports this claim. However, because avalanches are influenced by weather more directly than climate, it would be worth noting a time period / rate of change in this statement. What time span will snow cover characteristics change substantially from current general conditions that will affect natural (spontaneous) avalanche activity? [Government of United States of America, United States of America]	Taken into account - Explicit references to the flow regime and the friction coefficient were added. Avalanches events are indeed influenced by weather conditions, and this report focuses on long term changes of the statistics of the weather conditions, i.e. climate. There is medium confidence from existing literature that changes in snow conditions will induce avalanche activity, but providing quantitative figures at the regional scale is not possible, by lack of studies spanning such a large spatial domain (beyond local or national-scale studies).

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13833	2	31	55	31	56	I don't think you can conclude that the deaths of foreign trekkers and guides in avalanches in the 2015 earthquake was a direct consequence of poorly regulated infrastructure – I think it demonstrates that infrastructure was not designed to cope with large earthquakes, as borne out by the larger number of non-avalanche related deaths and the widespread destruction of roads and buildings. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text clarified
11661	2	31	56	31	56	Include definition of "moraines". [Government of Mexico, Mexico]	Accepted - explained at first occurence
33001	2	31	57	32	2	The work by Ballesteros-Cnovas et al. (2018) examined one slope/several adjacent avalanche paths in the Western Indian Himalaya with a relatively small sample size (n=144 trees) in the context of a regional assessment (i.e. western Indian Himalaya). It seems generous to use this as the one example that illustrates an increase in wet snow conditions given the spatial extent of the study as well as to use their claim that process-based studies suggest increasing air temp leads to a rise in LWC and an increase in shear deformation rate, and ultimately more wet snow avalanches. This notion is far too simplistic. There are more, as yet not fully understood, factors in wet snow avalanche propagation to suggest this. Suggest the authors rephrase this claim to reflect the limitations of this work, but still reflect the potential increase in wet snow avalanches in this study site. [Government of United States of America, United States of America]	Accepted - The text was revised to better highlight the local nature of the investigated spatial domain.
26345	2	32	2	32	15	Based on the specificity of the cited studies and the lack of any cohesive statistical analysis, it seems that there is low evidence (and low agreement) for the shift in avalanche activity. [Ethan Pierce, United States of America]	Taken into account - The statistical framework for the analysis of avalanche activity is considered robust, and there are several studies from independant teams provdigin similar conclusions, thus we consider that, for Europe at least, reported changes hold a medium confidence (medium evidence, medium agreement) level. This has been updated for FGD.
33003	2	32	5	32	5	This sentence is cumbersome to read and should be constrained by mention of which decades in particular show a reduction in mass and run-out distance decrease, and by the regions being discussed as there isn't enough study on this topic to portray the results as a ubiquitous trend. [Government of United States of America, United States of America]	Taken into account - The text was editored for clarity and complemented by more regional information.
8955	2	32	8	0		through' not 'thru' [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
30709	2	32	8	0		"thru" - Please refrain from using informal language [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Text revised accordingly.
33005	2	32	8	32	9	The referenced work of Pielmeier et al. (2013) supports this claim, but reviewers cannot comment on the work by Naaim et al. because it is not in English. May need to double check claim of support. [Government of United States of America, United States of America]	Accepted - LA and CA involved are proficient in English and French.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
11347	2	32	13	32	15	There is definitely no evidence for a shift from dry-snow to wet-snow avalanche activity. There is at best a trend to a an overall higher portion of wet-snow avalanches, but there are still many dry-snow avalanches and those might still present the majority of the avalanches in a certain mountain range. Most studies, e.g. Pielmeier et al. 2013, depend on visual observations of avalanche activity and include a strong, well known observation bias. It is quite common that observers record a wet-snow avalanche based on the observation of the deposit. However, this has nothing to do with the conditions in the starting zones. In January 2018 there were more than 15'000 avalanches observed on satellite images in the Swiss Alps. Avalanches type (wet, dry or mixed) is not known for all avalanches, but about 80% of the avalanches were originally dry-snow avalanches, about half of those entrained wet-snow at lower elevations on their way to the vallies. Those are called mixed, as the flow regime changes from dry to wet. In summary, I do not see any firm evidence to call the present state of knowledge "medium" that there is a shift towards wet-snow avalanches. After all, this only concerns the wet-snow avalanches triggered by rain, which overall considering all wet-snow avalanches, represent the minority. The majority of wet-snow avalanches occur in spring due to melt water infiltration. [Juerg Schweizer, Switzerland]	Taken into account - The text was revised to better reflect the fact that there is a reported increase in avalanches involving wet snow, but that dry snow avalanches have by far not disappeared. An additional sentence was added, indicating that avalanche management methods (control, prevention and early warning systems) have not changed over the past decades in relationship to climate change.
11349	2	32	17	32	19	I suggest to explicitly mention the decrease in snow depth and snow cover duration (instead of "annual scale"). Moreover, Frei at al. (2018) show that at elevations above 2000 m a.s.l. snow depth might not change much, but even increase slightly. They summarize: "In contrast, high-elevation regions could experience slight snowfall increases in midwinter for both emission scenarios despite the general decrease in the snowfall fraction. These increases in mean and heavy snowfall can be explained by a general increase in winter precipitation and by the fact that, with increasing temperatures, climatologically cold areas are shifted into a temperature interval which favours higher snowfall intensities." In other words, if heavy snowfalls, which are the main drivers of avalanche activity, will ocurr with similar frequency or even slightly increase, there is no reason to expect decreasing avalanche activity. The relevant starting zones endangering villages and transportation corridors in the Alps are above 2000 m a.s.l. [Frei, P., Kotlarski, S., Liniger, M.A. and Schär, C., 2018. Future snowfall in the Alps: projections based on the EURO-CORDEX regional climate models. The Cryosphere, 12(1): 1-24.] [Juerg Schweizer, Switzerland]	Taken into account - The text was revised for better clarity, including an explicit mention of the snow cover reduction at low elevation (consistent with the subsection on snow cover past and future trends). The revised text now conveys scientific findings in a manner which we hope will not result in misunderstandings.
26347	2	32	17	32	31	There are three citations in this section, but the claims are presented with “high confidence.” [Ethan Pierce, United States of America]	Accepted - Because of space restrictions, not all relevant literature can be quoted in the report - only the most relevant. Nevertheless, we agree that the level of confidence on future avalanche trends is rather medium than high in particular due to the paucity of regional studies in many mountain regions, and the limited number of studies where it has been addressed.
8957	2	32	19	0		Full-stop missing after 'century' [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
28229	2	32	19	32	20	What is SRES A1B? [Martin Truffer, United States of America]	Taken into account - Scenarios are now introduced in a Cross-Chapter Box on scenarios.
8959	2	32	21	0		Replace "require to upgrade or modify" with "necessitate the upgrade or modification of" [Nina Hunter, South Africa]	Taken into account - The text was revised using a policy relevant, but not policy prescriptive statement.

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8961	2	32	23	0		Add 'the' before 'mid' [Nina Hunter, South Africa]	Taken into account - The text was revised using a policy relevant, but not policy prescriptive statement.
11353	2	32	24	32	27	I do not see any strong evidence for the trend outlined in this sentence. As commented above, different scenarios are possible, depending on region and elevation. There are almost no comprehensive studies, and I cannot see where the strong evidence comes from to claim "high confidence". There is only one single study. [Juerg Schweizer, Switzerland]	Taken into account - The confidence language was revised to medium confidence (medium evidence, high agreement). There is more that one study on the topic (there is also evidence from North America and Japan). Nevertheless, we agree that the level of confidence on future avalanche trends is rather medium than high in particular due to the paucity of regional studies in many mountain regions, and the limited number of studies where it has been addressed.
11351	2	32	26	32	26	"increased wet-snow conditions". The view that warmer temperatures cause an increase in wet-snow conditions is oversimplified. First of all, one has to consider conditions under which wet-snow avalanches form, second temperature and precipitation are not indepedent, in other words it is crucial to anticipate the temperature during the heavy snowfall events. Considering the conditions, there are wet-snow avalanches triggered by rain, and wet-snow avalanches triggered by melt water percolation. For the first type we may see a shift of wet-snow avalanche occurrence to higher elevations, but not necessarily an increase in occurrence (depending on the elevation of the mountain range). In the other scenario, we will see a shift in timing, as snow melt will very likey start earlier. This will definitely not result in higher activity. With regard to the second point, if heavy snowfall events persist and even slightly increase snow avalanche activity will obviously depend on the temperature during this events. I do not know whether there is any evidence on how temperature will change during major storms. So at best, we can probably assume that above 2000 m a.s.l. we will still see the formation of dry-snow avalanches. How far they will run, will depend on the conditions in the avalanche paths. It is well possible that entrainment of wet-snow at lower elevations will reduce run-out distances in general. [Juerg Schweizer, Switzerland]	Taken into account - Due to space constraints it is not possible to discuss the processes in detail, but only to focus on most relevant results. The term "wet snow avalanches" was reformulated to "avalanches involving wet snow", which is more general and does not only focus on snowpack stability.
11355	2	32	27	32	31	As outlined above I cannot see the high confidence. With regard to wet-snow avalanche at any time of the winter. This is nothing new. During any major, long lasting storm that produces avalanches the snowfall limit varies. So that rain falls at elevations where it snowed before. That pattern will likely not change, but be shifted upwards. As already nowadays the snowfall limit is rarely in the lowlands where obviously no avalanches occur, but rather at mid-elevations, avalanche frequency will not change much as long as it does not rain substantially higher than the treeline. As mentioned above, I do not see strong evidence to claim that the frequency of dry-snow avalanches decreases; it all depends on the temperature during major storms at the elevation (>2000 m a.s.l.) of the starting zones. In other words, it is about future weather in a future climate. As there seems to be a trend to more intense preciptation and in general extreme events, I am not sure whether we can claim that avalanche activity will in general decrease. As we have to deal with future weather, it is no surprise, rather pretty evident in my view, that we simply cannot make statements with high confidence. We do not know the future weather. [Juerg Schweizer, Switzerland]	Taken into account - Climate models are used to simulate future weather under changed climate conditions (used to drive impact studies, e.g. for avalanche), and the outcome of such impacts models is reported in the literature cited. The text was rephrased for better clarity and avoiding misunderstandings.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33007	2	32	27	32	28	Is this medium evidence, high agreement? This seems reasonable given the few studies that model this projection, but need to clarify. Also include Lazar and Williams (2008) for a North American perspective. Lazar, B. and Williams, M., 2008. Climate change in western ski areas: Potential changes in the timing of wet avalanches and snow quality for the Aspen ski area in the years 2030 and 2100. Cold Regions Science and Technology, 51(2-3): 219-228. [Government of United States of America, United States of America]	Accepted - The reference from Lazar and Williams, even if pre-AR5, was added for the sake of completeness. We have revised the confidence statement to medium confidence (medium evidence, high agreement).
33009	2	32	29	32	29	This summary sentence must be rephrased to be consistent with the reported findings. The statement "reduction in snow conditions," for which there is "high confidence", makes little sense. [Government of United States of America, United States of America]	Accepted - The text was revised and the confidence statement was revised in light of literature findings and review comments.
8963	2	32	30	0		Insert 'is expected' before 'to' [Nina Hunter, South Africa]	Accepted - The text was revised and made more concise.
11357	2	32	33	32	34	I suggest the following editoral changes: ... links between climate change and artifically triggered avalanches by recreationists. ... will continue to pimarily depend on the behaviour of people travelling in avalanche terrain. [Juerg Schweizer, Switzerland]	Taken into account - The revised text was moved upfront to the beginning of the avalanche paragraph, to better illustrate that, in the following, only natural (spontaneous) avalanches are dealt with.
24577	2	32	33	0	35	I am not sure if this paragraph is necessary. I suggest to delete it. [Armand Hernández, Spain]	Taken into account - The revised (and shorter) text was moved upfront to the beginning of the avalanche paragraph, to better illustrate that, in the following, only natural (spontaneous) avalanches are dealt with.
1213	2	32	35	32	35	Add "and number" after "behaviour". [Daniel Farinotti, Switzerland]	Taken into account - The revised (and shorter) text was moved upfront to the beginning of the avalanche paragraph, to better illustrate that, in the following, only natural (spontaneous) avalanches are dealt with. The statements on causes for human casualties were deleted, because they were not necessary at the new location of this statement.
18405	2	32	37	32	37	Heading 2.3.2.1.3 Flood must be replaced with Glacial Lake Outbrust Floods(GLOFs) because in text under the heading of Floods we are mostly discussing the GLOFs. [APECS Group Review, Germany]	Rejected - IPCC reports try to avoid specialist terminology and abbreviations. Abbreviation introduced in the first sentence of the section.
11825	2	32	38	32	39	Glacial lake outburst floods (abbreviated GLOF) should be termed here. [William Lorenz, Australia]	Accepted - text revised
25187	2	32	38	32	38	What about bedrock dammed glacial lakes? Or maybe these are considered as cirque lakes. [Simon Allen, Switzerland]	Accepted - text revised
27151	2	32	38	33	4	Almost nothing is said about englacial water stored in glaciers potentially trigerring catastrophic flood events. This is only mentioned lines 50-52, saying that "little is known about the processes involved". Here there should be a mention of the thermal regime of the glaciers, because trapping water inside a glacier is strongly dependent on the thermal regime of the glacier. As a consequence, in a context of a warming, there might be changes in the water volume stored in glaciers (increase as well as decrease, because the snow cover is an important driver of the thermal regime) see Gilbert et al., The influence of snow thickness on the thermal regime of Tête Rousse Glacier (Mt Blanc range, 3200 m asl): consequences for outburst flood hazards and glacier response to climate change, J. Geophys. Res, 117, F04018, 2012 [Patrick Wagnon, France]	Accepted - a sentence added

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33011	2	32	41	32	41	Suggest replacing "…leave behind…" with "produce." [Government of United States of America, United States of America]	Accepted - text revised
28231	2	32	44	32	45	Advancing ice not only dams rivers, but also lakes (e.g. Perito Moreno, Argentina) or fjords (e.g. Hubbard, Alaska) [Martin Truffer, United States of America]	Accepted - text revised
18583	2	32	45	32	46	"There is high confidence…" <<< I would say this a factual statement and would remove the "high confidence" from the sentence. [APECS Group Review, Germany]	Rejected - we believe this is a scientific finding and not necessary an obvious fact for non-specialists
11663	2	32	47	32	49	(It would be advisable to include a map where glacier lakes will increase) It is necessary maps of vulnerability associated with areas of glacier lakes. [Government of Mexico, Mexico]	Rejected - related studies (cited) exist only for selected regions.
28075	2	32	47	0		You might add here the study by Paul and Mölg (2014) [Frank Paul, Switzerland]	Accepted - text revised
2279	2	32	50	32	50	Reference to Haeberli et al. 2017 would be apprpriate here [Wilfried Haeberli, Switzerland]	Accepted - text revised
8965	2	32	50	0		is' not 'are' [Nina Hunter, South Africa]	Accepted - text revised
25189	2	32	50	32	50	Not sure ICIMOD is the most appropriate reference here. I don't mean to self-cite, but I think Allen et al. 2016 is the only paper that really quantitatively demonstrates the effect of lakes developing closer to steep mountain walls on regional GLOF hazard/risk (Allen SK, Linsbauer A, Randhawa SS, Huggel C, Rana P, Kumari A. Glacial lake outburst flood risk in Himachal Pradesh, India: an integrative and anticipatory approach considering current and future threats. Nat Hazards 2016;84:1741–63. doi:10.1007/s11069-016-2511-x.). [Simon Allen, Switzerland]	Accepted - text revised
33013	2	32	55	32	55	The first statement in this sentence must be qualified as it refers only to moraine-dammed glacial lake outburst floods, and doesn't include outbursts from ice-dammed lakes. [Government of United States of America, United States of America]	Accepted - text revised
33015	2	33	1	33	2	Citations should be included with this statement. [Government of United States of America, United States of America]	Taken into account - statement removed
30711	2	33	2	0		“factors”: Could you list some examples briefly [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - statement removed
15195	2	33	6	33	6	should the record 2012 melt on Greenland Ice Sheet be mentioned here? It generated enormous floods (the largest ever flows on the only gauged river in Greenland: the Watson River) (seems a to fit logically between lake floods and snowmelt/rain-triggerred floods. e.g. Yde, J.C., Knudsen, N.T., Hasholt, B. and Mikkelsen, A.B., 2014. Meltwater chemistry and solute export from a Greenland ice sheet catchment, Watson River, West Greenland. Journal of Hydrology, 519, pp.2165-2179. [Jonathan Carrivick, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Arctic covered in Chapter 3
18739	2	33	6	33	7	Flood originating from the combination of rapid melting of snow and intense rain precipitation, preferred to as rain-on-snow events, are some of the most damaging (…) in mountain areas.' The sentence looks incomplete. In the bracket 'events' word need to be used [APECS Group Review, Germany]	Accepted - The term "floods" was added after "damaging".

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28233	2	33	6	33	31	Rain-on-snow events are not the only issue. Related is the fact that warming can lead to large precipitation events resulting in rain that runs off, rather than snow that is retained. That has at least contributed to large floods in the fall in the European Alps [Martin Truffer, United States of America]	Rejected - While this comment is appropriate to the mountain environment in general, it does not specifically concern the mountain cryosphere and is thus outside the scope of this chapter, and this particular subsection.
30713	2	33	6	33	20	Are there any data available for the Southern Hemisphere, incl. Africa (low latitudes) or South America? If yes – provide the information; if not, state so [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - We have explicitly stated that we are unaware of studies on this topic in Africa and South America.
18585	2	33	9	33	10	Turbulent heat fluxes are driven also by air temperature and typically contribute relatively little to the overall energy balance of melting surfaces, when compared to net radiation. Please clarify this statement. [APECS Group Review, Germany]	Rejected - During rain-on-snow events, turbulent fluxes indeed play a major role (see Pomeroy et al., 2016).
8967	2	33	10	0		Suggest comma after 'snowpack' [Nina Hunter, South Africa]	Accepted - The text was revised accordingly.
33017	2	33	11	33	14	High confidence is attached to these statements, but a statement related to causation is missing here. This is important because, for example, a decrease in the occurrence of rain-on-snow events at the lowest elevations could be interpreted as an increase in the fraction of snow precipitation, or the lack of snow on the ground during liquid precipitation events. [Government of United States of America, United States of America]	Accepted - The statement "due to a decreasing duration of snowpack" was added for better clarity.
18587	2	33	16	33	20	Please remove this paragraph summary, as it summarizes the two preceding sentences, except for the information on timing. [APECS Group Review, Germany]	Rejected - Previous statements provide traceable evidence from the literature. The "summary" statements provide the assessment, along with a confidence level.
30715	2	33	16	33	31	Suggest also to provide a crosslink to section 2.3.3.3 Wildlife, which mentions threats by rain-on-snow events on reindeer husbandry [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Note, however, that here rain-on-snow events are specifically addressed in the context of floods. Changes in snow conditions relevant to wildlife changes are addressed in the snow section and terrestrial ecosystem sections.
8969	2	33	17	0		transitions' should be singular [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
24579	2	33	20	0		Quantify high confidence even when there is limited evidences sounds rare, again. [Armand Hernández, Spain]	Taken into account - The report does not quote all relevant literature, only the most significant are reported. We consider that the existing body of knowledge is sufficient to provide a "high confidence" confidence level (robust evidence, high agreement). Note that this does not, however, corresponds to the highest possible confidence statement possible (very high confidence).
33019	2	33	22	33	31	Add results from the following publication to this section in order to more fully support the statement: Bieniek, P., Bhatt, U., Walsh, J., Lader, R., Griffith B., Roach, J., Thoman, R. 2018. Assessment of Alaska Rain-on-Snow Events Using Dynamical Downscaling. American Meteorological Society. 57. 1847-1863 https://doi.org/10.1175/JAMC-D-17-0276.1 [Government of United States of America, United States of America]	Accepted - This reference was considered for the preparation of the FGD.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18643	2	33	23	0		General summary, 2.3.3: This section describes the effects of changes in the high mountain cryosphere on terrestrial and freshwater ecosystems, as well as wildlife and fisheries. The changes are summarized in Fig. 2.9. These chapters list plant and animal species that will be affected by changing temperatures, changing water resources, and changing snow and permafrost conditions in high mountain environments. The section focuses on terrestrial vegetation, freshwater ecosystems, large vertebrates, and fisheries, with a few mentions of arthorpods and rodents. [APECS Group Review, Germany]	Comment no longer relevant with restructure
18645	2	33	23	0		General suggestion 1, ch 2.3.3: A commentary on the effects of climate change on biodiversity must mention arthopods, at the very least enough to point out that they are not well studied. Insects contribute greatly to the world's total species richness (see 'Number of Living Species in Australia and the World', A Chapman, 2009), and yet their numbers are falling far faster with climate change than the numbers of most other organisms; a recent paper found that insect numbers had dropped by 90-98% in one non-cryospheric ecosystem (Lister and Garcia, PNAS, 2018). [APECS Group Review, Germany]	Comment no longer relevant with restructure
18647	2	33	23	0		General suggestion 2, ch. 2.3.3: This section lacks commentary on birds. A recent paper has come out showing that climate change causes upslope shifts and an "elevator to extinction" for birds on a Peruvian mountain (Freeman, Scholer et al., PNAS, 2018, doi 10.1073/pnas.1804224115). [APECS Group Review, Germany]	Comment no longer relevant with restructure
18649	2	33	24	0		General comment, 2.3.3.1: I enjoyed the structure of this section; it drew my attention clearly to the most important natural processes (snow cover changes, upper elevation migration, thawing permafrost, retreating glaciers, fire), and illustrated each point clearly with example studies. [APECS Group Review, Germany]	Comment no longer relevant with restructure
8971	2	33	26	0		I would end the sentence "according to Beniston and Stoffel (2016)." so that when the next sentence starts it is clear which study is being referred to. [Nina Hunter, South Africa]	Accepted - Text revised accordingly.
18589	2	33	28	33	31	Please remove this paragraph summary, as it summarizes the two preceding sentences, except for the information on timing. [APECS Group Review, Germany]	Rejected - Previous statements provide traceable evidence from the literature. The "summary" statements provide the assessment, along with a confidence level.
10925	2	33	33	33	36	Re: cascading effects, see "Cascading effects at the third pole" by Xu and Grumbine 2009, at https://www.chinadialogue.net/article/show/single/en/3062-Cascading-effects-at-the-third-pole [Marc Foggin, Kyrgyzstan]	Noted - covered by the chapter as a whole
26349	2	33	33	34	21	The inclusion of anecdotal evidence is interesting, but not directly relevant. Consider including as a sidebar/box instead. [Ethan Pierce, United States of America]	Noted - as other reviewers supported anecdotal evidence they were kept.
9197	2	33	34	33	51	missing process: rockfall on glaciers; debris flow caused by it (e.g. Piz Cengalo 2017; Bregaglia, Switzerland) [Luzi Bernhard, Switzerland]	Accepted - text revised
1215	2	33	40	33	40	The timing of the "recent landslide-generated wave" should be stated explicitly. [Daniel Farinotti, Switzerland]	Accepted - text revised
1457	2	33	40	33	44	The Greenland tsunami event might be natural phenomena; permafrost change cause speculative [Rene Forsberg, Denmark]	Accepted - text revised

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2281	2	33	40	33	40	Add reference to Carey, M., Huggel, C., Bury, J., Portocarrero, C. and Haeberli, W. (2012): An integrated socio-environmental framework for glacier hazard management and climate change adaptation: lessons from Lake 513, Cordillera Blanca, Peru. Climatic Change112, 3, 733-767. doi:10.1007/s10584-011-0249-8 [Wilfried Haeberli, Switzerland]	Taken into account - see specialised box 2.4
15485	2	33	40	33	44	This sentence is ambiguous. The Greenland tsunami event might be a natural phenomena; permafrost change cause speculative, what rationale or evidence is there? Perhaps the point is that climate change will produce similar events, even if this one is not due to climate-change induced permafrost change. If that is the case, say so. [EUCE, Belgium]	Accepted - text revised
8973	2	33	41	0		ran' not 'run' [Nina Hunter, South Africa]	Accepted - text revised
2283	2	33	50	33	50	Make clear that the formation of a new lake greatly enhances the hazard zone (reach of flood wave or debris flow; cf. Haeberli et al. 2017) [Wilfried Haeberli, Switzerland]	Accepted - text revised
4049	2	33	51	33	51	Page 2-33 Line 51:suggest to add “Scientists in multiple disciplines should help local communities to understand what is happening and to manage and adapt to the risks. For example, scientific assessments of major ice collapses of the Aru glaciers in western Tibet in 2016 enabled the local government to establish a hazard warning system and to relocate threatened communities (Gao et al., 2019).”. References: Gao et al., (2019) Collapsing glaciers threaten Asia’s water supplies. Nature, 565, 19-21. [Fan Zhang, China]	Rejected - covered in 2.3.2.3 and else in chapter 2
33021	2	33	51	33	51	Suggest modifying the statement to "but there is limited direct evidence." in order to more accurately represent the implied confidence level. [Government of United States of America, United States of America]	Accepted - text revised
30087	2	33	53	34	21	This section is much more detailed and repetative than the other sections in this chapter. Reduce and compress, since the sheer size of text implies a large importance globally (compared to other processes already discussed) which is untrue, e.g. compared to snow avalanche occurence and hazard, globally. [Lena Rubensdotter, Norway]	Rejected - paragraph was strongly enhanced in response to review comments for first-order draft. Ice- and snow-clad volcanoes have massive potential for fatalities and damage.
30717	2	33	53	0		“ice” needs a hyphen to connect with "clad", otherwise the sentence would imply that ice can erupt [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
8975	2	33	54	0		Definition of 'lahars' needs to come on page 5 when it is first mentioned. [Nina Hunter, South Africa]	Accepted - text revised
30719	2	33	54	0		Move this explanation to where lahars are first mentioned [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
11665	2	34	3	34	3	According with a study Rodríguez, Córdoba and Delgado (2017) the probabilistic distribution indicates that there is a nearly 80% probability to be reached by lahars at communuty areas of Santiago Xalitzintla, locality in Puebla, at NE flank of the Popocatépetl volcano in Mexico. https://www.redalyc.org/articulo.oa?id=94350664012 [Government of Mexico, Mexico]	Noted
1217	2	34	6	34	6	The wording suggests that the term "jökulhlaupts" is only used in relation to volcanic activity, which is not true. [Daniel Farinotti, Switzerland]	Accepted - text revised
30721	2	34	7	0		“to decrease” – suggest adding “under climate change” to emphasise that these processes are interrelated [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18529	2	34	8	34	9	Sentence “Thus, and despite the limited possibility for according observations, there is medium confidence that the overall hazard related to floods and lahars will gradually diminish […].” [APECS Group Review, Germany]	Rejected - no request or recommendation given
30723	2	34	10	0		What does “though” refer to. Please do not start a sentence with this word. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
1459	2	34	12	34	20	The link of volcanic eruption frequency to climate change and GIA is totally speculative, even though a few authors have managed to get such statements published. It should be deleted, [Rene Forsberg, Denmark]	Accepted - text removed
15487	2	34	12	34	20	The link of volcanic eruption frequency to climate change and GIA is to a great extent speculative and should be deleted. [EUCE, Belgium]	Accepted - text removed
18531	2	34	15	34	15	“strong evidence” needs to be italic if taken from the IPCC vocabulary guidelines. [APECS Group Review, Germany]	Accepted - text revised
14983	2	34	16	34	21	This paragraph provides little substance and its relationship to the topic at hand is not clear. Suggest to specify or delete. [Government of Germany, Germany]	Accepted - text removed
30725	2	34	16	34	21	Confidence statements might be appropriate here to summarise the assessed information of this paragraph [Hans-Otto Poertner and WGII TSU, Germany]	Taken into accout - text on GIA removed
18533	2	34	17	34	17	to future changes in climate climate change [APECS Group Review, Germany]	Rejected - request or recommendation unclear
18591	2	34	18	34	18	"large volcanic eruptions will be more likely and more frequent with continued deglaciation" - this sounds redundant with regard to lines 13 and 14, please consider removing this fragment. [APECS Group Review, Germany]	Accepted - text removed
30727	2	34	19	0		What does “in all” mean? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
17775	2	34	23	35	30	In terms of structure, it might make sens for the concepts outlined in sections 2.3.2.2 Vulnerability, Exposure and Impacts; 2.3.2.2.1 Drivers of exposure; and 2.3.2.2.2 Drivers of vulnerability, to come at the beginning of section 2.3.2 Landslide, Avalanche and Flood Hazards (or even earlier in the report given the relevance of the content for adaptation). [Graham McDowell, Canada]	Accepted - text revised; paragraph moved to beginning of 2.3.2
18651	2	34	23	0		Could add comment on species movement and invasive species. There's a potentially relevant recent paper on 'Invasive alien plant species dynamics in the Himalayan region under climate change' that explains how climate change is decreasing the spread of two invasive species, and increasing the spread of two others (https://doi.org/10.1007/s13280-018-1017-z). [APECS Group Review, Germany]	Noted - one article by Winkler et al. 2016 on bamboo invasions in Japan that are influenced by water supply from snow.
24581	2	34	23	0		I would change the order of this title from "Vulnerability, Exposure and Impacts" to "Exposure, Vulnerability and Impacts". The subsections (2.3.2.2.1, 2.3.2.2.2 and 2.3.2.2.3) already follow this order [Armand Hernández, Spain]	Accepted - text revised
33023	2	34	23	34	23	Rename 'Vulnerability, Exposure and Impacts' to 'Exposure, Vulnerability and Impacts' to reflect topic order within the section. [Government of United States of America, United States of America]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1461	2	34	25	36	25	This whole sections gives the expression that "something had to be written". There is a lot of obvious statements (like more tourists in the mountains give more exposure), and some very large, really unexplained cost estimates. I suggest to condense this part to a few sections, but keep some of the major disaster examples in 2.3.2.2.3 as important illustrations. The lack of political will for disaster risk mitigation or local people's obstructions to such a thing (Peru example) is political and don't belong in an IPCC report. Fig 2.8 is a nice figure which illustrates many of the same things mentioned. [Rene Forsberg, Denmark]	Noted - text on risk moved and shortened; source of cost estimates specified more clearly; Peru example moved into the box and modified.
15489	2	34	25	36	25	This section is very good in the sense that it tries to discuss risk issues specific to the scope of the chapter. Nevertheless it could be shortened since more general risk/hazard approaches are discussed elsewhere in the report (and should therefore be referred to here). The fact that the section builds on SREX findings is also helpful. However, it also contains several very large cost estimates which need to be explained if they are to be retained. It is recommend retaining some of the major disaster examples in 2.3.2.2.3 as important illustrations. The lack of political will for disaster risk mitigation or local people's obstructions to such a thing (Peru example) is political and don't belong in an IPCC report. Fig 2.8 is a nice figure which illustrates many of the same things mentioned. [EUCE, Belgium]	Noted - text on risk moved and shortened; source of cost estimates specified more clearly; Peru example moved into the box and modified.
30895	2	34	25	0	32	This is largely a description of risk concept with different words. In light of glossary and chapter 1 as well as CC Box there one wonders whether that is needed. Missing is the aspect of value. The system of concern has some value. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text shortened and moved
30729	2	34	27	0		Please indicate a chapter in these reports, and cite them appropriately according to reference convention [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
12723	2	34	29	34	32	It is particularly important to include the societal dynamics, as mentioned here, as a driving component in the adaptation. The complexity of human-nature relations call for a combined assessment and consideration of different and differentiated adaptation pathways that take account of the specific relevance of changes in the cryosphere and its interlinkages with socio-economic development options. [Thomas Dax, Austria]	Taken into account - Paragraph of concern moved, and issues addressed better at several other places of the report.
28691	2	34	34	34	49	Tourism is the main driver in high mountin areas and can be overall taken into the considerationas a major threat to the environmnet, and society. [Irena Mrak, Slovenia]	Rejected - tourism highlighted at several other places, including Executive Summary
22657	2	34	35	34	35	Check the proper citation of this reference, which would be "Iribarren Anacona" and not only "Anacona" as it apears at several locations. [Lukas Arenson, Canada]	Accepted - text revised
8587	2	34	36	34	39	This sentence has an issue with the verb (“bringing”?) in its second part, which makes it difficult to understand: “In some regions, tourism development is one of the drivers that have been linked to this change, where often poorly regulated expansion of infrastructure such as roads, foot-tracks, and overnight lodging bringing more visitors into remote valleys and exposed sites”. [Deborah Verfaillie, Spain]	Accepted - text revised
13835	2	34	36	34	41	out migration (at least among males in Asia) is not driven by climate change or related threats to traditional livelihoods, but by the potential to earn significant amounts of money in response to demand for labour in other countries, facilitated by increasing accessibility from expanded road networks. It is much more of a set of pull factors than push factors. [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text has been added on this.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18535	2	34	39	34	41	The point is clear without the example made in “As an example for this development, many of the more than 350 fatalities resulting from the 2015 earthquake-triggered snow-ice avalanche in Langtang, Nepal, were foreign trekkers and their local guides (Kargel et al., 2016)”. Could be deleted. [APECS Group Review, Germany]	Rejected - including recent examples increases the relevance of the assessment and helps emphasise key issues.
13837	2	34	46	34	47	The definition "Event attribution methods" comes across as slightly vague, suggest adding some text to explain/unpack this further e.g. simulations based on events attributions methods…) [Government of United Kingdom (of Great Britain and Northern Ireland), United Kingdom (of Great Britain and Northern Ireland)]	Rejected - no instance of the term found in the chapter (wrong chapter?)
10927	2	34	51	34	55	Re: vulnerability of communities/societies in mountain regions to the effects/impacts of climate change, should see Xenarios, S., Gafurov, A., Schmidt-Vogt, D. et al. Reg Environ Change (2018). https://doi.org/10.1007/s10113-018-1384-9; and the various references contained therein. [Marc Foggin, Kyrgyzstan]	Taken into account - paper referred to
11667	2	34	54	34	55	Idem [Government of Mexico, Mexico]	Rejected - comment where this refers to was not found
8977	2	34	56	0		Insert a space between 'communities' and '(Carey' [Nina Hunter, South Africa]	Accepted - text revised
12069	2	35	12	35	30	In spite of the fact that there are references to the impacts of climate change on glacial disasters, the report as a whole does not mention the disaster-driven mechanism or its potential future developments. In addition, the report, which focuses much on the impact of warming on the balance of glacier mass, gives little consideration to the impact of double increases of temperature and precipitation on the stability of glaciers and the proneness to disasters. So it is suggested to make relevant additions. [Government of China, China]	Noted - impact aspect revised throughout the chapter
11827	2	35	15	35	15	Glacial lake outburst floods can be abbreviated correctly as GLOF. [William Lorenz, Australia]	Rejected - we try to avoid specialist abbreviations and terminology
18655	2	35	18	35	21	Run-on sentence with several instances of ambiguous grammar ("these tipping points with a shift" = ambiguous plurality, "switch" could be a very for glaciers or for species). Suggestion: The tipping points which entail shifts to alternate states arise from the loss of cold stenothermic species, many of which are endemic (see Glossary). This follows/causes a loss of beta diversity (turnover between reaches) and gamma diversity, caused by glaciers retreating and switching to a regime dominated by snowmelt." [APECS Group Review, Germany]	Taken into account - The text was considerably revised in preparation for the final draft.
25191	2	35	19	35	20	Regarding the disruption of transport etc, a relevant reference to cite would be "Khanal NR, Hu J-M, Mool P. Glacial Lake Outburst Flood Risk in the Poiqu/Bhote Koshi/Sun Koshi River Basin in the Central Himalayas. Mt Res Dev 2015;35:351–64." [Simon Allen, Switzerland]	Accepted - text revised
30897	2	35	23	0	26	Such aspects quantifying damage might be useful for the ES. [Hans-Otto Poertner and WGII TSU, Germany]	Noted - problem is that studies and numbers don't separate out cryosheric origins
11669	2	35	26	35	30	(If available, it would be advisable to include estimated costs related to drinking and irrigation water and livelihoods. [Government of Mexico, Mexico]	Noted - no studies found

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17777	2	35	26	35	27	Can cite paper below for following sentence if reference is needed: "Other impacts are related to drinking and irrigation water and livelihoods." McDowell, G., Ford, J., Lehner, B., Berrang-Ford, L., Sherpa, A. (2013) Climate-related hydrological change and human vulnerability in remote mountain regions: A case study from Khumbu, Nepal. Regional Environmental Change 13: 299-310. [Graham McDowell, Canada]	Taken into account - paper referred to
24583	2	35	32	0		This section 2.3.2.3 shows a lack of mention of confidence degrees. A higher quantification of these confidence degrees is required. [Armand Hernández, Spain]	Noted - We have added an opening confidence statement. However, as we state, there is rather a lack of mountain-specific studies to support strong confidence statements in this section. The section also ends with a synthesis statement, including confidence degree.
17779	2	35	37	35	40	For clarity and precision, I suggest reordering and revising these two sentences as follows. Some degree of adaptation action has been identified in a number of countries with glaciated mountain ranges, particularly across the Andes and Himalayas, mostly in the form reactive responses (rather than formal anticipatory plans) to hydrological changes (McDowell et al., 2019). However, critical scientific literature reflecting on lessons learned from adaptation efforts remains scarce. [Graham McDowell, Canada]	Accepted - text revised
11203	2	35	39	35	39	Change "glaciated" by "glacierized" [Antoine Rabatel, France]	Accepted - text revised
28077	2	35	42	0		Do you mean glacier lake lowering? I think this is what is normally done instead of drainage (which is for me a complete emptying of the lake). [Frank Paul, Switzerland]	Accepted - text revised
3497	2	35	49	35	54	Another important aspect for early warning systems is the governance of mountain systems that in most cases has opted for unidirectional hard solutions againts to glacial retreat across the Cordillera Blanca; therefore, when appear measures that implies soft holistic measures (eg. early warning system), emerge a challenge to decision makers and their paradigms. [Jahir Anicama Diaz, Chile]	Noted - however we cannot find sufficient literature that can be used to support adding text on this to the assessment.
24925	2	35	51	35	54	The incident of an early-warning system being installed (and later destroyed) in Peru, is repeated in the box on the following page (page 36, lines 52 - 56). [Dirk Hoffmann, Germany]	Accepted - text revised
24247	2	35	55	35	57	Is it really true that in these cases warnings etc have been largely community led? I have seen many such statements that do not pass thorough scrutiny but am not able to assess the cases here. [Christian Huggel, Switzerland]	Noted - According to the cited literature, and anecdotal evdidence reported therein, the warning/reponses were indeed community led.
8979	2	36	5	0		Change 'are' to 'were' [Nina Hunter, South Africa]	Accepted - text revised
18537	2	36	5	36	6	“[…] driven by short-term economic motives”. If the cited literature supports this statement I’d leave it in. Otherwise I think this is speculative and carries a negative connotation. [APECS Group Review, Germany]	Accepted - text revised to be consistent with the wording in the cited paper.
3499	2	36	14	35	17	Glaciares, Equipo Proyecto. "Pautas y consideraciones para la sostenibilidad de sistemas de alerta temprana frente a peligros glaciares." (2018). Another publication that bases the topic of the change of paradigm in the adaptation measures and the usal adaptive governance of the territory. See: https://scholar.google.cl/scholar?hl=es&as_sdt=0%2C5&q=Pautas+y+consideraciones+para+la+sostenibilidad+de+sistemas+de+alerta+temprana+frente+a+peligros+glaciares&btnG= [Jahir Anicama Diaz, Chile]	Taken into account - report taken into consideration as additonal supporting evidence.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1219	2	36	20	36	20	"SREX" should be spelled out. [Daniel Farinotti, Switzerland]	Accepted - now done at section start
25193	2	36	23	36	25	I'm surpised this final statement didn't make it into the ES. It seems like really important and strong statement. [Simon Allen, Switzerland]	Accepted - text revised
2427	2	36	30	0		My previous comment on FOD was unfortunately ignored. Therefore once again, the climate historical context is missing in this info box. The Cordillera Blanca glaciers have experienced significant fluctuations in pre-industrial times and reached their maximum extent of the entire Holocene during the Little Ice Age (LIA). See e.g. Stansell et al 2013 (doi: 10.1016/j.quascirev.2013.03.003). The glacier retreat after the LIA appears to be presented in this chapter as retreat from something like a "baseline", which however is not representative for the vast majority of the Holocene. Authors need to stay balanced and mark the extreme natural cold phase (LIA) as such by presenting the full context of natural pre-industrial variability. Otherwise this remains a strongly biased report that may be even misleading the readers because of lack of climate historical context. [Sebastian Luening, Portugal]	Rejected - out of the scope of the Chapter - pre-industrial changes
2285	2	36	36	36	36	Add reference to Carey, M., Huggel, C., Bury, J., Portocarrero, C. and Haeberli, W. (2012): An integrated socio-environmental framework for glacier hazard management and climate change adaptation: lessons from Lake 513, Cordillera Blanca, Peru. Climatic [Wilfried Haeberli, Switzerland]	Accepted - text revised
5331	2	36	36	36	37	Baraer says "seven of the nine study watersheds have probably crossed a critical transition point". I therefore recommend to say that "peak water" MAY have passed in most watersheds [Simone Schauwecker, Chile]	Taken into account - text modified.
24249	2	36	36	36	38	I just wanted to remind that the actual evidence about the timing of peak water is quite limited for the Cordillera Blanca (e.g. if the evidence and basic data quality of the Baraer et al 2012 study is assessed the confidence in the timing of peak water is not very high) [Christian Huggel, Switzerland]	Taken into account - text modified.
24251	2	36	41	36	52	I'm not sure whether here a concept of vulnerability is used which is not in line with the one that is used in IPCC reports (since AR5), ie, where risk is a function of hazard, vulnerability and exposure. In this context, human vulnerability would not be determined by physical variables as it is mentioned in lines 48/49. I recommend to use the IPCC concept, otherwise please clearly say why not. [Christian Huggel, Switzerland]	Accepted - text revised
25195	2	36	41	36	43	This use of "vulnerability" and "adapative capcity" here is inconistent with latest definitions used by IPCC, and as used elsewhere in the chapter. Vulnerablity is not driven by changes in the physical system. [Simon Allen, Switzerland]	Accepted - text revised
18667	2	36	45	0		General comment, 2.3.4: This section on 'Tourism and recreation' describes the effects of mountain cryosphere climate change on ski sports, glacier tourism, and alpine climbing. The section would be considerably strengthened if it included numbers showing the relative importance of each industry (in either money or visitor numbers); I was surprised that glacier tourism filled the largest section of this text, as I had previously believed that it was a niche activity. [APECS Group Review, Germany]	Taken into account - Note that the actual page number is most certainly 41, not 36, as inferred from the content of this question. This section was considerably edited, with more balanced attention given to summer ski tourism, and factual information about the economic weight of ski tourism was added.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
5333	2	36	46	36	54	This sentence may be confusing. Rising temperature is not a hazard but may cause a chain of processes that leads to hazards. E.g. Rising temperature -> thawing permafrost -> instability -> rockfall into (new lakes) -> flood. I would disentangle these processes. After this, explain why the vulnerability is high (refer to the figure 2.8 and differenciate exposure - vulnerability and hazard). Then a new paragraph to name an example to face these challenges, which is an early warning system. Other adaptation strategies might be possible, therefore clearly state that this is only one of many ways to adapt. [Simone Schauwecker, Chile]	Taken into account - text revised
18673	2	36	47	0		The importance of mountains for recreation and aesthetics has been described in many novels, travelogues, and holy books. Although Xiao et al.'s paper is relevant, it is hardly an original source for this idea. [APECS Group Review, Germany]	Rejected - Note that the actual page number is most certainly 41, not 36, as inferred from the content of this question. IPCC reports primarily build on peer-reviewed literature, thus quoting Cunde et al. here is fully in line with IPCC practices.
25197	2	36	48	36	51	Inhabitation within potential flood paths is not a driver of vulnerablity, but rather exposure. [Simon Allen, Switzerland]	Accepted -removed
18669	2	36	52	0		Rephrase for concision: "Winter sports and ski tourism rely on favorable snow and atmospheric conditions, which makes them particularly vulnerable to climate change in mountains (...)". This sentence also is common knowledge in the ski community and may need no citation. [APECS Group Review, Germany]	Taken into account - Note that the actual page number is most certainly 41, not 36, as inferred from the content of this question. This section was considerably edited, leading to more concise text.
2287	2	36	53	36	53	The level of Lake 513 was lowered by about 20m , the lake was not "drained". [Wilfried Haeberli, Switzerland]	Accepted - text revised
24253	2	36	54	36	54	I suggest to mention that the 2010 flood was much smaller and less destructive than a flood that would have happened if no previous lake mitigation works had been done. [Christian Huggel, Switzerland]	Accepted - text revised
8591	2	37	0	37		Figure 2.8 is not at the right location. It should be placed much closer to where it is called in the text, thus on page 34 or 35. [Deborah Verfaillie, Spain]	Taken into account - The figure was moved earlier in the text from the end of section 2.3.2.3 to before section 2.3.2.2 on exposure , vulnerability and Impacts
8593	2	37	0	37		Figure 2.8: The text inside the figure, on the top under “RIsk propeller” and “Rising Air Temperature” is too small to be read. [Deborah Verfaillie, Spain]	Taken into account - the text is simpler, shorter and easier to read. The font size (figure size) will be completed prior to publication .
8595	2	37	0	37		Figure 2.8: For consistency, in the “Risk propeller” subfigure, the text associated to the “Vulnerability”, “Cryospheric hazards” and “Exposure” components should have different colors associated to each component, as in the 3 columns at the bottom of the figure. [Deborah Verfaillie, Spain]	Accepted - The risk propeller is now integrated with the title and text using the same colour scheme.
10903	2	37	0	0		2.8 'spot the differences' think the changes between the two block diagrams should be much better emphasized, it is not up to the reader to find them. The Risk propeller is completely different in style and rather confuses than adds information [otto otto simonett, Switzerland]	Accepted - The changes are now highlighted in bubbles surrounding a large single figure and explained with a text. The risk propeller is integrated with the title and text using the same colour scheme. The final figure will be redrawn by graphic designer which design will highlight better these differences.
23079	2	37	0	37		Fig 2.8 should convey a sense of scale of impact and confidence (not just general ideas but also the outcome of the assessment). [Valerie Masson-Delmotte, France]	Taken ito account - figure revised
24429	2	37	0	0		Figure 2.8. What is the difference between the two bloch diagrams in the figure? Not much as a quick scan gives. The differences probably need to be accentuated to bring a more direct effect. [veijo pohjola, Sweden]	Accepted - The changes are now highlighted in bubbles surrounding a large single figure and explained with a text. The risk propeller is integrated with the title and text using the same colour scheme. The final figure will be redrawn by graphic designer which design will highlight better these differences.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8589	2	37	10	37	11	The end of this sentence is strange: " (…) thereby showing how socioeconomic and geophysical forces intersect in complex and ways". Should the "and" be removed? [Deborah Verfaillie, Spain]	Editorial – deleted. copyedit to be completed prior to publication
8981	2	37	11	0		Remove 'and' [Nina Hunter, South Africa]	Editorial – deleted. copyedit to be completed prior to publication
18539	2	37	11	37	11	"[…]intersect in complex and ways (Carey, 2010; Colonia et al., 2017)." Delete "ways" [APECS Group Review, Germany]	Editorial – deleted. copyedit to be completed prior to publication
25201	2	37	14	0		Under "measures to reduce vulnerability" I'd suggest to add "improved governance and institutional strengthening" [Simon Allen, Switzerland]	Accepted - text revised in the same lines
4999	2	37	15	37	19	In figure 2.8, does increase in population also imply new patterns of human settlements in previously unoccupied areas because of glacial retreat? If yes, what is the implication of this for climate change response? [Debra Roberts and Durban Team, South Africa]	Taken into account - agreed, figure revised
11829	2	37	15	37	16	Another measure to reduce vulnerability is to gradually release water from glacial lakes to prevent GLOFs. [William Lorenz, Australia]	Noted - encapsulated into "more preventive measures at/near glacier lakes"
23907	2	37	15	37	15	It is hard to see the differences between the left and right illustrations in Figure 2.8. It would be helpful to add marks, e.g. circled numbers, to show the parts that have changed and correspond to the notes for the changes and impacts written below. [Government of Japan, Japan]	Accepted - The changes are now highlighted in bubbles surrounding a large single figure and explained with a text. The risk propeller is integrated with the title and text using the same colour scheme. The final figure will be redrawn by graphic designer which design will highlight better these differences.
31605	2	37	15	0		Figure 2.8. Somehow, it seems that the propeller figure is a separate figure from the rest. Consider dividng the figure, or make the separation of panels more evident. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The risk propeller is now integrated with the title and text using the same colour scheme.
31607	2	37	15	0		Figure 2.8. Are the changes written below represented in this figure? Perhaps you could match the change with the corresponding place within the figure, either by distributing them with arrows, or by matching letters. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - The changes are now highlighted in bubbles surrounding a large single figure with number for each "region" and explained with a text.
30731	2	37	16	37	19	This figure is nice and informative, but could perhaps be streamlined with the mirror figure of Arctic/Antarctic in Chapter 3. That might make it easier to compare the two slices and immediately spot the differences [Hans-Otto Poertner and WGII TSU, Germany]	Noted
2289	2	37	17	37	17	Write "degrading permafrost" not "thawing permafrost". Mention somewhere "landscape change" [Wilfried Haeberli, Switzerland]	Taken into account - we kept "thawing permafrost" as easier to understand for policymakers. "Landscape change is "
5339	2	37	17	37	17	In Figure 2.8, there are only two measures to reduce vulnerability. Name more examples or say that there are more measures [Simone Schauwecker, Chile]	Taken into account
33025	2	37	17	37	17	The figure could be enhanced by highlighting the changes between the left and right panels (e.g., increased population, encroachment of recreational areas into more remote areas) and by enlarging some of the smaller text (e.g., in Risk propeller and Rising Air Temperature). [Government of United States of America, United States of America]	Accepted - The changes are now highlighted in bubbles surrounding a large single figure and explained with a text. The risk propeller is integrated with the title and text using the same colour scheme. The final figure will be redrawn by graphic designer which design will highlight better these differences.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1983	2	37	22	38	47	The biodiversity chapter on terrestrial ecosystems 2.3.3.1. needs restructuring and to be more focused on the specific effects arising from changes of the particular cryosphere components, which can strongly differ. The title of 2.3.3.1. could be changed to "Vegetation and Terrestrial Ecosystems", since wildlife (including a little bit on arthropods) is treated in 2.3.3.3 SEE MY SUGGESTIONS FOR CHAPTER 2.3.3.1 BELOW DIVIDED OVER SEVERAL LINES Several citations I would suggest to omit because: König et al. 2018, Post et al. 2018 do not deal with mountains nor with snow; were in unclear sentences (1st paragraph of page 38); Pauli et al. 2014 is unsuitable and reference not correct; Rashid et al. 2015 is cited for an unreliable statement. [Harald Pauli, Austria]	Accepted - the section is greatly restructured; these references are deleted. Thank you for your considered input to improve the section
15171	2	37	22	37	22	I think that you missed the concept of pedodiversity. Permafrost/patterned ground features and changes in snow cover depth and duration strongly control the pedogenesis and the soil functioning (see for example: Viglietti D., Freppaz M., Filippa G., Zanini E. (2014) Soil C and N response to changes in winter precipitation in a subalpine forest ecosystem, NW Italy. Hydrological Processes. Freppaz M., Williams M.W., Seastedt T., Filippa G. (2012) Response of soil organic and inorganic nutrients in alpine soils to a 16-year factorial snow and N-fertilization experiment, Colorado Front Range, USA. Applied Soil Ecology [Michele Freppaz, Italy]	Taken into account - though due to text limitations, it was not possible to develop this topic well.
16729	2	37	22	37	22	This is a well-written and well-referenced session that in my opinion covers some of the major aspects related to the topic, within the space constraints. Below I provide some general as well as more specific comments on how I believe this text could be further improved. In certain cases I only highlight some missing/unclear aspect but did not provide a definite suggestion on how to improve, since I felt this should be at the discretion of the author(s). General comments (see below for details): - There is an overly focus on species richness and almost none on the other axes of biodiversity (functional, [phylo]genetic) as well as units under the species level (eg populations). This could be at least mentioned in a few places - Whenever possible, it would be good to reduce ambiguity in terms of what spatial and temporal scales are dealt with - At least a sentence or two on the deep-time aspect of climate changes and responses of biodiversity may be warranted, see suggestion below. [Carl Wepking, United States of America]	Accepted - text revised to address the first two comments, though due to length limitations the third is not addressed.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17451	2	37	22	38	47	In this section are many important missinng points. The retreat of glaciers is accompanied by a general upper migration of environmental conditions associated with increments in temperature. Beacuse of structural conditionants this upper migration of environmental belts implies not only a substanctial reduction in the area of distribution of many taxa (plants and animals) but also and more important and more inmediate, changes in the aptterns of interaction among species (i. e. predator - prey). This aspect is closely with the emergennce of new: i) virus - host; ii) parasite - host relationships due to a phenomenom called dilution. Some of this new interactions may have undesirable effects not only on natural populations of plants and animals, but also in human populations. This aspect may also include [Hugo Mantilla-Meluk, Colombia]	Noted - due to length limitations to topic of disease is not included.
17455	2	37	22	38	47	There are many groups of organisms that play important ecological roles in mountain ecosystems, such as fungi. In temperate regions many animals use caves as refugia to spend the winter season. The time lapse spent within these refugia depens on climatic conditions, that also indirectly regulates the internal conditions of the caves and the presence of organisms such as fungi potentially harmful for cave dwellers (such bats). Recently the so called: White-nose syndrome which is a disease caused by a fungus that affects hibernating bats. It is considered one of the worst wildlife diseases in modern times having killed millions of bats across North America. [Hugo Mantilla-Meluk, Colombia]	Rejected - focus of the report is on cryosphere-related impacts
17781	2	37	22	37	22	In terms of structure, perhaps section '2.3.3 Biodiversity' should come after all of the human adaptation and risk sections, so after section '2.3.6 Impacts on Household Economics, Residence Patterns and Habitability, and National Economies.' [Graham McDowell, Canada]	Rejected - keeping sections ordered as n SOD
30733	2	37	22	41	43	Section lacks information on Africa (low latitudes) [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - some new references are added on the Andes, though we could not identify references on cryopshere-related high mountain ecosystem impacts in Africa.
32293	2	37	22	44	25	The whole section needs to be restructured in a coherent and more logical manner. I suggest to use ecosystem services as a possible means to structure, at least partly, albeit I could see alternatives as well. But what is dearly needed is some meaningful and logical structure. [Andreas Fischlin, Switzerland]	Taken into account as part of revising the structure and strengthening this section.
5001	2	37	24	38	47	Although this subsection is titled, "Terrestrial Ecosystems" the contents focus only on plants and there is nothing on animals or other forms of live. It will be also useful to consider whether the current and projected changes could create opportunities for alien invasive and the implications of this for native species. [Debra Roberts and Durban Team, South Africa]	Accepted - the text has been greatly revised and includes examples for animals and plants. Articles on impacts for expansion of invasive species in the alpine focus on climate warming and climate change, so are beyond the scope of the report.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1985	2	37	26	37	31	The subchapter may begin by explaining that the three cryosphere components have different effects on ecosystems and biodiversity. SUGGESTED ALTERNATIVE: "A shrinking cryosphere affects plant species composition and ecosystem function in all high mountain regions (Anthelme and Lavergne, 2018) (Figure 2.2). Effects, however, strongly differ among the cryosphere components. Retreating glaciers liberate area for colonization, thawing permafrost can change disturbance patterns, water availability and the thermal condition of soils in high mountain habitats, whereas a reduction of seasonal snow cover duration extends the length of the growing season, leading to higher temperature sums, alters the impact of frost events, and can have implications for water availability. Effects, thus, are strongly entangled with those of warmer thermal regimes." [Harald Pauli, Austria]	Taken into account - the text is greatly revised, though the structure is focused on types of impacts, summarizing how different aspects of the cryosphere effect each type.
30403	2	37	26	37	27	Not only cryosphere components determine species composition and ecosystem function but also climate and biotic factors. Therefore I suggest to replace "determine" with "affect". [Manuela Winkler, Austria]	Accepted - this statement was deleted.
30427	2	37	26	38	48	I believe it is very unfortunate that temperature effects are not considered in the terrestrial ecosystems chapter, as ecological climate change studies usually do not distinguish between cryosphere-related and unrelated drivers and/or focus on temperature effects. Furthermore, I miss a clear golden thread in this chapter and I think the literature cited is not exhaustive, nor (sometimes) the most relevant. [Manuela Winkler, Austria]	Taken into account - this is outside the scope of the report, though we have included an introductory text in the ecosystems section to provide context in relation to impacts attributed to warming and included in AR5 and SR1.5.
32259	2	37	26	37	27	"Determine" is wrong. There are many other factors that influence plant species as well. Perhaps some dominance can be attributed to the cryosphere, but this can be easily challenged, since cyrospheric as well as ecosystem parts of high mountains are present in the very same environment, e.g. in terms of a common temperature regime. I would argue the latter are at least as important than the cryospheric factors. And why talk only about plants here? [Andreas Fischlin, Switzerland]	Accepted - statements are greatly revised to reflect accuracy for attribution.
33027	2	37	26	37	26	"Cryosphere components determine plant species composition and ecosystem function in all high mountain regions (e.g., Anthelme and Lavergne, 2018) (Figure 2.2)." This is not quite correct as phrased; species composition and ecosystem function are both determined by other limiting factors as well, and the relative contribution of cryosphere components varies between components, among regions, and across species. Suggest modifying the language slightly: "Cryosphere components interact with other limiting factors to determine…" or similar. [Government of United States of America, United States of America]	Taken into account as part of revising the structure and strengthening this section.
18541	2	37	27	37	27	“Cryosphere components determine plant species composition and ecosystem function in all high mountain regions (e.g., Anthelme and Lavergne, 2018) (Figure 2.2).” Check Figure reference/number. Might have changed. [APECS Group Review, Germany]	Taken into account - text revised
16731	2	37	28	37	28	‘increases and decreases’ makes little sense here; these could be replaced by “decreases in” [Carl Wepking, United States of America]	Taken into account - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
18543	2	37	29	37	29	“diverse ecological processes with significant consequences on phenology, productivity, and biodiversity”. “significant” usually implies some statistical context where often some sort of confidence is assigned. If this is the case here I would suggest making use of IPCC guidelines to express the statistical confindence in this statement. Otherwise I would replace term “significant” with e.g. “measurable, notable, etc. ” [APECS Group Review, Germany]	Taken into account - text revised
8983	2	37	30	0		for' not 'on' [Nina Hunter, South Africa]	Accepted - text revised
32261	2	37	30	37	30	Productivity can be seen as a supporting service that is relevant for most providing services. But having this here under a heading biodiversity makes no sense.. [Andreas Fischlin, Switzerland]	Taken into account as part of revising the structure and strengthening this section.
18675	2	37	41	0	43	Specify "some operators of glacier tour companies in Norway" - reference provided does not attempt to cover international companies. [APECS Group Review, Germany]	Page number is probably 42. Comment Taken into account - the text has been revised for better clarity and consistency.
1987	2	38	1	38	47	continue with a paragraph on glacier recession SUGGESTED PARAGRAPHS: "Areas released through glacier recessions are colonised by surrounding plant populations, but recolonization velocity of plants can differ considerably depending on the environmental context. Recruitment success of temperate glacier foreland plants has improved through climate warming and early snowmelt (Mondoni et al., 2015). Colonisation occurs faster and more species are involved already in early stages, compared to a century ago (Fickert et al. 2017). In the tropical Central Andes, however, considerable time lags in filling opened areas of retreating glaciers were found, where dispersal limitation was a prominent constraint for succession (Zimmer et al., 2018)." ADDED CITATIONS (only refs which were not cited previously) Fickert, T., et al., 2017: Klebelsberg revisited: did primary succession of plants in glacier forelands a century ago differ from today? Alpine Botany, 127(1), 17-29, doi:10.1007/s00035-016-0179-1 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
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1989	2	38	1	38	47	next: on permafrost thaw SUGGESTED PARAGRAPH: Thawing permafrost in arid high-elevation regions, such as in the Qinghai-Tibetan Plateau, contributed substantially to plant water supply, thereby promoting plant growth (e.g., Ishikawa et al., 2005; Wang et al., 2016) (high confidence). Though, over time, permafrost degradation is expected to lead to habitats with low soil moisture and to changing species compositions adapted to semi-desert and steppe conditions (Cheng and Jin, 2013; Yang et al. 2010) (medium confidence). Permafrost thaw removed barriers to water flow, changing creek locations and causing the degradation of pastures (Jin et al., 2009). Permafrost degradation, especially in steeper terrain, may lead to enhanced disturbance through substrate movement, leading to declines in vegetation cover and of sensitive species (Cannone and Pignatti 2014). ADDED CITATIONS (only refs which were not cited previously) Cannone, N. and S. Pignatti, 2014: Ecological responses of plant species and communities to climate warming: upward shift or range filling processes? Climatic Change 123, 201-214, doi:10.1007/s10584-014-1065-8 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.
1991	2	38	1	38	47	next : PART 1 on increasing species numbers, range shifts and abundance changes (where reduced snow cover duration, permafrost thaw can have an influence in addition to warming effects) SUGGESTED PARAGRAPH: "Upslope expansions of treelines are expected to be driven by warming and changing snow cover effects (Lubetkin et al. 2017). Plant species richness has increased in alpine to subnival zones (high confidence), e.g., five times faster across Europe during the recent decade, 2007-2016, compared to 1957-1966, where species numbers have been rising synchronously with temperature trends (Steinbauer et al., 2018). Warmer thermal regimes also lead to changed snow cover periods and accelerated permafrost thaw in subnival/nival zones, which both could have ameliorated habitat conditions supporting the increase in plant diversity. Increases in species numbers are expected to slow down due to loss of cold-adapted specialist species, but their disappearance may be delayed due to their longevity (e.g., Dullinger et al., 2012) (medium confidence). High mountain ecosystems may, further, be buffered against large-scale biodiversity loss, because of high landscape heterogeneity in snow cover and thermal conditions, leading to different microhabitats (Scherrer and Körner, 2011; Graae et al., 2018)." [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.

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1993	2	38	1	38	47	next: PART 2 on increasing species numbers, range shifts and abundance changes SUGGESTED PARAGRAPH: "Declines in the abundance of alpine species, however, have been found near the warm-margins of their altitudinal (Lesica, 2014) and latitudinal distribution (Lesica and Crone, 2017). High-elevation specialist species, adapted to short and cold growing seasons have been found to progressively decrease in abundance near their lower range margins during the past two decades (Lamprecht et al. 2018). Considering 183 mountain plant species over their entire altitudinal distribution range revealed that lower range margins are shifting upwards at least as rapid than the upper ones (Rumpf et al. 2018), causing progressive shrinkage of alpine species' distribution ranges (medium confidence)." ADDED CITATIONS (only refs which were not cited previously) Lamprecht, A., et al., 2018: Climate change leads to accelerated transformation of high-elevation vegetation in the central Alps. New Phytologist, 220(2), 447-459, doi:10.1111/nph.15290 Lesica, P., 2014: Arctic-alpine plants decline over two decades in Glacier National Park, Montana, USA. Arctic Antarctic and Alpine Research, 46(2), 327-332, doi:10.1657/1938-4246-46.2.327 Rumpf, S. et al., 2018: Range dynamics of mountain plants decrease with elevation. PNAS, 115(8), 1848-1853, doi:10.1073/pnas.1713936115 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.
1995	2	38	1	38	47	next: PART 3 on increasing species numbers, range shifts and abundance changes SUGGESTED PARAGRAPH: "Due to reduced snow duration, snowbed communities, characterized by long-lasting seasonal snowpack (Bjork and Molau, 2007; Pickering et al., 2014) are expected to be vulnerable even in a short-term perspective (medium confidence). Comparing changes in species abundances in experimental warming plots versus repeatedly surveyed not manipulated plots in arctic and alpine North America and Europe yielded very similar values of the magnitudes of change and showed that increases occurred more commonly for species with larger thermal niches (Elmendorf et al., 2015)." ADDED CITATIONS (only refs which were not cited previously) Elmendorf, S. C., et al., 2015: Experiment, monitoring, and gradient methods used to infer climate change effects on plant communities yield consistent patterns. PNAS, 112(2), 448-452, doi:10.1073/pnas.1410088112 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1997	2	38	1	38	47	finally PART 1 on phenology and drought effects SUGGESTED PARAGRAPH: "Earlier snowmelt in spring strongly influences plant phenology, such as earlier onset of growth and flowering are linked to patterns of snow cover in high mountain regions (Xie et al., 2017; Winkler et al., 2018) (high confidence), but also increases the risk of frost damage through spring freezing events (Palacio et al. 2015). Decreasing snowfall and early snowmelt lead to longer growing seasons, usually with higher overall temperature sums, and reduced water availability, especially in climates with low summer precipitation. Combined effects of warming and less snowfall in spring may have caused species declines in Mediterranean mountain plant species (Pauli et al. 2012) (medium confidence)." ADDED CITATIONS (only refs which were not cited previously) Palacio, S., et al., 2015: Bud freezing resistance in alpine shrubs across snow depth gradients. Environmental and Experimental Botany 118, 95-101, doi:10.1016/j.envexpbot.2015.06.007 Pauli, H., et al., 2012: Recent plant diversity changes on Europe's mountain summits. Science, 336(353), 353-355, doi:10.1126/science.1219033 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.
1999	2	38	1	38	47	finally PART 2 on phenology and drought effects SUGGESTED PARAGRAPH: "More frequently occurring dry periods are also expected to occur in regions with humid summer climates, where high-elevation species were found to be more vulnerable to drought than lower-elevation species (Rosbakh et al. 2016). Less snow combined with dry summers increase the risk of disturbance by fire (Gergel et al., 2017). Mountain ecosystems across western North America are experiencing an increase in the severity and extent of wildfires (e.g., Westerling, 2016). Globally, climate variability that leads to fuel aridity accounts for nearly one third of burned area (Abatzoglou et al., 2018)." ADDED CITATIONS (only refs which were not cited previously) Rosbakh. S., et al., 2016: Contrasting effects of extreme drought and snowmelt patterns on mountain plants along an elevation gradient. Frontiers in Plant Science 8, 1478, doi:10.3389/fpls.2017.01478 [Harald Pauli, Austria]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some references and ideas are outside the scope of the chapter, which focuses on cryosphere-related impacts only.
28551	2	38	1	38	39	In re-surveys of elevational distribution of riparian trees in a protected area in the semi-arid Great Basin just 9 years after the first surveys, minimum elevation of Picea engelmannii, a tree often associated with shorter growing seasons, deep shade, and cooler microsites, had contracted upslope 175-200 m in three of the four studied watersheds (Beever et al. 2005, Western N. Am. Naturalist). At permanent plots across those drainages, changes in the log-transformed abundance of that tree species were >99% explained by elevation alone: abundance increased at highest-elevation plots, and decreased dramatically at lowest-elevation plots (Beever et al. 2005). When juxtaposed with the result that none of the other 7 tree species exhibited notable change in either their leading- or trailing-edge elevation over the 9 years, this suggests that some species may respond rapidly to contemporary climate changes, whereas others will respond over longer time scales. [Erik Beever, United States of America]	Rejected - focus of report is assessment of references since AR5, 2014.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28553	2	38	1	38	31	Consider adding a paragraph on animal distributions and responses to change, in High Mountain Areas: "Animal species have shown diverse responses to both contemporary and paleontological changes in climate (Rowe et al. 2015, Moritz et al. 2005, Sekercioglou et al. 2008). One species that is typically associated with alpine ecosystems is the American pika, historically used as a model for understanding metapopulation dynamics, source-sink dynamics, and local extinction dynamics. Re-surveys in North Cascades National Park reveal an elevationally dependent response in pika abundance to a snow drought, relative to abundance approximately a decade earlier (Johnston et al., in press Ecology). Whereas abundance declined dramatically at lowest elevations, it increased at higher elevations, likely due at higher elevations to greater access to forage in this heavy-snow area. Changes in abundance were best explained park-wide by variability across years in vapor pressure deficit and its interaction with cold stress in the absence of snowpack (Johnston et al. in press). The species has been lost altogether from Zion National Park, during 2012 to 2014 (Beever et al. 2016, J. Mammalogy), and marked declines in distribution have been found across the Great Basin (Beever et al. 2016) and across northern New Mexico below 3100 m (Westover, Beever, et al., in prep.). In contrast, the species is widely distributed at very low elevations in the Columbia River Gorge (Varner et al. 2015). Whereas initial work has found that extirpations and abundance of the species have been governed by aspect of temperature (Beever et al. 2010, Beever et al. 2011, Beever et al. 2016), more-recent work suggests that aspects of ecological water availability may b"e governing both abundance and distribution (e.g., Beever et al. 2013). [Erik Beever, United States of America]	Taken into account - Johnston 2019 reference is added and included in the impacts table, as well as another pika paper. Due to length limits, whole paragraphs on individual species are not possible.
32263	2	38	1	38	9	Unclear paragraph that seems to serve no purpose. Delete or completely revise by making it relevant for biodiversity or some other phenemona, i.e. move it to another section. The next paragraph is what I would expect in such a section. [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
33029	2	38	1	38	4	Line 1 states changes in earlier onset of growth will occur but line 4 says the time gap will increase, presumably because plant growth onset remains fixed. It is likely that some plants that are photoperiod-dependent may represent the second case but this apparent discrepancy in the text should be addressed with some edits. [Government of United States of America, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
16813	2	38	3	38	5	This sentence is not clear to me. Why woudl warmer winters with less snow cover increase the time gap between snow disappearance and start of plant growth. Both will happen earlier to my understanding, but why is the time lag increasing? Please check and/or modify. [Sven Kotlarski, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
8985	2	38	4	0		increase' not 'increases' [Nina Hunter, South Africa]	Accepted - text revised
30405	2	38	4	38	4	change to: "increases the time gap between snow melt and …" [Manuela Winkler, Austria]	Accepted - text revised
30735	2	38	4	0		“warmer winters (…) increase” – use plural form of verb for plural nouns throughout the chapter… [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15161	2	38	5	38	5	I think that it should be more stressed the impact of changes in snow depth and snow cover duration on soil nutrient dynamics (see for example Edwards A.C., Scalenghe R., Freppaz M. (2007) Changes in the seasonal snow cover of alpine regions and its effect on soil processes: a review. Quaternary International 162-163: 172-181.) [Michele Freppaz, Italy]	Rejected - due to space limits this topic could not be covered
30407	2	38	5	38	7	It is unclear what depends on regional climate and leaf life span: ecosystem shifts or snowpack ? If the latter, how does leaf life span affect snowpack? Rephrase! [Manuela Winkler, Austria]	Taken into account - as part of revising the structure and strengthening this section.
30737	2	38	5	38	9	Not clear whether this information is a description of general processes or has already been observed. Please clarify [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
16735	2	38	8	38	8	I can't see how 'exceptionally low' snow depth would counteract the upslope expansion of the treeline, only how 'exceptionally high' depth may do so. [Carl Wepking, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
33031	2	38	8	38	8	The sentence is not intuitive and the mechanism by which climatic extremes counteract the effect of land use on treeline expansion should be explained. [Government of United States of America, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
983	2	38	10	38	20	This entire section lacks the concept of WILDERNESS, and how it gets lost. See Huettmann (2012) Protection of Three Poles; also for mountain biodiversity [Falk Huettmann, United States of America]	Rejected - due to space limits this topic could not be covered
1221	2	38	11	38	12	The sentence is unclear. what is "faster" referring to? What is the meaning of a speed in "plant species richness increase", and compared to what? [Daniel Farinotti, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
2375	2	38	11	38	23	it could be added here that tropical montane species, with narrower thermal tolerance and reduced dispersal ability, will be especially vulnerable to rapid climate change Polato et al. (2018) PNAS www.pnas.org/cgi/doi/10.1073/pnas.1809326115 [Ruben Sommaruga, Austria]	Rejected - reference is outside scope of the report
30409	2	38	11	38	13	Steinbauer et al. clearly linked richness increase to rising temperatures which contradicts the statement in Introduction chapter 2.1 page 7, lines 19-21: «Mountain environments also change in response to climate change related effects on biodiversity or the physical environments unrelated to the cryosphere or socio-economic developments. These non-cryospheric drivers are not considered here, although unambiguous attribution can be difficult in some cases. » . [Manuela Winkler, Austria]	Taken into account - as part of revising the structure and strengthening this section.
30739	2	38	11	38	13	Could more complete information be provided, e.g., in a table, sorted by region? This could be placed in the annex but the information should be available somewhere as it supports a "high confidence" statement [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text revised to state regions
32265	2	38	11	38	23	The para is good in itself, but I find nowhere any reference to previous assessments of CC impacts on biodiversity, cf. AR5 or for that matter AR4 (having a mountain section) and also IPBES on mountain ecosystems. Always build on previous assessments. [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
16737	2	38	13	38	13	I'm generally opposed to the use of 'endemic' without a proper reference to its meaning: this is a relative term, and in fact ALL species can be said to be endemic (ultimately to the whole planet). 'Narrowly distributed' is usually a better term, or 'endemic to a single or a few mountains' might be an alternative. [Carl Wepking, United States of America]	Noted - we have used endemic, since it is used in past assessments
30411	2	38	13	38	13	Two times "due to" in a sentence - rephrase. [Manuela Winkler, Austria]	Taken into account - as part of revising the structure and strengthening this section.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
30741	2	38	13	38	14	This sentence is difficult to understand and should be rephrased [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
30413	2	38	14	38	16	You may also cite a recent review on range dynamics: Freeman, B.G. et al. Expanding, shifting and shrinking: The impact of global warming on species' elevational distributions. Global Ecology and Biogeography 27: 1268-1276 (2018), and a study on range dynamics of high-mountain plants in the European Alps: Rumpf, S. B. et al. Range dynamics of mountain plants decrease with elevation. Proceedings of the National Academy of Sciences, 115, 1848-1853 (2018). [Manuela Winkler, Austria]	Accepted - reference has been included
30743	2	38	14	38	17	Provide temporal and spatial range (e.g., globally? In the Northern Hemisphere?; since 1950?) [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
33033	2	38	15	38	17	Sentence construction is awkward. If the main point is the fact that declines in the abundance of alpine species have been found at the margin and in warming plots, simply state that fact. Drop the added bit about experimental warming also leading to earlier snowmelt. It's unclear whether the earlier melt is being attributed to the plant abundance change or the fact that it's snow in a experimental warming plot. [Government of United States of America, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
16739	2	38	16	38	16	define 'long-term' if possible, maybe 'decade-long'? [Carl Wepking, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
33035	2	38	16	38	17	There should be a little more weight given to the long-term warming experiments. Despite their limitations, these experiments offer a level of detail about responses that field studies cannot. [Government of United States of America, United States of America]	Rejected - outside scope of the report, which focuses on cryosphere-related impacts
1223	2	38	17	38	18	The wording is unclear, as it seems to pose "ecosystems" = "communities" [Daniel Farinotti, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
30745	2	38	17	38	19	It is not very clear which two systems they are. Is it a) nival and b) snowbed communities, which are both characterised by perpetual and long-lasting snow, or is it a) nival communities characterised by perpetual and long-lasting snow and b) snowbed communities characterised by perpetual and long-lasting snow? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
30747	2	38	17	38	19	Please provide timescale for this projection [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
16741	2	38	20	38	20	'biodiversity loss' is an ambiguous term. I guess it's meant here 'loss in species richness', as in the first sentence in this paragraph. This is an important distinction, since my understanding is that while species richness might increase locally due to warming, there could still be losses in (phylo)genetic diversity (eg due to the introduction of closely related species, such as many Asteraceae) and/or functional diversity (eg generalists / weeds / widespread species). Although I didn't receive the full session on freshwater ecosystems, this seems to be tackled there (as indicated by the figure on page 2-40), so it should also appear in this session in my opinion. [Carl Wepking, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
30415	2	38	20	38	23	It is not only heterogeneity in snow cover which leads to diverse microhabitats, but also rocks and scree provide microhabitats, for instance. [Manuela Winkler, Austria]	Noted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33037	2	38	20	38	23	"Large-scale biodiversity loss in high-mountain environments may be delayed, because high landscape heterogeneity in snow cover leads to different microhabitats (Scherrer and Korner, 2011; Graae et al., 2018), and the high longevity of most alpine species (Rosbakh and Poschlod, 2018) (medium confidence)." Because ecological communities are rarely static in species composition, this might also be delayed because of the balancing effect of new species arriving to high elevations from lower elevations (implied a couple of sentences ago, without mechanism). The net consequence for absolute species richness depends on the difference between the rate of loss in historically high elevation species and the rate of gain in historically absent species. If the important emphasis here is the loss of historically high elevation species or communities, suggest replacing "Large scale biodiversity" with "Large scale species loss or community disaggregation". [Government of United States of America, United States of America]	Taken into account - as part of revising the structure and strengthening this section.
30417	2	38	21	38	21	different microhatibats -> diverse microhabitats [Manuela Winkler, Austria]	Taken into account - as part of revising the structure and strengthening this section.
30419	2	38	22	38	22	insert "because of" before "the high longevity ..." [Manuela Winkler, Austria]	Taken into account - as part of revising the structure and strengthening this section.
30749	2	38	22	0		Again, does the high longevity really apply to all taxonomic groups, or only to plants? Longevity seldom applies to invertebrates or small mammals, so this needs to be clarified and the use of the term “species” should be applied with caution [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
30751	2	38	25	0		Where are these arid areas? Provide example [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
32267	2	38	25	38	26	Text book statement, albeit I like the uncertainty assessment. But, where is the relevance for policy making, that for biodiversity? [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
30753	2	38	27	0		The previous sentence was on exceptionally arid regions so it is not clear how the switch to wetlands arises [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
16733	2	38	28	37	28	It doesn’t make sense to include the ‘upslope expansion of treeline’ under ‘phenology’ – at least without an explicit explanation that this is an indirect link. That said, the treeline expansion is indeed an important aspect to mention, perhaps as a separate, next line. An additional relevant paper in this topic is: Morueta-Holme N, Engemann K, Sandoval-Acuña P, Jonas JD, Segnitz RM, Svenning J-C (2015) Strong upslope shifts in Chimborazo's vegetation over two centuries since Humboldt. PNAS 112(41): 12741-12745. doi: 10.1073/pnas.1509938112 [Carl Wepking, United States of America]	Accepted - reference has been included
30755	2	38	28	0		Please clarify to the reader: is the Tibetan Plateau an example for a wetland or an exc. arid region? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
32269	2	38	29	38	29	Degradation of pastures due to water flow? I am having difficulties to see this, despite being an ecologist. [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
32271	2	38	29	38	31	"Other"? The previous sentence does not talk about desertification. If you mean here of a positive feedback to permafrost thaw then say so and make an assessment of the relevance of this feedback for the permafrost. Again this has nothing to do with biodviersity. [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.

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18677	2	38	31	0		It is widespread knowledge that "the cryosphere plays an important role in sustaining livelihoods in mountain communities". Why justify this statement by citing a single paper, and one still under review? [APECS Group Review, Germany]	Taken into account - an ecosystem services section was developed instead of isolated statements such as this.
15163	2	38	33	38	33	I think it should be mentioned the rates of soil formation in glacier retreat area. See for example: D'Amico M., Freppaz M., Zanini E., Bonifacio E. (2016) Primary vegetation succession and the serpentine syndrome: the proglacial area of the Verra Grande Glacier, North-Western Italian Alps. Plant Soil. DOI 10.1007/s11104-016-3165-x. or D'Amico M. E., Freppaz M., Filippa G., Zanini E. (2014) Vegetation influence on soil formation rate in a proglacial chronosequence (Lys Glacier, NW Italian Alps). Catena 113: 122-137.) [Michele Freppaz, Italy]	Accepted - reference has been included
30421	2	38	33	38	35	There is rather more literature available on this topic, e.g., for the European Alps see: Erschbamer, B., Niederfriniger Schlag, R., & Winkler, E. (2008). Colonization processes on a central Alpine glacier foreland. Journal of Vegetation Science, 19(6), 855-862, and Erschbamer, B. (2007). Winners and losers of climate change in a central alpine glacier foreland. Arctic, Antarctic, and Alpine Research, 39(2), 237-244. [Manuela Winkler, Austria]	Rejected - focus of report is assessment of references since AR5, 2014.
32459	2	38	33	38	39	What is lacking is uncertainty assessment. The relevance of each of those processes needs to be assessed, also in terms of the various mountain regions on the globe. Finally, lacking is also what this means for biodiversity. [Andreas Fischlin, Switzerland]	Taken into account - as part of revising the structure and strengthening this section.
11671	2	38	35	38	37	It is necessary to evaluate the impact of shrinkage of tropical and mid-latitude glaciers to forest vegetation [Government of Mexico, Mexico]	Accepted - two key references and text have been added on tropical forest, glaciers Morueta-Holme et al. 2015, Fadrique et al. 2018
16743	2	38	35	38	35	define 'slow' if possible. I can't see the full references cited here, but I guess that most of this report and chapter deal with very recent (decade-long) research. There is complementary, important research (mostly in the Northern Andes) that stretches into thousands of years and investigate how treelines and vegetation zones have changed in response to climatic fluctuations (see e.g., work by Henry Hooghiemstra. [Carl Wepking, United States of America]	Rejected - this text was removed
30757	2	38	35	38	37	Terrestrial carbon storage is an important point – could more information be provided, e.g., estimates of carbon release due to degradation in high mountain regions, including wetlands? And impacts of fires on this (see paragraph below)? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - two studies on net ecosystem production are included in the new section on ecosystem services; few references focus on cryosphere-related terrestrial carbon storage to provide quantiative estimates. We've indicated whether areas have been increasing or decreasing NEP.
33039	2	38	37	38	38	The time frame should be given in the text; otherwise it sounds rather imminent. The study used years 2035 and 2085 and several climate change scenarios to arrive at this conclusion but the model used doesn't account for the lag times inherent in plant dispersal and suitable substrate evolution. So, the estimates are very optimistic. There is high confidence that this will happen eventually but low confidence that it will happen by 2085. [Government of United States of America, United States of America]	Taken into account - text is greatly revised; thank you for your considered recommendations. Efforts have been made to incorporate the ideas, though not the precise words; several of the references have been added from across your comments. Some reference
2291	2	38	38	38	38	The expression "climate warming" is popular language which should be avoided in a scientific report. Climate is defined as a statistical average of meteorological conditions and as such cannot "warm". Better use an expression like "global warming", "atmospheric temperature rise" or the like. [Wilfried Haeberli, Switzerland]	Accepted - text revised, often to 'atmospheric warming'

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
16745	2	38	38	38	38	maybe replace ‘rock or ice’ by ‘as being dominated by rocks or ice’? [Carl Wepking, United States of America]	Taken into account - text revised to focus on species establishing in areas where they were absent.
1463	2	38	41	38	48	Outside scope of climate change effects; delete [Rene Forsberg, Denmark]	Taken into account - as part of revising the structure and strengthening this section.
15491	2	38	41	38	48	Please, explain the context of this paragraph. Is "climate variability" part of, or different from, anthropogenic climate change? [EUCE, Belgium]	Taken into account - as part of revising the structure and strengthening this section.
30759	2	38	41	0		This is the first time fire is mentioned in combination with cryosphere changes. It is great that this important issue is being picked up on. However, it could be made more clear how they are related. This paragraph should link to the hazards in section 2.3.2. Perhaps also check out the information on fire & ecosystems in Chapter 3 [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - the text is revised, also reflecting comments of other reviewers. This topic of altered disturbance regimes is linked to the chapter 2 hazards section and the chapter 3 ecosystem services section.
32275	2	38	41	38	47	Uncertainty assessments missing [Andreas Fischlin, Switzerland]	Accepted - these are now added.
32273	2	38	42	38	42	A formulation such as "shifts may be rapid" and then making a confidence statement make no sense. Please correct "are rapid" or whatever the literature allows to state. [Andreas Fischlin, Switzerland]	Accepted - text revised
33041	2	38	43	38	43	The reduction in spring snowpack has contributed to more fire activity in western US mountains, but the key factor is moisture available (or not) to keep fuels wet during the fire season. Rephrasing to say "Decreasing snowfall and earlier snowmelt has contributed..." might be preferable. Other studies (e.g., Abatzoglou and Williams, 2016; Holden et al., 2018) suggest that a combination of warmer and drier warm season conditions play the predominant role. [Government of United States of America, United States of America]	Accepted - text revised
33043	2	38	43	38	45	Increasing wildfire in the western U.S. is only partially due to decreasing snowpack and earlier melt out, and this dynamic is of variable importance depending on which ecoregion in the western U.S. is being discussed. Suggest caveating this statement by listing the regions in which this is most important, and citing recent research showing the role of other variables like vapor pressure deficits and declines in precipitation. [Government of United States of America, United States of America]	Accepted - text revised to note other variables, though regions within the Western U.S. are not specified; partly attributing wildfires to earlier snowmelt was only found in this mountain region.
8987	2	38	44	0		Insert 'in' before 'the severity' [Nina Hunter, South Africa]	Accepted
27999	2	38	44	0		Add one or two more citations along with the Westerling 2016 citation, rather than casually suggesting just one example. [Marcos Mendoza, United States of America]	Accepted - some new references are added on wildfire, Littell 2018 and Littell et al. 2018, as well as several on the impacts of wildfire on ecosystem processes and ecosystem services.
30423	2	38	44	38	44	insert "in" before "the severety and extent …" [Manuela Winkler, Austria]	Accepted - text was reworded

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33045	2	38	44	38	45	Fire severity technically refers to either the percent of a canopy killed by fire (usually in temperate or arid forests) OR the fraction of surface and canopy carbon consumed by fire (usually in boreal forests and the Arctic). Westerling et al. 2006 (not cited here) do not discuss fire severity; they discuss the term "fire season severity", which refers to an index of the total number of fires above a certain size. That paper, and Westerling (2016), show that fire extent and fire season severity are related in part to the duration of the fire season, itself partially related to snow. The Westerling paper analyzes timing of snow melt and infers that increased fire season severity is contingent on arrival of earlier spring. It does not directly attribute increased fire activity to decreases in snowfall as stated here. If the authors need to cite this paper, suggest this phrasing instead: "Due in part to earlier snowmelt and increasing fire season length, mountain ecosystems across the Western U.S. are experiencing an increase the number and extent of wildfires (e.g., Westerling, 2016)." It may be worth noting that Dennison et al. (2014) found the trends in area burned to differ considerably across mountainous regions of the Western US and successfully related many of those to temperature and precipitation; and Littell et al. (2009, 2018, with 2018 explicitly considering snow water equivalent as a potential predictor) and Abatzoglou and Kolden (2013) demonstrated that area burned relationships with climate in Western mountain ecosystems over the recent three decades are usually driven more directly by water balance determinants (temperature, seasonal precipitation, evapotransopiration, vpd, etc.) than by snow. Finally, Abatzoglou and Williams (PNAS) showed that for forests in the western US (largely, but not exclusively in mountains), that a large fraction of the regional trends in fire, in aggregate, can be attributed to human caused climate change effects on fuel aridity, only a part of which is snow driven. The preponderance of evidence, therefore, would suggest the story is more complicated than indicated in the text as written, and also than Westerling et al. 2006 and Westerling 2016 indicate. [Government of United States of America, United States of America]	Accepted - thank you for the clarifications; wording is corrected to accurately state these patterns and additional references added.
2293	2	38	45	38	45	Sentence unclear [Wilfried Haeberli, Switzerland]	Taken into account as part of revising the structure and strengthening this section.
8989	2	38	45	0		Sentence meaning not clear. Please make clear. [Nina Hunter, South Africa]	Taken into account as part of revising the structure and strengthening this section.
18653	2	38	45	0		Typo: "Globally, climate variability that fuels aridity accounts for nearly one third..." [APECS Group Review, Germany]	Editorial – copyedit to be completed prior to publication
30761	2	38	45	0		This sentence structure is strange; please revise. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
18679	2	38	46	0	53	Description of wage labour migration in Nepal would fit best in the "residence patterns" subsection. [APECS Group Review, Germany]	Taken into account - this section has been extensively revised, and the material shifted.
30763	2	38	46	0		Please quantify how many years? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - as part of revising the structure and strengthening this section.
33047	2	38	46	38	46	This reference actually says that about a third of the interannual variability in regional burned area extent is explained by climate variability that materializes through fuel aridity. [Government of United States of America, United States of America]	Taken into account - as part of revising the structure and strengthening this section.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
2373	2	38	49	39	34	The consequences for lakes though referred in the figure (only for productivity) they are not mentioned at all. Examples on how the community is affected by glacial meltwaters and on chages in diversity after glacial lakes have lost the connectivity to the glacier are found in Sommaruga, R. (2015) When glaciers and ice sheets melt: consequences for planktonic organisms. Journal of Plankton Research 37: 509-518. Peter, H. and R. Sommaruga (2016) Shifts in diversity and function of lake bacterial communities upon glacier retreat. The ISME Journal 10: 1545-1554. doi:10.1038/ismej.2015.2 and Liu et al. (2019) Bacterial community changes in a glacial-fed Tibetan lake are correlated with glacial melting. Science of the Total Environment 651:2059–2067 [Ruben Sommaruga, Austria]	Accepted
30765	2	38	49	40	6	Section should link to some of the chemical threats listed in the above section 2.3.1.2 water quality, i.e., heavy metals and biotoxic pollutants, nutrients, water temperature [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - links made
32277	2	38	49	38	49	I am not convince that the separation of terrestrial and freshwater ecosystems is the most meaningful manner to subdivide a "mountain ecosystem" section. Please consider subdividing this by ecosystem services. [Andreas Fischlin, Switzerland]	Accepted - though we did not change this separation, a section on ecosystem services and adaptation was added.
2839	2	38	51	39	4	Impact of climate change on Athabasca river ecosystem in Rocky Maintains, west Canada, was assessed recently using three climate models under the Representative Concentration Pathways 4.6 and 8.5 scenarios (Du et al., 2019, Science of the Total Environment 650, 1872–1881). Results showed that warmer and wetter future condition would prevail in the basin. As a result, streamflow in the basin would increase despite the projected increases in evapotranspiration due to warmer condition. On the basin scale, annual stream temperatures are expected to increase by 0.8 to 1.1 °C in mid-century and by 1.6 to 3.1 °C in late century. Moreover, the stream temperature changes showed a marked temporal pattern with the highest increases (2.0 to 7.4 °C) in summer. The increasing stream temperatures would affect water quality dynamics in the basin by decreasing dissolved oxygen concentrations and increasing biochemical reaction rates in the streams. Furthermore, the magnitudes of temperature changes vary significantly among different months and seasons and the biggest temperature increases are found to be in summer season. Such spatial-temporal changes in stream temperature regimes in future period would also affect aquatic species. The marked increasing number of days exceeding the upper tolerance temperatures will pose a potential threat to the fish species, such as northern pike andwalleye in the basin. [Junye Wang, Canada]	Taken into account - This has been discussed further in the fisheries section
26353	2	38	51	39	3	Based on the evidence given earlier in the chapter (2.2.3), it is unclear that melt water from glaciers will decrease on time scales relevant to human societies. Reconcile this section with the earlier discussion of peak water. [Ethan Pierce, United States of America]	Rejected - as sentence discusses small size glaciers
32279	2	38	52	38	52	A formulation such as "should increase" and then making a confidence statement make no sense. Please correct. [Andreas Fischlin, Switzerland]	Accepted
32281	2	38	53	38	55	Uncertainty assessments missing [Andreas Fischlin, Switzerland]	Accepted
26351	2	38	56	39	3	It is not clear from the text how decreased glacial runoff will cause increased primary productivity, considering the relative importance of the nutrient supply from glacial discharge. [Ethan Pierce, United States of America]	Noted - Through improved water clarity and more stable channels
30767	2	38	56	0		Does this species dominate globally? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - species removed although does dominate globally

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32283	2	38	56	38	57	I do not understand why increased primary production should increase alpha diversity [Andreas Fischlin, Switzerland]	Noted - Separate increased primary production and increased alpha diversity - one is not causing the other
32285	2	39	1	39	2	Uncertainty assessments missing [Andreas Fischlin, Switzerland]	Accepted
24585	2	39	3	0		I do not see if the degree of confidence in brackets refers only to the last sentence or all the previous statements. It should be clearer. [Armand Hernández, Spain]	Accepted - made clearer
32287	2	39	5	39	14	Interesting material, but without uncertainty assessment not usable. Notably the last statement in the para needs a summarizing uncertainty assessment while the former part of the para needs to be reformulated to substantiate the last statement as a traceable account. [Andreas Fischlin, Switzerland]	Rejected - as uncertainity is included
30769	2	39	7	0		Please do not reference the Glossary in the text (here and elsewhere) [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - reference removed
1465	2	39	8	39	9	Explain "dispersial limitation" and "environmental filtering". These appear to be biology-specific use of terms. [Rene Forsberg, Denmark]	Accepted - sentence removed
15493	2	39	8	39	9	Pleasem define "dispersial limitation" and "environmental filtering". These appear to be biology-specific use of terms. [EUCE, Belgium]	Accepted - sentence removed
30771	2	39	13	0		“pool” could be misleading here (because this section is about freshwater) and it is not necessary. Suggest removing [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - pool removed
985	2	39	16	39	17	Tipping Points are a very wrong concept in Ecology and should NOT be used; nobody ever showed them really and we are now in a GRADIENT THEORY instead [Falk Huettmann, United States of America]	Accepted - this has been removed
1467	2	39	16	39	32	Rewrite and shorten this section to a few lines, stating the in clear words how some species change is expected. Its full of biology-specific terms without any meaning for ordinary reader. Or delete completely, there is no conclusion given, and the changes are also outlied in Fig. 2.9 [Rene Forsberg, Denmark]	Accepted - section shortened
11673	2	39	16	39	18	It is important identificate the most relevant mountain ecosystem and species in the tropics. Due to the endemism species in tropical and mid-latitud glaciers are most sensitive to shrinking habitat. [Government of Mexico, Mexico]	Accepted - clarified
12765	2	39	16	0	18	"transition or tipping points" -- say which or differentiate; make consistent with "These tipping points" ! [David Crookall, France]	Ttaken into account - ipping Points have been removed
15495	2	39	16	39	32	Consider, rewriting and shortening this section to a few lines, stating the in clear words how some species change is expected. The terminology used is too technical. As alternative, the section should be deleted as there is no conclusion given and the changes are also outlied in Fig. 2.9 [EUCE, Belgium]	Accepted - section shortened

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
32289	2	39	16	39	17	I do not understand where transition or tipping points are suddenly coming from. They need explanation and most of all, I would strongly argue against using tipping point for a mere transition boundary separating one state from another. Perhaps consult some of the classical literature on tipping points, e.g. Lenton et al., 2008, Appendix 1: Formal De¯nition of a Tipping Element and Its Tipping Point and the IPCC glossary Moreover, I find not evidence provided on their critical nature. Cited References: ---------- Lenton, T.M., Held, H., Kriegler, E., Hall, J.W., Lucht, W., Rahmstorf, S. & Schellnhuber, H.J., 2008. Tipping elements in the Earth's climate system. PNAS, 105(6): 1786-1793. doi: 10.1073/pnas.0705414105 Le182 [Andreas Fischlin, Switzerland]	Accepted - this has been removed
32291	2	39	16	39	33	The para is poorly structured, since some key statements are buried in the middle (lines 21-22). Uncertainty assessments missing mostly Integraton of this para into the subsection not clear [Andreas Fischlin, Switzerland]	Accepted - paragraph rewritten
8991	2	39	19	0		arise' not 'arises' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
30773	2	39	19	0		Jargon: e.g., “cold stenothermic (temperature-specialist) species” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - modified
26355	2	39	20	39	21	Alpha, beta, and gamma diversity should all be clearly defined. [Ethan Pierce, United States of America]	Accepted - more
30775	2	39	21	0		Above it reads “alpha (local) diversity” – please streamline [Hans-Otto Poertner and WGII TSU, Germany]	Accepted
18681	2	39	26	0		This summary of the state of research - "based on case studies…" - is important to this section. Move this paragraph one paragraph higher? [APECS Group Review, Germany]	Taken into account - discussion of methodology extensively revised
18693	2	39	29	0		General comment, 2.3.6.1: Is it possible to summarise the types of livelihoods that are most important to people in mountain regions (for example, numbers of people supported by tourism vs agriculture vs labor migration, etc)? [APECS Group Review, Germany]	Accepted - table and figure contain this information
30777	2	39	29	38	31	The disadvantage of plastic responses is that they are not generally heritable, i.e., some individuals might be able to adapt but their offspring won’t, so it is often of temporary advantage and cannot be seen as a cure-all [Hans-Otto Poertner and WGII TSU, Germany]	Noted
18657	2	39	31	0		Can remove passive voice: "Range-restricted prey taxa may go extinct at higher rates as more favorable conditions facilitate the upstream movement of large-bodied invertebrate predators" [APECS Group Review, Germany]	Taken into account
30779	2	39	31	0		Provide reason why adaptation is less likely/less advantageous, e.g., because it takes long… [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - clarified
8993	2	39	32	0		facilitate' not 'facilitates' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication

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18683	2	39	33	0		General comment 2.3.5: I enjoyed reading this section, and in particular seeing the attention paid to the contributions that mountain peoples make to our scientific and historical understanding. I was surprised that the section was placed below "tourism", as this topic affects a larger number of people. I was also deeply surprised that the section discusses religious values without reference to any named religion. The section appears to focus on justifying the idea that we should pay attention to intrinsic value at all (see it's opening reference, Batavia and Nelson 2017), rather than attempting to really explore the impacts of intrinsic value. [APECS Group Review, Germany]	Accepted - text revised.
18685	2	39	35	0		It is strange to attribute the statement that "cyospheric changes impact spiritual and intrinsic values" to Batavia and Nelson (a perfectly nice paper with 33 citations) rather than, to choose one example of many, Buddhist texts on the Great Mountains (which have shaped a religion followed by 500 million people). [APECS Group Review, Germany]	Taken into account - references in this section thoroughly reviewed.
18687	2	39	53	0		As an American, my immediate source for "the glaciated peaks of the Cascades have evoked a deep sense of awe and majesty" is John Muir's book, 'Steep Trails'. In contrast, Duntley and Carroll are secondary sources that analyse the beliefs of those who do feel awe and majesty, rather than expressing that awe and majesty themselves. Both papers are also considerably drier and more obfuscated (although Carroll's reference to religious pluralism is apt for any discussion of American spirituality). [APECS Group Review, Germany]	Rejected - John Muir is a figure of fundamental importance, but not within the scope of literature reviewed for IPCC reports.
10905	2	40	0	0		2.9 'messy' straight from a brainstorm without proper graphical work behind, needs adjustment! [otto otto simonett, Switzerland]	Noted - Not applicable, the Figure was removed and replaced by a table
12767	2	40	0	0		Simplify and make things more explicit. [David Crookall, France]	Noted - Not applicable, the Figure was removed and replaced by a table
18659	2	40	0	0		Figure 2.9 provides a very useful summary of the information in the previous section. The strenghts of the cryospheric elements, shown with different width connections, is well-designed and effective. [APECS Group Review, Germany]	Noted - Not applicable, the Figure was removed and replaced by a table
18661	2	40	0	0		What is "below 20% to 30% glacier cover" (Fig. 2.9)? Is that a reduction in land area, or volume, etc? [APECS Group Review, Germany]	Noted - Not applicable, the Figure was removed and replaced by a table
23081	2	40	0	40		Fig 2.9 : is it about observed impacts, or projected ones? What is the level of confficence associated with these various dimensions? Are there regional specificities affecting impacts on ecosystems? [Valerie Masson-Delmotte, France]	Noted - Not applicable, the Figure was removed and replaced by a table
24431	2	40	0	0		Figure 2.9. Not clear to me what the triangle in the left side represent. Energy flux? Also, why are some boxes white and some grey? I do not have a biological background, and to me this figure is difficult to understand. [veijo pohjola, Sweden]	Noted - Not applicable, the Figure was removed and replaced by a table
26883	2	40	0	0		I love this figure! It is a nice, simple graphic that adds value. [Ko Barrett, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
2001	2	40	1	40	5	Suggestions for impacts on terrestrial ecosystems: "Adaptation of plant traits"; "Earlier plant growth and flowering and pollination mismatch"; "forest and alpine species shift upslope"; "local increase in plant species richness"; not sure if we need 'desertification' here; "Key impacts" are a bit confusing, may be omitted. [Harald Pauli, Austria]	Noted - Not applicable, the Figure was removed and replaced by a table
13123	2	40	1	0		Simplify and make things more explicit. [David Crookall, France]	Noted - Not applicable, the Figure was removed and replaced by a table

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13125	2	40	1	0		Too many things to comment on - please see attached pdf file. [David Crookall, France]	Noted - Unfortunately, we could not get hold of your pdf despite efforts to contact you through the Technical Support Unit (TSU)
16747	2	40	1	40	1	Comments on the figure: - I wonder whether 'species' should be truly the focus here; there is abundant and increasing awareness that biodiversity changes may occur at lower biological levels, such as populations and even individuals. This is certainly reflected by the changes in eg genetics and perhaps other aspects of this arrow (physiology, genetics). - I think there's some contradiction here (where 'compromised animal movement under snow' seems to imply that there will be more snow in the future) and in the text - I object the statement of 'Greater plant species richness' without providing the spatial context: this has been shown to take place at local and regional levels, but if extremely unlikely to happen at global levels. Another problem that may occur is increase homogenisation of biotas, eg the same plant and animal species are increasingly found across mountain areas around the world, such as invasive Lupinus. Maybe 'Uniqueness of biotas' or 'endemism' could be added to distribution somehow? - I don't think that 'contractions' properly reflect the body of research showing that there is now a differential response of species' ranges to climate change: some species indeed contract in their ranges, while others (invasives, generalists) are increasing. This is most conspicuous for species introduced by humans but expanded naturally (eg Canada goose, American squirrels in southern Europe, etc etc). I think these two chapters should clarify this differential impact much more clearly. See e.g. research by Charles Davis at Harvard (including the PNAS study on Thoreau's forests). [Carl Wepking, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
17453	2	40	1	40	5	In this section are many important missinng points. The retreat of glaciers is accompanied by a general upper migration of environmental conditions associated with increments in temperature. Beacuse of structural conditionants this upper migration of environmental belts implies not only a substanctial reduction in the area of distribution of many taxa (plants and animals) but also and more important and more inmediate, changes in the aptterns of interaction among species (i. e. predator - prey). This aspect is closely with the emergennce of new: i) virus - host; ii) parasite - host relationships due to a phenomenom called dilution. Some of this new interactions may have undesirable effects not only on natural populations of plants and animals, but also in human populations. This aspect may also include [Hugo Mantilla-Meluk, Colombia]	Noted - Not applicable, the Figure was removed and replaced by a table
24903	2	40	1	40	1	In order to be more comprehensive, I propose to replace the expression "Compromised animal movement under snow", by "Compromised animal behaviour and survival under the snow". [Hernan Edgardo Sala, Argentina]	Noted - Not applicable, the Figure was removed and replaced by a table

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
31609	2	40	1	0		Figure 2.9. This nice figure may be improved with minor changes on the distribution of items. Specifically, the middle part compartments in gray/white shading may be upgraded by individualizing each "effect" with its own bounding and matching it with either terrestrial or fresh water, or both, using a Venn diagram approach. Meanwhile, the Species-Ecosystem triangle could work by itself outside of the other boxes. Furthermore, the distribution based on the Species-Ecosystem triangle may be inverted in order to go from large (upper) to small (lower) - this is better for the story line because the upper labels and freshwater/terrestrial " ecosystems", so it makes more sense to start with ecosystems closer to the upper label. Likewise, the key impacts at the bottom, tend to relate more to species level. [Hans-Otto Poertner and WGII TSU, Germany]	Noted - Not applicable, the Figure was removed and replaced by a table
33049	2	40	1	41	50	There was not much mention of wildlife and fish species that benefit from a changing cryosphere. Although the net impact of climate change is negative, it should be acknowledged that some species will do better. [Government of United States of America, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
1225	2	40	2	40	2	In the lower right part, the figure postulates a loss of cold water specialists for glacier cover below 20 to 30%. The text (P. 39 L. 14), however, reports some 5-30%. The numbers should be consistent. On a more fundamental note, it is evident that the degree of glacierization of a catchment mainly depends on... the location of the catchment outlet. It is somewhat difficult to understand, thus, how the numbers can give rise to a threshold. [Daniel Farinotti, Switzerland]	Noted - Not applicable, the Figure was removed and replaced by a table
30425	2	40	2	40	5	Figure 2.9 (left part) is not really consistent: 1) Physiology/Morphology/Genetics: surely animal traits will shift as well? 2) Phenology changes can also occur in animals, e.g. earlier bird nesting, arrival of migrant birds and butterflies (reviewed in Parmesan & Yohe 2003, Nature) 3) Dynamics=Population dynamics? 4) Changed species relative abundance is a consequence of changes in germination, survival (both of juveniles and adults) and growth 5) I think decreased foraging efficiency may be deleted here, it is one of many reasons for decreased survival and growth. 6) Distribution: the statement "Plant and animal species loss" contradicts "Greater plant species richness"; and range shifts also occur in plants. I suggest to summarize these statements to: Range shifts and contractions for plants and animals, Shrubline and treeline shift upslope, Changes in species richness. 7) Delete "Increased species richness in mountain meadows" . [Manuela Winkler, Austria]	Noted - Not applicable, the Figure was removed and replaced by a table
30899	2	40	2	0		On the terrestrial side the figure seems to emphasize physiological background only for plants and shifts in their traits. Temperature related physiology and consequences for performance and fitness clearly applies to other organisms, especially animals as well and shapes their latitudinal and altitudinal biogeography and competetiveness. This should at least be included conceptually in the figure. The freshwater side seems to be more successful in addressing some overarching principles for organisms. [Hans-Otto Poertner and WGII TSU, Germany]	Noted - Not applicable, the Figure was removed and replaced by a table

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
33051	2	40	2	40	5	This figure implies that the cryosphere changes driven by a warming climate are the exclusive drivers of the impacts. What if the yellow "warming climate" bar at the top were widened, and a small grey mechanism box in the next row of the figure were added that indicated "other climate" or similar to indicate that these cryosphere drivers interact with other, sometimes equally or more important, drivers? [Government of United States of America, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
33053	2	40	2	40	5	Though a nice attempt at generalizing some relationships and expectations with warming, certain aspects of this figure are of concern. First some of the findings appear either lightly supported by data, or are region-specific stories and which is not clear. Second, it's unclear how the relative importance of the part of the cryosphere to each ecosystem type was assessed. For example, only glaciers would be a major impact on freshwater ecosystems in areas that have historically had glaciers or perennial ice masses. For the vast majority of high mountain freshwater ecosystems, changing snow dynamics would be of larger importance, especially when considering 1st and 2nd order streams facing longer warm seasons with less snow reservoir available to prevent them from drying up seasonally. In summary, the broad generality of this figure may overly simplify the issue based upon unidentified regionally specific examples that may not apply more broadly. Consider reworking this figure or deleting it. [Government of United States of America, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
13147	2	40	5	0		What link? [David Crookall, France]	Noted - Not applicable, the Figure was removed and replaced by a table
18691	2	40	7	0		General comment, 2.3.6.2: This section gave me a clear picture of the state of the literature on studies of the human impacts of cryospheric change in mountains. It enhanced my understanding for the complexity of people's responses to environmental changed, and of the difficulty of doing research on human behaviors in these environments. [APECS Group Review, Germany]	Noted
10929	2	40	8	40	17	Wildlife population distributions change in context of climate change, including changes in cryosphere. Adaptive responses may include protected areas, heretofore not mentioned. See e.g. https://www.bfn.de/fileadmin/MDB/documents/service/BfN-Skript-321.pdf, http://www.fao.org/docrep/pdf/011/i0670e/i0670e13.pdf, also https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0185972. For more participatory approaches in PA management in Western China and Central Asia, see https://doi.org/10.1080/13880292.2014.953391. For broader review of issues in 'mountain conservation', see https://doi.org/10.1016/B978-0-12-409548-9.09199-5. [Marc Foggin, Kyrgyzstan]	Accepted - text has been revised to describe potential for natural adaptation in wildlife populations
24587	2	40	8	0		I wonder if "wildlife and fisheries" have to stand together or in different sections. I believe this sections is not well resolved in its current form. [Armand Hernández, Spain]	Accepted - text on wildlife and fisheries have been integrated into sections on terrestrial biota and freshwater biota, respectively.
18593	2	40	11	40	15	The text does not make it clear that mismatch in camoflauge occurs because of the decoupling between snow disappearance and increasing day length. I.e., it should be obvious the animals are biologically inclined to change color at a fixed time period, while snow-off is occurring earlier due to climate warming. [APECS Group Review, Germany]	Accepted - clarified
30781	2	40	12	0		“vertebrate species” - Suggest being more specific – this molt only applies to mammals and birds (i.e. endotherms) not to reptiles & amphibians [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - clarified

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30783	2	40	13	0		Replace “to track” with “thereby tracking” because the process happens passively, not actively [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - text greatly revised
30785	2	40	14	40	17	Please keep in mind that this goes both ways in the food chain. Predators might also be more easily detected when their pelage colour does not match the ground colour, thereby improving survival chances for prey animals and decreasing survival of predator species [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - revised in text and ES statement
30787	2	40	14	0		“confront” sounds strange here, perhaps “are confronted with” or “encounter” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - this is reworded
11311	2	40	17	40	17	Add the following sentence to the end of this first paragraph of 2.3.3.3: "Importantly, this visual trait with a known genetic basis and directly shaped by climate has been used to illuminate how global 'hotspots' for evolutionary rescue from climate change might be spatially identified, mapped, and susequently managed to maximize the efficacy of natural selection to shape rapid phenotypic changes that foster species persistence (Mills et al. 2018, Jones et al. 2018)." [L. Scott Mills, United States of America]	Accepted - text revised
11313	2	40	17	40	17	Although the 2 references in the previous comment are in the master reference list I provide above, here they are again:Jones, M.R., L.S. Mills, P. C. Alves, C. M. Callahan, J. M. Alves, D. J. R. Lafferty, F. M. Jiggins, J. D. Jensen, J. Melo-Ferreira, J. M. Good. 2018. Adaptive introgression underlies polymorphic seasonal camouflage in snowshoe hares. Science. 360: 1355–1358. Mills, L. S., E. V. Bragina, A.V. Kumar, M. Zimova, D.J. R. Lafferty, J. Feltner, B M. Davis, K Hackländer, P C. Alves, J. M. Good, J Melo-Ferreira, A Dietz, A V. Abramov, N Lopatina, K Fay. 2018. Winter color polymorphisms identify global hot spots for evolutionary rescue from climate change. Science 359:1033-1036. [L. Scott Mills, United States of America]	Noted
8997	2	40	19	0		It would be useful to have 'snowpack' defined [Nina Hunter, South Africa]	Taken into account - in snow section
11315	2	40	19	40	19	For clarity and brevity, delete the following: "subnivean space (under snow)," [L. Scott Mills, United States of America]	Accepted - text revised
18663	2	40	21	0		Typo: "A compromised subnivean space can..." [APECS Group Review, Germany]	Taken into account - text revised
18689	2	40	27	0		General comments, 2.3.6: This section discusses the effects of cryospheric changes on mountain people's households, incomes, and migrations. I was surprised that the section is below "tourism" as this issue should affect a larger number of people at a more critical level. I hoped for some numbers (e.g. numbers of people supported by various activities, or total incomes) that would help me identify the activities or environmental conditions that are most important for human life and prosperity. [APECS Group Review, Germany]	Accepted - Some discussison of numbers of people affected elsewhere in the chapter. Our review of the scientific literature found a number of case studies, but overall assessments that indicated total populations were lacking. The position of 2.3.6 before 2.3.7 does not reflect our sense that tourism was more important, but rather that 2.3.7 iintegrates the previous sections.
987	2	40	30	40	30	2.9 there are no keyimpacts and the ones we have here are off. It's wrong science. Impacts are much wider [Falk Huettmann, United States of America]	Noted - Not applicable, the Figure was removed and replaced by a table
27137	2	40	44	29	29	The national glacier protection law of Argentina has managed to remove the direct pressure of mining and other activities on glaciers, which allows the country to focus on strategies for adaptation to climate change and other conservation actions concerning glaciers as water resources, today in incipient stages. [Government of Argentina, Argentina]	Noted - Text revised in the corresponding setcion to reflect this note.

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18665	2	41	1	0	2	Inconsistent citation grammar between "Sinclair et al., 2013" and "Slayter et al. (2017)" [APECS Group Review, Germany]	Editorial – text revised
18595	2	41	2	41	3	Ice layer formation also negatively impacts foraging when it is at the surface or within the snowpack. [APECS Group Review, Germany]	Rejected - text was deleted as this is covered in chapter 3 on polar regions
30789	2	41	2	41	3	This study is about reindeer, i.e., not exactly a typical mountain ungulate. Could you provide a different example, i.e., Alpine ibex or other high altitude ungulates? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised
8999	2	41	7	0		the' before 'presence' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
18695	2	41	7	0		General comment, 2.3.6.3: Thank you for the clear summary of the literature. Sturm 2017 is a particularly relevant and well-written reference and I am glad to see it included. This section is relatively limited in focus: it covers floods and energy risks carefully, but does not quantify the economic costs of other changes (such as migration, loss/gain of agricultural land, or increased wildfire). I therefore suspect that this summary is a considerable underestimate of the total economic cost of climate change to these regions. [APECS Group Review, Germany]	Taken into account - The content of this section was moved nd distributed among other sections, to the sectors where it belongs.
11317	2	41	8	41	8	In addition to the Webb et al. 2016 citation, suggest adding the more recent article by Heim et al. 2017: Heim, N., J. T. Fisher, A. Clevenger, J. Paczkowski, and J. Volpe. 2017. Cumulative effects of climate and landscape change drive spatial distribution of Rocky Mountain wolverine (Gulo gulo L.). Ecology and Evolution 7:8903-8914. [L. Scott Mills, United States of America]	Taken into account text revised
11319	2	41	8	41	8	For clarity, insert before "Loss of snow" the phrase: For mountain deer and sheep. So the sentence would be "For mountain deer and sheep, loss of snow patches …" [L. Scott Mills, United States of America]	Accepted - text revised
18597	2	41	8	41	9	It is unclear what biting insects have to do with foraging here. [APECS Group Review, Germany]	Accepted - clarified - decreased snow patches, increase standing water and thus abundance of insects.
30791	2	41	9	0		Whose fitness? Which animals are affected by biting insects? [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - clarified
11321	2	41	10	41	10	After "vegetation growth" and before "survival of young", replace with the following: "created by earlier snowmelt can reduce " [L. Scott Mills, United States of America]	Accepted
30793	2	41	11	0		Has such decline in fitness been observed already? If so state this clearly – which species, which region, timeline, extent [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text specifies for which species and also considers these examples of current trends that could continue for these and other species
30795	2	41	12	0		Cross-link with section 2.3.2.1.3 floods (which currently provides info on rain-on-snow events [Hans-Otto Poertner and WGII TSU, Germany]	Rejected - text was deleted as this is covered in chapter 3 on polar regions

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24433	2	41	13	41	14	The references given in these lines to need a revision. I could not find these references on internet: Eira (2012); Mathiesen el al (2013); Cramer (2014). The Forbes and Kumpula (2009) is a very wide overview. I suggest to use the reference Mallory and Boyce (2018) instead, which brings a better and deeper overview. This reference is used later in the chapter to describe similar effects. Other good references for the effects on reindeers and icing events is given by Hansen et al (2011): https://esajournals.onlinelibrary.wiley.com/doi/10.1890/11-0095.1 and Forbes et al (2016): doi:10.1098/rsbl.2016.0466. The SWIPA report (Overland et al 2017) referred in Chapter 3 for rain on snow events may also be a good reference for the physical phenomenon. [veijo pohjola, Sweden]	Rejected - text was deleted as this is covered in chapter 3 on polar regions
30797	2	41	15	0		“vigour” as in “energy” or as in “likelihood of survival”? Please clarify [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - clarified
1469	2	41	17	41	22	Too specific and irrelevant; delete [Rene Forsberg, Denmark]	Accepted - text was removed
2833	2	41	17	41	38	Impact of climate change on Athabasca river ecosystem in Rocky Maintains, west Canada, was assessed recently using three climate models under the Representative Concentration Pathways 4.6 and 8.5 scenarios (Du et al., 2019, Science of the Total Environment 650, 1872–1881). Results showed that warmer and wetter future condition would prevail in the basin. As a result, streamflow in the basin would increase despite the projected increases in evapotranspiration due to warmer condition. On the basin scale, annual stream temperatures are expected to increase by 0.8 to 1.1 °C in mid-century and by 1.6 to 3.1 °C in late century. Moreover, the stream temperature changes showed a marked temporal pattern with the highest increases (2.0 to 7.4 °C) in summer. The increasing stream temperatures would affect water quality dynamics in the basin by decreasing dissolved oxygen concentrations and increasing biochemical reaction rates in the streams. Furthermore, the magnitudes of temperature changes vary significantly among different months and seasons and the biggest temperature increases are found to be in summer season. Such spatial-temporal changes in stream temperature regimes in future period would also affect aquatic species. The marked increasing number of days exceeding the upper tolerance temperatures will pose a potential threat to the fish species, such as northern pike andwalleye in the basin. [Junye Wang, Canada]	Rejected - Detailed paper involving modelling and does suggest two species will exceed their thermal tolerance for a few days. Did incorporate temporal differences in temp.
15497	2	41	17	41	22	Too specific and not relevant. Please, consider deleting the text. [EUCE, Belgium]	Accepted - text was removed
18599	2	41	18	41	22	The first sentence is at odds with the second sentence as the first implies there will be reduced aquatic invertebrates and the second implies there will be more. [APECS Group Review, Germany]	Rejected - The first part relates to mammals and says presence, the second to amphibians and to abundance so no conflict
30799	2	41	18	0		As suggested in earlier review periods, please provide correct and full species name [Hans-Otto Poertner and WGII TSU, Germany]	Accepted

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4003	2	41	24	41	38	I appreciate that space may be an issue, but the link between cryospheric change and thermal habitat suitability for fish is more complex and nuanced than what is included here. For example, using a community perspective, thermal sensitivity depends on both the initial temperature and the imposed change. If a stream's thermal regime is currently at the low end of the suitability range for a species and the imposed temperature change is not too extreme, the stream could remain thermally suitable habitat. See Parkinson, E., Lea, E.V., Nelitz, M., Knudson, J.M. and Moore, R.D. 2016. Identifying temperature thresholds associated with fish community changes in British Columbia, Canada, to support identification of temperature sensitive streams. River Research and Applications 32: 330–347. DOI: 10.1002/rra.2867. [Robert Moore, Canada]	Rejected - The four comments all have merit but space is an issue - however three comments below were incorporated
4005	2	41	24	41	38	Following from the preceding point, if a stream is currently below the optimal growth range for a species, modest increases in temperature could promote higher growth rates (unless prey availability is limiting). Examples based on stream warming following forest harvesting include Holtby (1988. Effects of logging on stream temperatures in Carnation Creek British Columbia, and associated impacts on the coho salmon (Oncorhynchus kisutch). Can J Fish Aquat Science 45:502–515) and Leach et al. (2012. Estimation of forest harvesting-induced stream temperature changes and bioenergetic consequences for cutthroat trout in a coastal stream in British Columbia, Canada. Aquatic Sciences 74: 427–441, doi:10.1007/s00027-011-0238-z.) [Robert Moore, Canada]	Accepted - Increased growth has been included.
4007	2	41	24	41	38	The discussion of thermal habitat suitability for fish focuses on effects of glacier retreat. However, changes in seasonal snow can influence thermal regimes. In the rain-on-snow zone, a decreased frequency of rain-on-snow events would increase winter temperature over and above the effects of increasing temperature on surface energy inputs (e.g., Leach and Moore, 2014. Winter stream temperature in the rain-on-snow zone of the Pacific Northwest: influences of hillslope runoff and transient snow cover. Hydrology and Earth Systems Science 18: 819-838, doi:10.5194/hess-18-819-2014). [Robert Moore, Canada]	Accepted - A section on winter temperatures has been included
4009	2	41	24	41	38	Following from the preceding point, earlier and reduced snowmelt in the seasonal snow zone would result in an earlier rise in stream temperature with higher temperatures through spring and early summer (Comola et al. 2015. Thermodynamics in the hydrologic response: Travel time formulation and application to Alpine catchments, Water Resour. Res., 51, 1671–1687, doi:10.1002/2014WR016228). [Robert Moore, Canada]	Accepted - Earlier increases in water temperature noted
18671	2	41	24	0		Here, "key variables" is used to refer to 12 variables. It seems unlikely that fisheries are equally sensitive to all 12 of these variables - Is it possible to highlight the 2-3 of these with greatest impact? If not, replace "key" with "significant" or "influential". [APECS Group Review, Germany]	Rejected - a number of variables were dropped so key would be appropriate and is similar to significant or influential.
30801	2	41	24	41	38	Logical flow might be improved if this information on fisheries were moved to the freshwater section and call it “freshwater and fisheries”, and call this section here “wildlife” [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - Section moved to be within Freshwater
33055	2	41	27	41	28	Alaska salmon are indeed important in both commercial and sport fisheries, but it would be an omission not to also state their importance in the food security of many Alaska natives. Suggest adding this to the list in this sentence, perhaps placing it first. [Government of United States of America, United States of America]	Accepted - Important point

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33057	2	41	30	41	32	For completeness, the authors could add cutthroat trout references (Wenger et al. PNAS ~2010/2011?) and Bull Trout (see Isaak et al references and perhaps Dunham et al.) that at least obliquely and sometimes directly consider the role of changing snowmelt / streamflow timing. [Government of United States of America, United States of America]	Accepted - A reference to trout has been added
9001	2	41	36	0		Take out 'in the future' - it is already said with 'will be' [Nina Hunter, South Africa]	Taken into account - The text was considerably revised.
30803	2	41	40	41	43	If this section is about wildlife, it does not make sense to place a concluding statement that includes plants here. Perhaps like under the agriculture section, place another subsection called “biodiversity and adaptation” although the information provided is very scant [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - This was a overview comment about the entire section - this has been made clearer.
30183	2	41	43	41	43	Add reference: Merino 2015 [Merino, E. 2015. Fierce Climate, Sacred Ground. Fairbanks: University of Alaska Press. [Sarah Strauss, United States of America]	Rejected - This reference is not appropriate - a popular book
11831	2	41	45	41	45	Nepal's economy will be greatly affected since most of it's economy relies on tourism related to the mountains and their ecosystems. [William Lorenz, Australia]	Noted
15179	2	41	45	48	49	Should be considered a comment about climate-related criteria tourists use to make decisions about destination choices, such as Tourism Climate Index (proposed by Mieczkowski, Z., (1985), The Tourism Climate Index: A method of evaluating world climates for tourism. The Canadian Geographer 29(3):220–233) or similar. [Alessandro Pezzoli, Italy]	Taken into account - The report focuses on changes to mountain tourism due to cryospheric changes. Tourism indices related to the meteorological conditions (demand side) are thus mostly beyond the scope of this report. Due to the impact of climate change on snow and glaciers, most of the changes to the tourism industry lie on the supply side. Demand side changes are mostly due to large scale, long term changes to visitors expectations in terms of landscape and activities, rarther than expected meteorological conditions such as sunshine duration or perceived temperature.
24589	2	41	45	0		There is a lack of degrees of confidence through this section (2.3.4), they are only included in the final summary paragraph. The reader would thank if he/she could know them before. I suggest to check this chapter and include the degrees of confidence earlier. [Armand Hernández, Spain]	Accepted - Agreed, The entire section was thoroughly revised to address this shortcoming.
17095	2	41	47	41	50	The report need to reflect more on African context and experience including on Mount Kilimanjaro. [Government of United Republic of Tanzania, United Republic of Tanzania]	Taken into acccount - but no evidence found for impacts of these glaciers
24843	2	41	47	43	31	It would be useful to include some map/figures to show the extent of changes and territorial diversity in snow quantity [Government of Hungary, Hungary]	Rejected - Interesting suggestion but space constraints do not make it possible to include a "tourism specific" map. Tourism is included in the "Impacts" overview figure and on the Mountain-related SPM figure.
12725	2	41	49	41	50	The assessment of mountain tourism development emphasizes past impacts by changes in the cryosphere. However, future implications might be even more substantial. In the introductory paragraph of this Section on Tourism and Recreation (2.3.4) at least this future risk for lower lying mountain areas and the need for substantial changes in tourism patterns should be presented explicitly. Changes (as revealed in the other parts of the report) are an on-going process with significant risks to be expected in coming decades. [Thomas Dax, Austria]	Accepted - Text revised for better clarity overall, although the narrative within the subsection starts with past changes before considering future changes.

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30181	2	41	50	41	50	Add reference--Smadja et al 2015. [Smadja,Joëlle, Olivia Aubriot, Ornella Puschiasis, Thierry Duplan, Juliette Grimaldi, Mickaël Hugonnet et Pauline Buchheit. 2015. Changement climatique et ressource en eau en Himalaya Enquêtes auprès de villageois dans quatre unités géographiques du bassin de la Koshi, Népal. In Impact du changement climatique sur les dynamiques des milieux montagnards. J. Alpine Res. 103-2.] [Sarah Strauss, United States of America]	Taken into account - This reference was added in the Agriculture section, and water scarcity issues are also referred to in the Tourism and Recreation sections.
18727	2	41	52	43	18	Due to the amount of information about the impacts of the change in glaciers in ski tourism in Europe, one has the impression that ski is the most important activity in mountain and this is not necessary true in other mountain ranges. Some information is given in one paragraphe in page 43. I suggest try to balance the arguments. I also recommend to include a reference (Shrestha and Aryal, 2011). If there is not bibliography enough for other mountain ranges, an alternative may be just mention it as a lack of studies. [APECS Group Review, Germany]	Taken into account - text revised for a better balance. The Shrestha and Aryal, Regionan Environmental Change, 2011, reference, only superficially alludes to tourism in its introduction, and is thus not fully relevant for this section.
15173	2	41	54	41	54	I think that ski slopes preparation during summer, with machine-grading, is a key adaptation measure in order to reduce the amount of snow necessary for alpine skiing. See for example: Pintaldi E., Hudek C., Stanchi S., Spiegelberger T., Rivella E., Freppaz M. (2017) Sustainable Soil Management in Ski Areas: Threat and Challenges. Sustainability 9: 1-17. [Michele Freppaz, Italy]	Accepted - Summertime slope preparation was included in FOD and left out in SOD due to space constraints. FGD text was revised in order to account for this management component.
18601	2	41	56	42	1	Although the definition of exposure is provided in the glossary, its use here comes off as jargon. It should likely be clarified. [APECS Group Review, Germany]	Accepted - Text was revised for better clarity. In fact, snow management and snow making reduce the vulnerability of ski resorts, not their exposure.
12727	2	42	9	42	17	This assessment of "moderate risk" is related to a series of assumptions and does not integrate the full range of effects of reduced snow reliability in mountain regions. The source cited here (Steiger et al. 2017) also includes data on high relevance for several of main ski areas in Europe etc. This source and other evidence also point to contraction of the ski areas and the numbers of skis areas. Moreover, the assessment underestimates the difficulties in snow making , and rising concern of implied effects, when including sustainable development concepts. Moreover, some allusion to the environmentally detrimental effects of some types and intensity of tourism (in mountain areas) is lacking or underrepresented here, respectively in the following paragraph. [Thomas Dax, Austria]	Taken into account - The text was revised to better reflect these points. Note, however, that taking the ski tourism as a whole (which is performed here), climate change effects are not the same as when individual ski resorts are considered. The text was revised to better represent this positioning. The text here rather responds to the long term future of ski tourism as a whole, than the individual fate of specific destinations. This could/should be addressed in regional-scale assessments.
18603	2	42	9	42	9	Snowmaking decisions are generally made on wet/ice bulb temperature, not air temperature. Also, inadequate should be clarified to say "too warm." [APECS Group Review, Germany]	Taken into account - The text was revised for clarity. "Air temperature" was replaced with "meterological", which is more general and less simplfying. Wet-bulb temperature is explicitly introduced a few lines above this statement, providing the required precision.
1471	2	42	19	42	56	Mostly redudant and irrelevant text. Shorten to 5-10 lines and remove very local examples like the Austrian summer-ski glacier changes. [Rene Forsberg, Denmark]	Accepted - This paragraph was considerably rephrased.
1865	2	42	19	42	56	Regarding climate change and glacier/summer skiing tourism, recent studies from Mayer et al. (2018) and Demiroglu et al. (2018) could be considered to include more empirical discussion from Austria and Norway. Links to references: https://www.mdpi.com/2071-1050/10/10/3536 & https://www.tandfonline.com/doi/full/10.1080/15022250.2018.1522721 [Cenk Demiroglu, Sweden]	Taken into account - However, text refering to summertime skiing needed to be shortened, in order to keep overall balance and respect size constraints.
9003	2	42	19	43	11	Is it possible to break up this paragraph into more than one paragraph? It is very long. [Nina Hunter, South Africa]	Accepted - This paragraph was considerably rephrased.

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15499	2	42	19	42	56	The text is mostly redudant and not relevant. Please, consider shortening it to 5-10 lines. [EUCE, Belgium]	Accepted - This paragraph was considerably rephrased.
18605	2	42	19	42	20	Sentence is unnecessary. Sources should be cited in relevant text that follows. [APECS Group Review, Germany]	Accepted - This paragraph was considerably rephrased.
18607	2	42	19	42	56	This may be the longest paragraph in the chapter and seems unnecessarily detailed and location-specific relative to other sections. I highly recommend revising, shortening, and simplifying all of the text. [APECS Group Review, Germany]	Accepted - This paragraph was considerably rephrased.
18729	2	42	19	42	27	Why this paragraph comes here? Maybe could be better to move it before Ln51. [APECS Group Review, Germany]	Accepted - This paragraph was considerably rephrased.
24845	2	42	19	42	57	A bit more detailed territorial analysis of Europe would be useful. Some examples are mentioned from the Alps, but what is the situation in the Pyrenees, the Apennines, the Charpathians or the Dinaric Mountains, in the Caucasus? [Government of Hungary, Hungary]	Taken into account - Note, however, that this paragraph was considerably rephrased and shortened. It is not possible to address every single sub-region in report with a global scope. Regional assessments could better address this goal.
18731	2	42	22	42	23	It is possible to put some references to the statement (Landscape change, increased exposure to hazards and water 22 scarcity are common problems.) e.g., (Iribarren Anacona et al., 2015; Kargel et al., 2016; Round et al., 2017) (Condom et al., 2012; Vergara et al., 2011). [APECS Group Review, Germany]	Taken into account - This paragraph was considerably rephrased, and water/natural hazards relationships to tourism are addressed in the water/natural hazards sections, too.
28693	2	42	24	42	29	The bussiness o European Glacirs in summer is predominatly vist of a glacier or a visit of a glacier cave (i.e. Mer de Glcae) [Irena Mrak, Slovenia]	Noted
24369	2	42	34	42	34	start new paragraph with the sentence beginning with "Beyond local management" [Philippus Wester, Netherlands]	Accepted - Note, however,that this paragraph was considerably rephrased.
24847	2	42	38	42	49	Some solutions are mentioned, but others only indirectly, e.g. complementary use of ski destinations in winter and summer seasons (in the summer some other active tourism products can be developed in these regions, like hiking, climbing, etc.) [Government of Hungary, Hungary]	Taken into account - The text was considerably revised and now refers to diversification explicitly.
28695	2	42	41	42	41	Is road development really a sustainable contribution to development? Glacier retreat can be widely used as an evidence of climate change! Ith e way it was done in Glacier NP (U.S.A.) [Irena Mrak, Slovenia]	Taken into account - The text was considerably revised.
24371	2	42	43	42	43	start new paragraph with the sentence beginning with "Glacier retreat has also" [Philippus Wester, Netherlands]	Accepted - Note, however,that this paragraph was considerably rephrased.
1227	2	42	51	41	52	The sentence mentioning New Zealand has to little information as to be understood. [Daniel Farinotti, Switzerland]	Taken into account - The text was revised for more clarity.
23083	2	43	0	43		Here and in many places in the report : is the notion of stranded assets relevant (loss of capital invested that will have no value in the future as a result of climate change consequences)? If yes this could be highlighted and this should be mentioned in SPM too. [Valerie Masson-Delmotte, France]	Accepted - The topic is now addressed in the revised chapter, although not elevated to the ES and SPM.
27945	2	43	0	44		The loss of cultural values should be explicitly linked to the issue of Non Economic Loss and Damage (NELD). Mentioning L&D en passant only at the end of the chapter and ignoring NELD in this section does not seem right. [Giovanna Gioli, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised here in this section and also in section 2.4

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
9005	2	43	4	0		hazards' not 'hazard' [Nina Hunter, South Africa]	Editorial – copyedit to be completed prior to publication
989	2	43	13	43	20	Lacks financial views and impacts, but which exist [Falk Huettmann, United States of America]	Accepted - The revised chapter text includes more quantitative economic figures.
1473	2	43	13	43	18	This is speculation, many more important drivers. Delete section. [Rene Forsberg, Denmark]	Taken into account - This part was considerably rephrased.
9007	2	43	13	0		visitation' not 'visitations' [Nina Hunter, South Africa]	Accepted - Note, however,that this paragraph was considerably rephrased.
15501	2	43	13	43	18	This is statement is speculative. There are many more important drivers. Please, consider deleting the section. [EUCE, Belgium]	Taken into account - This part was considerably rephrased.
18609	2	43	13	43	18	This can be shortened and combined with the following paragraph which includes a discussion of uncertainty. It is currently redundant. [APECS Group Review, Germany]	Taken into account - This part was considerably rephrased.
24849	2	43	13	43	18	Comment: similar situations were experienced in Hungary during a tourism vulnerability based research project in 2018. In some Hungarian pilot destinations, there are some minor changes in visitor numbers and composition, but these are not due to climate change processes, rather to some other social or financial issues. [Government of Hungary, Hungary]	Taken into account - This part was considerably rephrased.
18733	2	43	14	43	15	[…] as a potential consequence to […] IT is possible write this in terms of uncertainty, maybe replace this phrase with “medium or low confidence”. As the same for the Ln 15 […] may be a poor proxy to establish […]. [APECS Group Review, Germany]	Taken into account - This part was considerably rephrased.
1229	2	43	26	43	27	Consider removing this sentence. For one, it is unclear why "snowmaking" would be a "structural adaptation measure" (what's the meaning of "structural"?), and for another, it is unclear where the statement about the 2°C-limit comes from (for sure it does not follow from the preceding text, despite the paragraph starting with "in summary"…) [Daniel Farinotti, Switzerland]	Accepted - The term "structural" was removed. References to the global warming levels were provided in the first paragraph of the section - this comment stimulated restructuring this section.
28697	2	43	29	43	31	Mountaineering in highest orld areas tends to be driven by orestige and capital - that means that the tren is that the commrcial expeditionsare and will overtake the BC-s and routes on hights World pekas, Sustainability is questionable i all aspects. [Irena Mrak, Slovenia]	Taken into account - Mountaineering is both considered as part of tourism and recreation, and as part of the cultural value subsection.
9009	2	43	30	0		of' not 'on' [Nina Hunter, South Africa]	Accepted
1475	2	43	33	44	25	Religious beliefs and human history is completely irrelevant in an IPCC context. Delete the whole section. [Rene Forsberg, Denmark]	Rejected - this topic is within the scope of IPCC reports

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3937	2	43	33	44	24	While the elements discussed in the section “Spiritual and Intrinsic Values, and Human Well-being” is a bit confusing are a much-welcomed development to the IPCC report, it unfortunately is a bit confusing as it encompasses many ideas that are mentioned only in passing. I will make a few suggestions (specific to the Himalayas) towards its improvement. The notion of well-being could be strengthened by a discussion of the implications of climate change for traditional medicine and climate change (practitioners are named “amchi” in parts of the Himalaya). Again, the authors will not find a plethora of references, but this is something currently of concern in the Himalayas, to my knowledge. The work of Jan Salick could be a good start to articulate a discussion and find resources. Also, the paper "Indigenous Uses, Population Density, and Conservation of Threatened Medicinal Plants in Protected Areas of the Indian Himalayas" by Kala (2005) in Conservation Biology could be a good point of departure. The spiritual component could be better articulated by referring to the work (and the conclusions drawn by) Georgina Drew on the implications of religion for adaptation to climate change in her following piece: Drew G. Ecological change and the sociocultural con- sequences of the Ganges river’s decline. In: Johnston BR, Hiwasaki L, Klaver IJ, Castillo AR, Strang V, eds. Water, Cultural Diversity, and Global Environ- mental Change: Emerging Trends, Sustainable Futures? Jakarta and Dordrecht: UNESCO and Springer SBM; 2012, 203–218. The author should also consider looking at the work of Mabel Denzin Gergan, in particular her article “Living with Earthquakes and Angry Deities at the Himalayan Borderlands.” Last, although the following two references will only be available in the next few weeks/months, they would be of interest to the author and would provide many elements that would enrich this section of the report: Haberman, David (ed). 2019 Understanding Climate Change through Religious Life Worlds. Bloomington: University of Indiana Press. *This book will offer a comparative analysis from	Taken into account - section extensively revised.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
17457	2	43	33	44	25	Quyllurit'i (Quechua quyllu rit'i, quyllu bright white, rit'i snow, "bright white snow,"[1]) is a religious festival held annually at the Sinakara Valley in the southern highlands Cusco Region of Peru. Local indigenous people of the Andes know this festival as a native celebration of the stars. In particular they celebrate the reappearance of the Pleiades constellation, known in Quechua as Qullqa, or "storehouse," and associated with the upcoming harvest and New Year. The Pleiades disappears from view in April and reappears in June. The new year is marked by indigenous people of the Southern Hemisphere on the Winter Solstice in June, and it is also a Catholic festival. The people have celebrated this period of time for hundreds if not thousands of years. The pilgrimage and associated festival was inscribed in 2011 on the UNESCO Intangible Cultural Heritage Lists. The festival takes place in late May or early June, to coincide with the full moon. It falls one week before the Christian feast of Corpus Christi. Events include several processions of holy icons and dances in and around the shrine of the Lord of Quyllurit'i. The culminating event for the indigenous non-Christian population takes place after the reappearance of Qullqa in the night sky; it is the rising of the sun after the full moon. Tens of thousands of people kneel to greet the first rays of light as the sun rises above the horizon. The main event for the Church is carried out by ukukus, who climb glaciers over Qullqipunku and bring back crosses and blocks of ice to place along the road to the shrine. These are believed to be medicinal with healing qualities. [Hugo Mantilla-Meluk, Colombia]	Taken into account - The festival described here is mentioned in the peer-reviewed articles cited in this section, and this section refers to the Peruvian Andes.
28001	2	43	33	0		The first two paragraphs of 2.3.5 would be clarified by eliminating "Intrinsic Values". The primary thrust of these paragraphs is to review the spiritual values of high mountain societies, with reference to aesthetics and religious beliefs. Spirituality is not "intrinsic" in any sense of the word, but rather a cultural behavior (i.e. learned). In addition to the header, there are 3 instances of "intrinsic" in the first two paragraphs -- I would recommend striking these. [Marcos Mendoza, United States of America]	Rejected - not supported by the peer-reviewed published literature on intrinsic values.
28547	2	43	33	43	45	The section on spiritual matters and link to cryosphere is highly contraversial. Better use cultural. More clarification is needed or delete the section. [Government of United Republic of Tanzania, United Republic of Tanzania]	Taken into account -word "culture" added. Our use of the terms religious and spiritual is based on our assessment of the published peer-reviewed ltierature.
30805	2	43	33	44	25	Again missing: Africa / low latitudes (e.g., Kilimanjaro, mount Kenya, Rwenzori, Virunga for Africa) [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - text revised, reference added
1927	2	43	35	43	69	Excellent section on intrinsic values [Kimberley Miner, United States of America]	Noted
30185	2	43	41	43	41	Add reference: Crate 2016 [Crate, S. and M. Nuttall. 2016. Anthropology and Climate Change, 2nd ed. New York: Routledge. [Sarah Strauss, United States of America]	Taken into account - this reference is cited in Chapter 1.
18611	2	43	45	43	46	I am unclear as to whether this is a general statement or one specific to the cryosphere in a changing climate. [APECS Group Review, Germany]	Taken into account - text revised
3385	2	43	48	43	48	"Nepalese Himalaya" instead of "Nepal Himalaya". [Divyesh Varade, India]	Accepted - text revised
8597	2	43	56	43	56	There is an issue with the reference to Brugger et al., 2013 here. [Deborah Verfaillie, Spain]	Accepted
9011	2	43	56	0		Remove 'Brugger' before bracket [Nina Hunter, South Africa]	Accepted

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15175	2	43	56	43	56	Delete Brugger [Michele Freppaz, Italy]	Accepted
16819	2	43	56	43	56	Brugger is cited twice here. [Sven Kotlarski, Switzerland]	Accepted
24591	2	43	56	0		I do not understand this sentence, I suggest to check and re-write it. [Armand Hernández, Spain]	Taken into account - text revised
23085	2	44	0	44		Excellent to refer to solastagia, should also be covered in ES, introduced in chapter 1 and mentioned in SPM. [Valerie Masson-Delmotte, France]	Noted
23087	2	44	0	44		There is a lack of assessment of the value of ice core records from high mountain glaciers in this chapter. There could be a paragraph here also stressting the risk of loss of environmental archives (cf the ice memory initiative to drill and store these ice ice cores at risk of erasing due to melt). [Valerie Masson-Delmotte, France]	Taken into account - Sentence on ice cores added to CCBox glacier projections
10931	2	44	4	44	12	In regard to loal communities providing 'data', the approach of 'citizen science' is gaining some prominence and developing rapidly. See, e.g., Buytaert, W., Zulkafli, Z., Grainger, S., Acosta, L., Alemie, T.C., Bastiaensen, J., De Bièvre, B., Bhusal, J., Clark, J., Dewulf, A., Foggin, M., Hannah, D.M., Hergarten, C., Isaeva, A., Karpouzoglou, T., Pandeya, B., Paudel, D., Sharma, K., Steenhuis, T., Tilahun, S., Van Hecken, G. and Zhumanova, M. 2014. Citizen science in hydrology and water resources: opportunities for knowledge generation, ecosystem service management, and sustainable development. Frontiers in Earth Science, 2: 26. DOI: https://doi.org/10.3389/feart.2014.00026 [Marc Foggin, Kyrgyzstan]	Accepted - text revised
24593	2	44	4	0	12	Degrees of confidence? [Armand Hernández, Spain]	Rejected - no additional scientific evidence/publication provided to support changes suggested by the reviewers
28003	2	44	4	0		The suggestion that people provide "cultural services" to themselves is awkward and confusing -- recommend striking that. [Marcos Mendoza, United States of America]	Accepted - text revised
18613	2	44	14	44	25	This comes across as a description and defense of archaeology in the areas of retreating glaciers. This should be revised to present evidence, not a history of the field. [APECS Group Review, Germany]	Accpted--text revised.
24927	2	44	14	44	25	as this paragraph is dedicated to history and archeology, it might be a fitting place to include a reference of the importance of glaciers as "climate archives" for climate research (via ice cores), which are getting lost with the melting of mountain glaciers [Dirk Hoffmann, Germany]	Taken into account - combined with other comments

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28089	2	44	14	44	25	One of the reasons I requested to be a reviewer for this report was to be able to suggest references for ice patch archaeology if they hadn't already been included. So delighted to see this section here! An additional reference on ice patch archaeology is VANDERHOEK, R., DIXON, E., JARMAN, N., & TEDOR, R. (2012). Ice Patch Archaeology in Alaska: 2000–10. Arctic, 65, 153-164. Retrieved from http://www.jstor.org/stable/41638615. And a reference regarding use of archaeology as distributed observing networks of the past for human and environmental change is Hambrecht, George, Cecilia Anderung, Seth Brewington, Andrew J Dugmore, Ragnar Edvardsson, Francis Feeley, Kevin Gibbons, Ramona Harrison, Megan Hicks, Guðbjörg Ásta Ólafsdóttir, Marcy Rockman, Konrad Smiarowski, Richard Streeter, Vicki Szabo, and Thomas McGovern. (2018). Archaeological Sites as Distributed Long-term Observing Networks of the Past (DONOP). Quaternary International. https://doi.org/10.1016/j.quaint.2018.04.016. [Marcy Rockman, United States of America]	Taken into account - text revised
1231	2	44	22	44	22	Well, the way the Journal of Glacial Archaeology is mentioned looks somewhat misleading. A short web-site check reveals that the journal has published 16 articles in its whole existence, and none since 2016. Giving it that much weight is probably not opportune. (one might question whether a similar comment could apply to the whole paragraph) [Daniel Farinotti, Switzerland]	Taken into account - text revised
24255	2	44	22	44	22	I suggest no to mention the establishment of the Journal of Glacial Archeology, I don't see the relevance for this report. [Christian Huggel, Switzerland]	Taken into account - text revised
30187	2	44	22	44	22	Add reference, end of first sentence; Naudinot and Kelly 2017 [Naudinot, N., and R.L.Kelly,2017. Climate Change and Archaeology. Introduction to the Frison Institute Symposium on Archaeology and Climate Change. Quaternary International 428:1- 2.] [Sarah Strauss, United States of America]	Rejected - the peer-reviewed paper suggested by the reviewer does not address the topic of this seciton
1233	2	44	29	45	5	I have mixed feelings about this subsection. I think of the common statement that water from snow and icemelt is extremely important for livelihoods, and suspect a mismatch if the content of this subsection was to be brought into a "in summary"-statement: To me, the subsection given the impression that, after all, the evidence for effects on livelihoods is very limited; with the effect on "a community of indigenous pastoralists in Bolivia" being amongst the most prominent examples. Maybe a reword would help? [Daniel Farinotti, Switzerland]	Accepted - text revised to indicate the small size of the sample of peer-reviewed papers which discuss interactions of multiple livelihoods.
24257	2	44	29	0		I think this section 2.3.6.1. needs to be strengthened and go beyond a description or analysis of case studes. [Christian Huggel, Switzerland]	Accepted - text revised to indicate the small size of the sample of peer-reviewed papers which discuss interactions of multiple livelihoods.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
3935	2	44	31	47	26	This comment addresses the entire chapter and my reference to p. 44 onward here is only a suggestion. As I see it, this chapter is already strong, but critically it should better address the gender component climate change and all its implications. Perhaps the authors will not find a plethora of references on this but such references exist - "Gender, Agrobiodiversity, and Climate Change: A study of adaptation practices in the Nepal Himalayas" by Bhattarai et al. (2015) in World Development is one such example, and there are of course other studies. [the lack of research on this topic is a good reason why gender and climate change in mountain areas could be part of the knowledge gaps on pp. 2-47-49]. Specifically, in the Himalayas, rural depopulation and the gendered implications of climate change is a critical thing. Again, the authors will not find a plethora of references on this, but references about rural depopulation in mountain areas also exist, for instance, "Depopulating the Himalayan Highlands" by Child et al. (2014) in Mountain Research and Development. Such scholarship can be brought in conversation with the one on gender and climate change to make a strong case. Both in the Himalayas and the Andes, with rural depopulation also comes the increasing isolation of elders who are struggling to farm their land amid water stress (the article “Cultivating Ice Over Timer” by Karine Gagne alludes to this). This also has gendered implications as women (when elders are not left alone) are the ones who are often alone in the village to take care of aging people along with managing agro-pastoralist activities amid the implications of climate change. [Karine Gagne, Canada]	Taken into account - despite the great importance of the topic, the three suggested papers do not fill the gap in this particular section. The first two do not address cryosphere issues, and the third refers to the broad field program of a specific researcher, whose work is cited elsewhere in this chapter.
15177	2	44	31	44	31	Check the formatting: livelihoods—the basis of household economies-- [Michele Freppaz, Italy]	Accepted
24595	2	44	36	0	37	In my opinion all the confidence quantifiers should appear like here. [Armand Hernández, Spain]	Taken into account - The text was revised for better homogeneity.
17783	2	44	37	44	39	Following work by Carey and McDowell (the citations supporting this sentence), I think it is essential that the sentence acknowledge that high vulnerability to cryospheric changes is a result of social factors beyond resource dependency; namely, socio-economic marginalization and exclusion from relevant extension services. As written, the sentence does not adequately frame the causes of vulnerability in mountain communities affected by cryopsperic changes. Perhaps revise as follows: "Due to high dependency on natural resources and socio-economic constraints on adaptability, many people living in high mountain areas are highly vulnerable to cryospheric changes." [Graham McDowell, Canada]	Taken into account - the balance of cryosphere and other drivers has been addressed in revisions throughout the chapter.
30807	2	44	39	44	41	Reindeer farming is also mentioned in this chapter; perhaps worth including a cross-link to relevant sections in this or other chapters as appropriate [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account -reindeer herding mentioned in 2.3.6.2 within this section
12771	2	44	43	0		", which" should be "that" !!! Get those mixed up and you could be saying the oppoiste of what you want. [David Crookall, France]	Accepted - text revised
18615	2	44	48	44	48	Wage labour migration should be defined. [APECS Group Review, Germany]	Rejected - this term is widely used in the literature.
18617	2	44	52	44	53	Clarify if this is physical or economic exposure. [APECS Group Review, Germany]	Rejected - exposure is a standard element in the IPCC risk framework.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
28005	2	45	3	0		Labour availability does not just relate to age and gender but many other factors as well. I would recommend changing this sentence to something like the following: "…labour available to a household is differentiated by factors such as age, gender, and social role, so wage labour migration, often of young males…" [Marcos Mendoza, United States of America]	Taken into account - discussion of social differentiation expanded.
28699	2	45	3	45	5	The religion should lso be taken into the account - especially women in Muslim coutries are not allowed to participate in tourism and that is a major difference to the mountain areas where gender isnot a constraint. [Irena Mrak, Slovenia]	Rejected - no evidence/publication procided to support changes suggested by the reviewer
3343	2	45	7	46	44	In section 2.3.6.2, it is suggested to add studies conducted by Chinese scholars on the impact of climate change on the residence pattern and habitability in the high mountain areas. [Peng CUI, China]	Accepted - additional references from Chinese researchers have been added.
24259	2	45	7	0		This section on habitability could (or should) be a key section of the chapter with highest policy relevance. I think there is already valuable material in there but I suggest to strengthen it, and address important policy questions, such as: will regions affected by/ depending on mountain cryosphere still be habitable in the future? [Christian Huggel, Switzerland]	Accepted - text revised.
30809	2	45	7	47	5	Information gaps of this section: 1. Africa / low latitude regions. Please indicate if there is no literature available, otherwise include in the assessment 2. fire – how do wildfires in mountain regions affect habitability? [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - The section on gaps was considerably revised?
1477	2	45	9	45	14	The impacts might also be positive - more tourists, infrastructure possibilities - so the conclusion on "mediam agreement" is debatable [Rene Forsberg, Denmark]	Rejected - tourism and infrastructure are discussed in 2.3.4 and 2.3.2, with impacts shown to be negative; and reviewer does not provide scientific publication to support the suggested change.
3939	2	45	9	46	44	The book "Fire and Ice" by Jonathan Mingle provides a great (and very interesting) case of relocation due to water stress and climate change in North India [Karine Gagne, Canada]	Rejected - the book is solid journalism, but is not pulished by a peer-reviewed academic press.
15503	2	45	9	45	14	The impacts might also be positive - more tourists, infrastructure possibilities. Is there compelling evidence that the negative would outweigh the positive? (e.g. if it were the case that negative impacts of hydrological changes outweigh everything else). [EUCE, Belgium]	Rejected - tourism and infrastructure are discussed in 2.3.4 and 2.3.2, with impacts shown to be negative; and reviewer does not provide scientific publication to support the suggested change.
24261	2	45	10	45	10	inducing exposure and vulnerability seems to be an odd wording. [Christian Huggel, Switzerland]	Accepted - text revised.
1235	2	45	12	45	14	Why are "livelihoods" mentioned again, if there was just a dedicated subsection to them? It looks like merging Sec. 2.3.6.1 and 2.3.6.2 would make sense. [Daniel Farinotti, Switzerland]	Taken into account - discussion of livelihoods is now more fully integrated throughout the chapter.
9013	2	45	14	0		Remove full stop after 'migration' [Nina Hunter, South Africa]	Accepted - text changed
1479	2	45	16	45	24	It should be specified what the "high confidence" refers to (the text reads as there seems to be no causal relationship betweem cryosphere stressors and human mobility). [Rene Forsberg, Denmark]	Taken into account - text revised

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15505	2	45	16	45	24	It should be specified what the "high confidence" refers to (the text reads as there seems to be no causal relationship betweem cryosphere stressors and human mobility). Is it possible to separate the observed changes and their effects from the quite different changes (and migratory effects) we might expect under continued temperature increase? [EUCE, Belgium]	Taken into account - text revised
18619	2	45	16	45	16	I believe "transhuman" should be "transhumance" as the two words have very different meanings. [APECS Group Review, Germany]	Accepted - the adjective 'transhumant' was inserted.
24263	2	45	18	45	19	please reword, changes in snow and ice are controlled by climate change. [Christian Huggel, Switzerland]	Taken into account - text revised
9015	2	45	23	0		Insert 'is' before 'influenced'; insert 'the before 'interaction' [Nina Hunter, South Africa]	Taken into account - text revised
1237	2	45	26	45	28	The comment about "random -" vs "chain referral -" sampling seems on an inappropriate level of detail when compared against the general tone of the past few sections. [Daniel Farinotti, Switzerland]	Taken into account - text revised.
1481	2	45	26	45	33	Redundant section, no need to explain interview method and their limitations [Rene Forsberg, Denmark]	Taken into account - text revised.
15507	2	45	26	45	33	Redundant section, no need to explain interview method and their limitations [EUCE, Belgium]	Taken into account - text revised.
18621	2	45	26	45	33	Although it is good to know there few robust surveys, this paragraph provides little information and should be deleted. The following paragraph starts with "Though large sample surveys are lacking..." That clarifier and the calibrated language sufficiently conveys the uncertainty and shortcomings. [APECS Group Review, Germany]	Taken into account - text revised
27943	2	45	26	45	27	Please avoid saying that research on migration and (global) environmental change “rely on interviews”. It is just wrong and sloppy, Many case studies relies on “mixed methods” (triangulation of a variety of qualitative methods, NOT only interviews, or triangulation of quantitative and qualitative methods). GIS is also widely used. A minority of studies are longitudinal, this is worth mentioning (and this is also argued in the cited paper Milan 2015). This section is too vague, with too little references and it shows inadequate knowledge of state of the art literature on the topic. [Giovanna Gioli, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - text revised to indicate that this characterization applies to work in miountainc ryospherer regions only, rather than more broadly.
9017	2	45	35	45	36	The meaning of this sentence not clear, is it possible to rephrase? [Nina Hunter, South Africa]	Taken into account - text revised
10933	2	45	39	45	41	Some relationships between environment, livelihoods and (labour) migrations are noted in the article entitled "Environment, Rural Livelihoods, and Labor Migration: A Case Study in Central Kyrgyzstan", at https://doi.org/10.1659/MRD-JOURNAL-D-17-00029.1 [Marc Foggin, Kyrgyzstan]	Rejected - the reference which the reviewer suggests does not have sufficiently strong connections with cryosphere processes for inclusion in this chapter.
24597	2	45	39	0		Add refrence for this statement, please. "In another region, the reverse relationship was noted" [Armand Hernández, Spain]	Accepted - text revised
27941	2	45	39	45	39	You are referencing an earlier, comparative and less relevant paper on the Peruvian case study: Change Warner et al. 2012 to Milan, A. and Ho, R. 2014. : Livelihood and migration patterns at different altitudes in the Central Highlands of Peru, Clim. Develop., 6, 69– 76. [Giovanna Gioli, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - text changed, new reference inserts/

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1239	2	45	46	45	47	I'm certainly not an expert in the matter, but I would guess that the primary driver for the "decline in transhumant pastoralism in high mountain areas" is the general urbanisation trend, and not necessary the effect of cryospheric change. The sentence (and indeed the rest of the paragraph) conveys a somewhat different impression in this respect. [Daniel Farinotti, Switzerland]	Rejected - the specific cases described in this paragraph, supported by peer-reviewed publications, describe direct links between cryosphere processes and changes in pastoralism
9089	2	45	46	0		Transhumant pastoralism' should be defined in parentheses [Nina Hunter, South Africa]	Taken into account - transhumant pastoralism is described in the second paragraph of 2.3.6.2
18623	2	45	46	45	57	To me, this paragraph logically follows lines 16-24 on page 45 and should be moved. Another consideration would be to combine the information on transhumance migration into one paragraph. This paragraph (lines 46–57) has much more detailed information than others and seems out of place in terms of the location-specific information it provides. [APECS Group Review, Germany]	Taken into account - text largely revised
9091	2	45	53	0		Remove 'of' before 'water scarcity' [Nina Hunter, South Africa]	Rejected - it is correct to speak of the "effects of water scarcity," not "effects water scarcity." The phrase "affects water scarcity" can be used, but does not fit in this context.
12729	2	46	7	46	19	A number of case studies are quoted here and reveal interestingly the impact of changing water availability and/or increasing natural hazards on different areas/regions. From the diversity of observations a concluding assessment on the wide-spread trend and implications would be expected, but seemingly cannot be provided based on in-sufficient, generalizable evidence. Nevertheless more discussion on the general trend and indication of the local and sometimes contradictory observations could be instructive. [Thomas Dax, Austria]	Accepted -generalizations and confidence statements have been reviewed and modified.
9093	2	46	8	0		It would be useful if 'subdrainages' could be defined [Nina Hunter, South Africa]	Accepted - text revised
24265	2	46	13	46	19	further examples of changes related to habitability may include the case of Mustang, or Bondo (Switzerland). [Christian Huggel, Switzerland]	Accepted - refernce added for Mustang. Reviewer did not provide scientific publication for Bondo, so this suggestion was Rejected -
1483	2	46	21	46	44	These two sections appear more as sociology/society changes than climate-related issues. Suggest to delete. [Rene Forsberg, Denmark]	Accepted - text revised to provide clearer presentation of links to cryosphere changes
15509	2	46	21	46	44	These two sections should be rewrtitten streamlining the climate change context. [EUCE, Belgium]	Accepted - text revised to provide clearer presentation of links to cryosphere changes
18625	2	46	21	46	22	Line is unnecessary. Just provide the information as is done in the following sentences. [APECS Group Review, Germany]	Rejected: this sentence is retained to provide a bridge between the previous, more general oparagraphs, and the following, more specific paragraphs.
18627	2	46	28	46	35	Unnecessarily specific. Shorten to one sentence that includes the relevant information. [APECS Group Review, Germany]	Accepted - text shortened
991	2	46	31	46	31	Should mention the relevance of roads and how this connects with water access [Falk Huettmann, United States of America]	Rejected - no scientific evidence/publication provided to support changes suggested by the reviewer
9095	2	46	34	0		then' should be 'them' [Nina Hunter, South Africa]	Accepted - text changed
9097	2	46	43	0		Replace "issues of the" with "the issue of" [Nina Hunter, South Africa]	Accepted - text revised
5003	2	47	0	0	47	It is quite difficult to read the texts in Figure 2.10 because the texts are quite blurred. [Debra Roberts and Durban Team, South Africa]	Accepted - the quality of the figure has been improved

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
8599	2	47	0	47		Figure 2.10: The text located inside the figure, especially in the legend is often unreadable. Please enlarge the text and make it clearer. [Deborah Verfaillie, Spain]	Accepted - the quality of the figure has been improved
10907	2	47	0	0		2.10 see comments on SPM.2 [otto otto simonett, Switzerland]	Taken into account - comments on SPM figures and text will be answered separately
24435	2	47	0	0		Figure 2.10. This figure show impacts in different regions. Some regions show a few impacts, but I would guess each region/continent have impacts of all sorts given in the legend. I assume the symbols are placed where publications have been found on the impact. I would guess that many of the impacts is not reported in scientific litterature, since they may not have enough scientific value. If grey litterature such as governemental/departemental/minicipal reports were scanned, probably another picture may emerge. [veijo pohjola, Sweden]	Accepted - figure caption has been revised to be more informative
24599	2	47	0	0		Labels for Japan and Australia should be included [Armand Hernández, Spain]	Taken into account - only the main regions as shown in figure 2.1 are included in impacts figure. Other regions are included in Table SM2.11
24605	2	47	0	48		There is a lack of confidence quantification and references through this section (2.4.1) [Armand Hernández, Spain]	Taken into account - confidence statement and references are added
26885	2	47	0	0		Based on previous approval experience I can say this figure is likely to be more problematic than it is helpful. Even though it clearly shows it is a graphic about studies, when large sections of the map do not have info, it sends the wrong message. And the idea that places are exeriencing impacts is well covered in the text. Consider deletion. [Ko Barrett, United States of America]	Taken into account - a concerted effort was made to find articles from regions where much literature is not in English and which were poorly represented before. The purpose and limitations of the figure are more clearly described in the caption.
17343	2	47	1	0		Figure 2.10 Legend cannot be seen clearly and figure should be better quality. [Suleyman Toy, Turkey]	Accepted - the quality of the figure has been improved
18629	2	47	1	47	4	It is not clear the darker shading represents mountain regions. I had to go back to Figure 2.2 to identify the shading. [APECS Group Review, Germany]	Accepted - figure caption has been revised
18735	2	47	1	47	1	Figure 2.10. The figure is not clear. Some symbols are filled some other are not, why? If there is a difference it is necessary to explain those differences! [APECS Group Review, Germany]	Accepted - figure caption has been revised
24269	2	47	1	47	4	I think this sort of synthesis information is important. The resolution of the figure is very low, I can't read everything but in any case I feel that the figure and assessment behind needs some accompanying text. Detection and attribution is complex field and the applied approach and method needs some explanation, at least in the Annex. I assume that methods / approaches from IPCC AR5 (WGII), chapter 18 (Cramer et al) are followed. [Christian Huggel, Switzerland]	Accepted - more added to main body of text
29037	2	47	1	47	4	Confidence levels not possible to read but perhaps will improve with later resolution. [Pam Pearson, Sweden]	Accepted - the figure is now higher resolution
30235	2	47	1	47	4	Again, how are you defining the Yukon? If classed with Alaska then there are human impacts that aren't included in the figure such as hazards from lake ice breakup and changes in lake fisheries. I can't read the text for the categories properly so I can't suggest which symbols should also be included in the Alaska case. [Christine Dow, Canada]	Taken into account - this chapter includes the Yukon. Impacts that are documented in the scientific literature with at least medium confidence that observed impacts are due to changes in the cryosphere are included.
30811	2	47	1	47	4	Is there a data gap for Africa (low latitude) or was this region left out? Please clarify [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - impacts shown only for areas where articles/reports exist. The caption explains this more clearly now.
31611	2	47	1	0		Figure 2.10. In the caption, explain the meaning of the shading in the map, which seems to be mountain areas. [Hans-Otto Poertner and WGII TSU, Germany]	Accepted - caption more clearly describes aspects of figure

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31613	2	47	1	0		Figure 2.10. In the caption, you refer to "several decades"; it would be better to be more accurate in terms of the time frame being depicted. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - the caption now refers to recent cryosphere changes.
1241	2	47	2	47	2	The figure is of too low resolution as to allow a full assessment (parts are unreadable). A central question, however, is what criteria are used to decide on whether a particular sector is affected in a given region or not. To me, it is hard to imagine why (say) lake hazards are an issue in the Southern Andes but not in Iceland (the same is true for any other combination of sectors and regions; a definition seems necessary). [Daniel Farinotti, Switzerland]	Taken into account - the figure is now better resolution and shows documented impacts only
16821	2	47	7	47	26	This sub-chapter should contain some link to Chapter 2.3.4 (Tourism and recreation). Potential impacts on winter tourism can certainly be of larger / national econmic scale and should be mentioned here. [Sven Kotlarski, Switzerland]	Once we've completed the cost estimates in tourism, we can link to them here.
17341	2	47	7	0		Related to "2.3.6.3 Economic Impact" only the losses from disasters caused by cryospheric changes e.g. shrinkage, there should be some some results related to the economic losses from higher energy use due maybe to warming if the studies are present in this topics. [Suleyman Toy, Turkey]	Rejected - no evidence/publication provided to support changes suggested by the reviewer.
24267	2	47	9	47	11	can specify what these studies report in terms of USD? [Christian Huggel, Switzerland]	Rejected - this information is provided elsewhere in this paragraph
30901	2	47	9	0	10	These aspects and the related adaptation measures may be relevant for the ES and potentially SPM. [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - ES largely revised
1243	2	47	11	27	14	The sentence is too long and involved. A reword is necessary, better highlighting the "two pathways". [Daniel Farinotti, Switzerland]	Accepted - text revised
9099	2	47	11	47	14	Please indicate what the two pathways are through the use of an additional hyphen. It is unclear what they are. [Nina Hunter, South Africa]	Accepted - text revised
24601	2	47	11	0	14	Degrees of confidence? [Armand Hernández, Spain]	Accepted - location of confidence statements has been revised.
25727	2	47	14	47	21	It is stated that we lack considerable knowledge on “how Loss and Damage in the mountain cryosphere might be conceptualized, categorized, and assessed”. Under Article 8 of the Paris Agreement, Parties took cognizance of the importance of “averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage.” Issues mentioned under Article 8 could be elaborated at some length early on in Chapter 1. [Government of India, India]	Taken into account - the text mentioned here had been changed in an earlier revision
1245	2	47	17	47	20	Well, the two monetary examples of loss don't look too convincing: They refer to two events dating more than 30 years ago… [Daniel Farinotti, Switzerland]	Accepted - discussion of specific hazad events revised.
9101	2	47	19	0		Remove 'has' for consistency [Nina Hunter, South Africa]	Accepted - text revised
993	2	47	20	47	25	Lacks Antarctica mountains [Falk Huettmann, United States of America]	Rejected – Off the scope of the Chapter
27423	2	47	21	0	22	Similar adaptation action was followed with the construction of an artificial open channel of 55 meters in the Imja Glacier Lake that lowered the water level by 3.4 m including the installation of early warning system and prepadeness cost US $ 4 million in 2016 (Department of Hydrology and Meteorology, Government of Nepal/CFGORRP/UNDP/GEF) (https://doi.org/10.1080/07900627.2014.994116) [Government of Nepal, Nepal]	Accepted - text revised. A peer-reviewed article on Imja was added

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1247	2	47	23	47	26	Also in this case, the Peruvian example seems insufficient to justify the general statement that "the energy sector is likely to suffer hugely". Both the statement about likelihood ("is likely") and impact ("suffer hugely") look inopportune. [Daniel Farinotti, Switzerland]	Accepted - text revised
18631	2	47	23	47	26	This paragraph should include more information about how changing snow accumulation and melt processes will affect energy production. [APECS Group Review, Germany]	Accepted - text revised
24603	2	47	23	0		Degrees of confidence? [Armand Hernández, Spain]	Accepted -treatment of confidence statements revised.
9103	2	47	25	47	26	Where is the reference for this? [Nina Hunter, South Africa]	Taken into account - discussion of Vergara et al 2007 has been revised
25203	2	47	25	47	26	This additional cost of US$100 million can surely not be entirely linked crysopheric changes. Are there not other factors that are influencing deteriorating water quality? Are these numbers coming from a single study? [Simon Allen, Switzerland]	Taken into account - discussion of Vergara et al 2007 has been revised
2003	2	47	29	48	31	Suggest to more strongly underpin the "knowledge gaps on permafrost occurrence and degradations" as well as on "changes in species composition, especially regarding the role of snow and permafrost patterns; largest gaps exist for mountain regions in low latitudes." [Harald Pauli, Austria]	Taken into account - Text was ultimately revised to also respond to other similar comments.
5335	2	47	29	48	48	Since this is the last and concluding chapter about what we need to do next (knowledge gaps), I would carefully re-write it. It seems like a list of bullet points. Try to arrange it in a logical way and start with 1-2 introductory sentences. Try to find a logical structure (e.g. from general to specific). I would reduce the chapter 2.4.1 to one Section without subsections 2.4.1.1 and 2.3.1.2. Try to take this as an opportunity to explain what is needed to improve our knowledge (data, measurements, satellite data, collaborations etc) [Simone Schauwecker, Chile]	Taken into account - text revised to incude a brief preamble and structure the content accordingly.
5365	2	47	29	49	30	I think that the authors can improve the structure and content of the final chapter. The naming of the subchapters and sections is relatively difficult to follow because there are many items in them, e.g.: "High mountains, global policy frameworks, and climate-resilience development pathways". Can the authors integrate these concepts a bit more? Some paragraphs can also be substantially improved: e.g. 48:52-56. [Alvaro Ayala, Chile]	Taken into account - text revised to incude a brief preamble and structure the content accordingly.
30227	2	47	31	0		Another key knowledge gap is the thickness of many mountain glaciers and therefore how much mass they contain. There are few measurements of this relative to the number of mountain glaciers in the inventories. This is key for determining the sea level potential of mountain glaciers. [Christine Dow, Canada]	Taken into account - new paper by Farinotti 2019 added (new global-scale estimate); hence comapred to other gaps this issue is less of a gap than others. Here only the main gaps are mentioned
30813	2	47	33	48	31	Suggest considering fire / wildfires in mountain regions in this subsection as well [Hans-Otto Poertner and WGII TSU, Germany]	Taken into account - Text revised to also incude mention to wildfires.
12773	2	47	35	48	31	Low certainty because of special conditions (coarse tools, variable terrain) does not mean that massive changes are not taking place. A casual reader might interpret the text as saying that, because evidence is incomplete, the impact of CC is low. Again make use of citizen science (maybe akin to what you call local knowledge, which contrary to what you say does have huge value). [David Crookall, France]	Taken into account - text revised to consider how the findings may be interpreted.

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13129	2	47	35	48	31	Worse, a reader might draw the conclusion that it is not even possible to attribute certain changes to CC, when it is actually 'clear' that such atrtributions can be made, even if precise instrumental measures to quantify have not been possible up to now. What is obvios and visible, and lived daily by communities, and witnessed by citizen scientists, may be too difficult or expensive to measure quantitavely. Also an absence of measurtes does not mean that the phenomena suddenly dissappear. Expressing things in this way is playing right into the hands of deniers, and giving them material with which to spin their crazy yarns. [David Crookall, France]	Taken into account - text revised to consider how the findings may be interpreted.
9105	2	47	39	0		the Andes' not 'Andes' [Nina Hunter, South Africa]	Accepted - text revised as siggested
23089	2	48	0	48		Recent piece on monitoring needs for the Third Pole water cycle could be referred to (I am a co author, https://www.nature.com/articles/d41586-018-07838-4) [Valerie Masson-Delmotte, France]	Accepted - paper cited
1249	2	48	8	48	10	Well, above all, I would say that "coarse-scale simulations of future permafrost conditions are mostly of limited use due to" the difficulty in obtaining large-scale permafrost information (distribution, ice content, depth, temperature, etc.) at all! The former sections correctly make this point, and here would be a good place to re-iterate that [Daniel Farinotti, Switzerland]	Accepted - text revised accordingly
9107	2	48	9	0		Replace 'lacking' with 'the lack of' [Nina Hunter, South Africa]	Taken into account - text was eventually revised and does not include this formulation anymore.
12731	2	48	10	48	11	Here "incomplete knowledge" of past events is highlighted. However, the uncommented presentation of uncertainty might provoke impressions of negligeable effects due to changes in the cryosphere for mountain regions, an assessment which is also not supported and should be avoided in this chapter of the report. [Thomas Dax, Austria]	Taken into account - text revised to mention uncertainties.
12777	2	48	12	0		What would constitute complete evidence? Most scientific endeavours have to wotk with incomplere evidence, and cryosphere science is no exception. Incomplete evidence is what drives scientific endeavour. It is also dangerous to draw conclusions that, therefore, nothing exists or should be done. The principle of precaution is just as valid in climate science as it is in medecine or aviation. If your doctor says that he is unsure about your child's problem, do you ipso facto just ignore it or say you'll wait till you have more evidence? At what point can you say that you have complete evidence? What criteria do you use to declare that the evidence is complete? Can you have 100% completeness, especially as the cryospehre is changing, and changing fast? What is complete today will be incomplete in a week's or a month's time. In other words, you will never have complete evidence. That is part of the very nature (and excitement) of geoscience. [David Crookall, France]	Taken into accout - text revised to rephrase this sentece and place emphasis on what is known.

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Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13183	2	48	12	48	14	What would constitute complete evidence? Most scientific endeavours have to wotk with incomplere evidence, and cryosphere science is no exception. Incomplete evidence is what drives scientific endeavour. It is also dangerous to draw conclusions that, therefore, nothing exists or should be done. The principle of precaution is just as valid in climate science as it is in medecine or aviation. If your doctor says that he is unsure about your child's problem, do you ipso facto just ignore it or say you'll wait till you have more evidence? At what point can you say that you have complete evidence? What criteria do you use to declare that the evidence is complete? Can you have 100% completeness, especially as the cryospehre is changing, and changing fast? What is complete today will be incomplete in a week's or a month's time. In other words, you will never have complete evidence. That is part of the very nature (and excitement) of geoscience. [David Crookall, France]	Taken into accout - text revised to rephrase this sentece and place emphasis on what is known.
18725	2	48	17	48	20	This results show the urgent need to standardize the methods to quantify glaciological variables, i.e., glacier retreat, surface area change, mass balance, on the mountain glaciers of the world. Several protocols has been proposed (Huss, 2013; Paul et al., 2009; Zemp et al., 2013) or recently published (Basantes-Serrano et al., 2018; Vincent et al., 2018). I further recommend that this be taken into consideration in the Chapter to explain the relevance of this data in the assessment of the impacts, decision making and adaptation strategies. [APECS Group Review, Germany]	Taken into account - text revised to incorporate the suggested ways in which this issue is being addressed in the litearature
12779	2	48	19	0	22	Why the emphasis on homgenious or harmonized methdos? Esp as the variability of mountains & conditions is so huge? This takes us back to my previous comment. [David Crookall, France]	Taken into consideration - text revised to clarify on consistency, rather than homoginisation
13131	2	48	19	48	22	Why the emphasis on homgenious or harmonized methdos? Esp as the variability of mountains & conditions is so huge? This takes us back to my previous comment. [David Crookall, France]	Taken into consideration - text revised to clarify on consistency, rather than homoginisation
11987	2	48	20	48	20	A key gap in estimates about global glacier mass balance are debris-cover on glaciers (see also my comment above (p. 15, line 26). None of the large scale glacier mass balance models includes the effects of debris-covered glaciers so far. it is known, however, that debris-covered glaciers react differently to a warming climate than clean-ice glaciers. A better understanding of the influence of e.g. the debris-layer thickness and the glacier's surface processes (supraglacial ponds and backwasting of supraglacial ice cliffs) on the glacier mass balance are needed. Recently there is an increasing number of publications on these topics. [Pascal Buri, United States of America]	Taken into consideration - text revised to include mention of debris-covered glaciers
1251	2	48	33	48	48	See also comment for P.44 L.29 - P.45 L.5: Judging from the content of section 2.3.6, it looks like a "key gaps in knowledge and evidence" is the degree and extent to which livelihoods are actually affected by cryospheric change. Also the capacity to (economically) quantify possible impacts seems to be missing (cf. comments for P.47 L.17-20 and P.48 L.8-10). Mentioning the two points is probably worthwhile. [Daniel Farinotti, Switzerland]	Taken into consideration - text revised to include issues mentioned which are indeed important
25725	2	48	33	48	48	Integrating the concepts of vulnerability and resilience provides a useful framework for climate change adaptation. The relationship between the two is rather complex and far from being linear. The knowledge and insights acquired through vulnerability research, especially in a comparative perspective, can be usefully integrated to the concept of resilience.. [Government of India, India]	Taken into consideration - text revised to expand and clarify on vulnerability and resilience, consistent also with framing in CCB-1.

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9109	2	48	35	48	38	Sentence very difficult to understand. Please consider rephrasing. [Nina Hunter, South Africa]	Taken into consideration - text has been subsequently revised, an the sentence also split to clarify meaning.
9111	2	48	38	0		at global scales' - suggest replace with 'at the global level' [Nina Hunter, South Africa]	Accepted - Text revised and amended accordingly
9113	2	48	43	0		Leave out 'basis' - should only read 'sufficient data'; insert 'the' before 'future' [Nina Hunter, South Africa]	Accepted - Text revised and amended accordingly
12733	2	48	46	48	48	By addressing gaps in the assessments and evaluations of adaptation measures and their intended effects, attention shifts to technical issues of "measuring" effects and avoids discussions of the cause-effect relationships, systemic interrelations and transformation needs under altered global water cycle systems. It would be helpful to assess also aspects of limitations of such adaptation measures, their excessive costs and societal challenges for transition processes towards sustainable development pathways and resilient futures of mountain regions. [Thomas Dax, Austria]	Taken into consideration. A valid point integrated into the text. Text also relates to discussion raised in the content of global frameworks for sustainabile devleopment and those in Paris Agreement (L&D)
17785	2	48	46	48	48	For improved clarity and structure (flow into next section), I suggest revising this sentence as follows: "While adaptation measures are reported in the literature, comparative and transdisciplinary studies, monitoring and evaluation efforts, and assessments how adaptations contribute to key global frameworks for climate change and sustainable development remain limited (McDowell et al., 2014; McDowell et al 2019, Rasul and Molden)." The following citation should be added to support the revised sentence: McDowell, G., Huggel, C., Frey, H., Wang, F., Cramer, R., Ricciardi, V. (2019) Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? Global Environmental Change. 54: 19-30. [Graham McDowell, Canada]	Taken into consideration - text revised and also cross-referenced to new figure 2.5
995	2	48	50	48	55	Virtually all those agreements have failed, it should be stated. Development and Climate Change are in direct conflict. Please state also [Falk Huettmann, United States of America]	Noted
5337	2	48	52	49	30	The first sentence is a bit confusing. If mountain regions do not respond to global framweworks, what does this mean for future frameworks? Should they more focus on mountain regions? If so, state this clearly! Otherwise it might be confusing to read this Section or one could think that global frameworks are not useful for these regions. [Simone Schauwecker, Chile]	Taken into consideration, bearing in mind the mandate given the authors in this assessment to remain policy relevant but not policy prescriptibve in their assessment.
14985	2	48	52	48	56	After line 56 please add "At least, in one region there is evidence for reacting on the Paris Agreement and the SDGs. In 2016, the ministers for the environment of the Alpine countries agreed on the vision of a climate- neutral Alpine region until 2050 and established the Alpine Climate Board. At the XV Alpine Conference in 2019, the board will present the draft of a climate target system for reaching this vision. These activities and decisions under the Alpine Convention are a response to the Paris agreement. Moreover, the Alpine Convention set a priority on Green Economy in its multi-annual work programme (2017-2022), which is supporting activities towards a sustainable development in the Alpine region. Regarding to this activities a Green Economy Action Programme will be presented at the next Alpine Conference in 2019." [Government of Germany, Germany]	Accepted - suggested text and referneces to this new material have been reviewed and added to the assessment accordingly.

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15443	2	48	56	48	57	Please include at the end of the paragraph: ... and the Strategic Plan on Biodiversity and its Aichi Targets under the Convention on Biological Diversity. [EUCE, Belgium]	Taken into consideration - text revised to also include and make references to the Aichi targets
12735	2	49	1	49	7	Limited evidence for 'Loss and Damage' does not suggest that there are no severe impacts and changes due to climate change. The last sentence indicates with its reflection on "delayed response of glaciers" the inherent characteristic of impact processes to become visible only after long enough periods of observations. It might be informative to underline in this paragraph the difficulty to assess change processes and impacts that can be evidenced only after a sufficiently long observation period. Due to partly accelerating drivers (in past decades) increasing negative impacts can be expected for coming decades. [Thomas Dax, Austria]	Taken into consideration - text revised accordingly.
23909	2	49	1	49	2	Suggest adding, for example, the text "as one of the policy framework" at the end of first sentence because there are other policy frameworks, such as adaptation, addressing the negative impact of climate change. [Government of Japan, Japan]	Taken into consideration - text revised to make reference to other means for addressing adaptation. Globally.
26887	2	49	1	0	7	Why the limited treatment of negative impacts of climate change to only Loss and Damage? There are many other articles in the Paris Agreement and the UNFCCC itself that discuss the negative impacts. This is particularly narrow and seemingly only supported by one study resultin gin limited evidence. Consider broadening or deleting. [Ko Barrett, United States of America]	Taken into account - will consider expanding, also in response to other similar comments, suggesting a broader reference to adaptation measures, globally.
33059	2	49	1	49	7	Loss and damage should not be capitalized. This paragraph should be rephrased as follows: [DELETE: "In international climate policy,] THE IMPORTANCE OF AVERTING, MINIMIZING AND addressing LOSS AND DAMAGE ASSOCIATED WITH the [DELETE: negative] AVERSE impacts of climate change is articulated in the Paris Agreement under Article 8, more specifically [DELETE: depicted as 'Loss and Damage'](UNFCCC, 2015). Despite evident impacts of climate change on the mountain cryosphere, there is limited evidence or references in the literature to loss and damage in this context, lacking considerable knowledge on how loss and damage in the mountain cryosphere might be conceptualized, categorized, and assessed (Huggel et al., 2018). In high mountain regions, the already committed and unavoidable climate change due to delayed response of glaciers to climatic stimuli are relevant aspects to consider for loss and damage (Huggel et al., 2018)." [Government of United States of America, United States of America]	Taken into account - text has been revised to take into account this suggested reformulation.
9115	2	49	3	0		references' should be singular [Nina Hunter, South Africa]	Accepted - text revised accordingly
9117	2	49	4	49	5	Consider rephrasing 'lacking ... assessed' with 'considerable knowledge on how Loss and Damage in the mountain cryosphere might be conceptualized, categorized, and assessed is lacking' [Nina Hunter, South Africa]	Taken into account - text has been revised and suggestion integrated into that revision, in line with other comments to this paragraph.
9119	2	49	5	49	7	It is not clear what this sentence means. Please consider rephrasing. [Nina Hunter, South Africa]	Taken into consideration - text has been revised and comment integrated in that revision.
2295	2	49	6	49	7	Write " ...delayed response of glaciers and permafrost ...". The response of permafrost is even much more delayed than the response of glaciers and the corresponding "commitments" extend over much more future time. [Wilfried Haeberli, Switzerland]	Accepted - text revised to include reference to permafrost
27213	2	49	9	49	22	Refer to 1.5°C pathways in the context of SDG provided by recent IPCC 1.5°C report: Chapter 2 - Mitigation pathways compatible with 1.5°C in the context of sustainable development [ANIL MISHRA, France]	Taken into consideration - text revised to include reference to 1.5 C report

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1253	2	49	15	49	18	I disagree with the importance attributed to "commonly agreed definitions to delineate mountain areas". Provocatively speaking, the matter might be of concern to bureaucrats and people in the need of reporting whatever, but certainly not to the "mountain regions" as such - which is what the sentence claims. A reword seems necessary. [Daniel Farinotti, Switzerland]	Taken into consideration - text revised to clarify this is meant in the context of monitoring and reporting purposes
12781	2	49	15	0	21	Again, just because it is a challenge does not mean that CC is not having an impact!! A "lack commonly agreed definitions" does not reduce the impact, does not lessen the hardship and does not reduce the need for action!! It "may limit efforts to report on progress" -- by the use of the word 'may' you do two things, at least (a) you partially invalidate, or least lessen the importance of, what you have been saying about lack of agreement, and (b) it is not really 'limit efforts' because those efforts will be made; it is making reporting more difficult, not invalidating the reporting!! Similar comments can be made regarding lack of data. I would suggest that 'lack' is much too strong a term. [David Crookall, France]	Taken into consideration - text revised to suggested reformulation.
13133	2	49	15	49	21	Again, just because it is a challenge does not mean that CC is not having an impact!! A "lack commonly agreed definitions" does not reduce the impact, does not lessen the hardship and does not reduce the need for action!! It "may limit efforts to report on progress" -- by the use of the word 'may' you do two things, at least (a) you partially invalidate, or least lessen the importance of, what you have been saying about lack of agreement, and (b) it is not really 'limit efforts' because those efforts will be made; it is making reporting more difficult, not invalidating the reporting!! Similar comments can be made regarding lack of data. I would suggest that 'lack' is much too strong a term. [David Crookall, France]	Taken into consideration - text revised to suggested reformulation.
9121	2	49	21	0		of SDGs' not 'on SDGs' [Nina Hunter, South Africa]	Accepted - text revised accordingly
1255	2	49	24	49	39	It is not immediately clear why so much weight is given to the mentioned "Sendai Framework for Disaster Risk Reduction". For sure there are other documents specifically addressing the matter. Amongst other, one may consider mentioning the "Technical Guidance for Assessment of Glacier and Permafrost Hazards in Mountain Regions", issued by the "Glacier and Permafrost Hazards in Mountains (GAPHAZ)" scientific standing group of IACS/IUGG. [Daniel Farinotti, Switzerland]	Taken into consideration - text revised to also add references to the suggested document, considering that we specifically look to global policy frameworks in which nation states have signed commitments to report.
13135	2	49	27	49	30	I am not an expert in disasters, but I suggest that " limited evidence " may be too strong. [David Crookall, France]	Taken into account - text revised to clarify the intended message, which is to make refernce to the limited evidence on the specific monitoring and reporting in the mountain context.
1485	2	49	35	49	36	The acknowledgements should not be here. Instead it should be at the relevant figures, if at all. [Rene Forsberg, Denmark]	Taken into account - placement is prescribed by IPCC
8657	2	50	0	74		A lot of important researches performed by Russian glaciologists and published in English or in native languages are ignored [Vladimir Konovalov, Russian Federation]	Taken into account - detailed search performed
8659	2	50	0	74		in the Report. Using of these papers undoubtedly improve scientific level of glaciological parts in Chapter 2, if compare it [Vladimir Konovalov, Russian Federation]	Taken into account - detailed search performed
8661	2	50	0	74		with well known publications (see 2-3 in the reference list at the supplement). [Vladimir Konovalov, Russian Federation]	Taken into account - detailed search performed
32567	2	50	0	73		In Reference section provide list of all authors for all references listed eg "Abatzoghou J. T et al.,2018", "Di Mauro, B et al., 2015", and so should show the names of all authors. [John Diiwu, Canada]	Taken into account - all references formatted according to IPCC prescribed formatting rules

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
1487	2	50	1	73	6	It is confusing with two reference lists (one for main text, one for appendices). Merge into one large list at the end. [Rene Forsberg, Denmark]	Rejected - Appendices are only online and have their own literature lists according to IPCC requirements
15511	2	50	1	73	6	It is confusing with two reference lists (one for main text, one for appendices). Please, merge into one large list at the end. [EUCE, Belgium]	Rejected - Appendices are only online and have their own literature lists according to IPCC requirements
18737	2	50	1	50	1	Recommanded reference to include: Basantes-Serrano, R., Rabatel, A., Francou, B., Vincent, C., Maisincho, L., Cáceres, B., Galarraga, R. and Alvarez, D.: Slight mass loss revealed by reanalyzing glacier mass-balance observations on Glaciar Antisana 15α (inner tropics) during the 1995-2012 period, J. Glaciol., 62(231), 124–136, doi:10.1017/jog.2016.17, 2016. Basantes-Serrano, R., Rabatel, A., Vincent, C. and Sirguey, P.: An optimized method to calculate the geodetic mass balance of mountain glaciers, J. Glaciol., 2018. Condom, T., Escobar, M., Purkey, D., Pouget, J. C., Suarez, W., Ramos, C., Apaestegui, J., Tacsi, A. and Gomez, J.: Simulating the implications of glaciers' retreat for water management: a case study in the Rio Santa basin, Peru, Water Int., 37(4), 442–459, doi:10.1080/02508060.2012.706773, 2012. Huss, M.: Density assumptions for converting geodetic glacier volume change to mass change, Cryosph., 7(4), 877–887, doi:10.5194/tc-7-877-2013, 2013. Iribarren Anacona, P., Mackintosh, A. and Norton, K. P.: Hazardous processes and events from glacier and permafrost areas: Lessons from the Chilean and Argentinean Andes, Earth Surf. Process. Landforms, doi:10.1002/esp.3524, 2015 Kargel, J. S., Leonard, G. J., Shugar, D. H., Haritashya, U. K., Bevington, A., Fielding, E. J., Fujita, K., Geertsema, M., Miles, E. S., Steiner, J., Anderson, E., Bajracharya, S., Bawden, G. W., Breashears, D. F., Byers, A., Collins, B., Dhital, M. R., Donnellan, A., Evans, T. L., Geai, M. L., Glasscoe, M. T., Green, D., Gurung, D. R., Heijenk, R., Hilborn, A., Hudnut, K., Huyck, C., Immerzeel, W. W., Jiang Liming, Jibson, R., Kääb, A., Khanal, N. R., Kirschbaum, D., Kraaijenbrink, P. D. A., Lamsal, D., Liu Shiyin, Lv Mingyang, McKinney, D., Nahirnick, N. K., Nan Zhuotong, Ojha, S., Olsenholler, J., Painter, T. H., Pleasants, M., Kc, P., Yuan, Q. I., Raup, B. H., Regmi, D., Rounce, D. R., Sakai, A., Shangguan Donghui, Shea, J. M., Shrestha, A. B., Shukla, A., Stumm, D., van der Kooij, M., Voss, K., Wang Xin, Weihs, B., Wolfe, D., Wu Lizong, Yao Xiaojun, Yoder, M. R. and Young, N.: Geomorphic and geologic controls of geohazards induced by Nepal's 2015 Gorkha earthquake., Science (80-.)., 351(6269), 141–151, doi:10.1126/science.aac8353, 2016. Paul, F., Barry, R., Cogley, G., Frey, H., Haeberli, W., Ohmura, A., Ommanney, S., Raup, B., Rivera, A. and Zemp, M.: Guidelines for the compilation of glacier inventory parameters from digital sources, Ann. Glaciol., 50(January), 119–126, doi:10.3189/172756410790595778, 2009 Round, V., Leinss, S., Huss, M., Haemmig, C. and Hajnsek, I.: Surge dynamics and lake	Rejected - not possible to cite all glacier mass change papers due to space constraints
28701	2	50	1	73	5	Suggested additional references: H.. Khan, M. Shafique, M. A. Khan et al., Landslide susceptibility assessment using Frequency Ratio, a case study of northern Pakistan, The Egyptian Journal of Remote Sensing and Space Sciences. https://doi.org/10.1016/j.ejrs.2018.03.004; Caleb G. Pan, Allen Pope, Ulrich Kamp, Avirmed Dashtseren, Michael Walther & Margarita V. Syromyatina (2017): Glacier recession in the Altai Mountains of Mongolia in 1990–2016, Geografiska Annaler: Series A, Physical Geography, DOI: 10.1080/04353676.2017.1407560 [Irena Mrak, Slovenia]	Taken into account - This reference was assessed for the FGD.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
13215	2	61	46	61	46	Kormann C, Francke T, Bronstert A (2015a) Detection of regional climate change effects on alpine hydrology by daily resolution trend analysis in Tyrol, Austria Journal of Water and Climate Change, 6(1), 124-143 [Axel Bronstert, Germany]	Taken into account - This reference was assessed for the FGD.
13217	2	61	46	61	46	Kormann C, Francke T, Renner M, Bronstert A (2015b) Attribution of high resolution streamflow trends in Western Austria – an approach based on climate and discharge station data. Hydrology and Earth System Sciences, 19, 1225–1245 [Axel Bronstert, Germany]	Taken into account - This reference was assessed for the FGD.
2697	2	63	53	63	54	Incomplete reference: McDowell, G. et al., submitted: Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? [Thian Yew Gan, Canada]	Accepted
17787	2	63	53	63	54	McDowell, G. et al., submitted has been published. The full citation is listed below. Please update in text and bibliography. McDowell, G., Huggel, C., Frey, H., Wang, F., Cramer, R., Ricciardi, V. (2019) Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? Global Environmental Change. 54: 19-30. [Graham McDowell, Canada]	Accepted
11519	2	64	42	64	43	The reference should read: Mukherji, A. et al., in revision: Contributions of cryosphere to mountain communities in the Hindu Kush Himalaya: A review. Regional Environmental Change [Marcus Nüsser, Germany]	Taken into account - This submission was Accepted before the cut-off.
11521	2	65	31	65	32	add one reference: Nüsser et al., in review Cryosphere-fed irrigation networks in the north-western Himalaya: Threatened livelihoods and adaptation strategies under the impact of climate change. Submitted to Mountain Research and Development [Marcus Nüsser, Germany]	Taken into account -reference revised
2699	2	67	31	67	32	Incomplete reference: Rasul, G. and D. Molden, in review: Mountain cryosphere change and global social and economic concerns [Thian Yew Gan, Canada]	Accepted
212	2	67	33	67	33	Hyperlink to Rasul and Tripura goes to "Page Not Found." A working link is: http://lib.icimod.org/record/32373/files/icimodCHT-WP12-016.pdf [Scott Walker, United States of America]	Accepted
13221	2	67	59	67	59	Rottler, E. , Kormann, C. , Francke, T. and Bronstert, A. (2018), Elevation-dependent warming in the Swiss Alps 1981-2017: features, forcings and feedbacks. Int J Climatol. Article in press. https://doi.org/10.1002/joc.5970 [Axel Bronstert, Germany]	Taken into account - This reference was used for completing the assessment.
33061	2	74	1	84	1	Tables 1 and 2 in the Appendix need to be thoroughly re-checked. For Table 1, reviewers spot-checked six papers with which generally familiar and found differences between what is in the paper and what is represented in the table for five of them. In one case, this appears to be a relatively minor labeling error. In other cases, the table provides a subset of the information in the paper, and it's not clear why that particular choice of season, region, or variable was made. Summarizing a paper into a line or two of table is challenging and, where a choice needs to be made about which data to keep or exclude, the rationale should be transparent. For Table 2, some discrepancies were found between the variable listed in the table and what is used in the referenced paper. Authors need to cross-check each of the entries in these two tables. A fact-checking pass through all of the tables -- by TSU and/or writing team itself -- is warranted. [Government of United States of America, United States of America]	Taken into account - The table was considerably checked and amended. Hopefully, this includes fixes to the issues raised during the previous round of reviews (no details provided).

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
997	2	74	2	74	20	Table lacks work from Ken Tape and A Baltensperger for Alaska, besides others [Falk Huettmann, United States of America]	Taken into account - Additional literature search was carried out for the preparation of the final government draft.
1489	2	74	3	77	1	Make sure to add headers on each page of the table. There is a confusing mix of present changes and future projected changes, better group present and future separately, possibly in two separate Tables. It would be useful to add brief explanation on what the future scenarios are (SRES A1FA, SRES B1 etc ... RCP is well known, though). [Rene Forsberg, Denmark]	Taken into account - The tables were split between past and future (two separate tables).
15513	2	74	3	77	1	Make sure to add headers on each page of the table. There is a confusing mix of present changes and future projected changes, better group present and future separately, possibly in two separate Tables. It would be useful to add brief explanation on what the future scenarios are (SRES A1FA, SRES B1 etc ... RCP is well known, though). [EUCE, Belgium]	Taken into account - The tables were split between past and future (two separate tables).
999	2	74	6	74	6	This entire section just refers to some climate data sets, but less to studies. I propose the latter. BTW, is Bioclim and Worldclim missing in that list, as a data set and forecast ? [Falk Huettmann, United States of America]	Taken into account - The table refers to studies, which describe and are based upon datasets (past and future changes)
13181	2	74	6	74	6	Region: Central Europe; Switzerland [Axel Bronstert, Germany]	Rejected - Region and domain naming is consistent with the rest of the table
13219	2	74	6	74	6	Region: Central Europe; Switzerland Variable: Daily mean, min. and max. T (highly resolved trends) Change: Depending on elevation, time in the year and daytime (up to 0.25 and 0.35 °C/year for mean T.) Time period: 1981–2017 Scenario: Past (observations) Method: in-situ [Axel Bronstert, Germany]	Rejected - Region and domain naming is consistent with the rest of the table
1001	2	75	6	75	30	This section needs a better oirder too. The table is overwhelming for content, of sorts [Falk Huettmann, United States of America]	Taken into account - The tables were split between past and future (two separate tables).
3751	2	76	1	76	1	Regarding surface air temperature changes in the Tibetan Plateau region, it is recommended to enrich information on extreme high temperature and extreme low temperature trends. For example, You et al. (2018) reported that the trend of TXx is 0.21 °C/decade, while TNn is 0.51 °C/decade. You, Q., Jiang, Z., Wang, D., Pepin, N., & Kang, S. (2018). Simulation of temperature extremes in the Tibetan Plateau from CMIP5 models and comparison with gridded observations. Climate Dynamics, 51(1-2), 355-369. Zhou B., Y. Xu, J. Wu, S. Dong, Y. Shi, 2016: Changes in temperature and precipitation extreme indices over China: Analysis of a high-resolution grid dataset. International Journal of Climatology, 36: 1051–1066, doi: 10.1002/joc.4400. [Pengling WANG, China]	Taken into account - Additional literature search was carried out for the preparation of the final government draft.
8663	2	77	0	84		Great number of data on precipitation, air temperature, runoff, etc. are available in Russian language Reference Books and other translated sources, which are not used at the preparation of Tables on the pages 77-84. [Vladimir Konovalov, Russian Federation]	Taken into account - Additional literature search was carried out for the preparation of the final government draft.
1491	2	77	3	84	3	Table 2 is way too long - limit length of text in cells and add headers to each page. There is too much details, e.g. on page 2-83 with poor acronyms (e.g. write winter instead of DJFMA). Look to table 4 as a good example. [Rene Forsberg, Denmark]	Taken into account - The table was edited for clarity, including changes suggested by the reviewer.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15515	2	77	3	84	3	Table 2 is way too long - limit length of text in cells and add headers to each page. There is too much details, e.g. on page 2-83 with poor acronyms (e.g. write winter instead of DJFMA). Look to table 4 as a good example. [EUCE, Belgium]	Taken into account - The table was edited for clarity, including changes suggested by the reviewer.
13175	2	77	6	77	6	Region: Central Europe; Domain: European Alps; Variable: Daily precipitation (highly resolved trends); Change: Mostly insignificant, due to high variability Time period: 1980–2010 Scenario: Past (observations) Method: in-situ Reference: Kormann et al., 2015b [Axel Bronstert, Germany]	Rejected - Region and domain naming is consistent with the rest of the table
13177	2	77	6	77	6	Region: Central Europe; Domain: European Alps Variable: Daily mean, min. and max. T (highly resolved trends) Change: Depending on day (up to 0,1 °C/year for mean T.) Time period: 1980–2010 Scenario: Past (observations) Method: in-situ Reference: Kormann et al., 2015b [Axel Bronstert, Germany]	Rejected - Region and domain naming is consistent with the rest of the table
18431	2	77	7	84	1	E1a: Appendix 2.A, Table 2: Add lines: (Region) Africa, (Domain) Kenya, (Variable) Total annual and seasonal precipitation, (Change) seasonal shifts of rainy seasons, insignificant, (Time Period) <1979-2011, (Scenario) Past, (Method) In-situ, 49 stations, (Reference): Schmocker, J., H. P. Liniger, J. N. Ngeru, Y. Brugnara, R. Auchmann, and S. Brönnimann, 2016: Trends in mean and extreme precipitation in the Mount Kenya region from observations and reanalyses. International Journal of Climatology, 36, 1500–1514, doi:10.1002/joc.4438 [APECS Group Review, Germany]	Accepted - Reference added in the "low latitudes" entry.
17813	2	89	8	91	1	Though Appendix 2.A Table 4 (details of studies on peak water) is useful and contains a good set of literature citations, the "Remarks" column is flawed and should be deleted altogether. The material in that column is unnecessary, distracting, inconsistent with the other tables, and in at least one case, in basic factual error. [Sean Fleming, United States of America]	Accepted
23091	2	91	0	91		could you describe how you allocated the detection confidence level (if you used explicit criteria)? [Valerie Masson-Delmotte, France]	Taken into account - this isn't described in the table, but only impacts and corresponding articles where the description shows that an impacts was directly related to observed changes in the cryosphere are included.
1493	2	91	2	98	1	Table 5 is confusing and of limited use, this is more an overview of references than quantitve numbers. This could be incorporated in the text sessions as simple references, or summarized much shorter (and don't try to make large explantations in a cell by rotating text by 90 degree). More important: A table of quantitative data on permafrost changes is totally lacking - this would be a natural table to make, given that Table 1-3 covers the main areas of temperature, precipitation and snow changes; permafrost fills quite a bit in the main text, and uncertainties are large. [Rene Forsberg, Denmark]	Taken into account - The table is the input data used for the impacts figure in the chapter.

SROCC Second Order Draft Government and Expert Review Comments - Chapter 2							
Comment id	Chapter	From page	From line	To page	To line	Comment	Chapter Team Response
15517	2	91	2	98	1	Table 5 is confusing and of limited use, this is more an overview of references than quantitve numbers. This could be incorporated in the text sessions as simple references, or summarized much shorter (and don't try to make large explantations in a cell by rotating text by 90 degree). More important: A table of quantitative data on permafrost changes is totally lacking - this would be a natural table to make, given that Table 1-3 covers the main areas of temperature, precipitation and snow changes; permafrost fills quite a bit in the main text, and uncertainties are large. [EUCE, Belgium]	Taken into account - The table is the input data used for the impacts figure in the chapter.
24271	2	91	3	0		Annex Table 5: I much appreciate that this sort of underlying evidence and detail is provided. But the table and related assessment needs more work and rigor. E.g. there are several entries where no reference is given. How is confidence evaluated in these cases? D&A refers to the past (observation) but here it is not always clear whether it is past or also future (e.g. the entry for S. America, La Balsa, Vergara et al 2007 is clearly about future impacts and should therefore not be present in this table). What does it mean if a flood or snow avalanche is the specficied and detected impacts? In D&A commonly it is analyzed whether a trend can be detected against some background baseline. The question is then what the basline impact is if no cryosphere change had happened. What is the specified baseline here? These aspects are absolutely fundamental when doing a D&A assessment. In some cases and table entries I'm skeptical that the impact/trend can really be found in the referenced literature. [Christian Huggel, Switzerland]	Accepted - a more rigorous assess has been made and references have been added for all entries, and more information given on each impact.
18641	2	91	9	91	9	General comment for the appendix: There are multiple instances of gray literature being cited as evidence. While this is not inherently bad, the SROCC should focus primarily on peer-reviewed literature. For example, I could find very little information on the Manitoba Hydro (2014) report. In my opinion, the authors should remove references to gray literature that are not cited in peer-reviewed publications and/or have little information that can be easily and publicly accessed. [APECS Group Review, Germany]	Taken into account - grey literature was avoided where possible but for some topics, such as hydropower, it needs to be Taken into account -
17789	2	93	1	93	1	Add year (2019) to McDowell citation. [Graham McDowell, Canada]	Taken into account - although this particular reference is now deleted
17791	2	97	1	97	1	Add year (2019) to McDowell citation. [Graham McDowell, Canada]	Taken into account - although this particular reference is now deleted
23843	2	98	0	98	0	Entry for Landslides in NZ lacks a reference (as do many other entries in this table) [Government of New Zealand, New Zealand]	Accepted - reference list is now complete
2701	2	99	7	99	7	Incomplete reference: Brown, R. D. et al., 2017: Arctic Terrestrial Snow Cover (SWIPA). 25-64. [Thian Yew Gan, Canada]	Accepted - Reference edited.
13223	2	104	28	104	28	Rottler, E. , Kormann, C. , Francke, T. and Bronstert, A. (2018), Elevation-dependent warming in the Swiss Alps 1981-2017: features, forcings and feedbacks. Int J Climatol. Article in press. https://doi.org/10.1002/joc.5970 [Axel Bronstert, Germany]	Taken into account - This study was considered for the preparation of the final government draft.
206	2	106	11	106	12	Hyperlink to Warren and Lemmen goes to "Page Not Found." A working page is at: https://www.weadapt.org/placemarks/maps/view/26991 [Scott Walker, United States of America]	Accepted