CCP5 SM

Mountains
Supplementary Material

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SMCCP5.1 Delineation of Mountain Regions, Population Numbers and Densities in 2015, and Their Projections to 2100.

Global mountain extents and population estimates according to various combinations of mountain delineations and gridded population data sets were derived via a spatial analysis that was implemented in the open-source software PostGIS. This approach enabled the efficient calculation of essential zonal statistics (i.e., areal extents of the various geometrical zones and their corresponding population sums).

Three commonly used mountain delineations – K1 (Kapos et al., 2000), K2 (Körner et al., 2011) and K3 (Karagulle et al., 2017) – were obtained from the USGS's Global Mountain Explorer v2.0.[1] Five population grid sources were employed, four of which – the Gridded Population of the World v4.11 (CIESIN, 2018)[2], GHS-POP (Florczyk et al., 2019), LandScan (Rose et al., 2020) and World Pop (Tatem, 2017)[3] – provide historical estimates (in this case for 2015), and one of which – the Shared Socioeconomic Pathways (SSPs) (Gao, 2020) – provides future projections at decadal intervals under five scenarios up to the year 2100. The spatial data set representing the continental regions used in the analysis can be obtained from https://doi.org/10.6084/m9.figshare.16611739 (see also Annex II Atlas). All area statistics were computed on the spheroid using the 'geography' data type in PostGIS.

In this CCP, mountains are distinguished based on a combination of elevation, slope and local elevation range using the K1 delineation of mountain regions (Kapos et al., 2000), minus Antarctica, Greenland and Svalbard, which are part of the assessment in CCP6 Polar Regions. This characterisation is consistent with the mountain region extents used in the WGI report (see AR6 WGI Atlas (Gutiérrez et al., 2012)). Estimates for populations in mountain regions were derived (Table SMCCP5.1) by combining the K1 delineation with the 2015 population statistics available from the GPW v4.11 population grids (CIESIN, 2018). For comparison, Table SMCCP5.2 reveals that estimates of the global mountain population vary considerably depending on input data set combinations. While this is largely a function of the choice of mountain delineation, the choice of gridded population data set also has a discernible influence. Statistics relating to projected changes in population in CCP5 mountain regions, between 2015 and 2100 per IPCC WGII Continental Regions and SSP, are presented in Table SMCCP5.3, while disaggregated statistics for population in the CCP5 Mountain Regions, between 2030 and 2100 per IPCC WGII Continental Regions and SSP, are listed in SMCCP5.4.

Figure CCP5.1 a) shows the spatial distribution of population density and the population in mountain regions in 2015 aggregated per IPCC WGII Continental Regions, according to the K1 mountain delineation used in this CCP, and the Gridded Population of the World (v4.11) data set (CIESIN, 2018) (Tables SMCCP5.1 and 5.2). Figure CCP1.5 b), meanwhile, shows the projected future evolution of human populations in these same mountain regions, globally, according to the five alternative SSPs of Gao (2020) (Tables SMCCP5.3 and 5.4).

SMCCP5.2 Traceable Evidence for Detection and Attribution of Observed Impacts in Mountain Regions

SMCCP5.2.1 Assessment Method

The assessment method for the detection and attribution of observed impacts in mountain regions is conceptually broadly in line with Hansen et al. (2016). For each system and region peer-reviewed studies were identified that reported on observed changes in this system and region. Additional studies were identified, if available, on observations and trends of climate variables involved in the observed change in the impacted system.

In this assessment, detection considers whether a natural or human system is changing beyond a baseline behaviour in the absence of climate change, and attribution is the process of evaluating the contribution of one or more causal factors to the observed change, with anthropogenic climate change as one of these causal factors (Stone et al., 2013; Hansen and Cramer, 2015, Section 1.3.2 and Cross-Working Group Box ATTRIB in Chapter 1). The explicit distinction of different drivers contributing to or driving an observed change is often highly challenging because natural and, especially, human systems are highly complex and dynamic and, hence, difficult to simulate in process models.

Based on this, a confidence level for the detection of the observed change in the system was assessed, evaluating the evidence of the observed change using several criteria (quality of study, consistency of results, time period of observation, agreement among different studies), in line with IPCC guidelines (see also Mach et al. (2017). Then the strength of the contribution of climate change to the observed change in the system was evaluated, considering a concept of multiple climatic and non-climatic causal factors (Section 1.3.2, Cross-Working Group Box ATTRIB in Chapter 1).

Also indicated in Figure CCP5.4 is a percentage of local community perception. This number represents the proportion of studies (references) for a given system and region that include or consider local knowledge (LK) for an observed impact. Referenced studies include different ways of considering and referring to LK, for example, knowledge from local communities obtained from surveys or interviews with local people. However, the way in which LK was considered is not distinguished in this assessment; it is only reported whether or not LK is considered.

The number of references indicated for each system and region assessed refers to the total number of references that were considered to evaluate the corresponding impact. The assessment further distinguishes between negative and positive impacts: Figure CCP5.4 reports on the percentage of references indicating negative impacts for a given system and region. The term 'negative' indicates a detrimental effect for humans (individuals, communities, societies) related to the detected impact.

1 Accessed from https://rmgsc.cr.usgs.gov/gme/

2 Accessed from https://sedac.ciesin.columbia.edu/data/sets/browse

3 The 100-m resolution data were accessed from ftp://ftp.worldpop.org/GIS/Population/Global_2000_2020/

Table SMCCP5.1 | Mountain population estimates for 2015 according to the GPW v4.11 population grids (CIESIN, 2018) and the mountain extent delineations in the CCP Mountains based on Kapos (2000) ('K1'), presented in Figure CCP5.1 a).

IPCC region	Total population	Total mountain population (K1)	Total mountain area (K1) (km²)	Mean mountain population density (K1) (km⁻²)	Proportion of population in mountains (%)
Africa	1,135,725,637	227,804,121	3,851,791	59.1	20.1
Asia	4,329,236,682	720,315,545	15,915,570	45.3	16.6
Australasia	25,332,636	533,142	379,626	1.4	2.1
Central and South America	462,618,762	138,261,907	3,581,164	38.6	29.9
Europe	778,521,501	115,851,128	2,272,365	51.0	14.9
North America	480,613,418	63,751,007	5,418,728	11.8	13.3
Small Islands	70,993,314	16,578,003	321,752	51.5	23.4

Table SMCCP5.2 | Comparison of 2015 population estimates in mountain regions in CCP Mountains, according to various combinations of available population data sets and mountain delineations.

Population Data Source	Global population	Mountain population		
		Kapos et al. (2000) (K1)	Körner et al. (2011) (K2)	Karagulle et al. (2017) (K3)
GPW v4.11	7,329,886,101	1,285,255,489	746,806,057	2,289,068,972
GHS-POP	7,349,323,942	1,019,033,666	344,370,651	2,091,200,860
LandScan	7,284,273,061	1,025,345,709	355,300,352	2,079,259,051
WorldPop	7,330,048,571	1098,621,501	498,107,371	2,150,488,502

Table SMCCP5.3 | Projected changes in population in mountain regions between 2015 and 2100 per IPCC WGII Continental Regions and SSP presented in Figure CCP5.1 c) according to the mountain delineation in CCP Mountains, based on Kapos et al. (2000).

SSP	Africa	Asia	Australasia	Central and South America	Europe	North America	Small Islands
1	107,571,973	–242,813,434	768,769	–27,709,931	–21,864,257	1,481,885	3,442,860
2	247,669,056	–39,672,332	799,800	16,549,341	–3,319,602	18,972,817	14,428,853
3	492,860,214	369,312,026	161,430	116,645,357	18,321,332	44,835,727	34,972,666
4	415,817,525	–34,744,573	527,104	15,551,434	–27,053,252	–3,214,268	26,681,907
5	98,426,392	–247,621,276	1,637,941	–35,651,905	4,058,843	12,336,809	2,074,022

Finally, the attribution of the observed change in the system to anthropogenic climate change was assessed. In contrast to IPCC AR5 (Cramer et al., 2014) and some of the attribution of impacts done in this report, this assessment of climate change impacts in mountains evaluated the attribution specific to anthropogenic climate change. This was based on different lines of evidence and evaluation. A first line of evidence is the evaluation of the anthropogenic influence on observed climate trends relevant for each detected impact done by reviewing the existing literature and by taking into account well-documented knowledge about climate trends.

A second important line of evidence was the application of an earlier algorithm (Hansen and Stone, 2016; Stone and Hansen, 2016) for the attribution of trends in near-surface air temperature and annual mean precipitation to anthropogenic forcing using a collection of available observational products and climate model simulations, evaluating the evidence and agreement between them to produce an assessment of the confidence in the attribution of at least a minor role of anthropogenic forcing. In this way, a linear regression of the observed regional time series against two signals was performed: one estimated from simulations of climate models driven by anthropogenic (e.g., greenhouse gas [GHG] emissions) and natural (e.g., volcanic eruptions) drivers of climate change, and another signal estimated from simulations driven by the natural drivers only. Climate simulations were used from those submitted to the Detection and Attribution Model Intercomparison Project and a collection of global gridded observational products (Gillett et al., 2016). The regression is performed separately for each combination of observational product and climate model, with results combined into an overall confidence assessment that includes consideration of the quality of the data sets. The algorithm was applied to geographic areas on a scale of 0.5 and 2 million km², globally, and for the time period 1961–2015. The final attribution assessment was the result of an expert assessment evaluating the aforementioned evidence.

Table SMCCP5.4 | Disaggregated statistics for population in mountain regions in CCP Mountains, between 2030 and 2100 per IPCC WGII Continental Regions and SSP presented in Figure CCP5.1 b).

SSP	Year	Africa	Asia	Australasia	Central and South America	Europe	North America	Small Islands	World
1	2030	288,726,367	783,807,409	1,118,980	144,678,296	124,144,042	75,303,568	21,785,393	1,439,564,056
	2040	318,981,364	771,929,243	1,206,709	148,351,270	124,294,589	77,210,171	23,086,924	1,465,060,271
	2050	341,072,043	743,016,992	1,285,852	148,349,408	123,166,329	77,590,782	23,727,783	1,458,209,189
	2060	354,393,248	701,254,504	1,351,225	145,219,146	120,426,567	76,800,473	23,806,372	1,423,251,535
	2070	359,975,768	651,421,238	1,389,281	139,749,147	115,884,447	75,318,966	23,458,421	1,367,197,269
	2080	358,095,918	596,668,260	1,395,061	132,220,185	109,744,134	73,194,906	22,695,211	1,294,013,674
	2090	349,574,614	538,042,668	1,361,285	122,508,465	102,282,099	69,863,376	21,535,169	1,205,167,675
	2100	335,376,094	477,502,111	1,301,911	110,551,976	93,984,309	65,232,892	20,020,863	1,103,970,156
2	2030	305,484,284	826,714,130	1,114,083	151,567,437	128,140,587	78,366,109	23,393,843	1,514,780,474
	2040	349,866,043	840,794,426	1,193,662	159,937,802	129,791,149	82,072,179	25,921,901	1,589,577,162
	2050	389,422,834	837,998,751	1,265,658	165,078,657	130,101,794	84,318,443	27,974,226	1,636,160,364
	2060	421,410,265	820,119,534	1,325,793	167,001,040	128,780,998	85,314,559	29,514,299	1,653,466,487
	2070	445,678,662	791,694,628	1,362,691	166,540,740	125,925,970	85,565,305	30,583,813	1,647,351,810
	2080	462,494,577	756,869,372	1,377,692	164,031,410	122,031,805	85,225,149	31,199,406	1,623,229,411
	2090	472,204,968	718,478,772	1,368,159	159,885,204	117,537,409	84,183,029	31,297,186	1,584,954,728
	2100	475,473,177	680,643,213	1,332,943	154,811,249	112,528,965	82,723,824	31,006,856	1,538,520,226
3	2030	323,787,156	869,722,357	1,004,379	161,469,632	129,626,665	80,795,115	25,334,342	1,591,739,646
	2040	386,263,563	914,377,448	1,002,595	178,021,963	131,444,007	86,478,774	29,515,218	1,727,103,570
	2050	451,162,807	951,049,446	983,682	193,428,765	132,372,719	91,262,691	33,724,397	1,853,984,506
	2060	513,598,980	979,691,353	947,513	207,304,538	132,295,712	95,224,125	37,772,309	1,966,834,531
	2070	571,179,270	1,003,544,448	897,930	219,867,517	131,717,505	98,773,528	41,580,346	2,067,560,544
	2080	625,425,110	1,028,518,475	836,996	231,633,955	131,860,431	102,123,174	45,178,920	2,165,577,060
	2090	675,440,204	1,057,511,947	768,092	243,185,953	132,821,206	105,280,023	48,492,931	2,263,500,356
	2100	720,664,335	1,089,627,571	694,572	254,907,265	134,167,864	108,586,734	51,550,669	2,360,199,010
4	2030	316,342,164	805,380,890	1,088,016	150,985,342	125,310,158	75,224,272	24,077,193	1,498,408,035
	2040	372,427,325	809,365,905	1,145,887	158,865,116	124,681,941	76,709,038	27,366,531	1,570,561,743
	2050	429,076,932	801,372,463	1,187,374	163,542,655	122,239,093	76,384,331	30,575,437	1,624,378,285
	2060	481,870,315	782,872,026	1,210,758	165,126,870	117,843,832	74,673,864	33,556,747	1,657,154,412
	2070	529,041,091	757,988,063	1,209,776	164,338,058	111,706,567	72,137,662	36,307,904	1,672,729,122
	2080	572,158,812	731,778,816	1,183,202	161,742,383	104,527,553	68,868,831	38,884,003	1,679,143,599
	2090	610,404,287	706,876,701	1,133,315	158,007,296	96,859,493	64,929,467	41,200,741	1,679,411,300
	2100	643,621,646	685,570,971	1,060,246	153,813,341	88,796,600	60,536,739	43,259,910	1,676,659,454
5	2030	287,345,274	782,391,204	1,223,557	142,554,457	127,308,408	75,494,206	21,367,372	1,437,684,478
	2040	316,242,314	769,084,309	1,395,056	144,644,690	130,015,708	77,725,700	22,373,503	1,461,481,281
	2050	336,678,664	738,649,953	1,577,663	143,078,134	132,018,605	78,811,996	22,729,305	1,453,544,320
	2060	348,193,274	695,447,683	1,762,964	138,497,120	132,899,505	79,155,957	22,556,596	1,418,513,099
	2070	352,237,122	644,605,881	1,923,149	131,971,282	131,991,671	79,209,542	22,037,774	1,363,976,421
	2080	349,308,963	589,640,585	2,050,343	123,889,465	129,337,004	79,036,609	21,200,573	1,294,463,542
	2090	340,316,098	531,692,821	2,130,470	114,126,339	125,164,818	78,073,991	20,060,671	1,211,565,207
	2100	326,230,513	472,694,269	2,171,083	102,610,002	119,905,375	76,087,816	18,652,025	1,118,351,083

SMCCP5.2.2 Traceable Evidence for Figure CCP 5.4

The following tables contain the traceable evidence for the assessment of the detection of observed impacts and their attribution to anthropogenic climate change across global mountain regions. Tables SMCCP5.5–SMCCP5.12 present the traceable evidence for all impacts detected and assessed, structured by system and region. The code given in the left column of the tables unambiguously identifies a specific impact, which is the unit of analysis for this detection and attribution assessment. Table SMCCP5.13 represents a synthesis table containing all impacts for each system and region assessed with the summary statistics given at the end of each system/region. Table SMCCP5.14 is a summary table which builds on Table SMCCP5.13 and provides the direct input for Figure CCP5.4.

Systems: Water (W), Cryosphere (c), Terrestrial Ecosystems (te), Agriculture and Livestock (a), Tourism (t), Migration (m), Health and Life (h), Disasters (d), Community change and cultural values (co).

Table SMCCP5.5 | Water: River, lake, flood, drought (Code: W). Abbreviations in table: Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	LCP	IPCC Continental Region	Region	Location/ Country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
W1		Africa	East Africa	Upper Blue Nile	h	l-m	m	X
W2		Africa	East Africa	Tanzania	m	l-m	l-m	Neg
W3		Australasia	Australia	New South Wales, AU	m	h	m	Neg
W4		Asia	South Asia	SW Ghats, India	l	m	l	Neg
W5		Asia	Middle East	Zagros Mountains, Iran	m	h	m	Neg
W6		Europe	Alps	Italy	h	m	m	Neg
W7		Asia	Central Asia	Tarim River, Tien Shan	h	h	m-h	X
W8		Asia	Central Asia	Tarim River, Tien Shan	l-m	m	m	X
W9		Asia	Central Asia	Tarim River, Tien Shan	m	h	m-h	X
W9		Asia	Central Asia	Tarim River, Tien Shan	m	l-m	l	Neg
W10		NA	North America	Rockies, Canada	h	h	h	X
W11		CSA	Andes	Cord. Blanca, Peru	h	m-h	m-h	Neg
W12		Asia	Middle East	Anatolia, Turkey	m-h	h	m-h	X
W13		Europe	Alps	Switzerland	h	h	h	X
W14		Europe	Scandinavia	Arctic Norway	m-h	m-h	m-h	X
W15		NA	North America	Rockies, Canada	m-h	m-h	m-h	Neg
W16		NA	North America	Rockies, Canada	m-h	m	m-h	X
W17		Europe	Alps	Rhone, Po, Danube, Europe	h-vh	m-h	m-h	X
W17		Europe	Alps	Rhone, Po, Danube, Europe	h-vh	l-m	l	Neg
W18		Europe	Alps	Europe	m	m	m	X
W19		Europe	Alps	Austria	m-h	m-h	m-h	X
W20	yes	Asia	Himalaya	Nepal, India	l-m	m	l-m	Neg
W21		CSA	Andes	Argentina	m-h	m	l-m	X
W22		Asia	Himalaya	Nepal	m	m	l	Neg
W23		Asia	Karakoram	Central and Eastern Karakoram	m	m-h	m	X
W24		Asia	Himalaya	India	m	m	l-m	Neg
W25		Asia	Himalaya	Upper Indus	m	h	m	Neg
W26		Asia	Central Asia	Syr Darya, upper reaches	m	m-h	m-h	X
W26		Asia	Central Asia	Syr Darya, lower/middle reaches	m	l	l	Neg
W27		NA	North America	Columbia River, South and Central Canada	m	h	h	Neg
W28		NA	North America	BC, Canada	m	m	m	X

Code	LCP	IPCC Continental Region	Region	Location/ Country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
W28		NA	North America	BC, Canada	l	m	m	Neg
W29		Europe	Scandinavia	Northern Sweden	m-h	m-h	m-h	X
W30		Europe	Scandinavia	Northern Sweden	m-h	m-h	m-h	Neg
W31		Asia	Karakoram	Upper Indus	m	m-h	m	X
W32		Asia	Karakoram	Upper Indus	m	m-h	m	Neg
W33		CSA	Andes	Argentina, Chile	l	l	l	X
W34		Asia	Central Asia	Tien Shan	m	h	m-h	X
W35		Asia	Himalaya	Chota Shigri, India	m	m	m	X
W36		Asia	Central Asia	Tien Shan	m	m	m	X
W37		NA	North America	USA	m	m	m	X
W38		NA	North America	Western N. America	m	m	m	X
W39		Europe	Europe	Spain	m-h	h	m-h	X
W40		Asia	Central Asia	Upper Amu Darya r.	l-m	m	l-m	Neg
W41		Asia	Central Asia	Aksu r.	m	m	m	X
W42		Europe	Europe	Eastern Carphathians	h	m-h	m-h	X
W43		Europe	MED	Ebro river, Pyrenees	h	m	m	Neg
W44		Europe	CEU	Adige river, Italy	m	m	m	Neg
W45		Australasia	Australia	Murrumbidgee river	m	h	m	Neg

References:

Gallart and Llorens, 2004; Hemp, 2005; Stewart et al., 2005; Fowler and Archer, 2006; Masiokas et al., 2006; Grossmann, 2008; Pellicciotti et al., 2010; Zhang et al., 2010; Hänggi and Weingartner, 2011; López-Moreno et al., 2011; Masih et al., 2011; Tao et al., 2011; Baraer et al., 2012; Dahlke et al., 2012; Gebremicael et al., 2013; Kriegel et al., 2013; Bocchiola, 2014; Fleming and Dahlke, 2014; Morán-Tejeda et al., 2014; Reinfelds et al., 2014; Schauwecker et al., 2014; Bard et al., 2015; Duethmann et al., 2015; Kormann et al., 2015; Krysanova et al., 2015; Kundzewicz et al., 2015; Reggiani and Rientjes, 2015; Yucel et al., 2015; Zampieri et al., 2015; Buendia et al., 2016; Castino et al., 2016; Moyer et al., 2016; Rawat et al., 2016; Wang et al., 2016b; Bastakoti et al., 2017a; Brahney et al., 2017; Castino et al., 2017; Dudley et al., 2017; Engelhardt et al., 2017; O'Neil et al., 2017; Reggiani et al., 2017; Rood et al., 2017; Mekonnen et al., 2018; Shen et al., 2018; Sreelash et al., 2018; Mallucci et al., 2019; Mostowik et al., 2019; Said et al., 2019; Tuladhar et al., 2019; Zou et al., 2019; Rottler et al., 2020; Zhu et al., 2020

Table SMCCP5.6 | Cryosphere (Code: C). Abbreviations in table: Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
C9		Africa	Africa	East Africa	vh	m	l-m	Neg
C6		Asia	Asia	Caucasus and middle East	vh	h	h	Neg
C7		Asia	Asia	High mountain Asia	vh	m-h	m-h	Neg
C12		Asia	Asia	Tien Shan	h	h	m-h	Neg
C13		Asia	Asia	Tibet	h	h	m-h	Neg
C14		Asia	Asia	Mongolia	h	h	m-h	Neg
C8		Australasia	New Zealand	NZ Alps	vh	h	h	Neg
C1		CSA	Andes	Southern Andes	vh	h	h	Neg
C2		CSA	Andes	Tropical Andes	vh	h	h	Neg
C4		Europe	Europe	Central Europe	vh	h	h	Neg
C5		Europe	Scandinavia	Scandinavia	vh	h	h	Neg
C10		Europe	Europe	Alps	h	h	h	Neg
C11		Europe	Scandinavia	Scandinavia	h	h	m-h	Neg
C3		NA	North America	West Canada, mainland USA	vh	h	h	Neg

References:

Mölg et al., 2012; Cullen et al., 2013; Pepin et al., 2014; Prinz et al., 2016; Chen et al., 2018; Hock et al., 2019; Zemp et al., 2019

Table SMCCP5.7 | Terrestrial ecosystems (Code: TE). Abbreviations in table: Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
TE9		Europe	Alps	French/Italian Alps	m-h	m	l-m	Neg
TE16		Europe	Sierra Nevada	Spain	m	h	h	X
TE33		Asia	Qilian Mountains	China	m	m	m	X
TE43		Europe	French Alps	France	h	h	h	X
TE51		Europe	Carpathian Mountains	Romania	l	m	m	X
TE52		Europe	Tatra Mountains	Slovakia	m	l	l	Neg
TE54		Asia	Altay prefecture	China	m	m	m	Neg
TE63		Europe	Swiss Alps	Switzerland	m	h	h	X
TE68		NA	Sierra Nevada	California, USA	h	h	m	Neg
TE75		CSA	Patagonia	South America	h	vh	h	Neg
TE79	yes	Asia	Uttarakhand	India	h	m	l	Neg
TE81		Europe	Parangalitsa Forest Reserve	Bulgaria	m	l	l	Neg
TE82		global	Mediterranean forests	WNA (west north america), SWAF, SEAF, (south africa), MED, SWS, SAU	m	m	l	X
TE86		CSA	Tropical high-Andean Puna		m	m	l	Neg
TE93		Asia	Pamir Alay and Tien Shan ranges	Uzbekistan and Kyrgyzstan	m	m	m	Neg
TE97		NA	US Rocky Mountains	USA	h	m	m	Neg
TE111	yes	Asia	Upper Kedarnath Valley of Garhwal	India	h	h	h	X
TE113		Europe	Central Pyrenees	Spain	m	l	l	X
TE117		Africa	Abune Josef mountain range	Ethiopia	m	l	l	Neg
TE127		Asia	Ruoergai Plateau	Tibet, China	h	m	m	Neg

References:

Jacob et al., 2015; Dhyani and Dhyani, 2016; Feurdean et al., 2016Fleischer, 2017 #1432; Gartzia et al., 2016; Panayotov et al., 2016; Seim et al., 2016; Zhang et al., 2016b; Carlson et al., 2017; Fu et al., 2017; Jochner et al., 2017; Lubetkin et al., 2017; Negi et al., 2017; Peñuelas et al., 2017; Rolando et al., 2017; Miserendino et al., 2018; Stevens-Rumann et al., 2018; Deléglise et al., 2019; Jiménez et al., 2019; Teng et al., 2020

Table SMCCP5.8 | Winter and summer tourism (Code: T). Abbreviations in table: Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
T1		NA	North America	New England, USA	h	h	m-h	Neg
T2		NA	North America	New Hampshire, USA	h	h	m-h	Neg
T3		NA	North America	Alaska	m	m	m	Neg
T4		Europe	Scandinavia	Finland	m	m	m	Neg
T5		NA	North America	Western USA	h	h	h	Neg
T6		Europe	Europe	French Alps	h	h	h	Neg
T7		Europe	Europe	Austria	h	h	h	Neg
T8		Europe	Caucasus	Caucasus	m	m	l-m	Neg

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
T9		CSA	Andes	Chacaltaya, Bolivia	vh	h	h	Neg
T10		Asia	Asia	Yylong Snow Mountain, China	h	h	h	Neg
T11	yes	Europe	Alps	France, Austria	h	h	h	Neg
T12		Europe	Alps	France, Switzerland	h	h	h	Neg
T13	yes	Asia	Solokhumbu district	Nepal	m	m-h	m	Neg
T14		Europe		Slovenia, Iceland, France	vh	vh	h	Neg
T15		Europe		Norway	h	m-h	m-h	Neg
T16		Africa	SSA	Lesotho	h	m-h	m	Neg
T17		Asia	Albroz Mountains	Iran	h	m-h	m	Neg
T18		Europe	Alps	Austria	m-h	h	h	X
T19		Europe	Alps	Austria	m-h	m-h	m-h	X
T20		Australasia	Australian alps	Australia	m	m-h	m	Neg

References:

Hamilton et al., 2003; Falk, 2010; Wang et al., 2010; Beaudin and Huang, 2014; Ghaderi et al., 2014; Sokratov et al., 2014; Falk and Vieru, 2016; Harris et al., 2016; Kaenzig et al., 2016; Pröbstl-Haider et al., 2016; Fyfe et al., 2017; Marty et al., 2017; Mourey and Ravanel, 2017; Beniston et al., 2018; Demiroglu et al., 2018; Hagenstad et al., 2018; Marke et al., 2018; Verfaillie et al., 2018; Mourey et al., 2019; Spandre et al., 2019; Faulon and Sacareau, 2020; Pröbstl-Haider et al., 2020; Salim and Ravanel, 2020; Triglav Čekada et al., 2020; Welling et al., 2020; Hoogendoorn et al., 2021

Table SMCCP5.9 | Disasters (Code: D). Abbreviations in table: Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
D1		Europe	Europe	Alps	h	h	h	Neg
D2		Australasia	New Zealand	NZ Alps	m	m	m	Neg
D3		Europe	Italy	Italy	l	vl	vl	X
D4		Asia	Himalaya	Bhutan, Nepal, India	h	l	vl	Neg
D5		CSA	Andes	Peru	m	l	vl	Neg
D6		Asia	Himalaya	Uttarakhand, India	m	m	l	Neg
D7		Asia	Himalaya	Bhutan, Nepal, India	vh	h	h	Neg
D8		Asia	Tibet	China	vh	h	h	Neg
D9		Europe	Europe	Austria	h	h	h	Neg
D10		Asia	Central Asia	Tajikistan, Kyrgyzstan, Kazakhstan, Uzbekistan	h	h	h	Neg
D11		CSA	Andes	Peru	h	h	h	Neg
D12		CSA	Andes	Patagonia	h	m	m	Neg
D13		Asia	Himalaya	India, Nepal, Bhutan	l	l	l	Neg
D14		NA	British Columbia	Canada	h	l	l	X
D15		CSA	Bolivian Andes	Bolivia	h	vh	h	Neg
D16		NA	British Columbia	Canada	vl	l	l	Neg
D17		CSA	Bolivian Altiplano	Bolivia	m	m	l	Neg
D18		Europe	Alps	Switzerland	h	vh	h	Neg
D19		NA	St. Elias Mountains, Glacier Bay	Alaska/USA	m	l	l	Neg
D20		Europe		Switzerland	h	m	m	Neg
D21		Europe	European Alps	Italy, France, Austria, Switzerland	h	l-m	l	Neg
D22		Europe	European Alps	Italy, France, Austria, Switzerland	h	l	l	Neg
D23		Europe	European Alps	Italy, France, Austria, Switzerland	h	l	l	X

Code	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
D24		Europe	French Alps	France	m	m	m	X
D25		Europe	Tatra mountains	Poland	l	l	l	X
D26		Asia	Kullu, Western Himalaya	India	l	m	l	Neg
D27		NA	Gulf of Alaska	USA	h	h	h	Neg

References:

Geertsema et al., 2006; Petley et al., 2007; Stoffel et al., 2008; Allen et al., 2009; Petley, 2010; Stoffel, 2010; Allen et al., 2011; Gardelle et al., 2011; Ravanel and Deline, 2011; Fischer et al., 2012; Stoffel and Huggel, 2012; Allen and Huggel, 2013; Mergili et al., 2013; Wasson et al., 2013; Kundzewicz et al., 2014; McPhillips et al., 2014; Singh et al., 2014; Cox et al., 2015; Huggel et al., 2015; Vicente-Serrano et al., 2015; Zhang et al., 2015a; Cook et al., 2016; Gariano and Guzzetti, 2016; Paranunzio et al., 2016; Eckert et al., 2017; Gadek et al., 2017; Nie, 2017; Phillips et al., 2017; Ravanel et al., 2017; Ballesteros-Cánovas et al., 2018; Buckel et al., 2018; Coe et al., 2018; Froude and Petley, 2018; Giacona et al., 2018; Harrison et al., 2018; Kundzewicz et al., 2018; Paprotny et al., 2018; Stäubli et al., 2018; Wilson et al., 2018; Berghuijs et al., 2019; King et al., 2019; Veh et al., 2019; Bessette-Kirton and Coe, 2020; Emmer et al., 2020; Shugar et al., 2020; Walter et al., 2020; Chen et al., 2021; Field et al., 2021; Mölg et al., 2021; Strouth and McDougall, 2021; Zheng et al., 2021a; Zheng et al., 2021b

Table SMCCP5.10 | Local communities (Code: LC). This table has multiple systems. Abbreviations in table: System (Syst.), Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
LC3	a	yes	Asia	Himalayas	Bhutan	h	m	l-m	Neg
LC4	a	yes	Asia	Himalayas	India	h	m	m	Neg
LC5	a	yes	Asia	Himalayas	Nepal	h	m	m	Neg
LC6	a	yes	Asia	Himalayas	Nepal, India	vh	m	m-h	Neg
LC7	a	yes	Asia	Tibet	China	h	m	m-h	Neg
LC11	a	yes	Asia	Himalayas	India	vh	m	m	X
LC13	a	yes	Asia	Hindukush	Pakistan	vh	m	m	X
LC14	a	yes	Asia	Himalayas	Nepal	vh	m	m	X
LC15	a	yes	Asia	Tibet	China	vh	m	m	X
LC1	c	yes	Asia	Himalayas	Nepal, India	h	h	h	Neg
LC6	co	yes	Asia	Himalayas	Nepal, India	vh	m	m-h	Neg
LC8	co	yes	Asia	Himalayas	Nepal, India	h	m	m	Neg
LC15	co	yes	Asia	Tibetan plateau	China	vh	m	m	X
LC3	d	yes	Asia	Himalayas	Bhutan	h	m	l-m	Neg
LC4	d	yes	Asia	Himalayas	India	h	m	m	Neg
LC5	d	yes	Asia	Himalayas	Nepal	h	m	m	Neg
LC2	te	yes	Asia	Himalayas	Nepal, India	h	m	l-m	Neg
LC1	w	yes	Asia	Himalayas	Nepal, India	h	m	l-m	Neg
LC16	a	yes	CSA	Andes	Peru	h	m	m	X
LC106	a	yes	CSA	Andes	Ecuador, Cotacachi	h	m-h	m-h	X
LC108	a	yes	CSA	Andes	Colombia, Cauca	h	m	l-m	Neg
LC109	a	yes	CSA	Andes	Colombia, Nariño	m-h	m	l-m	Neg
LC104	c	yes	CSA	Andes	Peru, Colca	m	m	l-m	Neg
LC9	co	yes	CSA	Andes	Bolivia	h	l	l-m	Neg
LC10	co	yes	CSA	Andes	Peru	h	l	l-m	Neg
LC12	co	yes	CSA	Andes	Colombia	h	l	l-m	Neg
LC109	co	yes	CSA	Andes	Colombia, Nariño	m-h	m	l-m	Neg
LC110	co	yes	CSA	Andes	Colombia, Ecuador	m-h	m	l-m	Neg
LC105	te	yes	CSA	Andes	Bolivia, Sajama	h	m	l-m	Neg
LC110	te	yes	CSA	Andes	Colombia, Ecuador	m-h	m	l-m	X
LC100	w	yes	CSA	Andes	Ecuador, Chimborazo	h	m	m	Neg

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
LC101	w	yes	CSA	Andes	Peru, Santa r.	m	h	m-h	Neg
LC103	w	yes	CSA	Andes	Peru, Colca	m-h	l	l	Neg
LC107	w	yes	CSA	Andes	Peru, Huancavelica	h	l-m	l-m	Neg
LC108	w	yes	CSA	Andes	Colombia, Cauca	h	m	m	Neg
LC109	w	yes	CSA	Andes	Colombia, Nariño	h	m	l-m	Neg

References:

Puenayán Irua, 2011; Ramos García et al., 2011; Tupaz Pastás and Guzmán, 2011; Fabricant, 2013; Paerregaard, 2013; Klein et al., 2014; Namgay et al., 2014; Yeh et al., 2014; Feola, 2015; López-i-Gelats et al., 2015; Shijin and Dahe, 2015; Aryal et al., 2016; Gagné, 2016; Gentle and Thwaites, 2016; Sharma et al., 2016; Sharma and Shrestha, 2016; Skarbø and VanderMolen, 2016; Burman, 2017; Campbell, 2017; Feola, 2017; Gergan, 2017; Ingty, 2017; La Frenierre and Mark, 2017; Mark et al., 2017; Pandey et al., 2017a; Pandey et al., 2017b; Poudel and Duex, 2017; Raghuvanshi et al., 2017; Sayre et al., 2017; Yeh et al., 2017; Dalal et al., 2018; Dangi et al., 2018; Dendup, 2018; Dey et al., 2018; Dhungana et al., 2018; Hopping et al., 2018; Merrey et al., 2018; Nightingale, 2018; Paerregaard, 2018; Poudel, 2018; Suberi et al., 2018; Ullah et al., 2018; Wangchuk and Wangdi, 2018; Chakraborty et al., 2019; Ensor et al., 2019; Feroze et al., 2019; Hoy and Katel, 2019; Joshi et al., 2019; Khanal et al., 2019a; Meena et al., 2019; Shukla et al., 2019; Spies, 2019; Stensrud, 2019; Sujakhu et al., 2019; Yager et al., 2019; Chhogyel et al., 2020; Choden et al., 2020; Müller et al., 2020; Salick et al., 2020; Wang et al., 2021

Table SMCCP5.11 | Andes (Code: A). This table has multiple systems. Abbreviations in table: System (Syst.), Local Community Perception (LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and Negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
A1	w		CSA	Andes	Chile	vh	h/h	m	Neg
A2	w		CSA	Andes	West Patagonia	vh	h/h	m-h	Neg
A3	w		CSA	Andes	Bolivia	h	h/m	m	Neg
A4	te		CSA	Andes	Chile	vh	h	h	Neg
A5	te		CSA	Andes	Chile	vh	m	l-m	Neg
A5	h		CSA	Andes	Chile	vh	m	l-m	Neg
A6	h		CSA	Andes	Chile	vh	h	m	Neg
A7	w		CSA	Andes	All Andes, Chile	m	m	l-m	Neg
A8	w		CSA	Andes	Argentina	m	m	(l-m)	Neg
A8	d		CSA	Andes	Argentina	m	m	(l-m)	Neg
A9	a		CSA	Andes	Peru	m	m/h	h	Neg
A11	w		CSA	Andes	Ecuador	h	l-m	l-m	Neg
A12	te		CSA	Andes	Colombia	h	h	h	X
A13	h		CSA	Andes	Colombia	h	h	h	Neg
A14	c		CSA	Andes	Chile	h	h/h	h	Neg
A15	c		CSA	Andes	Chile, Argentina	h	m	h	Neg
A16	c		CSA	Andes	Peru	vh	h	h	Neg
A17	t	yes	CSA	Andes	Bolivia	h	h	h	Neg
A18	a	yes	CSA	Andes	Bolivia	h	h	l	Neg
A19	c	yes	CSA	Andes	Peru	m-h	h	h	Neg
A19	w	yes	CSA	Andes	Peru	m-h	h	h	Neg
A20	m	yes	CSA	Andes	Bolivia	m	h	h	Neg
A22	w	yes	CSA	Andes	Venezuela	m	h	m	Neg
A22	w	yes	CSA	Andes	Colombia	m	h	m	Neg
A23	w	yes	CSA	Andes	Peru	m	h	m	Neg
A23	h	yes	CSA	Andes	Peru	m	h	m	Neg
A23	a	yes	CSA	Andes	Peru	m	h	m	Neg
A24	te	yes	CSA	Andes	Colombia	l	m	m	Neg
A24	a	yes	CSA	Andes	Colombia	m	m	m	Neg
A25	te		CSA	Andes	Peru	h	h	h	Neg

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
A26	te		CSA	Andes	Argentina	h	l	l	Neg
A28	te		CSA	Andes	Bolivia	h	m	m	X
A30	te		CSA	Andes	Argentina	m	m	(l)	Neg
A31	a	yes	CSA	Andes	Peru	h	h	h	Neg
A31	h	yes	CSA	Andes	Peru	m	h	h	Neg
A32	c		CSA	Andes	Colombia	vh	h	h	Neg
A33	c		CSA	Andes	Peru	vh	h	h	Neg
A34	c		CSA	Andes	Peru	vh	h	h	Neg
A35	c		CSA	Andes	Argentina	vh	h	h	Neg
A36	c		CSA	Andes	Colombia	h	h	h	Neg
A37	c		CSA	Andes	Peru	h	h	h	Neg
A37	c		CSA	Andes	Bolivia	h	h	h	Neg
A38	c		CSA	Andes	Chile	h	h	h	Neg
A39	c		CSA	Andes	Chile	h	h	h	Neg
A40	c		CSA	Andes	Argentina	h	h	h	Neg
A41	w		CSA	Andes	Colombia	m-h	h	h	Neg
A42	w		CSA	Andes	Peru-Bolivia	m	h	h	Neg
A43	w		CSA	Andes	Peru-Brazil	m	h	h	Neg
A43	w		CSA	Andes	Argentina	m	h	h	Neg
A44	w		CSA	Andes	Peru	m	h	h	Neg
A45	d		CSA	Andes	Andes, Peru	m	m	m	Neg
A46	te		CSA	Andes	Ecuador	vh	h	h	Neg
A47	te		CSA	Andes	Peru	vh	h	h	X
A48	co		CSA	Andes	Peru	h	h	h	Neg
A50	h		CSA	Andes	Colombia	m	l	l	Neg
A51	w	yes	CSA	Andes	Bolivia	h	h	m	Neg
A52	w	yes	CSA	Andes	Bolivia	h	h	l	Neg
A53	w	yes	CSA	Andes	Chile	m	m	l	Neg
A54	a	yes	CSA	Andes	Chile	h	m-h	m	Neg
A55	te	yes	CSA	Andes	Chile	m	h	h	Neg
A56	co	yes	CSA	Andes	Chile	m	m	m	Neg
A57	c	yes	CSA	Andes	Peru	h	h	h	Neg
A58	w	yes	CSA	Andes	Peru	m	m	l-m	Neg
A59	a	yes	CSA	Andes	Peru	m	m	l	Neg
A60	m	yes	CSA	Andes	Peru	h	m	m	Neg
A61	m	yes	CSA	Andes	Peru	h	m	m	Neg
A62	m	yes	CSA	Andes	Bolivia	m	m	m	Neg
A63	c		CSA	Andes	Chile, Argentina	m	m-h	h	Neg
A64	d		CSA	Andes	Peru	m	m	m	Neg
A65	d		CSA	Andes	Peru	vh	h	h	Neg
A66	d		CSA	Andes	Chile	m	m	h	Neg
A67	d		CSA	Andes	Chile	m	m	m	Neg
A69	t	yes	CSA	Andes	Peru	h	h	h	Neg

References:

Seimon et al., 2007; El Mujtar et al., 2011; Lavado Casimiro et al., 2012; Pabón-Caicedo, 2012; Seiler et al., 2013; Skansi et al., 2013; Carmona and Poveda, 2014; Eastin et al., 2014; Postigo, 2014; Schauwecker et al., 2014; Wrathall et al., 2014; Aubry-Wake et al., 2015; Drenkhan et al., 2015; Iribarren Anacona et al., 2015; Jacobi et al., 2015a; Jurt et al., 2015; Michelutti et al., 2015; Molina et al., 2015; Morueta-Holme et al., 2015; Pepin et al., 2015; Quintero-Herrera et al., 2015; Raoul, 2015; Vuille et al., 2015; Boisier et al., 2016;

Brandt et al., 2016; Fierro et al., 2016; Kaenzig et al., 2016; Morán-Tejeda et al., 2016; Parraguez-Vergara et al., 2016; Dangles et al., 2017; Garreaud et al., 2017; Heikkinen, 2017; Mark et al., 2017; Polk et al., 2017; Ruiz et al., 2017; Santofimia et al., 2017; Satgé et al., 2017; Stiles and Rosselli, 2017; Barkhordarian et al., 2018; Chang Kee et al., 2018; de la Barrera et al., 2018; Harrison et al., 2018; Huss and Hock, 2018; Inaigem, 2018; Iribarren Anacona et al., 2018; Labaj et al., 2018; Malmros et al., 2018; Morán-Tejeda et al., 2018; Paerregaard, 2018; Rabatel et al., 2018; Saavedra et al., 2018; Stäubli et al., 2018; Vuille et al., 2018; Zimmer et al., 2018; Arriagada et al., 2019; Braun et al., 2019; Burger et al., 2019; Cordero et al., 2019; Córdova et al., 2019; Cuesta et al., 2019; Drenkhan et al., 2019; Dussaillant et al., 2019; Imfeld, 2019; Leroy, 2019; Rasmussen, 2019; Altea, 2020; Ayala et al., 2020; Emmer et al., 2020; Garreaud et al., 2020; Masiokas et al., 2020; Moret et al., 2020; Pabón-Caicedo et al., 2020; Stuart-Smith et al., 2021

Table SMCCP5.12 | Africa (Code: AF). This table has multiples systems. Abbreviations in table: system (Syst.), local community perception (LCP), confidence of detection (Conf. Det.), contribution of climate change (Contr. C.C.), confidence of attribution (Conf. Att.) and negative or no negative impact (Neg / x). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
AF2	te		Africa	SWAF	NW Namibia	m	l-m	l	Neg
AF3	te		Africa	SWAF	Namibia	h	h	m-h	Neg
AF10	te		Africa	SEAF	South Africa, Drakensberg, Namahadi Catchment	h	h	m-h	Neg
AF47	a		Africa	CAF	Equatorial Guinea, Atom and Kukumankok	m	m	l	Neg
AF48	a	Yes	Africa	CAF	Cameroon, Bui Division	h	h	l-m	Neg
AF49	w	Yes	Africa	CAF	Cameroon, Bui Division	h	m-h	l	Neg
AF50	a	Yes	Africa	CAF	DRC, Bukavu area	m	m	l-m	Neg
AF51	a	Yes	Africa	CAF	DRC, Bukavu area	h	m	l	Neg
AF52	w	Yes	Africa	CAF	DRC, Bukavu area	h	m	l	Neg
AF53	w	Yes	Africa	CAF	DRC, Bukavu area	m	m	l	Neg
AF54	a	Yes	Africa	CAF	Cameroon, Northwest	h	m	l	Neg
AF55	w	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	h	l-m	Neg
AF57	d	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	m	l	Neg
AF58	te	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	m	l	Neg
AF59	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	m	l	Neg
AF60	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	h	l-m	Neg
AF61	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	l-m	l-m	Neg
AF62	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	l-m	l-m	Neg
AF63	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	h	l-m	Neg
AF64	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	h	l-m	Neg
AF65	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	m	l-m	Neg
AF66	a		Africa	CAF	Cameroon, Northwest	h	h	l-m	Neg
AF67	a	Yes	Africa	CAF	Cameroon, Northwest	h	h	l-m	Neg
AF68	a	Yes	Africa	CAF	Nigeria, Riyom and Jos Plateau	h	h	l-m	Neg
AF69	w	Yes	Africa	CAF	Nigeria, Riyom and Jos Plateau	h	h	l-m	Neg
AF70	a	Yes	Africa	CAF	Cameroon, Southwest	h	m-h	l-m	Neg
AF71	a	Yes	Africa	CAF	Nigeria, Taraba state	h	h	l-m	Neg
AF72	a	Yes	Africa	CAF	Nigeria, Taraba state	m	h	l-m	Neg
AF73	w	Yes	Africa	CAF	Nigeria, Taraba state	m	h	l-m	Neg
AF74	a	Yes	Africa	CAF	Cameroon, Yaounde	m	h	l-m	Neg
AF75	a	Yes	Africa	CEAF	Uganda, Kibale NP	h	m-h	l	Neg
AF76	a	Yes	Africa	CEAF	Uganda, Kigezi highlands	h	h	l-m	Neg
AF77	w	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	h	l-m	Neg
AF78	d	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	h	l-m	Neg

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
AF79	a	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	m	l-m	Neg
AF80	a	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	m	l-m	Neg
AF81	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	m	l-m	Neg
AF82	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	m	l-m	Neg
AF83	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	m	l-m	Neg
AF84	a	Yes	Africa	CEAF	Central Uganda	h	m	l	Neg
AF85	a	Yes	Africa	CEAF	Rwenzori Mountains, Kazeze district, Uganda	h	h	m	Neg
AF86	a	Yes	Africa	CEAF	Rwenzori Mountains, Kazeze district, Uganda	h	h	l-m	Neg
AF87	te	Yes	Africa	CEAF	Rwanda, Volcanoes NP	m	h	l	Neg
AF88	a	Yes	Africa	CEAF	Rwanda, Volcanoes NP	m	h	l-m	Neg
AF89	a	Yes	Africa	WAF	Benin, Dassari	h	h	l-m	Neg
AF90	w	Yes	Africa	WAF	Benin, Dassari	h	h	l-m	Neg
AF91	a	Yes	Africa	WAF	Benin, Dassari	h	h	l-m	Neg
AF92	a	Yes	Africa	WAF	Guinea, Fouta Djallon	h	h	m-h	Neg
AF93	w		Africa	WAF	Guinea, Fouta Djallon	h	h	l-m	X
AF94	a	Yes	Africa	WAF	Sierra Leone, Kono district	h	h	l-m	Neg
AF95	w	Yes	Africa	WAF	Sierra Leone, Kono district	m	m	l-m	Neg
AF97	a	Yes	Africa	WAF	Northwest Benin	h	h	l-m	Neg
AF98	c	Yes	Africa	SEAF	Lesotho	h	h	m-h	Neg
AF99	a	Yes	Africa	SEAF	Madagascar	h	h	m	X
AF100	te	Yes	Africa	SWAF/SEAF	Southern Africa	h	m	m	Neg
AF101	te	Yes	Africa	SWAF/SEAF	Southern Africa	h	m-h	m	Neg
AF102	a	Yes	Africa	SEAF/CEAF/CAF	Drakensberg (South Africa), Mt Maloti (Lesotho), Chimanimani Mountains (Zimbabwe); Highlands of Kenya, Mt Elgon (Uganda); Mount Cameroon (Cameroon)	h	h	m-h	Neg
AF103	te		Africa	SEAF	South Africa, Maloti-Drakensberg	h	l	l	X
AF106	te		Africa	SWAF	South Africa, Table Mountains	m	m	l-m	Neg
AF107	t		Africa	SEAF	Lesotho	h	h	m-h	Neg
AF108	te		Africa	NEAF/(SEAF)	Mountains pan-tropical belt	m	h	m-h	Neg
AF110	te		Africa	SWAF	South Africa, Table Mountain NP	m	m	l	X
AF111	a		Africa	SEAF	Madagascar	h	h	m	Neg
AF112	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	m	m	Neg
AF113	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	m	m	Neg
AF114	w	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	m	l-m	Neg
AF115	te		Africa	NEAF	Kenya, Mt Kenya region	h	h	m	Neg
AF116	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	m	l	Neg
AF117	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	m	m	Neg
AF118	c		Africa	NEAF	Kenya, Mt Kenya	h	h	h	Neg
AF119	a		Africa	NEAF	Kenya, Kakamega	m-h	h	m	Neg
AF120	a		Africa	NEAF	Kenya, Kakamega	m-h	h	m	Neg
AF121	a	Yes	Africa	NEAF	Kenya, central Kenya	m	m-h	l-m	Neg
AF122	a	Yes	Africa	NEAF	Kenya, Kakamega	m	h	l	Neg

Code	Syst.	LCP	IPCC continental region	Region	Location/country	Conf. Det.	Contr. C.C.	Conf. Att.	Neg / x
AF123	a	Yes	Africa	NEAF	Kenya, Nakuru	m	h	m	Neg
AF124	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	m	l-m	Neg
AF125	w	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	h	m	Neg
AF126	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	h	m	Neg
AF127	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	m	l-m	Neg
AF128	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	m-h	m	Neg
AF129	m	Yes	Africa	CEAF	Tanzania, North Pare highlands	h	m	l-m	Neg
AF130	a	Yes	Africa	CEAF	Tanzania, Mt. Kilimanjaro	m	m	l-m	Neg
AF132	a	Yes	Africa	CEAF	Tanzania, Udzungwa mountains	m	l	l	Neg
AF134	h	Yes	Africa	CEAF	Tanzania, Udzungwa mountains	m	l	l	Neg
AF135	m	Yes	Africa	CEAF	Uganda, Nakasongola district	h	l-m	l	Neg
AF136	m	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	l-m	l	Neg
AF137	a	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	l-m	l	Neg
AF138	a	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	l	l	Neg

References:

Burke, 2004; Simmons et al., 2004; Bangura et al., 2012; Gerardeaux et al., 2012; Hartter et al., 2012; Paraiso et al., 2012; Mwakaje, 2013; OXFAM et al., 2013; Powell, 2013; Afifi et al., 2014; Bele et al., 2014; Hoang et al., 2014; Krishnaswamy et al., 2014; Leclerc et al., 2014; Onyekuru and Marchant, 2014; Wood and Mendelsohn, 2014; Carbutt and Edwards, 2015; Oruonye and Adebayo, 2015; Poulsen and Hoffman, 2015; Taylor et al., 2015; Tiyo et al., 2015; Bomuhangi et al., 2016; Mbue et al., 2016; Akwen, 2017; Asayehegn et al., 2017; Defang et al., 2017; Few et al., 2017; Grab et al., 2017; Twagiramarla et al., 2017; Zizinga et al., 2017; Callo-Concha, 2018; Chen et al., 2018; Chepkoech et al., 2018; Cuni-Sanchez et al., 2018; Goyol and Pathirage, 2018; Grab and Knigh, 2018; Kinoti et al., 2018; M'mboroki et al., 2018; Mukwada and Manatsa, 2018; Nematchoua et al., 2018; Prinz et al., 2018; Schumacher, 2018; Faye, 2019; Mulinde et al., 2019; Muntifering et al., 2019; Nsengiyumva, 2019; Tume et al., 2019; Leal Filho et al., 2020; Saalu et al., 2020; Batumike et al., 2021; Hoogendoorn et al., 2021; Tesfaye and Alemayehu, 2021; Wagner et al., 2021

Table SMCCP5.13 | Synthesis table ordered by IPCC region and system. Abbreviations in table: system (Syst.), local community perception (LCP), confidence of detection (Conf. Det.), contribution of climate change (Contr. C.C.), confidence of attribution (Conf. Att.), number of negative impacts (N° of Neg. Im.) and number of publications consulted (N° Pub.). Index can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

Code; N°. of codes	Syst.	LCP; N° . of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
AF122	a	Yes	Africa	NEAF	Kenya, Kakamega	m	3	h	5	l	1	Negative	1
AF84	a	Yes	Africa	CEAF	central Uganda	h	5	m	3	l	1	Negative	1
AF47	a		Africa	CAF	Equatorial Guinea, Atom and Kukumankok	m	3	m	3	l	1	Negative	1
AF116	a	Yes	Africa	NEAF	Kenya, Mt. Kenya region	m	3	m	3	l	1	Negative	1
AF75	a	Yes	Africa	CEAF	Uganda, Kibale NP	h	5	m-h	4	l	1	Negative	1
AF54	a	Yes	Africa	CAF	Cameroon, Northwest	h	5	m	3	l	1	Negative	1
AF68	a	Yes	Africa	CAF	Nigeria, Riyom and Jos Plateau	h	5	h	5	l-m	2	Negative	1
AF71	a	Yes	Africa	CAF	Nigeria, Taraba state	h	5	h	5	l-m	2	Negative	1

Code; N°. of codes	Syst.	LCP; N°. of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
AF76	a	Yes	Africa	CEAF	Uganda, Kigezi highlands	h	5	h	5	l-m	2	Negative	1
AF86	a	Yes	Africa	CEAF	Rwenzori Mts, Kazeze district, Uganda	h	5	h	5	l-m	2	Negative	1
AF94	a	Yes	Africa	WAF	Sierra Leone, Kono district	h	5	h	5	l-m	2	Negative	1
AF97	a	Yes	Africa	WAF	northwest Benin	h	5	h	5	l-m	2	Negative	1
AF72	a	Yes	Africa	CAF	Nigeria, Taraba state	m	3	h	5	l-m	2	Negative	1
AF74	a	Yes	Africa	CAF	Cameroon, Yaounde	m	3	h	5	l-m	2	Negative	1
AF88	a	Yes	Africa	CEAF	Rwanda, Volcanoes NP	m	3	h	5	l-m	2	Negative	1
AF51	a	Yes	Africa	CAF	DRC, Bukavu area	h	5	m	3	l	1	Negative	1
AF59	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	5	m	3	l	1	Negative	1
AF79	a	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	5	m	3	l-m	2	Negative	1
AF80	a	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	5	m	3	l-m	2	Negative	1
AF81	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	5	m	3	l-m	2	Negative	1
AF82	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	5	m	3	l-m	2	Negative	1
AF83	a	Yes	Africa	CEAF	Uganda, Nakasongola district	h	5	m	3	l-m	2	Negative	1
AF124	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal, Mt Nyiro	h	5	m	3	l-m	2	Negative	1
AF127	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal, Mt Nyiro	h	5	m	3	l-m	2	Negative	1
AF50	a	Yes	Africa	CAF	DRC, Bukavu area	m	3	m	3	l-m	2	Negative	1
AF121	a	Yes	Africa	NEAF	Kenya, central Kenya	m	3	m-h	4	l-m	2	Negative	1
AF48	a	Yes	Africa	CAF	Cameroon, Bui Division	h	5	h	5	l-m	2	Negative	1
AF60	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	5	h	5	l-m	2	Negative	1
AF63	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	5	h	5	l-m	2	Negative	1
AF64	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	5	h	5	l-m	2	Negative	1
AF66	a		Africa	CAF	Cameroon, Northwest	h	5	h	5	l-m	2	Negative	1
AF67	a	Yes	Africa	CAF	Cameroon, Northwest	h	5	h	5	l-m	2	Negative	1
AF70	a	Yes	Africa	CAF	Cameroon, Southwest	h	5	m-h	4	m	3	Negative	1
AF85	a	Yes	Africa	CEAF	Rwenzori Mountains, Kazeze district, Uganda	h	5	h	5	m	3	Negative	1
AF89	a	Yes	Africa	WAF	Benin, Dassari	h	5	h	5	l-m	2	Negative	1
AF91	a	Yes	Africa	WAF	Benin, Dassari	h	5	h	5	l-m	2	Negative	1
AF92	a	Yes	Africa	WAF	Guinea, Fouta Djallon	h	5	h	5	m-h	4	Negative	1
AF111	a		Africa	SEAF	Madagascar	h	5	h	5	m	3	Negative	2
AF126	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	5	h	5	m	3	Negative	1
AF123	a	Yes	Africa	NEAF	Kenya, Nakuru	m	3	h	5	m	3	Negative	1
AF119	a		Africa	NEAF	Kenya, Kakamega	m-h	4	h	5	m	3	Negative	1

Code; N°. of codes	Syst.	LCP; N° . of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
AF120	a		Africa	NEAF	Kenya, Kakamega	m-h	4	h	5	m	3	Negative	1
AF61	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	5	l-m	2	l-m	2	Negative	1
AF62	a	Yes	Africa	CAF	DRC, Mt Kahuzi area	h	5	l-m	2	l-m	2	Negative	1
AF65	a	Yes	Africa	CAF	Cameroon, Mt Oku and Mt Mbam	h	5	m	3	l-m	2	Negative	1
AF112	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	3	m	3	m	3	Negative	1
AF113	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	3	m	3	m	3	Negative	1
AF117	a	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	3	m	3	m	3	Negative	1
AF99	a	Yes	Africa	SEAF	Madagascar	h	5	h	5	m	3	Positive	1
AF102	a	Yes	Africa	SEAF/CEAF/ CAF	African Mountains: Drakensberg (South Africa), Mt Maloti (Lesotho) and Chimanimani Mountains(Zimbabwe); Highlands of Kenya, Mt Elgon (Uganda); and Mt Cameroon (Cameroon)	h	5	h	5	m-h	4	Negative	2
AF128	a	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	5	m-h	4	m	3	Negative	1
AF130	a	Yes	Africa	CEAF	Tanzania, Mt. Kilimanjaro	m	3	m	3	l-m	2	Negative	1
AF132	a	Yes	Africa	CEAF	Tanzania, Udzungwa mountains	m	3	l	1	l	1	Negative	1
AF137	a	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	5	l-m	2	l	1	Negative	1
AF138	a	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	5	l	1	l	1	Negative	1
55	a	51	Africa	-	-	h	4.5	h	3.9	l-m	2.1	56	57
LC3	a	Yes	Asia	Himalayas	Bhutan	h	5	m	3	l-m	2	Negative	7
LC4	a	Yes	Asia	Himalayas	India	h	5	m	3	m	3	Negative	4
LC5	a	Yes	Asia	Himalayas	Nepal	h	5	m	3	m	3	Negative	3
LC11	a	Yes	Asia	Himalayas	India	vh	6	m	3	m	3	Unclear	3
LC13	a	Yes	Asia	Hindukush	Pakistan	vh	6	m	3	m	3	Unclear	2
LC14	a	Yes	Asia	Himalayas	Nepal	vh	6	m	3	m	3	Unclear	2
LC15	a	Yes	Asia	Tibet	China	vh	6	m	3	m	3	Unclear	2
LC7	a	Yes	Asia	Tibet	China	h	5	m	3	m-h	4	Negative	6
LC6	a	Yes	Asia	Himalayas	Nepal, India	vh	6	m	3	m-h	4	Negative	4
9	a	9	Asia	-	-	vh	5.6	m	3.0	m	3.1	5	33
A31	a	Yes	CSA	Andes	Peru	h	5	h	5	h	5	Negative	1
A9	a		CSA	Andes	Peru	m	3	m/h	4	h	5	Negative	1
A59	a	Yes	CSA	Andes	Peru	m	3	m	3	l	1	Negative	1
LC108	a	Yes	CSA	Andes	Cauca, Colombia	h	5	m	3	l-m	2	Negative	1
LC109	a	Yes	CSA	Andes	Narino, Colombia	m-h	4	m	3	l-m	2	Negative	1
A23	a	Yes	CSA	Andes	Peru	m	3	h	5	m	3	Negative	1
LC16	a	Yes	CSA	Andes	Peru	h	5	m	3	m	3	Unclear	1

Code; N°. of codes	Syst.	LCP; N°. of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
A24	a	Yes	CSA	Andes	Colombia	m	3	m	3	m	3	Negative	1
A54	a	Yes	CSA	Andes	Chile	h	5	m-h	4	m	3	Negative	1
LC106	a	Yes	CSA	Andes	Ecuador, Cotacachi	h	5	m-h	4	m-h	4	Unclear	1
A18	a	Yes	CSA	Andes	Bolivia	h	5	h	5	l	1	Negative	1
11	a	10	CSA	-	-	h	4.2	m	3.8	m	2.9	9	11
ECO9	a		Europe	Alps	French/Italian Alps	m-h	4	m	3	l-m	2	Negative	1
1	a	0	Europe	-	-	m-h	4.0	m	3.0	l-m	2.0	1	1
76	**a**	**70**	**Global**	**Global**	**Global**		**4.5**		**3.4**		**2.5**	**71**	**102**
AF118	c		Africa	NEAF	Kenya, Mt. Kenya	h	5	h	5	h	5	Negative	2
C9	c		Africa	Africa	East Africa	vh	6	m	3	l-m	2	Negative	5
AF98	c	Yes	Africa	SEAF	Lesotho	h	5	h	5	m-h	4	Negative	1
3	c	1	Africa	-	-	h	5.3	h	4.3		3.7	8	8
LC1	c	Yes	Asia	Himalayas	Nepal, India	h	5	h	5	h	5	Negative	5
D10	c		Asia	Central Asia	Tajikistan, Kyrgyzstan, Kazakhstan, Uzbekistan	h	5	h	5	h	5	Negative	3
D7	c		Asia	Himalaya	Bhutan, Nepal, India	vh	6	h	5	h	5	Negative	6
D8	c		Asia	Tibet	China	vh	6	h	5	h	5	Negative	7
C6	c		Asia	Asia	Caucasus and middle East	vh	6	h	5	h	5	Negative	2
C12	c		Asia	Asia	Tien Shan	h	5	h	5	m-h	4	Negative	1
C13	c		Asia	Asia	Tibet	h	5	h	5	m-h	4	Negative	1
C14	c		Asia	Asia	Mongolia	h	5	h	5	m-h	4	Negative	1
C7	c		Asia	Asia	High mountain Asia	vh	6	m-h	4	m-h	4	Negative	2
9	c	5	Asia	-	-	h	5.4	h	4.9	h	4.6	9	28
C8	c		Australia	New Zealand	NZ Alps	vh	6	h	5	h	5	Negative	2
1	c	0	Australia	-	-	vh	6	h	5	h	5	1	2
A36	c		CSA	Andes	Colombia	h	5	h	5	h	5	Negative	3
A37	c		CSA	Andes	Peru	h	5	h	5	h	5	Negative	2
A37	c		CSA	Andes	Bolivia	h	5	h	5	h	5	Negative	2
A38	c		CSA	Andes	Chile	h	5	h	5	h	5	Negative	2
A39	c		CSA	Andes	Chile	h	5	h	5	h	5	Negative	3
A40	c		CSA	Andes	Argentina	h	5	h	5	h	5	Negative	1
A57	c	Yes	CSA	Andes	Peru	h	5	h	5	h	5	Negative	1
D11	c		CSA	Andes	Peru	h	5	h	5	h	5	Negative	2
A19	c	Yes	CSA	Andes	Peru	m-h	4	h	5	h	5	Negative	1
A16	c		CSA	Andes	Peru	vh	6	h	5	h	5	Negative	2
A32	c		CSA	Andes	Colombia	vh	6	h	5	h	5	Negative	1
A33	c		CSA	Andes	Peru	vh	6	h	5	h	5	Negative	1
A34	c		CSA	Andes	Peru	vh	6	h	5	h	5	Negative	1
A35	c		CSA	Andes	Argentina	vh	6	h	5	h	5	Negative	1
C1	c		CSA	Andes	southern Andes	vh	6	h	5	h	5	Negative	2
C2	c		CSA	Andes	tropical Andes	vh	6	h	5	h	5	Negative	2

Code; N°. of codes	Syst.	LCP; N° . of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
A14	c		CSA	Andes	Chile	h	5	h/h	5	h	5	Negative	1
A15	c		CSA	Andes	Chile and Argentina	h	5	m	3	h	5	Negative	1
LC104	c	Yes	CSA	Andes	Peru, Colca	m	3	m	3	l-m	2	Negative	1
D12	c		CSA	Andes	Patagonia	h	5	m	3	m	3	Negative	2
A63	c		CSA	Andes	Chile, Argentina	m	3	m-h	4	h	5	Negative	3
21	c	3	CSA	-	-	h	5.1	h	4.7	h	4.8	35	35
D9	c		Europe	Europe	Austria	h	5	h	5	h	5	Negative	2
C10	c		Europe	Europe	Alps	h	5	h	5	h	5	Negative	1
C4	c		Europe	Europe	Central Europe	vh	6	h	5	h	5	Negative	2
C5	c		Europe	Scandinavia	Scandinavia	vh	6	h	5	h	5	Negative	2
C11	c		Europe	Scandinavia	Scandinavia	h	5	h	5	m-h	4	Negative	1
5	c	0	Europe	-	-	h	5.4	h	5.0	h	4.8	8	8
C3	c		NAM	North America	W Canada, mainland USA	vh	6	h	5	h	5	Negative	2
1	c	0	NAM	-	-	vh	6.0	h	5.0	h	5.0	2	2
40	**c**	**9**	**Global**	**Global**	**Global**		**5.5**		**4.8**		**4.6**	**63**	**83**
LC8	co	Yes	Asia	Himalayas	Nepal, India	h	5	m	3	m	3	Negative	5
LC15	co	Yes	Asia		China	vh	6	m	3	m	3	Unclear	2
LC6	co	Yes	Asia	Himalayas	Nepal, India	vh	6	m	3	m-h	4	Negative	4
3	co	11	Asia	-	-	vh	5.7	m	3.0	m	3.3	9	11
A48	co		CSA	Andes	Peru	h	5	h	5	h	5	Negative	3
LC9	co	Yes	CSA	Andes	Bolivia	h	5	l	1	l-m	2	Negative	2
LC10	co	Yes	CSA	Andes	Peru	h	5	l	1	l-m	2	Negative	2
LC12	co	Yes	CSA	Andes	Colombia	h	5	l	1	l-m	2	Negative	2
LC109	co	Yes	CSA	Andes	Narino, Colombia	m-h	4	m	3	l-m	2	Negative	1
LC110	co	Yes	CSA	Andes	Pasto, Colombia and Ecuador	m-h	4	m	3	l-m	2	Negative	1
A56	co	Yes	CSA	Andes	Chile	m	3	m	3	m	3	Negative	1
7	co	9	CSA	-	-	h	4.4	l	2.4	l-m	2.6	12	12
10	**co**	**20**	**Global**	**Global**	**Global**		**5.0**		**2.7**		**3.0**	**21**	**23**
AF78	d	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	5	h	5	l-m	2	Negative	1
AF57	d	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	3	m	3	l	1	Negative	1
2	d	2	Africa	-	-		4.0		4.0		1.5	2	2
D6	d		Asia	Himalaya	Uttarakhand, India	m	3	m	3	l	1	Negative	2
LC3	d	Yes	Asia	Himalayas	Bhutan	h	5	m	3	l-m	2	Negative	7
LC4	d	Yes	Asia	Himalayas	India	h	5	m	3	m	3	Negative	4
LC5	d	Yes	Asia	Himalayas	Nepal	h	5	m	3	m	3	Negative	3
D4	d		Asia	Himalaya	Bhutan, Nepal, India	h	5	l	1	l	1	Negative	5
D13	d		Asia	Himalaya	India, Nepal, Bhutan	l	1	l	1	l	1	Negative	3
D26	d		Asia	Kullu, Western Himalaya	India	l	1	m	3	l	1	Negative	1
7	d	14	Asia	-	-	5	3.6	3	2.4	1	1.7	25	25

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D2	d		Australia	New Zealand	NZ Alps	m	3	m	3	m	3	Negative	4
1	d	0	Australia	-	-	m	3	m	3	m	3	4	4
A8	d		CSA	Andes	Argentina	m	3	m	3	l-m	2	Negative	1
A45	d		CSA	Andes	Peru and Andes	m	3	m	3	m	3	Negative	1
D5	d		CSA	Andes	Peru	m	3	l	1	vl	1	Negative	3
A65	d		CSA	Andes	Peru	vh	6	h	5	h	5	Negative	1
A66	d		CSA	Andes	Chile	m	3	m	3	h	5	Negative	1
A67	d		CSA	Andes	Chile	m	3	m	3	m	3	Negative	1
D15	d		CSA	Bolivian Andes	Bolivia	h	5	vh	6	h	5	Negative	2
7	d	0	CSA	-	-	m	3.7	m	3.4	h	3.4	10	10
D1	d		Europe	Europe	Alps	h	5	h	5	h	5	Negative	7
D3	d		Europe	Italy	Italy	l	1	l	1	l	1	Positive	1
D18	d		Europe	Alps	Switzerland	h	5	vh	6	h	5	Negative	2
D20	d		Europe		Switzerland	h	5	m	3	m	3	Negative	3
D21	d		Europe	European Alps	Italy, France, Austria, Switzerland	h	5	l-m	2	l	1	Negative	5
D22	d		Europe	European Alps	Italy, France, Austria, Switzerland	h	5	l	1	l	1	Negative	4
D23	d		Europe	European Alps	Italy, France, Austria, Switzerland	h	5	l	1	l	1	Positive	3
D24	d		Europe	French Alps	France	m	3	m	3	m	3	Positive	2
D25	d		Europe	Tatra mountains	Poland	l	1	l	1	l	1	Positive	1
9	d	0	Europe	-	-	h	3.9	l	2.6	l	2.3	21	28
D14	d		NAM	British Columbia	Canada	h	5	l	1	l	1	Positive	1
D16	d		NAM	British Columbia	Canada	l	1	l	1	l	1	Negative	1
D19	d		NAM	St Elias mountains, Glacier Bay	Alaska/USA	m	3	l	1	l	1	Negative	2
D27	d		NAM	Gulf of Alaska	USA	h	5	h	5	h	5	Negative	2
4	d	0	NAM	-	-	h	3.5	l	2.0	l	2.0	5	6
30	**d**	**16**	**global**	**global**	**global**		**3.6**		**2.9**		**2.3**	**67**	**75**
AF134	h	yes	Africa	CEAF	Tanzania, Udzungwa mountains	m	3	l	1	l	1	Negative	1
1	h	1	Africa	-	-	m	3.0	l	1.0	l	1.0	1	1
A13	h		CSA	Andes	Colombia (Cali)	h	5	h	5	h	5	Negative	1
A31	h	Yes	CSA	Andes	Peru	m	3	h	5	h	5	Negative	1
A50	h		CSA	Andes	Colombia	m	3	l	1	l	1	Negative	1
A23	h	Yes	CSA	Andes	Peru	m	3	h	5	m	3	Negative	1
A6	h		CSA	Andes	Chile	vh	6	h	5	m	3	Negative	1
A5	h		CSA	Andes	Chile	vh	6	m	3	l-m	2	Negative	1
6	h	2	CSA	-	-	m	4.3	h	4.0	h	3.2	6	6

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7	**h**	**3**	**Global**	**Global**	**Global**		**3.7**		**2.5**		**2.1**	**7**	**7**
AF129	m	Yes	Africa	CEAF	Tanzania, North Pare highlands	h	5	m	3	l-m	2	Negative	1
AF135	m	Yes	Africa	CEAF	Uganda, Nakasongola district	h	5	l-m	2	l	1	Negative	1
AF136	m	Yes	Africa	CEAF	Tanzania, Ngorongoro area	h	5	l-m	2	l	1	Negative	1
3	m	3	Africa	-	-	h	5.0	l-m	2.3	l	1.3	3	3
A20	m	Yes	CSA	Andes	Bolivia	m	3	h	5	h	5	Negative	1
A60	m	Yes	CSA	Andes	Peru	h	5	m	3	m	3	Negative	1
A61	m	Yes	CSA	Andes	Peru	h	5	m	3	m	3	Negative	1
A62	m	Yes	CSA	Andes	Bolivia	m	3	m	3	m	3	Negative	1
4	m	4	CSA	-	-	m	4.0	m	3.5	m	3.5	4	4
7	**m**	**7**	**Global**	**Global**	**Global**		**4.5**		**2.9**		**2.4**	**7**	**7**
AF107	t		Africa	SEAF	Lesotho	h	5	h	5	m-h	4	Negative	1
1	t	0	Africa	-	-	h	5.0	h	5.0	m-h	4.0	1	1
T10	t		Asia	Asia	Yylong Snow mtn, China	h	5	h	5	h	5	Negative	1
T13	t	Yes	Asia	Solokhumbu district	Nepal	m	3	m-h	4	m	3	Negative	1
T17	t		Asia	Albroz range	Iran	h	5	m-h	4	m	3	Negative	1
3	t	1	Asia	-	-	h	4.3	m-h	4.3	m	3.7	3	3
T20	t		Australia	Australian Alps	Australia	m	3	m-h	4	m	3	Negative	1
1	t	0	Australia	-	-	m	3	m-h	4	m	3	1	1
A17	t	Yes	CSA	Andes	Bolivia	h	5	h	5	h	5	Negative	1
T9	t		CSA	Andes	Chacaltaya, Bolivia	vh	6	h	5	h	5	Negative	1
A69	t	Yes	CSA	Andes	Peru	h	5	h	5	h	5	Negative	1
3	t	2	CSA	-	-	h	5.3	h	5.0	h	5.0	3	3
T6	t		Europe	Europe	French Alps	h	5	h	5	h	5	Negative	4
T7	t		Europe	Europe	Austria	h	5	h	5	h	5	Negative	2
T8	t		Europe	Caucasus	Caucasus	m	3	m	3	l-m	2	Negative	1
T4	t		Europe	Scandinavia	Finland	m	3	m	3	m	3	Negative	1
T11	t	Yes	Europe	Alps	France, Austria	h	5	h	5	h	5	Negative	2
T12	t		Europe	Alps	France, Switzerland	h	5	h	5	h	5	Negative	1
T14	t		Europe		Slovenia, Iceland, France	vh	6	vh	6	h	5	Negative	3
T15	t		Europe		Norway	h	5	m-h	4	m-h	4	Negative	1
T18	t		Europe	Alps	Austria	m-h	4	h	5	h	5	Positive	1
T19	t		Europe	Alps	Austria	m-h	4	m-h	4	m-h	4	Positive	1
10	t	2	Europe	-	-	h	4.5	h	4.5	h	4.3	15	17
T5	t		NAM	North America	western USA	h	5	h	5	h	5	Negative	2
T3	t		NAM	North America	Alaska	m	3	m	3	m	3	Negative	1

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T1	t		NAM	North America	New England USA	h	5	h	5	m-h	4	Negative	1
T2	t		NAM	North America	New Hampshire USA	h	5	h	5	m-h	4	Negative	1
4	t	0	NAM	-	-	h	4.5	h	4.5	m-h	4.0	5	5
22	**t**	**5**	**global**	**global**	**global**		**4.4**		**4.6**		**4.0**	**28**	**30**
AF87	te	Yes	Africa	CEAF	Rwanda, Volcanoes NP	m	3	h	5	l	1	Negative	1
AF103	te		Africa	SEAF	South Africa, Maloti-Drakensberg	h	5	l	1	l	1	Unclear	1
AF2	te		Africa	SWAF	NW Namibia	m	3	l-m	2	l	1	Negative	1
AF110	te		Africa	SWAF	South Africa, Table mountain NP	m	3	m	3	l	1	Unclear	1
AF58	te	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	3	m	3	l	1	Negative	1
AF115	te		Africa	NEAF	Kenya, Mt. Kenya region	h	5	h	5	m	3	Negative	1
AF100	te	Yes	Africa	SWAF/SEAF	Southern Africa	h	5	m	3	m	3	Negative	1
AF106	te		Africa	SWAF	South Africa, Table mountains	m	3	m	3	l-m	2	Negative	1
AF101	te	Yes	Africa	SWAF/SEAF	Southern Africa	h	5	m-h	4	m	3	Negative	1
AF3	te		Africa	SWAF	Namibia	h	5	h	5	m-h	4	Negative	1
AF10	te		Africa	SEAF	South Africa, Drakensberg, Namahadi Catchment	h	5	h	5	m-h	4	Negative	1
AF108	te		Africa	NEAF/(SEAF)	Mountains pan-tropical belt	m	3	h	5	m-h	4	Negative	1
TE117	te		Africa	Abune Josef range	Ethiopia	m	3	l	1	l	1	Negative	1
TE82	te		Africa	SWAF/SEAF	Mediterranean forests	m	3	m	3	l	1	Unclear	1
14	te	4	Africa	-	-	m	3.9	m	3.4	l	2.1	11	14
LC2	te	Yes	Asia	Himalayas	Nepal, India	h	5	m	3	l-m	2	Negative	3
TE33	te		Asia	Quilian Mountains	China	m	3	m	3	m	3	Unclear	1
TE54	te		Asia	Altay prefecture	China	m	3	m	3	m	3	Negative	1
TE79	te	Yes	Asia	Uttarakhand	India	h	5	m	3	l	1	Negative	1
TE93	te		Asia	Pamir Alay and Tien Shan ranges	Uzbekistan and Kyrgyzstan	m	3	m	3	m	3	Negative	1
TE111	te	Yes	Asia	Upper Kedarnath Valley	India	h	5	h	5	h	5	Unclear	1
TE127	te		Asia	Ruoergai Plateau	Tibet, China	h	5	m	3	m	3	Negative	1
7	te	3	Asia	-	-	h	4.1	m	3.3	m	2.9	7	9
TE82	te		Australia	Mediterranean forests	SAU	m	3	m	3	l	1	x	1
1	te	0	Australia	-	-	m	3	m	3	l	1	0	1
A30	te		CSA	Andes	Argentina	m	3	m	3	l	1	Negative	1
A12	te		CSA	Andes	Colombia (Bogota)	h	5	h	5	h	5	Unclear	1

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A25	te		CSA	Andes	Peru	h	5	h	5	h	5	Negative	1
A55	te	Yes	CSA	Andes	Chile	m	3	h	5	h	5	Negative	1
A4	te		CSA	Andes	Chile	vh	6	h	5	h	5	Negative	1
A46	te		CSA	Andes	Ecuador	vh	6	h	5	h	5	Negative	2
A47	te		CSA	Andes	Peru	vh	6	h	5	h	5	Positive	1
A26	te		CSA	Andes	Argentina	h	5	l	1	l	1	Negative	1
LC105	te	Yes	CSA	Andes	Bolivia, Sajama	h	5	m	3	l-m	2	Negative	1
LC110	te	Yes	CSA	Andes	Pasto, Colombia and Ecuador	m-h	4	m	3	l-m	2	Unclear	1
A28	te		CSA	Andes	Bolivia	h	5	m	3	m	3	Positive	1
A24	te	Yes	CSA	Andes	Colombia	l	1	m	3	m	3	Negative	1
A5	te		CSA	Andes	Chile	vh	6	m	3	l-m	2	Negative	1
TE75	te		CSA	Patagonia	South America	h	5	vh	6	h	5	Negative	1
TE86	te		CSA	Tropical high-Andean Puna		m	3	m	3	l	1	Negative	1
TE82	te		CSA	Mediterranean forests		m	3	m	3	l	1	Unclear	1
16	te	4	CSA	-	-	h	4.4	m	3.8	h	3.2	12	17
TE16	te		Europe	Sierra Nevada	Spain	h	5	h	5	h	5	Unclear	1
TE43	te		Europe	French Alps	France	h	5	h	5	h	5	Unclear	1
TE51	te		Europe	Carpathian Mountains	Romania	l	1	m	3	m	3	Unclear	1
TE52	te		Europe	Tatra Mountains	Slovakia	m	3	l	1	l	1	Negative	1
TE63	te		Europe	Swiss Alps	Switzerland	m	3	h	5	h	5	Unclear	1
TE81	te		Europe	Parangalitsa Forest Reserve	Bulgaria	m	3	l	1	l	1	Negative	1
TE113	te		Europe	Central Pyrenees	Spain	m	3	l	1	l	1	Unclear	1
TE82	te		Europe	Mediterranean	global	m	3	m	3	l	1	Unclear	1
8	te	0	Europe	-	-	m	3.3	h	3.0	l	2.8	2	8
TE68	te		NAM	Sierra Nevada	California, USA	h	5	h	5	m	3	Negative	1
TE97	te		NAM	US Rocky Mountains	USA	h	5	m	3	m	3	Negative	1
TE82	te		NAM	Mediterranean	global	m	3	m	3	l	1	Unclear	1
3	te	0	NAM	-	-	h	4.3	m	3.7	m	2.3	2	3
49	**te**	**11**	**Global**	**Global**	**Global**		**3.8**		**3.4**		**2.4**	**34**	**52**
W1	w		Africa	East Africa	Upper Blue Nile	h	5	l-m	2	m	3	Positive	2
AF69	w	Yes	Africa	CAF	Nigeria, Riyom and Jos Plateau	h	5	h	5	l-m	2	Negative	1
AF77	w	Yes	Africa	CEAF	Uganda, Mt Elgon area	h	5	h	5	l-m	2	Negative	1
AF73	w	Yes	Africa	CAF	Nigeria, Taraba state	m	3	h	5	l-m	2	Negative	1
W2	w		Africa	East Africa	Tanzania	m	3	l-m	2	l-m	2	Negative	3

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AF52	w	Yes	Africa	CAF	DRC, Bukavu area	h	5	m	3	l	1	Negative	1
AF53	w	Yes	Africa	CAF	DRC, Bukavu area	m	3	m	3	l	1	Negative	1
AF95	w	Yes	Africa	WAF	Sierra Leone, Kono district	m	3	m	3	l-m	2	Negative	1
AF114	w	Yes	Africa	NEAF	Kenya, Mt Kenya region	m	3	m	3	l-m	2	Negative	1
AF49	w	Yes	Africa	CAF	Cameroon, Bui Division	h	5	m-h	4	l-m	2	Negative	1
AF90	w	Yes	Africa	WAF	Benin, Dassari	h	5	h	5	l-m	2	Negative	1
AF93	w		Africa	WAF	Guinea, Fouta Djallon	h	5	h	5	l-m	2	Unclear	1
AF125	w	Yes	Africa	NEAF	Kenya, Mt Marsabit, Mt Kulal and Mt Nyiro	h	5	h	5	m	3	Negative	1
AF55	w	Yes	Africa	CAF	DRC, Mt Kahuzi area	m	3	h	5	l-m	2	Negative	1
14	w	11	Africa	-	-	h	4.1	h	3.9	l-m	2.0	14	17
W26	w		Asia	Central Asia	Syr Darya, lower/middle reaches	m	3	l	1	l	1	Negative	1
W9	w		Asia	Central Asia	Tarim River, Tien Shan	m	3	l-m	2	l	1	Negative	1
W4	w		Asia	South Asia	SW Ghats, India	l	1	m	3	l	1	Negative	1
W20	w	Yes	Asia	Himalaya	Nepal, India	l-m	2	m	3	l-m	2	Negative	1
W22	w		Asia	Himalaya	Nepal	m	3	m	3	l	1	Negative	1
LC1	w	Yes	Asia	Himalayas	Nepal, India	h	5	m	3	l-m	2	Negative	5
W40	w		Asia	Central Asia	Upper Amu Darya r.	l-m	2	m	3	l-m	2	Negative	1
W24	w		Asia	Himalaya	India	m	3	m	3	l-m	2	Negative	1
W5	w		Asia	Middle East	Zagros Mountains, Iran	m	3	h	5	m	3	Negative	1
W25	w		Asia	Himalaya	Upper Indus	m	3	h	5	m	3	Negative	1
W12	w		Asia	Middle East	Anatolia, Turkey	m-h	4	h	5	m-h	4	Unclear	1
W8	w		Asia	Central Asia	Tarim River, Tien Shan	l-m	2	m	3	m	3	Positive	1
W35	w		Asia	Himalaya	Chota Shigri, India	m	3	m	3	m	3	Positive	1
W36	w		Asia	Central Asia	Tien Shan	m	3	m	3	m	3	Positive	1
W23	w		Asia	Karakoram	Central and Eastern Karakoram	m	3	m-h	4	m	3	Unclear	1
W31	w		Asia	Karakoram	Upper Indus	m	3	m-h	4	m	3	Positive	1
W32	w		Asia	Karakoram	Upper Indus	m	3	m-h	4	m	3	Negative	1
W7	w		Asia	Central Asia	Tarim River, Tien Shan	h	5	h	5	m-h	4	Positive	1
W9	w		Asia	Central Asia	Tarim River, Tien Shan	m	3	h	5	m-h	4	Positive	1
W34	w		Asia	Central Asia	Tien Shan	m	3	h	5	m-h	4	Positive	1
W41	w		Asia	Central Asia	Aksu r.	m	3	m	3	m	3	Positive	2
W26	w		Asia	Central Asia	Syr Darya, upper reaches	m	3	m-h	4	m-h	4	Positive	1
22	w	6	Asia	-	-	m	3.0	m	3.6	m	2.7	15	27
W3	w		Australia	Australia	New South Wales, AU	m	3	h	5	m	3	Negative	1
W45	w		Australia	SAU	Murrumbidgee River	m	3	h	5	m	3	Negative	1
2	w	0	Australia	-	-	m	3.0	h	5.0	m	3.0	2	2
A8	w		CSA	Andes	Argentina	m	3	m	3	l-m	2	Negative	1
A42	w		CSA	Andes	Peru-Bolivia	m	3	h	5	h	5	Negative	2

Code; N°. of codes	Syst.	LCP; N°. of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ un-clear); N° of Neg. Im.	N° Pub.
A43	w		CSA	Andes	Peru-Brazil	m	3	h	5	h	5	Negative	1
A43	w		CSA	Andes	Argentina	m	3	h	5	h	5	Negative	1
A44	w		CSA	Andes	Peru	m	3	h	5	h	5	Negative	1
A19	w	Yes	CSA	Andes	Peru	m-h	4	h	5	h	5	Negative	1
A41	w		CSA	Andes	Colombia	m-h	4	h	5	h	5	Negative	2
A52	w	Yes	CSA	Andes	Bolivia	h	5	h	5	l	1	Negative	1
W33	w		CSA	Andes	Argentina, Chile	l	1	l	1	l	1	Positive	1
A53	w	Yes	CSA	Andes	Chile	m	3	m	3	l	1	Negative	1
LC103	w	Yes	CSA	Andes	Peru, Colca	m-h	4	l	1	l	1	Negative	1
A11	w		CSA	Andes	Ecuador	h	5	l-m	2	l-m	2	Negative	1
LC107	w	Yes	CSA	Andes	Huancavelica, Peru	h	5	l-m	2	l-m	2	Negative	1
LC109	w	Yes	CSA	Andes	Narino, Colombia	h	5	m	3	l-m	2	Negative	1
A7	w		CSA	Andes	All Andes and Chile	m	3	m	3	l-m	2	Negative	1
A58	w	Yes	CSA	Andes	Peru	m	3	m	3	l-m	2	Negative	1
W21	w		CSA	Andes	Argentina	m-h	4	m	3	l-m	2	Positive	2
A51	w	Yes	CSA	Andes	Bolivia	h	5	h	5	m	3	Negative	1
A22	w	Yes	CSA	Andes	Venezuela	m	3	h	5	m	3	Negative	1
A22	w	Yes	CSA	Andes	Colombia	m	3	h	5	m	3	Negative	1
A23	w	Yes	CSA	Andes	Peru	m	3	h	5	m	3	Negative	1
A1	w		CSA	Andes	Chile	vh	6	h	5	m	3	Negative	2
LC100	w	Yes	CSA	Andes	Ecuador, Chimborazo	h	5	m	3	m	3	Negative	1
LC108	w	Yes	CSA	Andes	Cauca, Colombia	h	5	m	3	m	3	Negative	1
W11	w		CSA	Andes	Cord. Blanca, Peru	h	5	m-h	4	m-h	4	Negative	2
LC101	w	Yes	CSA	Andes	Peru, Santa r.	m	3	h	5	m-h	4	Negative	1
A2	w		CSA	Andes	W Patagonia	vh	6	h	5	m-h	4	Negative	1
A3	w		CSA	Andes	Bolivia	h	5	m-h	4	m	3	Negative	1
D17	w		CSA	Andes	Bolivian altiplano	m	3	m	3	l	1	Negative	1
29	w	14	CSA	-	-	m	3.9	h	3.8	m	2.9	31	34
W13	w		Europe	Alps	Switzerland	h	5	h	5	h	5	Unclear	1
W17	w		Europe	Alps	Rhone, Po, Danube, Europe	h-vh	6	l-m	2	l	1	Negative	3
W44	w		Europe	Europe	Adiger., Italy	m	3	m	3	m	3	Unclear	1
W6	w		Europe	Alps	Italy (mostly)	h	5	m	3	m	3	Negative	1
W43	w		Europe	Europe	Pyrenees, Ebro	h	5	m	3	m	3	Negative	3
W18	w		Europe	Alps	Europe	m	3	m	3	m	3	Positive	1
W42	w		Europe	Europe	Eastern Carphathians	h	5	m-h	4	m-h	4	Unclear	1
W14	w		Europe	Scandinavia	Arctic Norway	m-h	4	m-h	4	m-h	4	Unclear	1
W39	w		Europe	Europe	Spain	m-h	4	h	5	m-h	4	Unclear	1
W17	w		Europe	Alps	Rhone, Po, Danube, Europe	h-vh	6	m-h	4	m-h	4	Unclear	3
W19	w		Europe	Alps	Austria	m-h	4	m-h	4	m-h	4	Unclear	1
W29	w		Europe	Scandinavia	Northern Sweden	m-h	4	m-h	4	m-h	4	Positive	1

Code; N°. of codes	Syst.	LCP; N°. of (yes)	IPCC region	IPCC sub-region/ sub-regions	Location/country	Conf. Det. (index); mode	Conf. Det. (value); mean	Contr. C.C. (index); mode	Contr. C.C. (value); mean	Conf. Att. (index); mode	Conf. Att. (value); mean	Impact (neg/posit/ unclear); N° of Neg. Im.	N° Pub.
W30	w		Europe	Scandinavia	Northern Sweden	m-h	4	m-h	4	m-h	4	Negative	1
13	w	0	Europe	-	-	m-h	4.5	m-h	3.7	m-h	3.5	4	19
W10	w		NAM	North America	Rockies, Canada	h	5	h	5	h	5	Unclear	1
W28	w		NAM	North America	BC, Canada	l	1	m	3	m	3	Negative	1
W28	w		NAM	North America	BC, Canada	m	3	m	3	m	3	Positive	1
W37	w		NAM	North America	USA	m	3	m	3	m	3	Unclear	1
W38	w		NAM	North America	Western N. America	m	3	m	3	m	3	Unclear	1
W27	w		NAM	North America	Columbia River, South and Central Canada	m	3	h	5	h	5	Negative	1
W16	w		NAM	North America	Rockies, Canada	m-h	4	m	3	m-h	4	Positive	1
W15	w		NAM	North America	Rockies, Canada	m-h	4	m-h	4	m-h	4	Negative	1
8	w	0	NAM	-	-	m	3.3	m	3.6	m	3.8	3	8
88	**w**	**31**	**Global**	**Global**	**Global**		**3.6**		**3.9**		**3.0**	**69**	**107**

Table SMCCP5.14 | Summary table ordered by region and system supporting figure CCP5.4. Abbreviations in table: System (Syst.), Number of publications consulted (N° Pub.), percentage of local community perception taken into account (% LCP), Confidence of detection (Conf. Det.), Contribution of climate change (Contr. C.C.), Confidence of attribution (Conf. Att.) and percentage of impacts that are negative (% Neg. Im.). Confidences and contributions can be l=*low*, m=*medium*, h=*high* and vh=*very high*.

IPCC Continental Region	Syst.	N° Pub.	% LCP	Conf. Det.	Contr. C.C.	Conf. Att.	% Neg. Im.
Africa	a	57	89%	h	m	m	98%
Africa	c	8	13%	h	h	m	100%
Africa	d	2	100%	h	h	l	100%
Africa	h	1	100%	m	l	l	100%
Africa	m	3	100%	h	m	l	100%
Africa	te	14	29%	m	m	m	79%
Africa	t	1	0%	h	h	h	100%
Africa	w	17	65%	h	m	m	82%
Asia	a	33	100%	vh	m	m	73%
Asia	c	28	18%	h	h	h	100%
Asia	co	11	100%	vh	m	m	82%
Asia	d	25	56%	m	m	l	100%
Asia	t	3	33%	h	h	m	100%
Asia	te	9	56%	h	m	m	78%
Asia	w	27	22%	m	m	m	56%
Australasia	c	2	0%	vh	h	h	100%
Australasia	d	4	0%	m	m	m	100%
Australasia	te	1	0%	m	m	l	0%
Australasia	w	2	0%	m	h	m	100%
Australasia	t	1	0%	m	h	m	100%
CSA	a	11	91%	h	m	m	82%
CSA	c	35	9%	h	h	h	100%
CSA	co	12	75%	h	m	m	100%

IPCC Continental Region	Syst.	N° Pub.	% LCP	Conf. Det.	Contr. C.C.	Conf. Att.	% Neg. Im.
CSA	d	10	0%	m	m	m	100%
CSA	h	6	33%	h	h	m	100%
CSA	m	4	100%	h	m	m	100%
CSA	t	3	67%	h	h	h	100%
CSA	te	17	24%	h	m	m	71%
CSA	w	34	41%	m	m	m	91%
Europe	a	1	0%	h	m	m	100%
Europe	c	8	0%	h	h	h	100%
Europe	d	28	0%	m	m	m	75%
Europe	t	17	12%	h	h	h	88%
Europe	te	8	0%	m	m	m	25%
Europe	w	19	0%	h	m	m	42%
NAM	c	2	0%	vh	h	h	100%
NAM	d	6	0%	m	m	m	83%
NAM	t	5	0%	h	h	h	100%
NAM	te	3	0%	h	m	m	67%
NAM	w	8	0%	m	m	m	38%
Global	a	102	69%	h	m	m	70%
Global	c	83	11%	vh	h	h	76%
Global	co	23	87%	h	m	m	91%
Global	d	75	21%	m	m	m	89%
Global	h	7	43%	m	m	m	100%
Global	m	7	100%	h	m	m	100%
Global	t	30	17%	h	h	m	93%
Global	te	52	21%	m	m	m	65%
Global	w	107	29%	m	m	m	64%

SMCCP5.3 Analysis of Articles Reporting Adaptation in Mountain Regions Included in the Global Adaptation Mapping Initiative Data Set

SMCCP5.3.1 Methods

For full reanalysis results see (McDowell et al., 2021).

SMCCP5.3.1.1 Overview

The Global Adaptation Mapping Initiative (GAMI) was a collective global effort to systematically gather and synthesise literature on climate change adaptation. GAMI reviewed thousands of peer-reviewed articles in order to develop the first systematic global assessment of empirical evidence on adaptation progress. The initiative was developed to provide synthesis results to inform the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6). More information about GAMI can be found at https://globaladaptation.github.io/.

We conducted a reanalysis of the full GAMI data set to identify articles reporting adaptations to climate change in mountain regions and then re-recalculate results specific to adaptation in mountain regions, as described in what follows.

SMCCP5.3.1.2 Document Identification

The identification of documents to be included for reanalysis followed a six-step process:

i) Open GAMI data set containing all articles included in GAMI project.
ii) Identify documents flagged by the GAMI coding team as being focused on mountains (Q1.3) in the GAMI data set. Automatically include these documents for reanalysis.
iii) Identify documents reviewed in the McDowell et al. (2019) systematic review of adaptation in glaciated mountain regions in the GAMI data set. Automatically include these documents for reanalysis.
iv) Review remaining documents in the GAMI data set individually to determine whether they provide information about adaptation associated with mountain areas (as defined by the Kapos et al. (2000) K1 criteria for mountains). Determine eligibility using the Global Mountain Explorer platform (https://rmgsc.cr.usgs.gov/

gme/gme.shtml), where location searches and visual inspections can be undertaken to determine whether reported studies are within K1 (select K1 layer, deselect all other layers). Include regional studies if at least 50% of the study region is within K1. Exclude national-scale and policy-focused studies with no obvious relevance to mountains. Note: documents do not have to be explicitly focused on mountains, they just have to report adaptations occurring within the K1 mountain area or explicitly associated with adjacent K1 terrain (e.g., adaptation to the downstream effects of glacio-hydrological change in a study site just outside of K1).

v) Construct a reference library that only contains documents reporting adaptations associated with K1 mountain areas.
vi) Construct a data set (Excel sheet) that only contains documents reporting adaptations associated with K1 mountain areas. Retain all original GAMI data that correspond with the included articles.

SMCCP5.3.1.3 Data Reanalysis

GAMI used a questionnaire to extract information about numerous variables related to adaptation from individual articles. Our reanalysis of the subsequent GAMI spreadsheet followed three steps:

i) Review, clean and reclassify GAMI data for documents reporting adaptations associated with K1 mountain areas as necessary. Any changes to the original data followed the reconciliation protocols used by GAMI, in compliance with instructions provided by the data reconciliation leader for GAMI.
ii) Calculate summary statistics for each 'restricted choice' variable.
iii) Write brief summaries for each 'restricted' and 'open' response variable.

SMCCP5.3.1.4 Caveats and Limitations

Broadly speaking the caveats and limitations that apply to the GAMI project also apply to this reanalysis. For example, adaptations reported in the peer-reviewed literature are an imperfect proxy for actual adaptation (i.e., what is reported in the literature does not capture the full reality of adaptation on the ground), the omission of grey literature leads to an underrepresentation of planned adaptations, and reviewer subjectivity can and, in our determination, does influence coding and results. Moreover, GAMI only includes information about observed adaptation action; groundwork and planning activities are not reviewed.

In addition, the GAMI project uses 'articles' as the unit of analysis, not 'discrete adaptations'. Several discrete adaptations might be reported in an individual article; the GAMI data do not provide data at the level of individual adaptations. However, discrete adaptations were the unit of analysis for McDowell et al. (2019) and, subsequently, in Chapter 2: High Mountain Areas (HMA) of the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) (Hock et al., 2019). The SROCC HMA findings and those from the GAMI reanalysis are therefore not directly comparable.

We did not include a synthesis report for the IPCC Polar Regions category (i.e., Greenland), but this has no bearing on the results because no studies were reported for Greenland.

Counts used for results are based on the assumption that text in the GAMI data set matches that provided in the codebook and that spelling mistakes were resolved by the GAMI team (e.g., COUNTIF function will not include variants or misspelled content). Various sensitivity checks were performed (e.g., 'and' vs. '&', American vs. UK English spellings), with satisfactory results.

Coding consistency among GAMI coders was often imperfect, with relatively high inter-coder variation observed for several variables. Consistent with GAMI reconciliation protocols, inter-coder discrepancies were resolved in favour of affirmative responses or, in the case of 3 or more coders for an individual document, the most commonly reported response was selected.

Lastly, several caveats related to article inclusion/exclusion include the following:

- Multi-sited studies with only some study sites within K1 were excluded so as not to bias results with reporting based on non-mountain areas (= exclusion of some potentially relevant content).
- Review studies summarising a large number of articles were excluded unless they explicitly focused on mountains (= exclusion of some potentially relevant content).
- Some articles tagged by the GAMI as being related to mountains were borderline in terms of their relevance to mountains. These were retained for consistency with our inclusion criteria (see Point 2 of STAGE 1) (inclusion of some potentially irrelevant content).

SMCCP5.3.2 GAMI Mountain Reanalysis Global Synthesis and Regional Reports

See GAMI Codebook for full list of questions and definitions of all variables reported in what follows. The Q x.x.x in each table heading refers to the specific question in the GAMI Codebook.

SMCCP5.3.2.1 Global

Globally, 423 articles report adaptation associated with K1 terrain.

Approximately 26% of all documents from GAMI (n = 1682) are associated with K1 terrain, although not necessarily framed as mountain-focused.

SMCCP5.3.2.1.1 Who is adapting?
In what regions are adaptations reported? Q 1.1.1

Region	Count	Percentage
North America	39	9
C. and S. America	46	11
Europe	26	6
Africa	157	37

Region	Count	Percentage
Asia	167	39
Australasia	6	1
Small Islands	7	2
Global	3	1

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents. Specifically, 20 articles (5%) focused on 2 or more regions.*

Synthesis Statement:

Adaptations were reported most frequently in Asia (39% of studies), closely followed by Africa (37% of studies). The Central and South American region, a distant third, accounted for 11% of studies reporting adaptations. Few studies (6%) reported adaptations occurring in Europe. The proportion of studies sited in Africa was high, in part due to a prevalence of articles in this region in the GAMI database and in part due to large areas of marginally or intermittently K1 terrain in Southern and Eastern Africa. The highest number of studies in Africa were sited in Ethiopia, where K1 terrain is particularly prevalent.

In what countries are adaptations reported? Q 1.1.1

Country	Count	Percent-age	Country	Count	Percent-age
North America			*Africa*		
United States	23	5	Ethiopia	46	11
Mexico	12	3	Kenya	39	9
Canada	6	1	Tanzania	20	5
C. and S. America			Uganda	15	4
Peru	13	3	South Africa	13	3
Colombia	8	2	Cameroon	6	1
Guatemala	8	2	Zimbabwe	5	1
Bolivia	6	1	Malawi	4	1
Brazil	5	1	Algeria	3	1
Chile	4	1	Morocco	2	<1
Ecuador	4	1	Niger	2	<1
Honduras	4	1	Rwanda	2	<1
Costa Rica	2	<1	Benin	1	<1
El Salvador	2	<1	Burkina Faso	1	<1
Nicaragua	2	<1	Central African Republic	1	<1
Argentina	1	<1	Congo	1	<1
Asia			Lesotho	1	<1
Nepal	56	13	Libya	1	<1
India	40	9	Mali	1	<1
China	37	9	Nigeria	1	<1
Pakistan	15	4	Senegal	1	<1
Iran	11	3	Swaziland	1	<1
Bhutan	8	2	Tunisia	1	<1
Mongolia	6	1	*Europe*		
Vietnam	5	1	Norway	6	1
Indonesia	4	1	Switzerland	5	1
Bangladesh	2	<1	Austria	4	1
Kazakhstan	2	<1	Spain	4	1
Kyrgyzstan	2	<1	France	3	1
Sri Lanka	2	<1	Italy	2	<1
Tajikistan	2	<1	Russia	2	<1
Thailand	2	<1	Finland	1	<1
Afghanistan	1	<1	Netherlands	1	<1
Laos	1	<1	Poland	1	<1
Lebanon	1	<1	Sweden	1	<1
Oman	1	<1	*Mediterranean (region)*	1	<1
Philippines	1	<1	*Small Islands*		
Turkey	1	<1	Fiji	2	<1
Turkmenistan	1	<1	Madagascar	2	<1
Uzbekistan	1	<1	Puerto Rico	1	<1
Australasia			Canary Islands (Spain)	1	<1
Australia	4	1	*Caribbean (region)*	1	<1
New Zealand	2	<1	*Global*	3	1

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents. Some values above differ slightly from those reported in regional summaries; regional summaries did not count countries included in multi-regional studies.*

Synthesis Statement:

Globally, the countries with the greatest number of studies reporting adaptation actions are (in descending order) Nepal (56), Ethiopia (46), India (40), Kenya (39), China (37), United States (23), Tanzania (20), Uganda (20), Pakistan (15) and Peru (15). Despite the significant area of K1 coverage, few studies reported adaptation actions in Canada (6), Chile (4), Russia (2), New Zealand (2) and Turkey (1).

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	76	18
Ocean and coastal ecosystems	3	1
Water and sanitation	118	28
Food, fibre and other ecosystem products	323	76
Cities, settlements and key infrastructure	17	4
Health, well-being and communities	112	26
Poverty, livelihoods and sustainable development	234	55

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as involved in reported adaptation actions was food, fibre and other ecosystem products (76% of studies), followed by poverty, livelihood and sustainable development (55% of studies). Approximately half as many studies reported involvement in water and sanitation (28% of studies), closely followed by health, well-being and communities (26% of studies). Few studies identified involvement in cities, settlements and key infrastructure (4%).

These results are consistent across most regions, with the exception of Europe. Poverty, livelihoods and sustainable development was not reported as a focus of any studies in Europe; water and sanitation was reported more frequently (46% of studies).

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	387	91
Local government	130	31
National government	118	28
Sub-national government	44	10
Civil society (sub-national or local)	124	29
Civil society (international, multi-national, national)	54	13
Private sector: small and medium-size enterprises	38	9
Private sector: corporations	27	6
International or multi-national governance	30	7
Other	49	12

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 91% of studies reviewed. Local governments were involved in 31% of reported adaptations, while civil society actors at the sub-national or local scale were involved in 29% of reported adaptations. Involvement of larger-scale civil society actors (international, multi-national, national) was reported less frequently. Among responses coded as 'other,' the most common actors were smallholder farmers or farming groups (41 studies). Also mentioned frequently were pastoralists; indigenous and tribal communities, leaders and governing institutions; community forest user groups and/or managing bodies; and research institutes or scientists. Organisations operating at the community level (e.g., farmers' associations, women's groups) were the most commonly noted as implementing actors. Many of these were informal, for example, kinship groups and social networks participating in cooperative adaptation efforts at the community scale.

Regional departures from global patterns: The regional analyses for Africa and Asia yielded similar results, with local governments and civil society actors approximately equally involved in adaptation efforts. In both Europe and Central and South America, civil society organisations (sub-national or local) were reported as involved actors more frequently than the global average (54% and 53% of studies respectively). In both Europe and North America, individuals or households were reported as involved actors less frequently than in the global results.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

A wide range of types of implementation tools was reported, most commonly farming-related changes (e.g., resilient or drought-tolerant crop varieties, irrigation techniques, crop storage options, micro-loans or insurance schemes for livestock farmers). Also mentioned were infrastructure developments, Indigenous knowledge (IK), community-based capacity building and ecosystem-based adaptation. Implementation of adaptation actions was more frequently autonomous than formal or planned, with approximately two thirds of studies reporting some form of autonomous adaptation. This finding was particularly distinct in farming contexts, where smallholders implemented autonomous actions such as changing crop varieties or planting strategies as approaches to coping with rapid change. Livelihood diversification was the most common autonomous adaptation. A smaller number of studies reported a combination of planned policy frameworks for adaptation on a larger scale which were implemented locally or paired with autonomous adaptation efforts. Financial incentives were the most commonly reported formal/planned implementation tool in the global analysis.

Regional results suggest that the prevalence of autonomous implementation (particularly by smallholder farmers) is highest in Africa and Asia. Ecosystem-based adaptation was more frequently reported in Central and South America than any other region. Adaptation planning was frequently reported in both Asia and North America. North America was the only region in which more adaptation efforts were formal/planned than autonomous; this was also the only region which frequently reported the adoption of informational tools (e.g., early warning systems).

Is there evidence about who financed reported adaptation actions? Q 4.2

Funding info	Count	Percentage
Yes	169	40
No	254	60

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.1.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

- Two hundred twenty articles (52%) included evidence that particularly vulnerable groups were included in adaptation planning
- Two hundred twenty-three articles (53%) included evidence that particularly vulnerable groups were targeted in adaptations.

Who is addressed in the context of equity in reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	102	24	Low-income	125	30
Indigenous	59	14	Indigenous	46	11
Women	68	16	Women	55	13
Elderly	15	4	Elderly	13	3
Migrants	7	2	Migrants	8	2
Youth	10	2	Youth	11	3
Disability	0	0	Disability	0	0
Ethnic minorities	24	6	Ethnic minorities	22	5
Other	52	12	Other	47	11
Equity not Addressed	203	48	Equity not Addressed	200	47

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Nearly half of the studies reviewed did not explicitly address equity in the context of reported adaptations. Among studies which did so, the greatest number of studies reported addressing equity for low-income individuals or populations—24% of studies addressed equity planning and 30% addressed equity targeting for low-income groups. Women were the group next most commonly identified as a focus of equity planning (16% of studies) and equity targeting (13% of studies), followed by Indigenous Peoples (equity planning: 14% of studies and equity targeting: 11% of studies). Few studies (2%) reported focusing on equity planning for youth (equity targeting: 3%). No studies reported a focus on disability in either equity planning or targeting. There were no significant discrepancies between equity planning and equity targeting foci among studies reporting on equity in adaptation actions.

Others (both equity planning and targeting): The other most mentioned was farmers, particularly smallholder farmers. Also mentioned were widows, herders or pastoralists, rural or peasant communities, and members of lower castes.

In addition to a clear focus on equity for farming communities, the qualitative data indicated a focus on equity planning and targeting for resource-dependent groups. These included local water users, collectors of non-timber forest products and nomadic pastoralists. Quotes selected by coders also suggest overlapping vulnerabilities of groups, for example, studies which focus on intersections of gender and poverty or rural livelihoods and poverty.

Regional results: Qualitative results from the Asia region reported more frequently on social status as a determinant of vulnerability and indicated an emphasis on equity planning and targeting for marginalised socioeconomic groups. Studies in Central and South America reported a greater focus on equity planning and targeting for Indigenous Peoples, and much less on women, than the global results. Of all regions, a significantly higher proportion of studies sited in Africa indicated a focus on equity planning and targeting; studies sited in Europe and North America did so less frequently.

Note on coding: Other responses sometimes duplicated the closed-ended response options, for example, the coder wrote 'Indigenous' or 'tribal' as 'other' instead of coding as Indigenous; or the coder wrote 'gender' instead of coding as women.

Is there reference to contributions from Indigenous knowledge in the reported adaptations? Q 1.4

Indigenous Knowledge Contribution	Count	Percentage
Yes	144	34
No	279	66

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in the reported adaptations? Q 1.5

Local Knowledge Contribution	Count	Percentage
Yes	148	35
No	275	65

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are the costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—cost of response	119	28
Yes—cost savings from response	44	10
No	267	63

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.1.3 What responses are documented? What category of adaptation is reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	258	61
Behavioural/cultural	357	84
Institutional	157	37
Ecosystem-based	272	64

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed, 84% reported adaptation responses that were behavioural/cultural. Ecosystem-based responses were reported in 64% of studies, while the third highest percentage of studies reported responses that were technological or infrastructural (61%). Fewer studies reported

institutional responses, which is consistent with a higher proportion of autonomous adaptation efforts than formal or planned adaptation.

The qualitative analysis corroborated this finding, suggesting that systemic or institutional adaptation efforts are less frequently reported than autonomous adaptation occurring at the individual and household scales, particularly among farmers. In many cases, farmers engaged in a series of adaptation responses which were categorised as all three of the high count variables: behavioural/cultural (e.g., diversifying livelihoods), ecosystem-based (e.g., community forest management for agricultural inputs, watershed management) and technological/infrastructural (e.g., use of novel irrigation techniques). Specifically, studies frequently reported efforts to increase the resilience of rural livelihoods to shocks and stressors such as droughts, floods and other natural disasters.

The qualitative analysis revealed an emphasis on adapting through diversification—both of livelihoods (e.g., supplementing agriculture with wage labour activities) and within specific livelihood practices (e.g., crop diversification) as a risk mitigation strategy. Both traditional and novel practices were frequently reported as pathways to diversified livelihoods. In many cases, diversification was also complemented by other risk-mitigation measures such as primarily locally supported or community-based insurance programmes. This finding was distinct in Africa and Asia specifically.

Other regional results: The prevalence of behavioural/cultural responses was highest in Asia (92%) and small island states (100%)* and lowest in Europe (62%) and North America (70%). Results from Central and South America indicated a greater emphasis on ecosystem-based responses (87%), particularly through the adoption of agroforestry. Institutional responses were least commonly reported in Africa (29% of studies).

*Note that the sample size for small island states is small for the purpose of determining patterns of adaptation.

What hazards are the adaptations aimed at addressing? Q 3.3.1; 3.3.2; 3.3.3

Hazards	Count	Percentage
Extreme precipitation and inland flooding	157	37
Drought	292	69
General climate impacts	271	64
Sea level rise	9	2
Precipitation variability	243	57
Increased frequency and intensity of extreme heat	114	27
Rising ocean temperature and ocean acidification	1	0
Loss of Arctic sea ice	5	1
Other	140	33

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In the global analysis, 69% of studies reviewed reported adaptation to address drought, and 57% reported adaptation to address precipitation variability. The next most prevalent hazard addressed was general climate impacts (64% of studies). Extreme heat was reported in 37% of studies reviewed.

Other hazards listed included increased prevalence of pests and diseases and seasonal unpredictability of weather systems (e.g., rainfall variability, unseasonable frosts). Many studies reported adaptations addressing general climate impacts rather than specific hazards; qualitative results suggest that adaptation efforts frequently address multiple hazards simultaneously. Hazards were most frequently framed in terms of their risk to smallholder farmers' agricultural livelihoods; drought and changes to rainfall were frequently reported as hazards requiring adaptation. The qualitative results corroborated the quantitative finding on the prevalence of adaptation efforts targeting drought resilience.

Also frequently mentioned in reviewed studies were efforts to adapt to increasingly unpredictable seasons and increased prevalence of unseasonable weather events, such as erratic rainfall inconsistent with historical seasons. The qualitative results further indicated a concern with hazards not only caused by climate change, but also exacerbated by other forms of ecosystem degradation (e.g., deforestation) and anthropogenic pressures (e.g., population growth, pollution). Changes in water supply quality and/or quantity were also frequently reported, both in farming and non-farming contexts.

Regional results: Studies in Central and South America reported the greatest focus on increased frequency and intensity of heat events (34%). Compared to other regions, studies sited in Europe and Asia more frequently mentioned mountain regions as being especially vulnerable to climate impacts.

What aspects of vulnerability are the adaptations aimed at addressing? Q 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	76	18
Sustainable cities and ecosystem services	55	13
Consumption and production	153	36
Health and well-being	84	20
Work and economic growth	111	26
Industry/innovation/technology	15	4
Poverty	199	47
Food security	317	75
Terrestrial and freshwater ecosystem services	81	19
Marine and coastal ecosystem services	5	1
Energy security	10	2
Education	23	5
Gender equality	31	7
Inequalities (other than gender)	20	5
Peace, justice and strong institutions	10	2
Other	65	15

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed, 75% reported on adaptations aimed at addressing food security, 47% of studies reported addressing poverty, while the third highest percentage of studies reported addressing consumption and production (36%). Gender equality was reported as a focus in 7% of studies, while clean water and sanitation was reported in 18% of studies. Terrestrial and freshwater ecosystem services were reported as targeted vulnerabilities in 19% of studies reviewed.

The 'Other' response most frequently reported was livelihood security. Other aspects of vulnerability reported included sites/practices of cultural or spiritual significance, water security, biodiversity loss and land or tenure insecurity. Several studies also mentioned a non-specific focus on targeting social vulnerability. Qualitative results confirmed a distinct emphasis on food security as the focal vulnerability targeted by adaptation efforts; this variable was reported as frequently overlapping with poverty. Gender was not a prevalent aspect of vulnerability addressed by adaptation efforts, nor was health and well-being (except in Europe) or peace, justice and strong institutions.

Regional results: Studies reviewed in Africa reported a more significant focus on both poverty and gender than the global analysis, while the Central and South American region indicated less focus on these dimensions of vulnerability. Studies reviewed in Central and South America reported a greater emphasis on addressing terrestrial and freshwater ecosystem services than other regions. The European region showed a greater focus on education and health and well-being aspects of vulnerability than the global analysis, and none on gender or poverty.

SMCCP5.3.2.1.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? Q 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	72	17
Adaptation planning and early implementation	149	35
Implementation expanding	94	22
Implementation widespread	53	13
Evidence of risk reduction associated with adaptation efforts	19	4

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the adaptation planning and early implementation stage in this region (35%), 22% were identified as implementation expanding, while 17% were in the vulnerability assessment and/or early planning stage. Little evidence of risk reduction associated with adaptation efforts was reported (4%).

Qualitative results suggested that the stage of implementation is frequently unclear, particularly given the prevalence of autonomous adaptation at the household level. Results in this region confirmed the primarily informal, autonomous nature of adaptation efforts. Few adaptation efforts were formal/planned, so assessment of their progress was more difficult. The studies reviewed also noted considerable diversity between households with regard to the stage of implementation, within the same cases.

Particularly within the smallholder farming sector, some specific adaptations were reported as widespread in this region, including the diversification of crop varieties, multi- or inter-cropping, and changing seasonal practices to accommodate climatic shifts. Livelihood diversification was also reported to be widespread.

Regional results: Results in Asia and Africa appeared to be consistent, with the majority of adaptation activities in adaptation planning and early implementation, with a smaller proportion expanding. Quantitative results from North America and Central and South America showed the least evidence of widespread implementation; however, qualitative results in Central and South America indicated similar levels of widespread implementation of specific activities as in other regions, with some variability at the household level.

Coding note: It is possible that coders treated 'Adaptation planning and early implementation' as a catch-all in the absence of an 'indeterminant' option, thereby inflating counts for this response. Apparent autonomous adaptations are also often coded as 'Adaptation planning and early implementation'. Several responses note efforts to scale up and/or formalise adaptation strategies; in these cases, the planning stage would be separate from (and subsequent to) the early implementation stage.

What is the depth of change for reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	262	62
Medium	68	16
High	71	17

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

Globally, the majority of reported adaptations were characterised by *low* (limited) depth of change (62%), 17% were assessed as *high*, and 16% were assessed as *medium*.

In all regions, the majority of reported adaptations were described as extensions to or modifications of existing practices (business as usual), rather than systemic or structural changes. Significant barriers to structural change were identified, including entrenched power asymmetries, costs or capital requirements of adaptation, lack of coordinated planning, resistance to change among governing bodies, risk aversion and lack of access to information. Reported adaptations were described as primarily short term and reactive to shocks and

stressors (i.e., many being akin to coping). However, many studies indicated that low or moderate levels of change at the household level (e.g., extensions of traditional practice) may also be effective in enhancing adaptive capacity.

Several studies also noted that adaptations were not exclusively adopted in response to climate risks, but an array of pressures on (primarily) farming livelihoods which prompt households and individuals to modify their practices. Formal/planned adaptations were more frequently identified as of high depth than autonomous adaptations in most cases. These results appear consistent with the emphasis on livelihood diversification found in other sections. Rather than fundamentally altering practices, autonomous adaptations primarily occur by incremental and partial changes in order to maximise flexibility and livelihood options.

Regional results: North America and Central and South America indicate a lower proportion of studies characterised by low (limited) depth of change (47% in each region) than the global analysis. Results from Europe indicated the lowest proportion of studies reporting a high depth of change (8%). In Asia and Africa, qualitative results emphasised systemic and capacity-related barriers to higher depths of change, while results from Europe and North America indicated a higher prevalence of behavioural or attitude-related barriers.

What is the scope of change for reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	296	70
Medium	44	10
High	60	14

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the global analysis, the majority of reported adaptations were characterised by a *low* (limited) scope of change (70%), 14% were assessed as *high*, while 10% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in the scope of change, implemented at the individual, household or community scale. Results overlapped with the reported prevalence of autonomous adaptation activities undertaken at the individual/household level. Responses to this question focused primarily on adoption of adaptation activities by specific actors. Some studies reported high rates of adoption and a broader scope of change; most reported significant variability in adoption among actors. Most also indicated limited integration across scales and a lack of linkages among changes at the institutional scale and the community, household or individual scale.

Regional results: Studies in Africa, Europe and Central and South America most frequently reported a low scope of change (77%, 77% and 76% respectively), attributed to the autonomous and variable nature of adoption of adaptation activities. The highest proportion of studies reporting a broader scale (high scope) of change were sited in North America (20%); this region indicated somewhat higher levels of integration across scales and coordinated and/or planned/formal adaptation programmes.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (e.g., the unit of analysis being household/individual, village, region), rather than the activity itself. Few studies indicated confidence in the broader generalisability of case study results.

What is the speed of change for the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes are happening.

Speed	Count	Percentage
Low (slow)	263	62
Medium	40	9
High	26	6

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

The majority of reported adaptations were characterised by *low* (slow) speed of change (62%), 9% were assessed as *medium*, and 6% were assessed as *high*. Almost a quarter, 23%, of the studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations are slow and incremental (particularly in the farm sector). Many studies across all regions did not evaluate or describe the speed of change; however, several suggested that changes were mostlyincremental and reactive to specific climatic events/observed climate change impacts. Individual adaptation activities were frequently reported as occurring quickly, but the overall speed of change was most frequently described as slow. Adaptation activities undertaken by private-sector actors were more frequently reported as exhibiting a high speed of change.

Qualitative results indicated an overlap with the depth and scale of reported responses; ad hoc, autonomous changes at the household level were frequently reported as low depth, low scale and low speed.

Regional results: The prevalence of studies indicating low speed of change was higher in Asia (70%) than in Africa (55%). Results from Africa indicated longer time scales than the global analysis, most frequently in the 20- to 30-year range. Results from Central and South America suggest a high prevalence of more recent and higher speed of change (5- to 15-year implementation periods).

SMCCP5.3.2.1.5 Are adaptation-related responses reducing risk/vulnerability?

What is the stated (or implied/assumed) link to reduction in risk? Q 3.5.1; 3.5.2

Synthesis Statement:

In the global analysis, the most commonly reported link between adaptation-related responses and reduction in risk was improving financial security (specifically household income level and stability of income) as a result of livelihood diversification. Other commonly reported results were enhanced water and food security (the latter frequently as a function of increased income), increased agricultural productivity and minimised hazard risk (most commonly to droughts, precipitation variability). Adaptation-related responses such as livestock compensation and insurance programmes were frequently reported to reduce risk of pastoralists to climate-related shocks.

Also mentioned were reductions in the risk associated with ecosystem dependence, such as reducing soil erosion, mitigating land degradation and protecting watersheds. Very few studies indicate reductions in the risk associated with specific aspects of vulnerability (e.g., gender, ethnic identity, health). Some studies stated that there was no observed reduction in the risk associated with adaptation-related responses. Some also indicated that maladaptation may pose additional risk, particularly when short-term responses to specific shocks prove maladaptive in the longer term.

Regional results: Studies reviewed in both Africa and Asia noted reductions in income variability as a common aspect of adaptation-related risk reduction, but results from Africa indicated more emphasis on reducing the risk of food security and alleviating poverty; results from Asia reported relatively more emphasis on water security and securing ecosystem services.

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	290	69
No	133	31

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

Globally, 69% of the studies reviewed reported evidence (implicit or explicit) that responses were reducing risk or vulnerability, while 31% indicated no evidence to this effect.

Qualitative results indicated significantly more uncertainty. Risk reduction was described in some studies but infrequently quantified or investigated in depth; many studies report possible , assumed, or partial reductions in risk. Several studies reported measurable reductions in farming-related risks (e.g., increased crop yields, mitigation of crop losses as a result of climate related hazards). A majority of studies, however, indicated that responses were insufficient to substantially reduce climate risk, or that there was insufficient evidence to determine if risk reduction was occurring. Most studies which evaluated formal/planned responses indicated that there was little to no reduction in risk.

Regional results: Results were largely consistent across regions. The analysis of the North American region reported the highest prevalence of studies which did not provide evidence for reduced risk. However, all regions indicated considerably more uncertainty in the qualitative results, with little empirical evidence of risk reduction demonstrated.

Do actors or institutions undertaking the response identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	238	56
No	185	44

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the global analysis, 56% of the studies reviewed identified indicators of success, while 44% did not.

Among indicators of success identified, most commonly reported were crop yields (production), food security and household income. Other financial indicators assessed included household savings, access to credit and employment status. Frequently, studies reported using adoption rates or perceptions as proxy indicators for success. Multiple studies specifically evaluated responses using the Sustainable Livelihoods Framework (measuring different types of capital) as an indicator for success.

Regional results: Several studies sited in Africa reported identifying changes in gender roles and women's adoption of adaptation responses as an indicator of success; this was very infrequently mentioned in other regions. Results from Central and South America suggest a lower prevalence of studies identifying indicators for success than in other regions. Compared to other regions, ecological indicators were more commonly identified in studies sited in North America. Studies sited in the Australasian and North American regions less frequently reported the use of indicators than in other regions.

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	161	38
No	262	62

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of the studies reviewed (62%), actors and institutions undertaking adaptation did not consider the risks of maladaptation associated with the adaptation. Consideration of maladaptation risk was reported in 38% of studies.

The majority of studies did not report qualitative results for this variable. Among those which did, the types of maladaptation risk most commonly considered were farming changes poorly suited to local ecological and social conditions and the adverse effects of land or water management on water quality and/or supply (e.g., introducing chemical inputs which result in land degradation or water contamination). Several studies indicated that adaptive responses could further entrench existing social vulnerabilities and marginalisation (particularly for women). Also noted were risks associated with reactively adapting to one hazard and increasing the exposure risk to another (e.g., people migrating to flood risk areas). Some studies indicated that short-term reactive responses (e.g., selling household assets) may have short-term benefits but prove maladaptive in the long term.

Results for this variable were largely consistent across regions.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	146	35
No	277	65

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (65%), actors and institutions undertaking adaptation did not consider the co-benefits associated with the adaptation. Consideration of co-benefits was reported in 35% of studies.

The majority of studies were not assessed qualitatively on this variable. Among those which were, the type of co-benefit most commonly considered was climate change mitigation, including carbon sequestration resulting from reforestation efforts. Other reported ecological co-benefits associated with adaptation frequently included biodiversity, soil and land quality and water quality/supply. Social and economic co-benefits were also frequently identified, including women's empowerment, social cohesion, increased household income and improvements in governance.

Regional results: Results from Asia indicate the most consideration of transforming gender roles as a co-benefit of adaptation. Studies sited in North America, Central and South America commonly reported co-benefits of ecosystem-based adaptation responses, particularly climate change mitigation and biodiversity. Studies sited in Africa indicated the most emphasis on household income and governance changes as co-benefits of adaptation efforts.

SMCCP5.3.2.1.6 What evidence is given for the extent to which responses challenge or exceed adaptation limits?

Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	349	83
No	74	7

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the global analysis, 83% of studies reviewed reported constraints or limits to adaptation, and 7% did not.

Globally, the most commonly reported limits to adaptation were related to economic factors (including lack of access to credit and markets, fixed livelihoods). Other frequently reported limits were associated with information, awareness and technology (including limited availability of climate forecasts, erosion of existing skills and knowledge and awareness of climate risk more broadly). Social and cultural limits were also frequently reported; among these, the most commonly identified constraints were related to social inequities, lack of trust and social cohesion, gender norms and perceptions of conflict or scarcity.

The limits on governance, institutions and policy reported most frequently included land tenure insecurity, poor integration of adaptation programmes across governing scales and lack of decision-making power among vulnerable groups. Financial constraints identified included inadequate funding for government-implemented adaptation programmes. Physical limits commonly reported included farm size, water availability and temperature change. Also noted—though infrequently in most regions—were human capital constraints (including labour supply, education).

The majority of studies reported more than one category of limits and constraints and identified linkages between different types of constraints (e.g., social inequities perpetuated in the implementation of adaptation policies, lack of educational capacity limiting awareness of appropriate responses). Economic constraints were frequently reported as overlapping with social/cultural limits, and financial constraints were frequently linked to governance, institutions and policy.

Regional results: Studies in Africa, Asia and Central and South America reported a greater prevalence of economic limits to adaptation compared to North America and Europe. Results from Europe reported the least consideration of constraints and limits to adaptation. Both physical constraints (in particular farm size and land availability) and biological constraints (including soil productivity, water availability) were most commonly reported in studies in Africa.

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	23	5
Soft	208	49
Both	120	28
N/A	69	16

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the global analysis, 49% of constraints or limits were identified as soft, 5% as hard, and 28% as both. This variable was not applicable in 16% of studies.

There were limited qualitative responses to this question in most regions. Where a qualitative description was given, limits and constraints identified as soft were described as potentially resolvable with more information or investment, frequently related to governance, economics and social/cultural constraints. Hard limits were more frequently described as being biophysical (related to natural capital), such as water supply and land scarcity. Some economic limits (including poverty, costs of livelihood diversification) and social/cultural limits (including gender inequality) were identified as hard in some studies and soft in others. Many studies identified both hard and soft limits to adaptation. Few studies describe only hard limits, although these were reported most frequently in the European region.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	155	37
No	159	38
N/A	103	24

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the global analysis, 37% of studies reviewed indicated that they were approaching limits to adaptation, while 38% indicated that they were not. This variable was not applicable in 24% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: 'Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits?' Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.2 Africa

Adaptations associated with K1 terrain in Africa were reported in 157 articles. However, three articles were multi-region studies. These multi-region articles have been removed from this synthesis report to ensure that results only reflect adaptation in the target region. Results below are based on 154 articles.

SMCCP5.3.2.2.1 Who is adapting?
In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Ethiopia	46	30
Kenya	38	25
Tanzania	19	12
Uganda	14	9
South Africa	13	8
Cameroon	6	4
Zimbabwe	5	3
Malawi	4	3
Algeria	3	2
Morocco	2	1
Rwanda	2	1
Benin	1	1
Burkina Faso	1	1
Central African Republic	1	1
Democratic Republic of Congo	1	1
Lesotho	1	1
Libya	1	1
Mali	1	1
Niger	1	1
Nigeria	1	1
Senegal	1	1
Swaziland	1	1
Tunisia	1	1

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in Africa are (in descending order) Ethiopia (46), Kenya (38), Tanzania (19), Uganda (14) and South Africa (13). Despite the significant area of K1 coverage in these countries, few studies reported adaptation actions in Morocco (2) and none in Burundi (0).

Which sectors/systems are involved in the reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	21	14
Ocean and coastal ecosystems	0	0

Sectors	Count	Percentage
Water and sanitation	33	21
Food, fibre and other ecosystem products	117	76
Cities, settlements and key infrastructure	3	2
Health, well-being and communities	31	20
Poverty, livelihoods and sustainable development	101	66

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as being involved in reported adaptation actions was food, fibre and other ecosystem products (76% of studies), followed by poverty, livelihood and sustainable development (66% of studies). Fewer studies reported involvement in water and sanitation (21% of studies), closely followed by health, well-being and communities (20% of studies). Few studies (2%) identified involvement in cities, settlements and key infrastructure. These percentages are consistent with findings at the global scale.

Who is involved with the reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	147	95
Local government	41	27
National government	37	24
Sub-national government	7	5
Civil society (sub-national or local)	36	23
Civil society (international, multi-national, national)	21	14
Private sector: small and medium-size enterprises	8	5
Private sector: corporations	11	7
International or multi-national governance	13	8
Other	17	11

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 95% of studies reviewed. Local governments were involved in 27% of reported adaptations, while national government was involved in 24% of reported adaptations. Among responses coded as 'other', the most common actors were smallholder farmers or farming groups. Also mentioned frequently were pastoralists and local-scale institutions, such as women's groups and producer associations. Non-governmental organisations (NGOs)—both local and national or international-scale—were commonly identified as an 'other' actor, frequently acting in a supportive capacity for household-level adaptation efforts (primarily via funding and knowledge transfer activities). Household surveys were the source of data for the majority of studies in this region.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

Implementation of adaptation actions was found to be more autonomous than formal/planned. The most commonly reported implementation tools were adaptive farming practices (e.g., soil and water conservation, agroforestry, crop diversification, improved irrigation or seasonal changes to planting timelines). Approximately two-thirds of studies reported adaptations implemented autonomously by households or individuals. Livelihood diversification was frequently noted as an adaptation strategy, led either by households and individuals in direct response to climatic changes and/or disasters or as part of an NGO or government adaptation programme. Livelihood changes reported included shifts to less climate-risky livelihood options (e.g., transitions away from pastoralism) and diversification of crops planted.

Also frequently mentioned were tools for mitigating financial risk (e.g., livestock insurance schemes), the application of traditional knowledge (e.g., in crop varieties, irrigation techniques) and changes to local governance (e.g., formation of community-based cooperatives). Several studies reported acquisition of more land or more access to land (e.g., grazing rights) as an adaptation tool among pastoralists; other studies identify migration as an adaptation strategy.

Formal or planned implementation was less commonly reported. Capacity building and training, frequently led by NGOs, was noted in some studies. Policy mainstreaming or governmental policy interventions directed were less frequently mentioned.

Is there evidence as to who financed the reported adaptation actions? Q 4.2

Funding information?	Count	Percentage
Yes	65	42
No	89	58

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.2.2 Evidence of equity in planning / targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was found in 88 articles (57%), and evidence that particularly vulnerable groups were targeted in adaptations was found in 101 articles (66%).

Who is addressed in the context of equity in the reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percent-age	Equity targeting	Count	Percent-age
Low-income	46	30	Low-income	61	40
Indigenous	16	10	Indigenous	10	6
Women	35	23	Women	31	20

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Elderly	4	3	Elderly	7	5
Migrants	3	2	Migrants	4	3
Youth	6	4	Youth	2	1
Disability	0	0	Disability	0	0
Ethnic minorities	7	5	Ethnic minorities	6	4
Other	16	10	Other	20	13
Equity not addressed	66	43	Equity not addressed	53	34

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Of the reviewed studies sited in Africa, 43% did not explicitly address equity planning in the context of reported adaptations, and 34% did not address equity targeting. Among studies which did so, the greatest number of studies reported addressing equity for low-income individuals or populations—30% of studies addressed equity planning and 40% addressed equity targeting for low-income groups. Women were the group next most commonly identified as a focus of equity planning (23% of studies) and equity targeting (20% of studies), followed by Indigenous Peoples (equity planning: 10% of studies and equity targeting: 6% of studies). Few studies (4%) reported focusing on equity planning for youth (equity targeting: 1%). No studies reported a focus on disability in either equity planning or targeting. There were no significant discrepancies between equity planning and equity targeting foci among studies reporting on equity in adaptation actions.

The other group most frequently mentioned (in both equity planning and targeting categories) was smallholder farmers. Others mentioned also included pastoralists and socially disadvantaged groups (e.g., those living in informal settlements, widows) and rural or isolated communities. Elderly, youth and Indigenous Peoples were mentioned occasionally.

The qualitative data also indicate an emphasis on equity for low-income households and communities, particularly equity targeting (e.g., via pro-poor policies) owing to their acute vulnerability to climatic shocks and stressors associated with climate change. Women in agricultural (particularly those also experiencing poverty) and female-headed households were also noted frequently as a focus of equity targeting; the marital status of women was a sub-category of equity targeting. The specific vulnerabilities of female-headed households (including social marginalisation, lower household income, for example) were mentioned frequently in this region. Land tenure insecurity was also identified as a source of vulnerability in several studies.

Is there reference to contributions from Indigenous knowledge in reported adaptations? Q 1.4

Indigenous knowledge contribution	Count	Percentage
Yes	55	36
No	99	64

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

Local knowledge contribution	Count	Percentage
Yes	56	36
No	98	64

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are the costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—cost of response	40	26
Yes—cost savings from response	19	12
No	99	64

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.2.3 What responses are documented? What categories of adaptation are reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	84	55
Behavioural/cultural	124	81
Institutional	45	29
Ecosystem-based	104	68

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 81% reported adaptation responses that were behavioural/cultural. Ecosystem-based responses were reported in 68% of studies, while the third highest percentage of studies reported responses that were technological or infrastructural (55%). Fewer studies reported institutional responses, which is consistent with a higher proportion of autonomous adaptation efforts than formal or planned adaptation.

The qualitative analysis corroborated this finding, suggesting that systemic or institutional adaptation efforts were less frequently reported than autonomous adaptation occurring at the individual and household scale, particularly among farmers. A wide variety of agricultural adaptations were reported, including changes to crop and livestock varieties, tillage and irrigation practices, soil and water conservation and management (sometimes referred to as climate-smart agriculture). Changes to financial decision-making (e.g., selling livestock, saving income) were also frequently reported.

In most cases, farmers engaged in multiple types of adaptation responses simultaneously: behavioural/cultural (e.g., planting cash crops, temporary or permanent migration, saving income), ecosystem-based (e.g., watershed management, afforestation, focus on maintenance of ecosystem services) and technological/infrastructural (e.g., use of novel

irrigation techniques). Specifically, studies frequently reported efforts to increase the resilience of rural livelihoods to shocks and stressors such as droughts, floods and other natural disasters. Formal/planned implementation occasionally supported technological/infrastructural responses but was otherwise infrequently reported in this region. Among these responses, changes to governance practices were reported most commonly as occurring within local governing institutions.

What hazards are the adaptations aimed at addressing? Q 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	53	34
Drought	118	77
General climate impacts	90	58
Sea level rise	0	0
Precipitation variability	96	62
Increased frequency and intensity of extreme heat	39	25
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	0	0
Other	27	18

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 77% of studies reviewed reported adaptation to address drought. The next most prevalent hazard addressed was precipitation variability (62% of studies), followed by general climate impacts (58%). Extreme heat was reported in 25% of studies reviewed.

Other hazards listed included increased prevalence of crop pests, strong winds, seasonal unpredictability of weather systems (e.g., rainfall variability) and the effects of climatic hazards exacerbated by other stressors, such as ecosystem degradation (e.g., soil erosion and declining soil productivity, deforestation and land degradation).

Hazards were frequently framed in terms of their risk to smallholder farmers' agricultural livelihoods; drought and changes to rainfall were frequently reported as hazards requiring adaptation. The qualitative results corroborated the quantitative finding on the prevalence of adaptation efforts targeting drought resilience. Specifically, several studies mentioned conversion of ecosystems to more arid conditions (progressive growth of aridity, desertification) as a significant climate hazard. High temperatures were frequently reported in the qualitative responses, though only 25% of studies were coded as being interested in extreme temperatures.

The qualitative results indicated a concern with hazards not only caused by climate change but also exacerbated by other forms of ecosystem degradation (e.g., deforestation) and anthropogenic pressures (e.g., population growth). Changes in water supply quality and/or quantity were also frequently reported, both in farming and non-farming contexts. Responses indicate a significant reliance on rainfall for crop irrigation in the region. An emphasis on crop pests and disease as a climate-associated hazard was also apparent in this region.

Also mentioned in several studies were efforts to adapt to increasingly unpredictable seasons and increased prevalence of unseasonable weather events. Several studies noted that while rainfall might be consistent with historical norms, changes to the seasonal distribution of precipitation had negative impacts on farmers in particular, often necessitating adaptation via shifted irrigation practices or migration to more suitable regions.

What aspects of vulnerability are the adaptations aimed at addressing? Q 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	22	14
Sustainable cities and ecosystem services	10	6
Consumption and production	43	28
Health and well-being	23	15
Work and economic growth	32	21
Industry/innovation/technology	2	1
Poverty	95	62
Food security	134	87
Terrestrial and freshwater ecosystem services	20	13
Marine and coastal ecosystem services	1	1
Energy security	2	1
Education	9	6
Gender equality	17	11
Inequalities (other than gender)	6	4
Peace, justice and strong institutions	6	4
Other	22	14

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 87% reported on adaptations aimed at addressing food security, 62% of studies reported addressing poverty, while the third highest percentage of studies reported addressing consumption and production (28%). Gender equality was reported as a focus in 11% of studies, while clean water and sanitation was reported in 14% of studies. Terrestrial and freshwater ecosystem services were reported as targeted vulnerabilities in 13% of studies reviewed.

The 'other' response most frequently reported was livelihood security, followed by land security and disaster risk reduction. Several studies also mentioned a non-specific focus on targeting social vulnerability.

Qualitative results confirmed a distinct emphasis on food security and poverty as the focal vulnerabilities targeted by adaptation efforts; these were frequently listed as overlapping dimensions of vulnerability, specifically among smallholder farmers. Several studies also aimed to address the specific vulnerability of female-headed households. With the

exception of gender-specific vulnerabilities, qualitative results indicate that the majority of studies did not specifically aim to address most of the vulnerabilities identified as variables in this question. Ecosystem services were rarely mentioned as an aim of adaptation efforts.

SMCCP5.3.2.2.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	28	18
Adaptation planning and early implementation	54	35
Implementation expanding	31	20
Implementation widespread	22	14
Evidence of risk reduction associated with adaptation efforts	6	4

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the adaptation planning and early implementation stage in this region (35%), 20% were identified as implementation expanding, while 18% were in the vulnerability assessment and/or early planning stage.

Qualitative results suggest that the stage of implementation is frequently unclear, particularly given the prevalence of autonomous adaptation at the household level. Results in this region confirm the primarily informal, autonomous nature of adaptation efforts. Few adaptation efforts are formal/planned, so assessment of their progress is more difficult. The studies reviewed also noted considerable diversity among households with regard to the stage of implementation, within the same cases.

Particularly within the smallholder farming sector, some specific adaptations were reported as widespread in this region, including the diversification of crop varieties, multi- or inter-cropping and changing seasonal practices to accommodate climatic shifts. Livelihood diversification was also reported to be widespread.

Note: Several responses note efforts to scale up and/or formalise adaptation strategies; in these cases, the planning stage would be separate from (and subsequent to) the early implementation stage.

What is the depth of change of the reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	101	66
Medium	22	14
High	27	18

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) depth of change (66%), 18% were assessed as *high*, and 14% were assessed as *medium*.

Most reported adaptations were described as modifications of existing practices, rather than systemic or structural changes. Significant barriers to structural change (e.g., governing structures, major infrastructure) were identified, including entrenched power asymmetries (e.g., gender norms), costs or capital requirements of adaptation, low rates of literacy and access to information, resistance to change among governing bodies, risk aversion, lack of planning or shared vision. Several studies also mentioned that adaptation activities entailed trade-offs and costs, which were sometimes considerable; financial barriers were frequently mentioned as prohibitive. Reported adaptations were described as primarily short term and reactive to shocks and stressors (i.e., many being akin to coping).

However, examples of transformative change in this region were also reported: 'farmers are engaged in novelty production; that is, they are generating something new: new practices, new insights, new artefacts and innovative social or institutional arrangements'. Multiple studies in this region indicated that addressing vulnerabilities within climate adaptation would require transformative changes in governance and addressing social inequities. However, several studies also noted that low or moderate levels of change at the household level may also be effective at enhancing adaptive capacity.

Several studies also noted that these changes are in response not exclusively to climate risks but to an array of pressures on (primarily) farming livelihoods which prompt households and individuals to modify their practices. Studies reporting high levels of adaptation were primarily limited in scope (see question 4c) at the village scale. Adaptations characterised by a high depth of change also include major infrastructure projects (e.g., dams).

What is the scope of change of the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	118	77
Medium	14	9
High	15	10

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) scope of change (77%), 10% were assessed as *high*, while 9% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in the scope of change, implemented at the individual, household or community scale. Responses to this question focused primarily on the adoption of adaptation activities by specific actors. Some studies reported high rates of adoption and a broader scope of change; most reported significant variability in adoption among actors. In this region, variability was frequently attributed to livelihoods and specific aspects of vulnerability (e.g., gender). Frequently, the scale of change was identified as low for studies which reported adaptation as occurring only within specific livelihoods (e.g., smallholder farming). The autonomous nature of adaptation efforts was frequently identified as the reason for reporting limited scope. Studies which reported on activities implemented by civil society actors or government programmes were more likely to report a higher scope of change.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (e.g., the unit of analysis being household/individual, village, region), rather than the activity itself.

What is the speed of change of the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	85	55
Medium	19	12
High	12	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (slow) speed of change (55%), 8% were assessed as *high*, and 12% were assessed as *medium*; however, 25% of studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations were slow and incremental. Many studies did not evaluate or describe the speed of change or indicated uncertainty about the speed of change. Several of these also suggested that changes were likely incremental and reactive to specific climatic events/observed climate change impacts. In this region individual adaptation activities were frequently reported as occurring quickly, but the overall speed of change was most often described as slow, occurring over the course of two to three decades. Some studies in this region indicated that economic adaptation responses (e.g., selling assets) were implemented quickly, while adjustments to farming practices occurred slowly and incrementally.

Qualitative results indicate an overlap with the depth and scale of reported responses; ad hoc, autonomous changes at the household level were frequently reported as low depth, low scale and low speed.

SMCCP5.3.2.2.5 Do adaptation-related responses reduce risk/ vulnerability?

What is the stated (or implied/assumed) link to risk reduction? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported links between adaptation-related responses and reduction in risk were improving financial security (specifically household income level and stability of income and poverty alleviation) through livelihood diversification and food security, by means of improved agricultural productivity. Other commonly reported results were enhancements in water security and minimisation of hazard risk (most commonly to droughts, precipitation variability). Several studies in this region noted that institutional change (e.g., formation of cooperatives, stronger local governance) supported risk reduction broadly by building decision-making capacity at local scales.

A few studies also mentioned reductions in risk associated with ecosystem dependence, such as reducing soil erosion and protecting watersheds (increasing ecosystem resilience). In several studies, adaptation-related responses were also reported to reduce the perception of risk among smallholder farmers. A few studies also mentioned reduced disease and other health risks.

A majority of studies either assumed reductions in risk or stated but did not empirically demonstrate these reductions. Very few studies indicated reductions in risk associated with specific aspects of vulnerability (e.g., gender, ethnic identity). Several studies also indicated that short-term reductions in risk may not result in long-term reductions as new shocks and stresses emerge.

Is there any evidence (implicit or explicit) that responses are reducing risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	107	69
No	47	31

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 69% of the studies reviewed reported evidence (implicit or explicit) that responses were reducing risk or vulnerability, while 31% indicated no evidence to this effect.

Qualitative results indicated significantly more uncertainty. Risk reduction was described in some studies but infrequently quantified or investigated in depth; many studies reported likely, assumed or partial reductions in risk. Several studies reported measurable reductions in smallholder farming-related risks (e.g., increased crop yields due to crop diversification, improved irrigation) and improved resilience of ecosystem services to shocks. Some improvements in food security were also demonstrated. A majority of studies, however, indicated that

responses were insufficient to substantially reduce climate risk. Some studies suggested that reactive responses may lead to maladaptation in the longer term.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	92	60
No	62	40

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 60% of the studies reviewed identified indicators of success, while 40% did not.

The qualitative results indicated a lower prevalence of studies which identified indicators of success. Among indicators identified, the most commonly reported was crop yields (agricultural production), followed by food security. Also mentioned were household income, diversity of income sources, soil fertility and the percentage of households adopting adaptation responses. Several studies reported identifying changes in gender roles and women's adoption of adaptation responses as an indicator of success. Different forms of capital (e.g., social, financial) were somewhat frequently identified as indicators of success. Financial indicators assessed included household savings, access to credit and employment status.

Do actors or institutions undertaking adaptation consider (implicitly or explicitly) risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	51	33
No	104	67

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (67%), actors and institutions undertaking adaptation did not consider risks of maladaptation associated with the adaptation. Consideration of maladaptation risk were reported in 33% of studies.

The majority of studies did not report qualitative results for this variable. Among those which did, the types of maladaptation risk most commonly considered were changes to farming practices resulting in adverse social impacts ('negative consequences for the local socioeconomic fabric') and reduced migration exacerbating pastoralist vulnerability. Some studies reported that adaptive responses by one group may impoverish or marginalise another, particularly in formal/planned adaptation efforts which are inequitably implemented: 'Most adaptations simply reproduce unsustainable patterns of social vulnerability rooted in unequal access to land and other resource entitlements.'

Other risks noted included increased degradation of resources and ecosystem services as a result of diversification activities (e.g., non-timber forest product harvesting), increased labour burdens on women and reduced adaptive capacity of female-headed households. Some studies indicated that short-term reactive responses (e.g., selling household assets) delivered short-term benefits but may prove maladaptive in the long term.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q 5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	59	38
No	95	62

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (62%), actors and institutions undertaking adaptations did not consider co-benefits associated with the adaptations. Consideration of co-benefits was reported in 38% of studies.

The majority of studies were not assessed qualitatively on this variable. Among those which did, in this region the types of co-benefits most commonly considered were associated with livelihoods, crop yields and poverty alleviation. Other social co-benefits identified included enhanced social cohesion, gender-role shifts (gender equality), preservation of traditional practices/cultures and improvements in governance. Also mentioned were climate-change-mitigation co-benefits, such as carbon sequestration (reforestation, soil carbon), and improvements in food security as a result of farming resilience. Of the various adaptation responses reported, forestry and agroforestry projects were most frequently reported to demonstrate co-benefits.

SMCCP5.3.2.2.6 What evidence is provided on the extent to which responses challenge or exceed adaptation limits? Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	124	81
No	30	19

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 81% of studies reviewed reported constraints or limits to adaptation, while 19% did not.

The most commonly reported limits to adaptation were related to economic factors (including fixed livelihoods and lack of access to credit,

markets and agricultural inputs). The next most frequently reported limitations were social and cultural limits (including women's access to capital and gender norms, risk-averse behaviour among farmers, trust and social cohesion, and cultural expectations for family size). Limits associated with information, awareness and technology were the third most frequently reported (including limited access to climate forecasting, lack of technical skills to implement new technologies, erosion of traditional skills and knowledge and awareness of climate risk more broadly).

Limits on governance, institutions and policy were reported fourth most frequently (most commonly including limits related to land tenure security and inadequate water governance), followed by financial constraints (including lack of funding for adaptation efforts at the household scale, limited municipal funding). The physical limits reported most frequently were farm size and land availability, in addition to crop storage constraints. Biological limits reported included soil productivity, water availability and the frequency of climate shocks (e.g., droughts). Also noted were human capital constraints (including availability of labour, education).

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	4	3
Soft	79	51
Both	44	29
N/A	27	18

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 51% of constraints or limits were identified as soft, 3% were identified as hard, and 29% were identified as both. This variable was not applicable in 18% of studies.

There were limited qualitative responses to this question. In those which provided qualitative descriptions, the majority of limits and constraints were identified as soft; these were described as potentially resolvable with more information or investment, primarily related to governance and economics. Hard limits were more frequently described as being biophysical (related to natural capital), such as water supply and land scarcity (frequently identified). Some economic limits (including costs of livelihood diversification, systemic poverty) and governance, institutional and policy limits (including laws) were identified as hard in some studies and soft in others. Frequently, studies identified both hard and soft limits.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	55	36
No	58	38
N/A	40	26

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 36% of studies reviewed indicated that they were approaching limits to adaptation, while 38% indicated that they were not. This variable was not applicable in 26% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.3 Asia

Adaptations associated with K1 terrain in Asia were reported in 166 articles. However, seven articles were multi-region studies. These multi-region articles were removed from this synthesis report to ensure that results only reflected adaptations in the target region. The following results are based on 159 articles.

SMCCP5.3.2.3.1 Who is adapting?
In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Nepal	52	33
China	35	22
India	35	22
Pakistan	13	8
Iran	10	6
Bhutan	7	4
Mongolia	6	4
Vietnam	5	3
Indonesia	4	3
Bangladesh	2	1
Sri Lanka	2	1
Thailand	2	1
Afghanistan	1	1
Kazakhstan	1	1
Kyrgyzstan	1	1
Laos	1	1
Lebanon	1	1
Oman	1	1
Philippines	1	1
Tajikistan	1	1
Turkey	1	1

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in Asia are (in descending order) Nepal (52), India (35), China (35), Pakistan (13) and Iran (10). Despite significant area of K1 coverage, few studies reported adaptation actions in Russia (2), Afghanistan (1), Tajikistan (1), Turkey (1) or Japan (0).

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	22	14
Ocean and coastal ecosystems	0	0
Water and sanitation	38	24
Food, fibre and other ecosystem products	137	86
Cities, settlements and key infrastructure	4	3
Health, well-being and communities	52	33
Poverty, livelihoods and sustainable development	96	60

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as being involved in reported adaptation actions was food, fibre and other ecosystem products (86% of studies), followed by poverty, livelihood and sustainable development (60% of studies). Approximately half as many studies reported involvement in water and sanitation (33% of studies). Few studies identified involvement in cities, settlements and key infrastructure (3%). These percentages are consistent with findings at the global scale.

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	151	95
Local government	43	27
National government	39	25
Sub-national government	10	6
Civil society (sub-national or local)	36	23
Civil society (international, multi-national, national)	13	8
Private sector: small and medium-size enterprises	9	6
Private sector: corporations	4	3
International or multi-national governance	7	4
Other	11	7

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 95% of studies reviewed. Local governments were involved in 27% of reported adaptations, while the national government was involved in 25% of reported adaptations. Among responses coded as 'other', the most common actors were smallholder farmers or farming groups, followed by herders or pastoralists. Also mentioned frequently were community forest users and managers (and other community-based natural resource management organisations). In a few instances, NGOs were identified as acting in a supportive capacity for household-level adaptation. Household surveys were the source of data for the majority of studies in this region.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

Implementation of adaptation actions was found to be more autonomous than formal/planned. Most commonly reported implementation tools were adaptive farming practices (e.g., changing crop varieties, water conservation practices, seasonal changes to planting timelines). Approximately two-thirds of studies reported adaptations implemented autonomously by households or individuals. Livelihood diversification was frequently noted as an adaptation strategy, spearheaded primarily by households and individuals. Livelihood changes reported included shifts to less climate-risky livelihood options (e.g., transitions away from pastoralism), planting of cash crops and shifts to non-farming labour.

Coordinated village and community-level planning was commonly identified as an implementation tool in this region. Also frequently mentioned were tools for mitigating financial risk (e.g., livestock insurance schemes), the application of traditional knowledge (e.g., in crop varieties, irrigation techniques) and changes to local governance (including the establishment of cooperatives and changes to property rights).

Formal or planned implementation was less commonly reported overall; studies reporting governmental policy implementation frequently also reported autonomous adaptation occurring simultaneously. The most common formal implementation tool reported was financial support for adaptation efforts (e.g., compensation schemes for livestock loss or subsidies/incentives for climate adaptation actions).

Is there evidence on who financed the reported adaptation actions? Q 4.2

Funding info	Count	Percentage
Yes	57	36
No	102	64

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.3.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was presented in 84 articles (53%), while evidence that particularly vulnerable groups were targeted in adaptations was given in 75 articles (47%).

Who is addressed in the context of equity in the reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	33	21	Low-income	40	25
Indigenous	18	11	Indigenous	16	10
Women	24	15	Women	16	10
Elderly	9	6	Elderly	3	2
Migrants	1	1	Migrants	2	1
Youth	3	2	Youth	7	4
Disability	0	0	Disability	0	0
Ethnic minorities	15	9	Ethnic minorities	14	9
Other	26	16	Other	18	11
Equity Not Addressed	75	47	Equity Not Addressed	84	53

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Approximately half of the reviewed studies sited in Asia did not explicitly address equity planning in the context of reported adaptations. Among studies which did so, the greatest number of studies reported addressing equity for low-income individuals or populations—21% of studies addressed equity planning and 25% addressed equity targeting for low-income groups. Women were the group next most commonly identified as a focus of equity planning (15% of studies) and equity targeting (10% of studies), closely followed by Indigenous Peoples (equity planning: 11% of studies and equity targeting: 10% of studies). Few studies (2%) reported focusing on equity planning for youth (equity targeting: 4%). No studies reported a focus on disability in either equity planning or targeting. There were no significant discrepancies between equity planning and equity targeting foci among studies reporting on equity in adaptation actions.

The other group most frequently mentioned (in both equity planning and targeting categories) was farmers. Others mentioned also included herders, members of ethnic minority groups, resource users (e.g., water users) and members of disadvantaged social groups (e.g., members of the Dalit caste in India and Nepal). Mountain communities were specifically identified in two studies. Youth and children were mentioned infrequently.

The qualitative data indicate an emphasis on equity targeting and planning for groups whose livelihoods render them vulnerable to climatic changes. These included farmers, individuals or households who experience social marginalisation and/or economic vulnerability and resource-dependent groups such as local water users and nomadic pastoralists.

Intra-household vulnerabilities were also identified in several studies (e.g., individuals engaged in resource collection were listed as requiring specific equity planning and targeting, most frequently women). Women (gender) emerged as a focus of equity planning carried out by community-based institutions and co-operatives; several studies indicated that women were not only particularly vulnerable but also bore primary responsibility for adaptation in this context.

Qualitative results also indicated that household or community remoteness was a dimension of equity planning and targeting. Quotes selected by coders suggest overlapping vulnerabilities of groups (e.g., studies which focus on intersections of gender and poverty, or rural livelihoods and poverty).

Is there reference to contributions from Indigenous knowledge in reported adaptations? Q 1.4

Indigenous knowledge contribution	Count	Percentage
Yes	54	34
No	105	66

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

Local knowledge contribution	Count	Percentage
Yes	56	35
No	103	65

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are the costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—cost of response	48	30
Yes—cost savings from response	13	8
No	101	64

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.3.3 What responses are documented?
What categories of adaptation are reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	109	69
Behavioural/cultural	147	92
Institutional	61	38
Ecosystem-based	90	57

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 92% reported adaptation responses that were behavioural/cultural. Technological/infrastructural adaptations were reported in 69% of studies, while the third highest percentage of studies reported ecosystem-based responses (57%). Fewer studies reported institutional responses, which is consistent with a higher proportion of autonomous adaptation efforts than formal or planned adaptation.

The qualitative analysis corroborated this finding, suggesting that systemic or institutional adaptation efforts were less frequently reported than autonomous adaptation occurring at the individual and household scale, particularly among farmers. A wide variety of agricultural adaptations were reported in all categories, including changes to crop and livestock varieties, tillage and irrigation practices, soil and water conservation and management (sometimes referred to as climate-smart agriculture).

Among behavioural/cultural adaptations, forms of livelihood diversification were reported very commonly. Migration (including adjusted patterns and locations) and changes to financial decision-making (e.g., selling livestock, saving income) were also frequently reported. Within the category of technical/infrastructural responses, several studies reported that less capital-intensive technological changes (e.g., changing varieties of crops) were more prevalent than capital-intensive infrastructure changes. Institutional changes reported included changes to water and land management regimes. Formal/planned institutional responses were very infrequently reported.

In most cases, farmers engaged in multiple types of adaptation responses simultaneously: behavioural/cultural (e.g., planting cash crops, temporary or permanent migration, saving income), ecosystem-based (e.g., community forest management for agricultural inputs, watershed management, maintenance of ecosystem services) and technological/infrastructural (e.g., use of novel irrigation techniques). Specifically, studies frequently reported efforts to increase the resilience of rural livelihoods to shocks and stressors such as droughts, floods and other natural disasters.

What hazards are the adaptations aimed at addressing? 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	53	33
Drought	111	70
General climate impacts	111	70
Sea level rise	3	2
Precipitation variability	87	55
Increased frequency and intensity of extreme heat	44	28
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	1	1
Other	54	34

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 70% of studies reviewed reported adaptation to address drought, and 70% reported general climate impacts. The next most prevalent hazard addressed was precipitation variability (55% of studies).

Other hazards listed included increased prevalence of pests and diseases, landslides, seasonal unpredictability of weather systems (e.g., monsoons in this region), temperature extremes (including severe cold events), glacial mass variability and the effects of climatic hazards exacerbated by other stressors, such as ecosystem degradation (e.g., soil erosion, deforestation).

Qualitative results indicated a concern with hazards not only caused by climate change but also exacerbated by other forms of ecosystem degradation (e.g., deforestation) and anthropogenic pressures (e.g., pollution). Hazards were frequently framed in terms of their risk to smallholder farmers' agricultural livelihoods; drought and changes to rainfall were frequently reported as hazards requiring adaptation. Changes in water supply quality and/or quantity were frequently reported, in both farming and non-farming contexts.

Also mentioned in several studies were efforts to adapt to increasingly unpredictable seasons and increased prevalence of unseasonable weather events. For example, while rainfall might be consistent with historical norms, changes to the seasonal distribution of rain events ('the increasingly erratic nature of rainfall') negatively impacted farmers in particular, often necessitating adaptation via shifted irrigation practices. Many studies suggested that mountain communities face elevated levels of risk associated with these hazards owing to livelihood vulnerability and greater severity of climate impacts. Heavy snowfall and unusually harsh winter conditions were noted as particularly affecting high-altitude mountain communities.

What aspects of vulnerability are adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	32	20
Sustainable cities and ecosystem services	19	12
Consumption and production	67	42
Health and well-being	34	21
Work and economic growth	46	29
Industry/innovation/technology	5	3
Poverty	72	45
Food security	122	77
Terrestrial and freshwater ecosystem services	20	13
Marine and coastal ecosystem services	1	1
Energy security	4	3
Education	10	6
Gender equality	11	7
Inequalities (other than gender)	10	6
Peace, justice and strong institutions	1	1
Other	30	19

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 77% reported on adaptations aimed at addressing food security, 45% of studies reported addressing poverty, while the third highest percentage of studies reported addressing consumption and production (42%). Gender equality was reported as a focus in 11% of studies, while clean water and sanitation was the focus in 7% of studies. Terrestrial and freshwater ecosystem services were reported as targeted vulnerabilities in 13% of studies reviewed.

Other responses included sociopolitical conflict, displacement and land insecurity, water insecurity, traditional ways of life and natural resource management.

Qualitative results confirmed a distinct emphasis on food security as the focal vulnerability targeted by adaptation efforts. Water insecurity was also frequently reported. While quantitative results did not indicate a significant emphasis on health and well-being, vulnerability to disease was frequently reported in the qualitative results. Ecosystem services were mentioned infrequently as an aim of adaptation efforts. However, vulnerability associated with resource dependence and resource-dependent livelihoods (e.g., pastoralism) was frequently reported as a target of adaptation efforts.

SMCCP5.3.2.3.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	24	15
Adaptation planning and early implementation	55	35
Implementation expanding	36	23
Implementation widespread	25	16
Evidence of risk reduction associated with adaptation efforts	7	4

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the adaptation planning and early implementation stage in this region (35%), 23% were identified as implementation expanding, while 16% were widespread, and 15% were in the vulnerability assessment and/or early planning stage.

Qualitative results suggested that the stage of implementation was frequently unclear, particularly given the prevalence of autonomous adaptations at the household level. The studies reviewed also noted considerable diversity among households with regard to the stage of implementation, within the same cases. A majority of studies reported that most households had undertaken at least some adaptation efforts (particularly in farming practices), but few had implemented all potential options.

Few adaptation efforts were formal/planned, so assessment of their progress was more difficult. Among formal/planned adaptation activities reported, assessment of actual implementation was reported to be challenging and variable; the majority appeared to be incipient.

Although quantitative results suggested that few adaptation activities were widespread, qualitative results suggested that, though ad hoc, some specific farming adaptations were widespread in this region. These included the diversification of crop varieties, multi- or inter-cropping, and changing seasonal practices to accommodate climatic shifts. Livelihood diversification was also reported to be widespread, specifically shifts away from exclusively livestock-based livelihoods.

Note: Several responses noted efforts to scale up and/or formalise adaptation strategies; in these cases, the planning stage would be separate from (and subsequent to) the early implementation stage.

What is the depth of change of the reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	104	65
Medium	24	15
High	25	16

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) depth of change (65%), 16% were assessed as *high*, and 15% were assessed as *medium*.

Most reported adaptations are described as modifications of existing practices, rather than systemic or structural change. Significant barriers to structural change (e.g., governing structures, major infrastructure) were identified, including entrenched power asymmetries, costs or capital requirements of adaptation, lack of coordinated planning, resistance to change among governing bodies, risk aversion and lack of access to information. Reported adaptations were described as primarily short term and reactive to shocks and stressors (i.e., many being akin to coping). Some adaptation activities (specifically agroforestry, forest management and some farming activities) were also based on traditional practices and, thus, were not typically characterised by high levels of change.

Several studies also noted that these changes are not exclusively in response to climate risks but represent an array of pressures on (primarily) farming livelihoods which prompt households and individuals to modify their practices. Studies which reported high levels of adaptation were primarily limited in scope, at the village scale.

What is the scope of change for reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	108	68
Medium	20	13
High	25	16

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited scope) of change (68%), 16% were assessed as *high*, while 13% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in the scope of change, implemented at the individual, household or community scale. Responses to this question focused primarily on the adoption of adaptation activities by specific actors. Some studies reported high rates of adoption and a broader scope of change; most reported significant variability in adoption among actors. In this region, variability was frequently attributed to specific vulnerabilities and power relations. Most studies also indicated limited integration across scales and a lack of linkages between changes at the institutional scale and the community, household or individual scale.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (the unit of analysis being household/individual, village or region, for example), rather than the activity itself.

What is the speed of change for reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	112	70
Medium	11	7
High	5	3

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (slow) speed of change (70%), 7% were assessed as *high*, and 3% were assessed as *medium*, while 20% of studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations are slow and incremental. Many studies did not evaluate or describe the speed of change; however, several of these also suggested that changes were likely incremental and reactive to specific climatic events/observed climate change impacts. Individual adaptation activities were reported as occurring quickly, but the overall speed of change was most frequently described as slow. Some studies in this region indicated changes occurring incrementally through multiple generations, with seasonal adaption activities contributing to a longer-term trend of adaptive changes.

Qualitative results indicated an overlap with the depth and scale of reported responses; ad hoc, autonomous changes at the household level were frequently reported as low depth, low scale and low speed.

SMCCP5.3.2.3.5 Are adaptation-related responses reducing risk/vulnerability?

What is the stated (or implied/assumed) link to reduction in risk? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported link between adaptation-related responses and reduction in risk was improving financial security (specifically household income level and stability of income) as a result of livelihood diversification. Other commonly reported results were enhancing water and food security (the latter frequently as a function of increased income), increasing agricultural productivity and minimising hazard risk (most commonly to droughts, precipitation variability). Adaptation-related responses such as livestock compensation and insurance programmes were frequently reported to reduce pastoralists' vulnerability to climate-related shocks.

Also mentioned were reductions in risk associated with ecosystem dependence, such as reducing soil erosion, mitigating land degradation and ensuring future resource availability (including water, fodder, forest products—commonly from community forests). A majority of studies either assumed reductions in risk or stated but did not empirically demonstrate these reductions. Very few studies indicated reductions in risk associated with specific aspects of vulnerability (e.g., gender, ethnic identity, health). Some studies reported no observed reduction in risk associated with adaptation-related responses. Several also indicated that maladaptation may pose additional risk, particularly when short-term responses to specific shocks prove maladaptive in the longer term.

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	113	71
No	46	29

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 71% of the studies reviewed reported evidence (implicit or explicit) that responses reduced risk or vulnerability, while 29% indicated no evidence for this effect.

Qualitative results indicate significantly more uncertainty. Risk reduction was described in some studies but infrequently quantified or investigated in depth; many studies report likely, assumed or partial reductions in risk. Several studies reported measurable reductions in farming-related risks (e.g., increased crop yields, mitigation of crop losses as a result of climate-related hazards). A majority of studies, however, indicated that responses were insufficient to substantially reduce climate risk. Most studies which evaluated formal/planned responses indicated little to no reduction in risk.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	97	61
No	62	39

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 61% of the studies reviewed identified indicators of success, while 39% did not.

The qualitative results indicated a lower prevalence of studies which identified indicators of success. Among indicators identified, the most commonly reported was a change in household income, followed by crop yields (production). Also mentioned were good governance (including institutional checks and balances), food security, improvements in livestock survival rates, irrigation water use efficiency and the percentage of households adopting adaptation responses. Several studies also used perceptions of success as a proxy indicator; a few others identified social capital and collective action as indicators to assess adaptive capacity within communities. A few studies also reported evaluating success based on a reduction of migration behaviours, considered to indicate better livelihood security and a transition away from vulnerable pastoral livelihoods.

Do actors or institutions undertaking adaptation consider (implicitly or explicitly) risks of maladaptation associated with the adaptation? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	65	41
No	94	59

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (59%), actors and institutions undertaking adaptations did not consider the risks of maladaptation associated with the adaptations. The consideration of maladaptation risk was reported in 41% of studies.

The majority of studies did not report qualitative results for this variable. Among those which did, the types of maladaptation risk most commonly considered were farming changes poorly suited to local ecological and social conditions (e.g., adoption of high-yield varieties resulting in the loss of traditional crops), trade-offs associated with reductions in migration and adverse effects of water management on water quality and/or supply (e.g., introducing chemical inputs which result in land degradation or water contamination).

Several studies also indicated that adaptive responses could further entrench existing social vulnerabilities and marginalisation (particularly for women); similarly, increased labour burdens were identified frequently as a consequence of adaptive responses in farming contexts. Also noted were risks associated with reactively adapting to one hazard while increasing exposure risk to another (e.g., people migrating to flood-prone areas).

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q 5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	47	30
No	112	70

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (70%), actors and institutions undertaking adaptation did not consider co-benefits associated with the adaptation. The consideration of co-benefits was reported in 30% of studies.

The majority of studies were not assessed qualitatively on this variable. Among those which were, in this region the types of co-benefits most commonly considered were women's empowerment and gender-role transformations. Other social co-benefits identified included enhanced social cohesion, collective action and improvements in governance. Also mentioned were climate-change-mitigation co-benefits, such as carbon sequestration resulting from reforestation efforts (specifically in community forests) and economic benefits (e.g., from improved crop yields).

SMCCP5.3.2.3.6 What evidence is provided on the extent to which responses challenge or exceed adaptation limits?
Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	134	84
No	25	16

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 84% of studies reviewed reported constraints or limits to adaptation, and 16% did not.

The most commonly reported limits to adaptation were related to economic factors (including lack of access to credit and the inability of poor farmers to engage in adaptive responses). The next most frequently reported were limits associated with information, awareness and technology (including limited access to knowledge about responses options, lack of technical skills to implement new technologies and awareness of climate risk more broadly). Social and cultural limits were the third most frequently reported; among these, the most frequently identified constraints were related to power imbalances and the role of social-political forces which limit the effectiveness of interventions (including caste and gender).

Limits on governance, institutions and policy were reported fourth most frequently (including poor integration of adaptation programmes across governing scales, a lack of decision-making power among vulnerable groups), followed by financial (including lack of funding for adaptation efforts at the household scale). Physical and biological limits were reported infrequently, but the latter most commonly included water availability and temperature change. Also noted were human capital constraints (including labour supply, education).

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	10	6
Soft	78	49
Both	45	28
N/A	25	16

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 49% of constraints or limits were identified as soft, 6% were identified as hard, and 28% were identified as both. This variable was not applicable in 16% of studies.

Limits and constraints identified as soft were described as potentially resolvable with more information or investment, related to governance and economics. Hard limits were more frequently described as being biophysical, such as water supply and land scarcity. Some economic limits (including poverty) and social/cultural limits (including gender inequality) were identified as hard in some studies and soft in others. Most studies identified both hard and soft limits.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	65	41
No	53	33
N/A	39	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 41% of studies reviewed indicated that they were approaching limits to adaptation, while 33% indicated that they were not. This variable was not applicable in 25% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge, or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.4 Australasia

Adaptations associated with K1 terrain in Australasia were reported in six articles, though one article was a multi-region study. This multi-region article was removed from this synthesis report to ensure that results only reflected adaptation in the target region. The following results are based on five articles.

SMCCP5.3.2.4.1 Who is adapting?
In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Australia	4	80
New Zealand	1	20

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in Australasia are (in descending order) Australia (4) and New Zealand (1).

Note: Due to the small sample size in this region, statistical comparisons with global-scale results yield inconsistencies which may or may not be significant.

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	1	20
Ocean and coastal ecosystems	0	0
Water and sanitation	2	40
Food, fibre and other ecosystem products	0	0
Cities, settlements and key infrastructure	0	0
Health, well-being and communities	2	40
Poverty, livelihoods and sustainable development	1	20

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sectors/systems most frequently identified as involved in reported adaptation actions were health, well-being and communities (40%) and water and sanitation (40%).

Who is involved in the reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	2	40
Local government	2	40
National government	2	40
Sub-national government	2	40
Civil society (sub-national or local)	2	40
Civil society (international, multi-national, national)	0	0
Private sector: small and medium-size enterprises	3	60
Private sector: corporations	3	60
International or multi-national governance	0	0
Other	0	0

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Private sector: small and medium-size enterprises and private sector: corporations were each identified as actors involved in the reported adaptations in 60% of studies. One response was coded as 'other', which identified a researcher as an additional actor. The qualitative results indicate that two of the studies are concerned with private-sector actors in the tourism industry. Household surveys were the source of data for the majority of studies in this region.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

The type of implementation tool most frequently reported in this region was autonomous adaptation by businesses, specifically changes to management and practices in the tourism industry. Diversification of tourism offerings was noted in three studies, while two reported water conservation or recycling as an implementation tool; sustainable forestry was also mentioned. No formal or planned adaptation by government actors was mentioned.

Is there evidence about who financed the reported adaptation actions? Q 4.2

Funding information?	Count	Percentage
Yes	1	20
No	4	80

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.4.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was reported in two articles (40%), while two articles (40%) included evidence that particularly vulnerable groups were targeted in adaptations.

Who is addressed in the context of equity in reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	0	0	Low-income	0	0
Indigenous	0	0	Indigenous	0	0
Women	0	0	Women	0	0
Elderly	0	0	Elderly	0	0
Migrants	0	0	Migrants	0	0
Youth	0	0	Youth	0	0
Disability	0	0	Disability	0	0
Ethnic minorities	0	0	Ethnic minorities	0	0
Other	2	40	Other	2	40
Equity Not Addressed	3	60	Equity Not Addressed	3	60

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The majority of studies reviewed in this region did not explicitly address equity planning or targeting (60%) in the context of reported adaptations. Two studies reported addressing equity, one for irrigators and one for stakeholders associated with a national park.

Is there reference to contributions from Indigenous knowledge in reported adaptations? Q 1.4

IK Contribution	Count	Percentage
Yes	0	0
No	5	100

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

LK Contribution	Count	Percentage
Yes	0	0
No	5	100

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—Cost of response	2	40
Yes—Cost savings from response	0	0
No	3	60

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.4.3 What responses are documented? What category of adaptation is reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	3	60
Behavioural/cultural	4	80
Institutional	2	40
Ecosystem-based	2	40

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 80% reported adaptation responses that were ecosystem-based. Technological/infrastructural responses were documented in 60% of studies.

Qualitative results suggested that a majority of actors engaged in multiple types of adaptation responses simultaneously and emphasised maximising economic flexibility.

What hazards are the adaptations aimed at addressing? 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	1	20
Drought	0	0
General climate impacts	2	40
Sea level rise	0	0
Precipitation variability	2	40
Increased frequency and intensity of extreme heat	2	40
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	0	0
Other	3	60

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 60% of studies reviewed reported adaptations to address other impacts of climate change, including landslides and loss of snowpack. General climate impacts, precipitation variability and increased frequency and intensity of extreme heat were each reported in 40% of cases. Qualitative results indicated that increased prevalence of natural disasters (e.g., storms, wildfires) and decreased ecosystem resilience were hazards targeted by adaptation efforts.

What aspects of vulnerability are the adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	0	0
Sustainable cities and ecosystem services	1	20
Consumption and production	0	0
Health and well-being	1	20
Work and economic growth	2	40
Industry/innovation/technology	2	40
Poverty	0	0
Food security	1	20
Terrestrial and freshwater ecosystem services	2	40
Marine and coastal ecosystem services	0	0
Energy security	0	0
Education	0	0
Gender equality	0	0
Inequalities (other than gender)	0	0
Peace, justice and strong institutions	0	0
Other	0	0

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, adaptations aimed at addressing terrestrial and freshwater ecosystem services, work and economic growth and industry/innovation/technology were each reported in 40% of cases; no other responses were recorded. Qualitative results described adaptations aimed at addressing the vulnerability of the ski industry to changes in snowpack and the vulnerability of forest-based ecosystem services.

SMCCP5.3.2.4.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	0	0
Adaptation planning and early implementation	2	40
Implementation expanding	1	20
Implementation widespread	2	40
Evidence of risk reduction associated with adaptation efforts	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 40% of adaptation activities were in the adaptation planning and early implementation stage, 40% were considered widespread, and 20% were considered in the expanding stage of implementation.

Qualitative results indicated more widespread implementation than the quantitative results suggest. All of the studies reviewed in this region reported well-established adaptation activities (in the forestry and ski industry sectors) occurring in the case study regions.

What is the depth of change of the reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	4	80
Medium	1	20
High	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) depth of change (80%), and 20% were assessed as *medium*, and none were assessed as *high*.

Most reported adaptations were described as very minor modifications of existing practices or institutions in order to mitigate immediate economic risk. These adaptations were primarily described as reactive, not novel.

What is the scope of change of the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	2	40
Medium	1	20
High	1	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) scope of change (40%), 20% were assessed as *high*, and 20% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in the scope of change (e.g., autonomous adaptations by specific economic sectors, namely tourism and forestry). A majority of studies reported on low (limited)-scope changes, implemented via local initiatives.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (the unit of analysis being, for example, household/individual, village, region), rather than the activity itself.

What is the speed of change for reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	2	40
Medium	1	20
High	1	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (slow) speed of change (40%), 20% were assessed as *high*, and 20% were assessed as *medium*.

Qualitative results indicated that all studies were described as incremental; however, two were categorised as slow, one as fast (a private sector adaptation in the tourism industry) and one as medium. Several studies described uncertainty about this variable.

SMCCP5.3.2.4.5 Are adaptation-related responses reducing risk/vulnerability?

What is the stated (or implied/assumed) link to reduction in risk? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported link between adaptation-related responses and reduction in risk was minimising hazard/disaster risk (in addition to financial risks associated with climate-related hazards); several studies specifically noted reductions in the risk of fire.

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	3	60
No	2	40

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 60% of the studies reviewed reported evidence (implicit or explicit) that responses were reducing risk or vulnerability, while 40% indicated no evidence to this effect. One study noted a reduction in economic risk associated with adaptation responses in the tourism sector. The majority of studies did not report sufficient qualitative results to assess this variable.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicator	Count	Percentage
Yes	1	20
No	4	80

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 20% of the studies reviewed identified indicators of success, while 80% did not. Only one study in this region reported qualitative results; it noted that perceptions and environmental values were linked to evaluating success in adaptive water conservation.

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) risks of maladaptation associated with the adaptation? Q 5.3.1; 5.3.2

Maladaptation s	Count	Percentage
Yes	1	20
No	4	80

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (80%), actors and institutions undertaking adaptations did not consider the risks of maladaptation associated with the adaptation. Only one study (20%) in this region reported qualitative results; it noted that short-term coping strategies (in this case, making snow for the ski industry) risked being untenable and a poor investment in the longer term.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	1	20
No	4	80

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (80%), actors and institutions undertaking adaptation did not consider the co-benefits associated with adaptations. Consideration of co-benefits was reported in 20% of studies. Only one study (20%) in this region reported qualitative results; it identified new business opportunities as a potential co-benefit.

SMCCP5.3.2.4.6 What evidence is offered on the extent to which responses are challenging or exceeding adaptation limits?

Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	4	80
No	1	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 80% of studies reviewed reported constraints or limits to adaptation, and 20% did not.

The most commonly reported limits to adaptation were biological (including temperature and ecological health). Also reported were constraints related to technology, economics and finance.

Are constraints or limits hard or soft? Q 6.3

Type of Limit	Count	Percentage
Hard	0	0
Soft	1	20
Both	3	60
N/A	1	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 20% of constraints or limits were identified as soft, none were identified as hard, and 60% were identified as both. This variable was not applicable in 20% of studies. There were no qualitative results reported in this region.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	65	41
No	53	33
N/A	39	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 40% of studies reviewed indicated that they were approaching limits to adaptation. This variable was not applicable in 60% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.5 Central and South America

Adaptations associated with K1 terrain in Central and South America were reported in 46 articles. However, 8 articles were multi-region studies. These multi-region articles were removed from this synthesis report to ensure that results only reflected adaptation in the target region. The following results are based on 38 articles.

SMCCP5.3.2.5.1 Who is adapting?

In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Peru	9	24
Colombia	7	18
Guatemala	7	18
Bolivia	5	13
Brazil	4	11
Ecuador	3	8
Honduras	3	8
Nicaragua	2	5
Chile	1	3
Costa Rica	1	3
El Salvador	1	3

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in Central and South America are (in descending order) Peru (9), Colombia (7), Guatemala (7), Bolivia (5) and Brazil (4). One study reported adaptations in Chile, whereas no studies reported adaptations in Argentina.

Which sectors/systems are involved in the reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	5	13
Ocean and coastal ecosystems	0	0
Water and sanitation	9	24
Food, fibre and other ecosystem products	32	84
Cities, settlements and key infrastructure	3	8
Health, well-being and communities	4	11
Poverty, livelihoods and sustainable development	16	42

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as involved in reported adaptation actions was food, fibre and other ecosystem products (84% of studies), followed by poverty, livelihood and sustainable development (42% of studies). Water and sanitation was reported in 24% of studies. Few studies identified involvement in cities, settlements and key infrastructure (8%). These percentages are consistent with findings at the global scale.

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actor	Count	Percentage
Individual or household	35	92
Local government	11	29
National government	8	21
Sub-national government	5	13
Civil society (sub-national or local)	20	53
Civil society (international, multi-national, national)	7	18
Private sector: small and medium-size enterprises	4	11
Private sector: corporations	0	0
International or multi-national governance	3	8
Other	6	16

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 92% of studies reviewed. Civil society actors at the sub-national or local scale were involved in 53% of reported adaptations, followed by local government actors (29%). Others mentioned included farmers, policymakers, academic institutions and local organisations (e.g., farmers' associations, water user associations and coffee cooperatives). Qualitative results also indicated that local-scale civil society actors were frequently involved with reported adaptations.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

The most common implementation tools reported were agroforestry and changes to farming practices (e.g., adoption of novel irrigation techniques, crop variety diversification). Ecosystem-based adaptation was also frequently reported, including reforestation and restoration projects, watershed protection and 'changes in ecosystem structures to enhance resilience'. Approximately half of the implementation tools were identified as autonomous, rather than formal/planned implementation. Autonomous implementation was reported as having been driven primarily by farmers and farming communities. The most frequently reported formal/planned implementation tool was fiscal incentives for adaptation, followed by education and awareness programmes. One study also reported the relocation of vulnerable communities to reduce disaster risk.

Is there evidence on who financed the reported adaptation actions? Q 4.2

Funding information?	Count	Percentage
Yes	19	50
No	19	50

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.5.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was presented in 19 articles (50%), and evidence that particularly vulnerable groups were targeted in adaptations was given in 19 articles (50%).

Who is addressed in the context of equity in the reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	11	29	Low-income	10	26
Indigenous	10	26	Indigenous	8	21
Women	2	5	Women	1	3
Elderly	0	0	Elderly	0	0
Migrants	0	0	Migrants	0	0
Youth	0	0	Youth	1	3
Disability	0	0	Disability	0	0
Ethnic minorities	1	3	Ethnic minorities	1	3
Other	5	13	Other	4	11
Equity not addressed	19	50	Equity not addressed	19	50

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Half of the studies reviewed sited in Central and South America did not explicitly address equity planning in the context of reported adaptations. Among studies which did so, the largest number reported addressing equity for low-income individuals or populations—29% of studies addressed equity planning and 26% addressed equity targeting for low-income groups. Indigenous Peoples were the group next most commonly identified as a focus of equity planning (26% of studies) and equity targeting (21% of studies). Few studies (2%) reported focusing on equity planning (5%) or equity targeting (3%) for women, particularly compared with the global results. There were no significant discrepancies between equity planning and equity targeting foci among studies reporting on equity in adaptation actions.

Others mentioned (both equity planning and targeting) included smallholder farmers, peasant communities and rural populations. The qualitative results for this region indicated that equity planning processes were largely participatory, with targeted groups (particularly Indigenous Peoples) taking an active role. Qualitative results also confirmed the quantitative finding that there was a significant focus on Indigenous Peoples at large, particularly indigenous smallholder farmers. Urban poverty was also targeted in several studies.

Is there reference to contributions from Indigenous knowledge in the reported adaptations? Q 1.4

Indigenous Knowledge Contribution	Count	Percentage
Yes	16	42
No	22	58

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

Local Knowledge Contribution	Count	Percentage
Yes	17	45
No	21	55

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—Cost of response	11	29
Yes—Cost savings from response	4	11
No	22	58

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.5.3 What responses are documented? What category of adaptation is reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	21	55
Behavioural/cultural	30	79
Institutional	13	34
Ecosystem-based	33	87

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 87% reported adaptation responses that were ecosystem-based. Behavioural/cultural adaptations were reported in 79% of studies, while the third highest percentage of studies reported responses that were behavioural/cultural (55%). Fewer studies reported institutional responses, which is consistent with a higher proportion of autonomous adaptation efforts than formal or planned adaptation.

The qualitative analysis corroborated this finding, suggesting that systemic or institutional adaptation efforts are less frequently reported than autonomous adaptation occurring at the individual, household and community scale, particularly among farmers and rural communities. A wide variety of agricultural adaptations were reported in all categories, including changes to crop and livestock varieties, tillage and irrigation practices, soil and water conservation and management.

Results from this region indicated more implementation of ecosystem-based responses (e.g., watershed management, reforestation) than the global analysis. The adoption of agroforestry was the most commonly reported, which included both behavioural/cultural changes and technological/infrastructural changes. Diversification and changes to financial decision-making were also frequently reported. Several studies also reported land purchases as a risk mitigation strategy. Formal/planned institutional responses were infrequently reported.

What hazards are the adaptations aimed at addressing? 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	15	39
Drought	25	66
General climate impacts	22	58
Sea level rise	0	0
Precipitation variability	25	66
Increased frequency and intensity of extreme heat	13	34
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	0	0
Other	25	66

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 66% of studies reviewed reported adaptation to address drought, and 66% reported adaptation to address precipitation variability. The next most prevalent hazard addressed was general climate impacts (58% of studies). Extreme heat was reported in 34% of studies reviewed.

The next most frequently listed hazard was increased prevalence of pests and diseases. Other hazards noted were seasonal unpredictability of weather systems (e.g., rainfall variability), changes to glacial extent, landslides and the effects of climatic hazards exacerbated by other stressors, such as ecosystem degradation (e.g., soil erosion and declining soil productivity, deforestation and land degradation).

Hazards were frequently framed in terms of their risk to smallholder farmers' agricultural livelihoods; drought and changes to rainfall were frequently reported as hazards requiring adaptation. The qualitative results indicated a concern with hazards not only caused by climate change but also exacerbated by other forms of ecosystem degradation (e.g., deforestation) and anthropogenic pressures (e.g., population growth, land-use changes). Changes in water supply quality and/or quantity were also frequently reported, both in farming and non-farming contexts; this hazard was attributed in several studies to both climate change and other factors, such as land-use changes and poor water management. An emphasis on crop pests and disease as a climate-associated hazard was also apparent in this region.

What aspects of vulnerability are the adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	6	16
Sustainable cities and ecosystem services	4	11
Consumption and production	19	50
Health and well-being	6	16
Work and economic growth	12	32
Industry/innovation/technology	1	3
Poverty	15	39
Food security	29	76
Terrestrial and freshwater ecosystem services	12	32
Marine and coastal ecosystem services	0	0

Exposure vulnerability	Count	Percentage
Energy security	2	5
Education	0	0
Gender equality	1	3
Inequalities (other than gender)	3	8
Peace, justice and strong institutions	3	8
Other	9	24

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 76% reported on adaptations aimed at addressing food security, 50% of studies reported on addressing consumption and production, while the third highest percentage of studies reported on addressing poverty (39%). Gender equality was reported as a focus in 3% of studies, while clean water and sanitation was reported in 16% of studies. Terrestrial and freshwater ecosystem services were reported as targeted vulnerabilities in 32% of studies reviewed.

Other responses included biodiversity loss (loss of native species), seasonal hunger, farming livelihoods and governance systems.

Qualitative results confirmed a distinct emphasis on food security as the focal vulnerability targeted by adaptation efforts. The vulnerability of ecosystem services (terrestrial and freshwater), most frequently biodiversity and water supply/water quality, was frequently noted in qualitative results. Several studies identified a focus on overlapping vulnerabilities associated with food security and health and well-being. Traditional livelihoods and practices—in addition to being identified as adaptation strategies—were mentioned as aspects of vulnerability addressed by adaptation efforts in several cases.

SMCCP5.3.2.5.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	4	11
Adaptation planning and early implementation	17	45
Implementation expanding	12	32
Implementation widespread	0	0
Evidence of risk reduction associated with adaptation efforts	3	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the adaptation planning and early implementation stage in this region (45%), 32% were identified as implementation expanding, and 11% were in the vulnerability assessment and/or early planning stage. None were identified as widespread.

Qualitative results suggested that the stage of implementation is frequently unclear, particularly given the prevalence of autonomous adaptation at the household level. Several studies noted the difficulty of assessing progress towards the implementation of activities undertaken ad hoc at the household level.

The studies reviewed also noted considerable diversity among households with regard to the stage of implementation, within the same cases and regions. What is the threshold for 'widespread' here? The qualitative responses seemed inconsistent in this case with the aforementioned statistics. Adaptation activities which involved novel technologies or practices reported less progress towards implementation than those based on traditional practices.

What is the depth of change for the reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	18	47
Medium	9	24
High	8	21

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) depth of change (47%), 21% were assessed as *high*, and 24% were assessed as *medium*.

Most reported adaptations were described as modifications of existing practices rather than systemic or structural changes. Significant barriers to structural change were identified, including costs or capital requirements of adaptations, lack of coordinated planning, resistance to change among governing bodies and household risk aversion. Reported adaptations were described as primarily short term (small, incremental, reversible) and reactive to shocks and stressors (i.e., many being akin to coping); these reflected 'no real difference in the underlying values, assumptions, and norms'.

Some adaptation activities (in this region most commonly agroforestry, in addition to forest management and some farming activities) were reported as being based on traditional practices with inherent adaptive capacity, and coders indicated that adaptation may be effective at *low* or *medium* levels of change. Several studies reported a *high* depth of change in one aspect (e.g., crop diversification) with *low* (limited) institutional or political change associated. Examples of activities characterised by a *high* depth of change included the establishment of protected areas and new community-based governing bodies (e.g., cooperatives).

What is the scope of change for the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	29	76
Medium	4	11
High	4	11

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) scope of change (76%), 11% were assessed as *high*, and 11% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in the scope of change, implemented at the individual, household or community scale. Responses to this question focused primarily on the adoption of adaptation activities by specific actors. Some studies reported high rates of adoption and a broader scope of change, particularly in broader ecosystem-based adaptation efforts (e.g., watershed conservation projects), which were integrated with larger governing bodies or initiatives. Most studies reported significant variability in adoption among actors. In this region, variability was frequently attributed to livelihood differences, with resource-dependent smallholders adapting most commonly.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (the unit of analysis being household/individual, village or region, for example), rather than the activity itself.

What is the speed of change for the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	22	58
Medium	5	13
High	3	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (slow) speed of change (58%), 13% were assessed as *medium*, and 8% were assessed as *high*. However, 8% of studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations are slow and incremental. Many studies did not evaluate or describe the speed of change or indicated uncertainty as to the speed of change. Several of these also suggested that changes were likely incremental and reactive to specific climatic events/observed climate change impacts. In this region, individual adaptation activities were frequently reported as occurring quickly, but the overall speed of change was most often described as medium-slow, occurring over 5- to 15-year time scales. Adaptation activities described as changing more quickly frequently involved planning and institutional support (e.g., establishment of protected areas).

Qualitative results indicated an overlap with the depth and scale of reported responses; ad hoc, autonomous changes at the household level were frequently reported as being low depth, low scale and low speed.

SMCCP5.3.2.5.5 Do adaptation-related responses reduce risk/vulnerability?

What is the stated (or implied/assumed) link to risk reduction? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported links between adaptation-related responses and reduction in risk were enhancements in ecosystem resilience (reducing soil erosion, improving forest condition, watershed protection) and reductions in crop losses (and as a result reducing risk due to food insecurity) through improved agricultural productivity and crop diversification. Other commonly reported links were enhancements in water security, improving household incomes (mitigating financial risk) and minimising hazard risk (most commonly to droughts, precipitation variability, landslides). Several studies also noted a reduction in risk associated with disease, for both humans and livestock.

A majority of studies either assumed or stated reductions in risk but did not empirically demonstrate these reductions. Very few studies indicated reductions in risk associated with specific aspects of vulnerability (e.g., gender, ethnic identity).

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	25	66
No	13	34

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 66% of the studies reviewed reported evidence (implicit or explicit) that responses were reducing risk or vulnerability, while 34% indicated no evidence to this effect.

Qualitative results indicated significantly more uncertainty. Risk reduction was described in some studies but infrequently quantified or investigated in depth; many studies reported likely, assumed, potential or partial reductions in risk. Several studies reported improved resilience of ecosystem services to shocks, as a result of agroforestry responses, and others reported general reductions in risk associated with climate-related hazards. Some corresponding improvements in food security were also demonstrated. A majority of studies identified as reducing risk were more broadly focused on resilience, rather than specific aspects of risk reduction.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	20	53
No	18	47

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 53% of the studies reviewed identified indicators of success, while 47% did not.

The qualitative results indicated a lower prevalence of studies which identified indicators of success. Among the indicators identified, most commonly reported were measures of economic security at the household level (e.g., income, access to credit). Also mentioned were crop yields (and agricultural productivity more broadly), use of traditional knowledge systems (including native seed varieties, application of traditional practices), overall soil health and the use of agricultural inputs.

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	17	45
No	21	55

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (55%), actors and institutions undertaking adaptations did not consider risks of maladaptation associated with the adaptations. Considertation of maladaptation risk was reported in 45% of studies.

No qualitative results on this variable were reported for approximately half of the studies. Among those which did, the types of maladaptation risk most commonly considered were farming changes poorly suited to local ecological and social conditions (e.g., adoption of high-yield varieties resulting in the loss of traditional crops) and adverse effects of farming inputs on water and soil quality condition (e.g., introducing chemical inputs which result in land degradation or water contamination).

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	15	39
No	23	61

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (61%), actors and institutions undertaking adaptations did not consider the co-benefits associated with adaptations. The consideration of co-benefits was reported in 39% of studies.

In this region the types of co-benefits most commonly considered were mitigative, specifically carbon sequestration as a result of ecosystem-based adaptation responses, including agroforestry and reforestation/afforestation efforts. Biodiversity protection was also frequently reported as a co-benefit of these adaptation activities. Others mentioned include improvements in food security, water quality and supply, household income and good governance. Of the various adaptation responses reported, forestry and agroforestry projects were most frequently reported to demonstrate co-benefits.

SMCCP5.3.2.5.6 What evidence is provided on the extent to which responses challenge or exceed adaptation limits? Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	33	87
No	5	13

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 87% of studies reviewed reported constraints or limits to adaptation, and 13% did not.

The most commonly reported limits to adaptation were related to governance, institutions and policy (including most frequently land tenure insecurity, followed by law enforcement, lack of regulations and lack of integration of policies across scales). The next most frequently reported limits to adaptation were social and cultural limits (including perceptions of conflict over land and resources, erosion of traditional knowledge, and inequality; this was identified as a cross-cutting issue in several studies). Financial limits were the third most frequently reported (including limited funding for government-run adaptation

programmes), followed by economic factors (including lack of access to markets and fixed livelihoods).

The physical limits reported most frequently were farm size and land availability, in addition to the topography and climate of particular plots of land. Biological limits reported included soil productivity, water availability and temperature. Also noted were human capital constraints (including health).

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	3	8
Soft	19	50
Both	10	26
N/A	5	13

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 50% of constraints or limits were identified as soft, 8% were identified as hard, and 26% were identified as both. This variable was not applicable in 13% of studies.

The majority of limits and constraints were identified as soft; these were described as potentially resolvable with efforts to address perceptions and awareness, primarily related to social/cultural constraints. Hard limits were more frequently described as being biophysical (related to natural capital), such as water availability and topography. Some economic and financial constraints (including costs of infrastructure development, funding for programmes) and governance, institutional and policy limits (including laws) were identified as hard in some studies and soft in others. Frequently, studies identified both hard and soft limits.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	11	29
No	19	50
N/A	7	18

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 29% of studies reviewed indicated that they were approaching limits to adaptation, while 50% indicated that they were not. This variable was not applicable in 18% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.6 Europe

Adaptations associated with K1 terrain in Europe were reported in 27 articles. However, 14 articles were multi-region studies. These multi-region articles were removed from this synthesis report to ensure that results only reflect adaptation in the target region. The following results are based on 13 articles.

SMCCP5.3.2.6.1 Who is adapting?

In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Norway	5	38
Austria	3	23
Switzerland	2	15
Mediterranean (region)	1	8
Russia	1	8
Spain	1	8
Sweden	1	8

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in Europe are (in descending order) Norway (5), Austria (3), Switzerland (2), Russia (1) and Spain (1). One study also reported adaptations in the Mediterranean region.

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	4	31
Ocean and coastal ecosystems	0	0
Water and sanitation	6	46
Food, fibre and other ecosystem products	7	54
Cities, settlements and key infrastructure	1	8
Health, well-being and communities	5	38
Poverty, livelihoods and sustainable development	0	0

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as being involved in reported adaptation actions was food, fibre and other ecosystem

products (54% of studies), followed by water and sanitation (46% of studies) and health, well-being and communities (38% of studies). Few studies identified involvement in cities, settlements and key infrastructure (8%). Poverty, livelihoods and sustainable development are not reported as involved in any studies in Europe, which is inconsistent with global results (which report 55% of studies involved).

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	9	69
Local government	4	31
National government	4	31
Sub-national government	3	23
Civil society (sub-national or local)	7	54
Civil society (international, multi-national, national)	2	15
Private sector: small and medium-size enterprises	5	38
Private sector: corporations	1	8
International or multi-national governance	2	15
Other	5	38

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 69% of studies reviewed. Civil society actors at the sub-national or local scale were involved in 54% of reported adaptations, followed by private sector: small and medium-size enterprises (38%). Other actors reported were forest managers and decision makers, researchers or scientists, and herding communities.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

Implementation of adaptation actions was more frequently reported to be autonomous (primarily by businesses and communities) than formal/planned, though autonomous adaptation efforts were frequently paired with or supported by policy tools in this region. Implementation tools identified included adjustment of farming techniques, informal social support schemes, the development of compensation schemes and risk management. Policy tools identified included expansion of protected area networks and increased disaster response capacity.

Is there evidence about who financed reported adaptation actions? Q 4.2

Funding info	Count	Percentage
Yes	3	23
No	10	77

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.6.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was presented in five articles (38%), whereas evidence that particularly vulnerable groups were targeted in adaptations was presented in four articles (31%).

Who is addressed in the context of equity in the reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	0	0	Low-income	0	0
Indigenous	2	15	Indigenous	2	15
Women	1	8	Women	1	8
Elderly	1	8	Elderly	1	8
Migrants	1	8	Migrants	0	0
Youth	1	8	Youth	1	8
Disability	0	0	Disability	0	0
Ethnic minorities	0	0	Ethnic minorities	1	8
Other	1	8	Other	0	0
Equity not addressed	8	62	Equity not addressed	9	69

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The majority of studies reviewed in this region did not explicitly address equity planning (62%) or targeting (69%) in the context of reported adaptations. Two studies (15%) reported addressing equity for Indigenous Peoples. Others mentioned were farming women (equity planning) and socioeconomic factors in general. Few qualitative results were reported in this region owing to the limited focus on equity.

Is there reference to contributions from Indigenous knowledge in the reported adaptations? Q 1.4

Indigenous Knowledge Contribution	Count	Percentage
Yes	2	15
No	11	85

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in the reported adaptations? Q 1.5

Local Knowledge Contribution	Count	Percentage
Yes	2	15
No	11	85

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are the costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—Cost of response	2	15
Yes—Cost savings from response	1	8
No	11	85

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.6.3 What responses are documented? What category of adaptation is reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	8	62
Behavioural/cultural	11	85
Institutional	8	62
Ecosystem-based	8	62

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 85% reported adaptation responses that were ecosystem-based. The other three variables were each reported in 62% of studies.

Qualitative results suggested that in most cases, actors engaged in multiple types of adaptation responses simultaneously and emphasised maximising economic flexibility. Behavioural/cultural responses reported included programmes to raise education/awareness.

What hazards are the adaptations aimed at addressing? 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	7	54
Drought	5	38
General climate impacts	9	69
Sea level rise	2	15
Precipitation variability	6	46
Increased frequency and intensity of extreme heat	3	23
Rising ocean temperature and ocean acidification	1	8
Loss of Arctic sea ice	2	15
Other	6	46

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 69% of studies reviewed reported adaptation to address general climate impacts. Extreme precipitation and inland flooding were mentioned in 54% of studies, while 46% of studies identified precipitation variability as the target hazard. Other hazards, including changes to snow cover (both loss of snowpack, avalanches) and fires, were reported in 46% of studies.

Qualitative results also indicated that changes to snow cover are a primary concern. Invasive species are also reported as a hazard targeted by adaptation efforts, particularly in the forestry sector. Several studies suggested that mountain regions face elevated levels of risk associated with these hazards owing to a greater severity of climate impacts.

What aspects of vulnerability are the adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	1	8
Sustainable cities and ecosystem services	4	31
Consumption and production	5	38
Health and well-being	7	54
Work and economic growth	4	31
Industry/innovation/technology	2	15
Poverty	0	0
Food security	5	38
Terrestrial and freshwater ecosystem services	5	38
Marine and coastal ecosystem services	0	0
Energy security	0	0
Education	3	23
Gender equality	0	0
Inequality (other than gender)	1	8
Peace, justice and strong institutions	0	0
Other	2	15

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 54% reported on adaptations aimed at addressing health and well-being. Consumption and production, food security and terrestrial and freshwater ecosystem services were each addressed by 38% of studies. Education was addressed in 23% of studies. Neither poverty nor gender was identified as an aspect of vulnerability addressed in any studies reviewed in this region.

Other responses included livelihoods, business interests and cultural significance. The vulnerability of existing infrastructure was specifically noted in several studies, including ski tourism infrastructure and residential housing. In several studies, ecosystem services provided by forests were specifically identified as aspects of vulnerability targeted by adaptation efforts.

SMCCP5.3.2.6.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	3	23
Adaptation planning and early implementation	3	23
Implementation expanding	4	31
Implementation widespread	1	8
Evidence of risk reduction associated with adaptation efforts	1	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the expanding stage of implementation (31%), 23% were identified as being in the vulnerability assessment and/or early planning stage, and 23% were identified as being in the adaptation planning and early implementation stage.

Qualitative results indicated limited planning of adaptation activities. Several studies reported that private-sector actors (e.g., tourism companies) were undertaking widespread adaptation activities, but otherwise adaptation activities were primarily ad hoc and/or implicit, with little planning. Infrastructure-based projects were noted as an exception to this in multiple studies.

What is the depth of change for reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	9	69
Medium	2	15
High	1	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) depth of change (69%), 15% were assessed as *medium*, and 8% were assessed as *high*.

Most reported adaptations were described as very minor modifications of existing practices or institutions in order to mitigate immediate economic risk. These adaptations were frequently described as reactive, not novel. Several studies also noted that these changes are not exclusively in response to climate risks but constitute an array of pressures on economic security which prompt households and individuals to modify their practices.

What is the scope of change for the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	10	77
Medium	0	0
High	3	23

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) scope of change (77%), 23% were assessed as *high*, and none were assessed as *medium*. Qualitative results supported the conclusion that most reported adaptations are small in terms of scope of change (e.g., autonomous adaptations by specific economic sectors). A majority of studies reported a *low* (limited) scope of changes, implemented via local initiatives.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (the unit of analysis being household/individual, village or region, for example), rather than the activity itself.

What is the speed of change for the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	11	85
Medium	0	0
High	1	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (slow) speed of change (85%), 8% were assessed as *high*, and none were assessed as *medium*, while 7% of studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations are slow and incremental. Frequently, studies did not evaluate or describe the speed of change; several studies reporting slow changes also indicated uncertainty about this variable.

SMCCP5.3.2.6.5 Do adaptation-related responses reduce risk/vulnerability?

What is the stated (or implied/assumed) link to reduction in risk? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported link between adaptation-related responses and reduction in risk was minimising hazard/disaster risk (in addition to financial risks associated with climate-related hazards, including fire, drought, flooding, and avalanches). Other reported links included enhancing ecosystem resilience (specifically related to forest health).

A majority of studies either assumed reductions in risk or stated but did not empirically demonstrate these reductions.

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	9	69
No	4	31

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 69% of the studies reviewed reported evidence (implicit or explicit) that responses reduced risk or vulnerability, while 31% indicated no evidence to this effect.

Qualitative results indicated less evidence of risk reduction. Risk reduction (most frequently with regard to climate-related hazards and associated economic damages) was described in some studies but infrequently quantified or investigated in depth. Some studies indicated that longer-term evaluation would be required to assess evidence of risk reduction.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	4	31
No	9	69

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 31% of the studies reviewed identified indicators of success, while 69% did not.

The majority of studies coded in this region did not report qualitative results for this variable. Among those which did, the indicators most frequently reported were related to forest health (e.g., stand diversity, forest cover).

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	5	38
No	8	62

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of the studies reviewed (62%), actors and institutions undertaking adaptations did not consider risks of maladaptation associated with the adaptations. Consideration of maladaptation risk consideration was reported in 38% of studies.

Qualitative results were not reported for the majority of the studies reviewed in this region. The risks and maladaptation considered included the loss of local cultural traditions and associated sustainability as a result of adopting new agricultural practices.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	9	69
No	4	31

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of the studies reviewed (69%), actors and institutions undertaking adaptations did not consider the co-benefits associated with the adaptations. The consideration of co-benefits was reported in 31% of studies.

In this region the types of co-benefits most commonly considered were income generation, increased forest cover and associated climate-change-mitigation co-benefits. Several studies also noted consideration of co-benefits in human and social capital and general human well-being.

SMCCP5.3.2.6.6 What evidence is given regarding the extent to which responses challenge or exceed adaptation limits?

Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	10	77
No	3	23

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 77% of studies reviewed reported constraints or limits to adaptation, and 23% did not.

In this region, the most commonly reported limits were related to governance, institutions, and policy (including the politicisation of climate change and a lack of innovation in governing frameworks). The next most frequently reported limitations were biological (including temperature and water availability), followed by social/cultural factors (including risk perceptions, others unspecified). Economic constraints were not identified in this region.

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	2	15
Soft	6	46
Both	3	23
N/A	2	15

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 46% of constraints or limits were identified as soft, 15% as hard, and 23% as both. This variable was not applicable in 15% of studies. Few qualitative results were reported in this region, but education was identified as a soft limit.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	8	62
No	3	23
N/A	1	8

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 62% of the studies reviewed indicated that they were approaching limits to adaptation, while 23% indicated that they were not. This variable was not applicable in 8% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further is being reached (first interpretation), that efforts are being undertaken to ameliorate limits (second interpretation) or that limits had already been surpassed (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.7 North America

Adaptations associated with K1 terrain in North America were reported in 39 articles. However, nine articles were multi-region studies. These multi-region articles were removed from this synthesis report to ensure that results only reflect adaptation in the target region. The following results are based on 30 articles.

SMCCP5.3.2.7.1 Who is adapting?

In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
United States	18	60
Mexico	8	27
Canada	4	13

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in North America are (in descending order) United States (18), Mexico (8) and Canada (4).

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	16	53
Ocean and coastal ecosystems	1	3
Water and sanitation	18	60
Food, fibre and other ecosystem products	16	53
Cities, settlements and key infrastructure	3	10
Health, well-being and communities	10	33
Poverty, livelihoods and sustainable development	9	30

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/system most frequently identified as being involved in reported adaptation actions was water and sanitation (60% of studies), followed by food, fibre and other ecosystem products (53% of studies) and terrestrial and freshwater ecosystems (53% of studies). Compared to findings at the global scale, poverty, livelihoods and sustainable development is underrepresented (55% of studies in the global data set), while water and sanitation was twice as commonly reported by percentage (28% of studies in the global data set).

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	21	70
Local government	16	53
National government	15	50
Sub-national government	12	40
Civil society (sub-national or local)	10	33
Civil society (international, multi-national, national)	5	17
Private sector: small and medium-size enterprises	5	17
Private sector: corporations	3	10
International or multi-national governance	0	0
Other	5	17

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 70% of the studies reviewed. Local governments were involved in 53% of the reported adaptations, followed by national governments (50% of studies). Other actors reported included tribal governments or leaders, farmers, resource managers (e.g., water or forest managers) and academics/researchers. The prevalent role of government actors was corroborated in the qualitative results, with a majority of studies identifying one or several relevant institutions as key actors in implementing or planning adaptation actions.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

Implementation tools reported included planning and capacity-building efforts (e.g., community-based planning workshops), investments in infrastructure, changes in land-use patterns and changes in technology use in agricultural systems. More of the implementation reported was formal/planned than autonomous; this is inconsistent with global findings. Among formal implementation tools, the most frequently reported were adaptation planning efforts and infrastructure development. Also identified frequently were informational tools (e.g., early warning systems, monitoring and forecasting tools). Ecosystem restoration was identified as an implementation tool in several studies.

Is there evidence about who financed the reported adaptation actions? Q 4.2

Funding info	Count	Percentage
Yes	8	27
No	22	73

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.7.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was presented in 10 articles (33%), while evidence that particularly vulnerable groups were targeted in adaptations was given in 11 articles (37%).

Who is addressed in the context of equity in the reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	3	10	Low-income	6	20
Indigenous	7	23	Indigenous	5	17
Women	1	3	Women	2	7
Elderly	0	0	Elderly	1	3
Migrants	0	0	Migrants	0	0
Youth	0	0	Youth	0	0
Disability	0	0	Disability	0	0
Ethnic minorities	1	3	Ethnic minorities	0	0
Other	0	0	Other	1	3
Equity not addressed	20	67	Equity not addressed	19	63

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The majority of studies reviewed in this region did not explicitly address equity planning (67%) or targeting (63%) in the context of reported adaptations. Among studies which did so, the greatest number of studies reported addressing equity for Indigenous Peoples—23% of studies addressed equity planning and 17% addressed equity targeting for low-income groups. No other group was frequently indicated in this region.

Other groups mentioned include farmers, private forest owners and low-income rural communities. Qualitative results confirm that the majority of studies addressing equity do so for/with Indigenous Peoples. Several studies also addressed specific vulnerabilities of forest users, including Indigenous forest users. In addition to addressing low-income groups, one study reported on dimensions of social marginalisation, including illiteracy.

Is there reference to contributions from Indigenous knowledge in the reported adaptations? Q 1.4

Indigenous Knowledge Contribution	Count	Percentage
Yes	8	27
No	22	73

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

Local Knowledge Contribution	Count	Percentage
Yes	8	27
No	22	73

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are the costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—Cost of response	7	23
Yes—Cost savings from response	1	3
No	20	67

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.7.3 What responses are documented? What categories of adaptation are reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	15	50
Behavioural/cultural	21	70
Institutional	17	57
Ecosystem-based	21	70

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 70% reported adaptation responses that were ecosystem-based, and 70% reported behavioural/cultural adaptations. The third highest percentage of studies reported responses that were institutional (57%). Technological/infrastructural responses were reported in 50% of the studies.

The majority of adaptation responses reported were autonomous rather than formal or planned and were carried out by farmers, private landowners or land/resource managers. In most cases, actors engaged in multiple types of adaptation responses simultaneously: behavioural/cultural (e.g., planting cash crops), ecosystem-based (e.g., riparian buffers, soil conservation practices) and technological/infrastructural (e.g., installation of flood barriers). An emphasis on diversification of income sources in order to maximise economic flexibility was commonly reported at the household level and among private companies engaging in adaptation efforts. Compared to the global average, this region demonstrated greater implementation of ecosystem-based responses, and somewhat less behavioural/cultural adaptation responses.

What hazards are the adaptations aimed at addressing? 3.3.1; 3.3.2; 3.3.3

Hazard	Count	Percentage
Extreme precipitation and inland flooding	11	37
Drought	19	63
General climate impacts	21	70
Sea level rise	1	3
Precipitation variability	16	53
Increased frequency and intensity of extreme heat	9	30
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	1	3
Other	14	47

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, 70% of the studies reviewed reported adaptation to address general climate impacts, and 63% reported adaptations to address drought. The next most prevalent hazard addressed was precipitation variability (53% of studies). Extreme heat was reported in 30% of the studies reviewed.

The other hazard listed most frequently was increased prevalence of pests (invasive species) and diseases. Other hazards noted were wildfires, hurricanes, severe wind events, increased frequency of cold spells and permafrost degradation.

Drought and precipitation variability was frequently reported in terms of risk to smallholder farmers' agricultural livelihoods. Pests and diseases were reported most frequently as affecting the forestry sector (pine beetles as an invasive species), in addition to some farming impacts. Changes in water supply quality and/or quantity were also frequently reported, both in farming and non-farming contexts.

What aspects of vulnerability are the adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	6	20
Sustainable cities and ecosystem services	10	33
Consumption and production	10	33
Health and well-being	6	20
Work and economic growth	10	33
Industry/innovation/technology	3	10
Poverty	6	20
Food security	14	47
Terrestrial and freshwater ecosystem services	14	47
Marine and coastal ecosystem services	1	3
Energy security	0	0
Education	1	3
Gender equality	2	7

Exposure vulnerability	Count	Percentage
Inequalities (other than gender)	0	0
Peace, justice and strong institutions	0	0
Other	0	0

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, 47% reported adaptations aimed at addressing food security, and 47% were aimed at terrestrial and freshwater ecosystem services. Sustainable cities and ecosystem services, consumption and production, and work and economic growth were each addressed by 33% of studies. Poverty was addressed in 20% of studies, and gender equality was addressed in 7%.

Other responses included general socioeconomic status and remoteness from markets. Livelihood-specific vulnerabilities (e.g., resource dependence and lack of livelihood diversification) were identified specifically as aspects of vulnerability addressed by adaptation efforts. Multiple studies also noted the vulnerability of 'intangible values', sites or practices of specific cultural and spiritual significance which are vulnerable to climate change.

SMCCP5.3.2.7.4 What is the extent of adaptation-related responses? What is the general stage of adaptation activities? 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	9	30
Adaptation planning and early implementation	12	40
Implementation expanding	6	20
Implementation widespread	0	0
Evidence of risk reduction associated with adaptation efforts	1	3

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

A majority of adaptation activities were in the adaptation planning and early implementation stage in this region (40%), 30% were identified as in the vulnerability assessment and/or early planning stage, and 20% were identified as expanding. None were identified as widespread.

Qualitative results suggested that the stage of implementation is frequently unclear, particularly given the prevalence of autonomous adaptation at the household level. The studies reviewed noted considerable diversity among households with regard to the stage of implementation, within the same cases and regions. While the quantitative results indicated no widespread implementation, qualitative results indicated that a few studies did report widespread adaptation activities; at least two studies described several decades of region-wide adaptation efforts, and several others reported that most households in the study region engaged in at least some adaptation.

What is the depth of change for the reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	14	47
Medium	6	20
High	6	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (limited) depth of change (47%), 20% were assessed as *high*, and 20% were assessed as *medium*.

Most reported adaptations were described as modifications of existing practices or institutions (particularly at the individual, household or private enterprise scale), rather than systemic or structural changes. Some barriers to structural change were identified: lack of change in perspectives, lack of coordinated planning, resistance to change among governing bodies and lack of awareness and access to information. However, a higher proportion of studies reported a high depth of change in perspectives, awareness and attitudes in this region than in the global analysis.

What is the scope of change for the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	18	60
Medium	1	3
High	6	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) scope of change (60%), 20% were assessed as *high*, and 3% were assessed as *medium*.

Qualitative results supported the conclusion that most reported adaptations are small in terms of scope of change (e.g., pilot studies, autonomous adaptations by households/individuals). A few studies indicated a broad scope of change; these described adaptation activities being implemented through coordinated programmes which involved multiple scales in the range of actors. Most studies reported local-scale (limited-scope) changes.

Coding note: In many cases, the scope of adaptation reported appeared to be based on the scale of research conducted (the unit of analysis being household/individual, village or region, for example), rather than the activity itself.

What is the speed of change for the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	21	70
Medium	3	10
High	2	7

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by *low* (slow) speed of change (70%), 10% were assessed as *medium*, and 7% were assessed as *high*, whereas 13% of studies contained insufficient information to assess this variable.

Qualitative results supported the conclusion that most reported adaptations are slow and incremental. Some studies did not evaluate or describe the speed of change or indicated uncertainty about the speed of change. Adaptation activities described as changing more quickly frequently involved private-sector actors (e.g., tourism-related businesses, private landholders).

SMCCP5.3.2.7.5 Do adaptation-related responses reduce risk/ vulnerability?

What is the stated (or implied/assumed) link to risk reduction? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported link between adaptation-related responses and risk reduction was minimising hazard/disaster risk (in addition to financial risks associated with climate-related hazards; the most frequently noted hazards were droughts, fire and flooding). Other commonly reported links included enhancing ecosystem resilience, agricultural productivity (including through crop diversification) and food security.

A majority of studies either assumed risk reductions or stated but did not empirically demonstrate these reductions.

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	17	57
No	13	43

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 57% of the studies reviewed reported evidence (implicit or explicit) that responses reduced risk or vulnerability, while 43% indicated no evidence to this effect.

Qualitative results indicate less evidence of risk reduction. Risk reduction (most frequently with regard to economic impacts from climate-related hazards) was described in some studies but infrequently quantified or investigated in depth. Some studies indicated that longer-term evaluation would be required to assess the evidence for risk reduction.

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	11	37
No	19	63

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 37% of the studies reviewed identified indicators of success, while 63% did not.

The majority of studies coded in this region did not report qualitative results for this variable. Among those which did, the qualitative results indicate a lower prevalence of studies which identified indicators of success. Indicators reported included income and employment rates, forest health (e.g., plant species richness, growth and regeneration rates) and livestock health. Compared to other regions, ecological indicators were more commonly identified in studies sited in North America.

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) the risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	12	40
No	18	60

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (60%), actors and institutions undertaking adaptations did not consider the risks of maladaptation associated with the adaptations. Considerations of maladaptation risk was reported in 40% of studies.

No qualitative results on this variable were reported for approximately half of the studies. Among those which did, the types of maladaptation risk most commonly considered trade-offs between financial and environmental resilience and the adverse effects of private land management decisions (e.g., grazing intensification) on water, soil and land condition on a broader scale.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	9	30
No	21	70

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of studies reviewed (70%), actors and institutions undertaking adaptations did not consider the co-benefits associated with the adaptations. Consideration of co-benefits was reported in 30% of studies.

In this region the type of co-benefit most commonly considered was biodiversity, followed by other ecological improvements (e.g., protection of wildlife and wildlife habitat, soil or land quality). Also noted were behavioural changes which contributed to climate-change mitigation (emissions reduction) and co-benefits for the socioeconomic status of the adopting actors.

SMCCP5.3.2.7.6 What evidence is provided regarding the extent to which responses challenge or exceed adaptation limits?

Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	23	77
No	7	23

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 77% of the studies reviewed reported constraints or limits to adaptation, and 23% did not.

The most commonly reported limits to adaptation were related to social/cultural factors (including beliefs about climate change, conflicts over resources, low levels of social trust and gender roles) and governance, institutions and policy (including power imbalances in decision-making, land tenure, barriers to collective action and inadequate water management). Financial limits were the third most frequently reported (including limited funding for government-run adaptation programmes), followed by limits and constraints associated with human capital (including labour markets) and information, awareness and technology (including lack of communication between implementing actors, lack of clarity of information about climate change, access to technologies and research gaps).

Biological limits reported included water availability and temperature. Economic and physical limits were reported infrequently.

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	2	7
Soft	12	40
Both	10	33
N/A	6	20

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 40% of constraints or limits were identified as soft, 7% were identified as hard, and 33% were identified as both. This variable was not applicable in 20% of studies.

The majority of limits and constraints were identified as soft; these were described as potentially resolvable with efforts to address perceptions and awareness, primarily related to social/cultural constraints (including gender roles, social cohesion and trust). Some economic and financial limits (including funding constraints) and governance, institutional and policy limits (including laws) were identified as hard in some studies and soft in others.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	10	33
No	13	43
N/A	7	23

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 33% of the studies reviewed indicated that they were approaching limits to adaptation, while 43% indicated they were not. This variable was not applicable in 23% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence

to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further is being reached (first interpretation), that efforts are being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal on how answers to this question should be interpreted.

SMCCP5.3.2.8 Small Islands

Adaptations associated with K1 terrain in small islands were reported in seven articles. However, three articles were multi-region studies. These multi-region articles were removed from this synthesis report to ensure that results only reflected adaptations in the target region. The following results are based on four articles.

SMCCP5.3.2.8.1 Who is adapting?

In what countries are adaptations reported? Q 1.1.1

Country	Count	Percentage
Madagascar	2	50
Puerto Rico	1	25
Caribbean (region)	1	25

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The countries with the greatest number of studies reporting adaptation actions in small islands are (in descending order) Madagascar (2) and Puerto Rico (1). One study also reported adaptations in the Caribbean region.

Note: Though Madagascar is commonly considered to be an African country, we assume, based on the GAMI coding, that these regions are consistent with the IPCC continental-scale classifications.

Which sectors/systems are involved in reported adaptations? Q 1.2

Sectors	Count	Percentage
Terrestrial and freshwater ecosystems	0	0
Ocean and coastal ecosystems	1	25
Water and sanitation	1	25
Food, fibre and other ecosystem products	4	100
Cities, settlements and key infrastructure	0	0
Health, well-being and communities	1	25
Poverty, livelihoods and sustainable development	2	50

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The sector/systems most frequently identified as involved in reported adaptation actions were food, fibre and other ecosystem products (100%), followed by poverty, livelihoods and sustainable development (50%).

Who is involved with reported adaptations (e.g., leading, financing or enabling)? Q 2.1.1; 2.1.2; 2.1.3

Actors	Count	Percentage
Individuals or households	4	100
Local government	1	25
National government	2	50
Sub-national government	0	0
Civil society (sub-national or local)	1	25
Civil society (international, multi-national, national)	0	0
Private sector: small and medium-size enterprises	0	0
Private sector: corporations	1	25
International or multi-national governance	1	25
Other	1	25

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Individuals or households were involved in reported adaptations in 100% of the studies reviewed. National governments were involved in 50% of the reported adaptations. Other actors reported were farmers, regional institutions and banks.

What types of implementation tools are reported? Q 3.2.1

Synthesis Statement:

Implementation tools reported include drought-related adaptation practices, changes to farming practices (e.g., mulching, replanting crops, food storage) and development of disaster-resilient infrastructure. Two studies reported on autonomous implementation, and two reported on formal implementation via policy changes (e.g., incentives for drought-related conservation practices).

Is there evidence as to who financed the reported adaptation actions? Q 4.2

Funding info	Count	Percentage
Yes	4	100
No	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.8.2 Evidence of equity in planning/targeting
How many articles address equity in adaptation planning? In adaptation targeting? Q 2.2.1; 2.3.1

Evidence that particularly vulnerable groups were included in adaptation planning was presented in one article (25%), and one article (25%) included evidence that particularly vulnerable groups were targeted in adaptations.

Who is addressed in the context of equity in reported adaptations? Q 2.2.1; 2.2.2; 2.2.3; 2.3.1; 2.3.2; 2.3.3

Equity planning	Count	Percentage	Equity targeting	Count	Percentage
Low-income	1	25	Low-income	0	0
Indigenous	0	0	Indigenous	0	0
Women	1	25	Women	1	25
Elderly	0	0	Elderly	0	0
Migrants	0	0	Migrants	0	0
Youth	0	0	Youth	0	0
Disability	0	0	Disability	0	0
Ethnic minorities	0	0	Ethnic minorities	0	0
Other	0	0	Other	0	0
Equity not addressed	3	75	Equity not addressed	3	75

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

The majority of studies reviewed in this region did not explicitly address equity planning or targeting (75%) in the context of reported adaptations. One study (25%) reported addressing equity planning for women, and one reported addressing equity planning for low-income groups. The former was interested in how men and women adapted in response to cyclones.

Is there reference to contributions from Indigenous knowledge in reported adaptations? Q 1.4

Indigenous Knowledge Contribution	Count	Percentage
Yes	2	50
No	2	50

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Is there reference to contributions from local knowledge in reported adaptations? Q 1.5

Local Knowledge Contribution	Count	Percentage
Yes	2	50
No	2	50

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Are costs of adaptation considered? Q 4.3

Costs	Count	Percentage
Yes—Cost of response	3	75
Yes—Cost savings from response	2	50
No	20	67

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

SMCCP5.3.2.8.3 What responses are documented?
What category of adaptation is reported? Q 3.1.1; 3.1.2

Response type	Count	Percentage
Technological/infrastructural	2	50
Behavioural/cultural	4	100
Institutional	1	25
Ecosystem-based	4	100

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among studies reviewed in this region, all reported adaptation behavioural/cultural and ecosystem-based responses. Technological/infrastructural responses were documented in half of the studies.

Qualitative results suggested that a majority of actors engaged in multiple types of adaptation responses simultaneously and emphasised enhancing ecosystem resilience to climate-related shocks and stressors. Multiple studies described implementing agroforestry practices which incorporated several types of response.

What hazards are the adaptations aimed at addressing? Q 3.3.1; 3.3.2; 3.3.3

Hazards	Count	Percentage
Extreme precipitation and inland flooding	4	100
Drought	2	50
General climate impacts	3	75
Sea level rise	1	25
Precipitation variability	2	50
Increased frequency and intensity of extreme heat	0	0
Rising ocean temperature and ocean acidification	0	0
Loss of Arctic sea ice	0	0
Other	1	25

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

In this region, all studies reviewed reported adaptations to address extreme precipitation and inland flooding. Also reported were general

climate impacts (75%), precipitation variability (50%) and drought (50%). Qualitative results indicated that increased prevalence of natural disasters (e.g., cyclones, hurricanes, floods) was the primary hazard targeted by adaptation efforts.

What aspects of vulnerability are the adaptations aimed at addressing? 3.4.1; 3.4.2; 3.4.3

Exposure vulnerability	Count	Percentage
Clean water and sanitation	1	25
Sustainable cities and ecosystem services	0	0
Consumption and production	2	50
Health and well-being	1	25
Work and economic growth	0	0
Industry/innovation/technology	0	0
Poverty	3	75
Food security	3	75
Terrestrial and freshwater ecosystem services	0	0
Marine and coastal ecosystem services	1	25
Energy security	0	0
Education	0	0
Gender equality	0	0
Inequalities (other than gender)	0	0
Peace, justice and strong institutions	0	0
Other	0	0

**Response totals for this question can exceed 100% because multiple options could be selected for individual documents.*

Synthesis Statement:

Among the studies reviewed in this region, adaptations aimed at addressing poverty and food security were each reported in 75% of cases. Qualitative results described adaptations aimed at addressing the vulnerability of individuals experiencing poverty, particularly their vulnerability to disasters and farming-related losses. Critical infrastructure (e.g., roads, bridges) was also identified as an aspect of vulnerability targeted by adaptation efforts.

SMCCP5.3.2.8.4 What is the extent of adaptation-related responses? What are the general stages of adaptation activities? Q 4.1; 4.1.2

Implementation stage	Count	Percentage
Vulnerability assessment and/or early planning	1	25
Adaptation planning and early implementation	2	50
Implementation expanding	0	0
Implementation widespread	0	0
Evidence of risk reduction associated with adaptation efforts	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 50% of adaptation activities were in the adaptation planning and early implementation stage, and 25% related to vulnerability assessment and/or early planning.

Qualitative results also indicated that the majority of responses were in the planning stages, particularly for disaster response, with none indicating widespread implementation.

What is the depth of change for reported adaptations? Q 4.4.1; 4.4.2

The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

Depth	Count	Percentage
Low (limited depth)	2	50
Medium	0	0
High	1	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) depth of change (50%), 25% were assessed as *high*, and none were assessed as *medium*.

One study reported a high depth of change following the implementation of a flood-resilience programme. Two other studies indicated a low depth of change, one due to a lack of behavioural change and another due to the spontaneous nature of adaptation activities.

What is the scope of change for the reported adaptations? Q 4.5.1; 4.5.2

The scope of a response typically refers to the scale of change.

Scope	Count	Percentage
Low (limited scope)	2	50
Medium	0	0
High	1	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, the majority of reported adaptations were characterised by a *low* (limited) scope of change (50%), 25% were assessed as *high*, and none were assessed as *medium*.

Qualitative results supported the conclusion that a majority of reported adaptations are small in terms of scope of change and

limited to specific communities implementing local initiatives. One study reported on adaptation responses across an entire island and was coded as reflecting a high scale of change.

What is the speed of change for the reported adaptations? Q 4.6.1; 4.6.2

The speed of change refers to the dimension of time within which changes happen.

Speed	Count	Percentage
Low (slow)	0	0
Medium	0	0
High	1	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, only one study provided sufficient information to assess this variable and was assessed as describing a high speed of change (25%). All other studies described uncertainty about this variable. Qualitative results suggest a prevalence of incremental change.

SMCCP5.3.2.8.5 Do adaptation-related responses reduce risk/vulnerability?
What is the stated (or implied/assumed) link to risk reduction? Q 3.5.1; 3.5.2

Synthesis Statement:

In this region, the most commonly reported link between adaptation-related responses and risk reduction was minimising hazard/disaster risk (primarily flooding, sea level rise). Other links reported were enhancing ecosystem resilience (reducing soil erosion, watershed protection).

Is there any evidence (implicit or explicit) that responses reduce risk or vulnerability? Q 5.1.1; 5.1.2

Reduced risk	Count	Percentage
Yes	3	75
No	1	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 75% of the studies reviewed reported evidence (implicit or explicit) that responses reduced risk or vulnerability, while 25% indicated no evidence to this effect. Qualitative results indicated more uncertainty and assumed, rather than demonstrated, reductions in risk. The majority of studies reported on risks associated with climate-related hazards (e.g., cyclones).

Do actors or institutions undertaking responses identify (implicitly or explicitly) indicators of success? Q 5.2.1; 5.2.2

Indicators	Count	Percentage
Yes	3	75
No	1	25

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 75% of the studies reviewed identified indicators of success, while 25% did not.

Indicators reported included perceptions of yield increase among farmers and a variety of indicators of drought impact (including measures of soil moisture, vegetation health and crop moisture).

Do actors or institutions undertaking adaptations consider (implicitly or explicitly) the risks of maladaptation associated with the adaptations? Q 5.3.1; 5.3.2

Maladaptation	Count	Percentage
Yes	2	50
No	2	50

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, half of the studies reviewed reported consideration of the risks of maladaptation associated with the adaptations, and half did not. Qualitative results indicated that actors were cognizant of maladaptation risks but did not describe them in detail.

Do actors or institutions undertaking responses consider (implicitly or explicitly) co-benefits? Q5.4.1; 5.4.2

Co-benefits	Count	Percentage
Yes	1	25
No	3	75

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In the majority of the studies reviewed (75%), actors and institutions undertaking adaptations did not consider the co-benefits associated with adaptations. Consideration of co-benefits was reported in 25% of studies. Only one study in this region reported qualitative results; it identified diversification of livelihood options as a potential co-benefit.

SMCCP5.3.2.8.6 What evidence is provided on the extent to which responses challenge or exceed adaptation limits?

Are constraints or limits to adaptation reported? Q 6.1; 6.2

Limits	Count	Percentage
Yes	4	100
No	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, all of the studies reviewed reported constraints or limits to adaptation. Reported limits to adaptation were related to governance, institutions and policy (including land tenure insecurity), information, awareness and technology (prevalence of misinformation) and social/cultural factors (including mistrust of governing bodies, social capital). Also reported were economic constraints (including access to credit) and inadequate technical and financial resources for disaster relief.

Are constraints or limits hard or soft? Q 6.3

Type of limit	Count	Percentage
Hard	0	0
Soft	2	50
Both	1	25
N/A	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, half of the constraints or limits were identified as soft, none were identified as hard, and 25% were identified as both. No qualitative results were reported in this region.

Are limits to adaptation being approached? Q 6.4.1; 6.4.2

Approaching limit?	Count	Percentage
Yes	1	25
No	3	75
N/A	0	0

**If sub-100% total, some documents did not contain sufficient information to assess this variable.*

Synthesis Statement:

In this region, 25% of the studies reviewed indicated that they were approaching limits to adaptation. This variable was not applicable in 75% of studies.

Coding note: The question GAMI coders were given for data entry makes it difficult to interpret these findings: Is there evidence to indicate whether responses approach, challenge or exceed constraints/limits? Given this structure, it is difficult to determine whether an affirmative response means that the capacity to adapt further was being reached (first interpretation), that efforts were being undertaken to ameliorate limits (second interpretation) or that limits had already been exceeded (third interpretation). Furthermore, qualitative content related to this question was relatively sparse and did not provide a clear signal as to how answers to this question should be interpreted.

SMCCP5.3.3 Summary of Articles Reporting on Adaptation in Mountain Regions

Table SMCCP5.15 | List of articles assessed reporting on adaptation in mountain regions

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Global	Adapting water and sanitation technologies in response to climate-related hazards	Water and sanitation	Drought; extreme precipitation and inland flooding; precipitation variability; sea level rise	Technological/infrastructural	Shallow	None	No	Luh et al. (2017)
Global	Diversification in the farming sector to address food insecurity at household level	Food, fibre and other ecosystem products	Precipitation variability; drought; extreme precipitation and inland flooding; general climate impacts	Behavioural/cultural	Shallow	None	Yes	Waha et al. (2018)
Global	Livelihood diversification among pastoral communities in the Hindu Kush Himalaya	Food, fibre and other ecosystem products	General climate impacts	Behavioural/cultural	Moderate	None	Yes	Wu et al. (2014)
Asia	Development projects and autonomous responses (migration, farming) as adaptation strategies among rural communities	Food, fibre and other ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts; precipitation variability	Institutional; behavioural/cultural; ecosystem-based	Shallow	Ethnic minorities; low-income groups	Yes	Adam et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Agricultural adaptations to secure rural livelihoods in response to drought	Food, fibre and other ecosystem products	Drought; general climate impacts; precipitation variability	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Moderate	Low-income groups	Yes	Adhikari (2018)
Asia	Collaborative and landscape-level adaptation strategies (e.g., ecosystem-based adaptation) in a rural mountain region	Food, fibre and other ecosystem products; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development; health, well-being and communities	General climate impacts	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Significant	None	No	Adhikari et al. (2018a)
Asia	Adoption of rainwater harvest technology in response to precipitation variability and associated impacts on farming income	Food, fibre and other ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Precipitation variability; drought	Technological/ infrastructural; behavioural/ cultural	Significant	Youth; women	Yes	Adhikari et al. (2018b)
Asia	Adaptations to increase water use efficiency, social and ecological implications for water management	Water and sanitation	Drought	Institutional; behavioural/ cultural; technological/ infrastructural	Significant	None	Yes	Al-Kalbani et al. (2016)
Asia	Transhumant livelihood responses to low temperatures and livestock fodder availability	Food, fibre and other ecosystem products; poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems	Increased frequency and intensity of extreme heat; precipitation variability; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; behavioural/ cultural; institutional	Significant	None	Yes	Aryal et al. (2014)
Asia	Farming adaptations in response to drought (crop diversification, water management and financial responses)	Water and sanitation; food, fibre and other ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Ashraf and Routray (2013)
Asia	Sociopsychological aspects of adaptation behaviours among wheat growers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability; general climate impacts; increased frequency and intensity of extreme heat	Institutional; behavioural/ cultural; ecosystem-based	Moderate	Youth; women	Yes	Azadi et al. (2019)
Asia	Changes to water management models in response to climate-related water scarcity in Central Asia	Water and sanitation	Drought; general climate impacts	Technological/ infrastructural; institutional; behavioural/ cultural	Shallow	Low-income groups	Yes	Barrett et al. (2017)
Asia	Household-level adaptation of agricultural practices in response to climate change in the Himalaya	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; precipitation variability	Technological/ infrastructural; institutional; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Bastakoti et al. (2017b)
Asia	Coping strategies in response to water insecurity and emerging climate variability in a dry, semihumid rural region	Health, well-being and communities	Drought; general climate impacts	Behavioural/ cultural; ecosystem-based; institutional; technological/ infrastructural	Shallow	Low-income groups; indigenous; elderly; women	Yes	Basu et al. (2015)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Stakeholder perceptions regarding climate adaptation in the livestock sector in Central Asia	Terrestrial and freshwater ecosystems; Food, fibre and ecosystem products	Drought; precipitation variability; general climate impacts	No data	No data	No data	No	Batbaatar et al. (2018)
Asia	Management of agro-biodiversity using IK as an adaptation strategy to climate change in a Himalayan farming context	Food, fibre and ecosystem products	General climate impacts; precipitation variability	Behavioural/ cultural	Moderate	None	Yes	Baul and McDonald (2014)
Asia	Determinants of autonomous adaptation choices among farmers in different agroclimatic zones	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; precipitation variability; drought; general climate impacts	Behavioural/ cultural; ecosystem-based; institutional; technological/ infrastructural	Shallow	None	Yes	Begum and Mahanta (2017)
Asia	Emerging agricultural innovations as a response to climate change in South Asia	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts; drought; precipitation variability; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Significant	Women	Yes	Bhatta et al. (2017)
Asia	Autonomous adaptation strategies employed by local peoples in the Himalaya in response to climate impacts on ecosystem services	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; general climate impacts; drought; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Bhatta et al. (2015)
Asia	Response strategies adopted by rural farmers for managing agrobiodiversity amid climatic and socioeconomic changes (focus on gender relations)	Poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems; food, fibre and ecosystem products; health, well-being and communities	Precipitation variability; drought	Behavioural/ cultural; ecosystem-based; institutional; technological/ infrastructural	Significant	Low-income groups; ethnic minorities; women	Yes	Bhattarai et al. (2015)
Asia	Application of multi-stakeholder knowledge of tea production practices to climate adaptation planning	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	General climate impacts; drought; precipitation variability; increased frequency and intensity of extreme heat	Institutional; technological/ infrastructural; behavioural/ cultural; ecosystem-based	Significant	None	Yes	Biggs et al. (2018)
Asia	Autonomous agricultural adaptations in response to increased temperatures and unpredictable precipitation in the Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Biggs et al. (2013)
Asia	Influence of livestock insurance on household resilience of livestock herders to climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Institutional	Significant	None	Yes	Biglari et al. (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Household-level adaptation to climate-caused economic and ecological variability through diversification and livestock management	Poverty, livelihoods and sustainable development; health, well-being and communities; terrestrial and freshwater ecosystems; food, fibre and ecosystem products	Drought; increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural	Shallow	None	Yes	Brown et al. (2013)
Asia	Social ecological factors contributing to adaptation decision-making among smallholders (maize adoption and drip irrigation)	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities; terrestrial and freshwater ecosystems	General climate impacts; increased frequency and intensity of extreme heat; precipitation variability; drought; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Significant	No data	Yes	Burnham and Ma (2017)
Asia	Factors influencing perceptions of self-efficacy in terms of climate change adaptation among smallholder farmers	Food, fibre and ecosystem products	Drought; precipitation variability	Technological/ infrastructural	No data	None	Yes	Burnham and Ma (2018)
Asia	Farming adaptations and associated constraints for small ruminant producers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; increased frequency and intensity of extreme heat; precipitation variability	Behavioural/ cultural	Shallow	None	Yes	Chedid et al. (2018)
Asia	Coffee growers' adaptive strategies and vulnerability in South Asia (agronomic management interventions, crop diversification)	Food, fibre and ecosystem products	Drought; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Chengappa et al. (2017)
Asia	Farmers' responses to climatic limitations using innovative agricultural practices	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	No	Chhetri et al. (2013)
Asia	Rainfall-related risks and opportunities for farming; application of cropping strategies to enhance water and soil conservation	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; drought; general climate impacts	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Moderate	Low-income groups	Yes	Cornish et al. (2015)
Asia	Local perceptions of impacts of environmental change in two mountain regions (agricultural diversification, soil management, afforestation)	Health, well-being and communities; Food, fibre and ecosystem products	General climate impacts; loss of Arctic sea ice; precipitation variability	Ecosystem-based	Shallow	Indigenous; low-income groups; ethnic minorities	Yes	Dangi et al. (2018)
Asia	Impacts of extreme weather variability for livelihoods and food security and coping mechanisms employed by mountain farmers	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities	Drought; precipitation variability; general climate impacts	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	Ethnic minorities; low-income groups	Yes	Delisle and Turner (2016)
Asia	Adaptive water-saving behaviours adopted by youth in a drought prone region	Water and sanitation; poverty, livelihoods and sustainable development	Drought	Behavioural/ cultural	Shallow	None	Yes	Deng et al. (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Combining local perceptions and scientific data on climate change variability to prioritise adaptation for resilience in the Himalaya	Food, fibre and ecosystem products; water and sanitation	Drought; extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	Elderly	No	Devkota et al. (2017)
Asia	Indigenous forest-fringe farmers' perceptions of and adaptive responses to climate change in theEastern Himalaya	Food, fibre and ecosystem products; health, well-being and communities; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Drought; precipitation variability; general climate impacts; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural; institutional; technological/ infrastructural	Shallow	Low-income groups; indigenous	Yes	Dey et al. (2018)
Asia	Summary of human-natural system balance in pastoralism management in the Himalaya	Food, fibre and ecosystem products	General climate impacts	Institutional; behavioural/ cultural	Moderate	None	No	Dong et al. (2016)
Asia	Livestock farmers' adoption of adaptation measures and coping strategies (changes to grazing and forage management) and driving factors	Food, fibre and ecosystem products	Drought; precipitation variability	Behavioural/ cultural	Shallow	None	Yes	Dorji et al. (2016)
Asia	Lived experiences of climate change among rural communities, focused on household reproduction and changing rural political economies	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability	Behavioural/ cultural; institutional	Shallow	None	Yes	Ensor et al. (2019)
Asia	Adaptation strategies implemented by farmers in Sri Lanka (cropping, irrigation, land management, income diversification, rituals)	Food, fibre and ecosystem products	Drought; precipitation variability	Technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Esham and Garforth (2013)
Asia	Crop insurance as a risk management strategy for farmers affected by flood events	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Extreme precipitation and inland flooding	Institutional	Shallow	None	No	Fahad et al. (2018)
Asia	Role of community-based natural resource management in herders' responses to an extreme cold event in Central Asia	Health, well-being and communities; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Institutional; behavioural/ cultural; technological/ infrastructural; ecosystem-based	Significant	Low-income groups	Yes	Fernández-Giménez et al. (2015)
Asia	Household experiences of and adaptive responses to resource scarcity	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Forsyth and Evans (2013)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Communities' awareness of and coping strategies for environmental and climate change-induced health issues	Health, well-being and communities	Sea level rise; extreme precipitation and inland flooding; general climate impacts	Institutional; behavioural/ cultural; ecosystem-based	Significant	Youth	Yes	Furu and Van (2013)
Asia	Access to resources (income, education) as a determinant of rural household adaptation strategies	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; general climate impacts; drought	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	Low-income groups; indigenous	Yes	Gentle et al. (2018)
Asia	Ski businesses' adaptive responses to impacts of climate change	Poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural	Shallow	None	Yes	Ghaderi et al.)
Asia	Environmental and social (gendered) dimensions of labour migration as coping strategy for environmental shocks	Poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural	Shallow	Women; migrants	Yes	Gioli et al. (2014a)
Asia	Mountain communities' perceptions of and adaptations to environmental change	Poverty, livelihoods and sustainable development; health, well-being and communities	Extreme precipitation and inland flooding; general climate impacts; precipitation variability	Behavioural/ cultural	Shallow	Women	Yes	Gioli et al. (2014b)
Asia	Climate change adaptation benefits of plants in rural Himalaya	Poverty, livelihoods and sustainable development	General climate impacts	Technological/ infrastructural	Significant	Youth; women	No	Gippner et al. (2013)
Asia	Role of social capital in individual farmers' adoption of technology as adaptation strategy	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; water and sanitation; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Significant	Ethnic minorities; low-income groups	Yes	Gong et al. (2018)
Asia	Community-based grazing quota systems to build resilience in response to economic, policy and climatic changes	Health, well-being and communities	Drought; general climate impacts	Institutional; behavioural/ cultural	Significant	Low-income groups	Yes	Gongbuzeren et al. (2018)
Asia	Adaptation options adopted by tea estate managers (perennial cropping system) in South Asia	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; precipitation variability; general climate impacts	Ecosystem-based; technological/ infrastructural; institutional; behavioural/ cultural	Moderate	None	Yes	Gunathilaka et al. (2018)
Asia	Alternative livelihood activities adopted in highland farming communities in response to climate-driven risks of rice shortage	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural; institutional	Significant	Ethnic minorities	Yes	Hirota (2018)
Asia	Irrigation water use efficiency in small-scale tea production	Food, fibre and ecosystem products	Drought	Institutional; behavioural/ cultural	Shallow	None	Yes	Hong and Yabe (2017)
Asia	Farmers' perceptions of and adaptations to drought and influence of access to early warning information	Food, fibre and ecosystem products	Drought	Technological/ infrastructural; behavioural/ cultural	Shallow	Youth; elderly	Yes	Hou et al. (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Farming adaptations to climate change impacts (cropping, land management) on regional food production in the Hindu-Kush Himalaya	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	General climate impacts; precipitation variability; drought	Institutional; behavioural/ cultural; technological/ infrastructural	No data	Low-income groups	Yes	Hussain et al. (2016)
Asia	Household experiences of changing crop yields and responses for building agricultural resilience to climate change	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Hussain et al. (2018)
Asia	Household-level adaptations to climate change in the Western Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat; precipitation variability; general climate impacts	Technological/ infrastructural; behavioural/ cultural	Shallow	Indigenous; low-income groups	Yes	Hussain et al. (2019)
Asia	Indigenous adaptation practices (traditional ecological knowledge, governance) in two high alpine communities in the Himalaya	Health, well-being and communities; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts	Behavioural/ cultural; institutional	Shallow	Indigenous	Yes	Ingty (2017)
Asia	Impact of agriculture-related external support on farmers' adaptation to climate change in a highland region of Central Asia	Food, fibre and ecosystem products	Drought; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Jawid and Khadjavi (2019)
Asia	Determinants of adaptive behaviour (changing practices, adoption of technologies) among mountain farming communities in the Himalaya	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Joshi et al. (2017)
Asia	Herders' perceptions of and adaption strategies to climate change in high-altitude arid and semiarid rangeland ecosystems	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural; ecosystem-based; technological/ infrastructural; institutional	Shallow	Migrants; ethnic minorities	Yes	Joshi et al. (2013)
Asia	Yield impacts of climate change responses adopted by smallholder farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; increased frequency and intensity of extreme heat; drought; precipitation variability	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Karapinar and Özertan (2020)
Asia	Impacts of climate change and adaptation responses on crop yields, water requirements and welfare of farm families	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; drought	Institutional; behavioural/ cultural; ecosystem-based; technological/ infrastructural	Significant	Low-income groups	Yes	Karimi et al. (2018)
Asia	Rural farmers' autonomous adaptation strategies in a dryland region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought; general climate impacts; extreme precipitation and inland flooding	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Kattumuri et al. (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Impacts of and responses to stages of drought among farmers (changes to cultivation area, irrigation infrastructure and water resource use)	Poverty, livelihoods and sustainable development	Drought	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	Yes	Keshavarz and Karami (2014)
Asia	Farming adaptations in response to drought and climate variability (agronomic management, income diversification, water use)	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought; precipitation variability	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Keshavarz and Karami (2014)
Asia	Drivers of livelihood vulnerability to drought among farming households and impact of vulnerability on adaptive capacity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; general climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Keshavarz et al. (2017)
Asia	Factors influencing farmers' decision-making in adoption of adaptation strategies and impacts on farm yields	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; precipitation variability; drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Khanal et al. (2018b)
Asia	Influence of smallholder farmers' membership in community-based organisations on decisions to adopt adaptive behaviours	Health, well-being and communities; food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural	Moderate	None	No	Khanal and Wilson (2019)
Asia	Factors affecting autonomous adaptation practices among rice farmers and impacts on rice productivity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts; increased frequency and intensity of extreme heat	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Khanal et al. (2019b)
Asia	Technical efficiency of smallholder farmers and adoption of adaptation practices	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; general climate impacts; precipitation variability	Technological/ infrastructural; ecosystem-based; behavioural/ cultural; institutional	Moderate	None	No	Khanal et al. (2018b)
Asia	Adaptation responses in smallholder farms in Nepal and effect on food productivity	Food, fibre and ecosystem products	General climate impacts; drought; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Khanal et al. (2018a)
Asia	Use of an adaptation index to assess determinants of and barriers to adaptation-related responses among smallholder farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; precipitation variability; drought; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Khanal and Wilson (2019)
Asia	Adaptation practices of potato farmers in South Asia and influence of constraints on adoption	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural; institutional	Shallow	No data	Yes	Kharumnuid et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Sociocultural implications of climate-related change on traditional livelihoods in a remote mountain region	Food, fibre and ecosystem products; water and sanitation; poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems	Precipitation variability	Behavioural/ cultural	Shallow	Indigenous	No	Konchar et al. (2015)
Asia	Costs of farmers' adaptations to changes in water availability	Food, fibre and ecosystem products; water and sanitation; poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems	Precipitation variability; general climate impacts	Technological/ infrastructural; behavioural/ cultural; institutional; ecosystem-based	Shallow	None	Yes	Kusters and Wangdi (2013)
Asia	Farmers' perceptions of climate change impacts on agricultural productivity and adaptive measures adopted in response	Food, fibre and ecosystem products	General climate impacts; precipitation variability; drought; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Ecosystem-based	Shallow	None	Yes	Li et al. (2013a)
Asia	Institutional frameworks for supporting local communities to cope with climate-change-induced drought	Poverty, livelihoods and sustainable development; health, well-being and communities	Drought	Institutional; technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Li et al. (2013b)
Asia	Farmers' perceptions of warm-drought in an ecologically fragile transition zone, effects on agricultural production and adaptation responses	Food, fibre and ecosystem products	Drought; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Li et al. (2015)
Asia	Participatory investigation of herders' climate adaptation strategies and associated long-term benefits for grassland management	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability; general climate impacts	Institutional; behavioural/ cultural	Moderate	None	No	Li et al. (2017a)
Asia	Role of community assets (social capital, access to public services) in responding to impacts of drought on grain production	Food, fibre and ecosystem products	Drought	Institutional; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Li et al. (2017b)
Asia	Effects of a state-led sedenterisation process on pastoralist adaptation practices	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; general climate impacts	Behavioural/ cultural; ecosystem-based; institutional	Shallow	Low-income groups	Yes	Liao and Fei (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Environmental displacement of farmers; migration as an adaptation strategy in response to degradation of farmland	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	No data	Behavioural/ cultural	Shallow	None	Yes	Liu et al. (2018)
Asia	Factors influencing adaptation measures adopted by hill farming communities and limiting factors hampering adaptive capacity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Loria and Bhardwaj (2016)
Asia	Mountain communities' perceptions of change and associated livelihood impacts, use of IK&LK to mitigate climate risk	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	General climate impacts; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	Women; ethnic minorities	Yes	Ukamaka and Eberechukwu (2018)
Asia	Effectiveness and challenges in the use of indigenous climate change adaptation measures by bee farmers in a West African region	Food, fibre and ecosystem products; health, well-being and communities	Drought; extreme precipitation and inland flooding; precipitation variability	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Macchi et al. (2015)
Asia	Classification of farm households' varying levels of resilience to water scarcity in arid and semiarid regions	Water and sanitation; health, well-being and communities; food, fibre and ecosystem products	General climate impacts	Institutional; technological/ infrastructural; behavioural/ cultural	Moderate	None	No	Maleksaeidi et al. (2016)
Asia	Indigenous communities' perceptions of climate change impacts and adaptation strategies adopted by mountain farmers in Western Himalaya	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	Precipitation variability; increased frequency and intensity of extreme heat; drought; general climate impacts	Ecosystem-based; technological/ infrastructural; institutional; behavioural/ cultural	Shallow	None	Yes	Meena et al. (2019)
Asia	Local perceptions of climate change impacts on livelihoods; threats and opportunities for adaptation in high mountain region	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural	Shallow	None	Yes	Merrey et al. (2018)
Asia	Evaluation of climate intervention policies and programmes in South Asian region, their limitations in accounting for impacts of social stratification	Poverty, livelihoods and sustainable development; health, well-being and communities	Drought; extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; behavioural/ cultural; institutional	Shallow	Low-income groups; women	Yes	Mili et al. (2017)
Asia	Financial coping responses of rural farming households to agricultural income shocks and losses	Food, fibre and ecosystem products	General climate impacts; increased frequency and intensity of extreme heat	Behavioural/ cultural; institutional	Shallow	Low-income groups	Yes	Møller et al. (2019)
Asia	Determinants of farmers' decisions on coping strategies employed in response to climatic variability	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; drought; precipitation variability; general climate impacts	Institutional; behavioural/ cultural	Shallow	None	Yes	Mutaqin (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Role of civil society organisation in enhancing climate resilience and securing carbon stocks in village setting	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; general climate impacts	Technological/ infrastructural; ecosystem-based; institutional	Significant	Indigenous	Yes	Muttaqin et al. (2019)
Asia	Local communities' perceptions of climate change and its impact on agriculture; influence of awareness on adaptive behaviour	Food, fibre and ecosystem products	General climate impacts; precipitation variability; extreme precipitation and inland flooding; drought	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Nasir et al. (2018)
Asia	IK of local people, perceptions and adaptation responses to climate change in Western Himalaya	Food, fibre and ecosystem products	General climate impacts; precipitation variability; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	None	No	Negi et al. (2017)
Asia	Occurrence and impacts of hydro-meteorological disasters on people's livelihoods, coping strategies for resilience of disaster-prone regions	Terrestrial and freshwater ecosystems; water and sanitation; poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Extreme precipitation and inland flooding; drought	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Nizami et al. (2019)
Asia	Role of local society-environment interactions (social institutions and social capital) in determining adaptive capacity	Food, fibre and ecosystem products; water and sanitation; terrestrial and freshwater ecosystems; health, well-being and communities	General climate impacts	Ecosystem-based; institutional; behavioural/ cultural	Shallow	Women; Youth	Yes	Padigala (2015)
Asia	Farm-level adaptation strategies for improving rice farm income in river basins, perceptions of climate change	Food, fibre and ecosystem products; health, well-being and communities; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Drought; general climate impacts; increased frequency and intensity of extreme heat	Behavioural/ cultural; technological/ infrastructural	Shallow	No data	Yes	Palanisami et al. (2015)
Asia	Variation in responses to climate change in Himalayan foothills (modifying cultivation strategies, water conservation) and information-related barriers	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; increased frequency and intensity of extreme heat	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Moderate	None	Yes	Pandey et al. (2018)
Asia	Role of community forests in Himalayas for increasing livelihoods and adaptive capacity, climate mitigation	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat; precipitation variability; general climate impacts	Ecosystem-based; institutional; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups; ethnic minorities	Yes	Pandey et al. (2016)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Mountain communities' perceptions of climate variability impacts and responses to overcome associated stresses	Food, fibre and ecosystem products; water and sanitation; poverty, livelihoods and sustainable development	Precipitation variability; drought; general climate impacts; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Women	Yes	Pandit et al. (2016)
Asia	Factors influencing adaptation practices in highly marginalised Himalayan indigenous community	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Extreme precipitation and inland flooding; precipitation variability	Technological/ infrastructural; behavioural/ cultural	Shallow	Indigenous	Yes	Piya et al. (2013)
Asia	Factors associated with farm level variability in livestock-related agricultural adaptations	Terrestrial and freshwater ecosystems; water and sanitation; food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; drought; general climate impacts; precipitation variability	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Moderate	Low-income groups	Yes	Poudel (2015)
Asia	Farmers' perceptions of declining availability of/ access to water and resulting changes to management practices in a mid-hill region	Food, fibre and ecosystem products; water and sanitation; cities, settlements and key infrastructure	Drought; extreme precipitation and inland flooding	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Moderate	None	Yes	Poudel and Duex (2017)
Asia	Household perceptions about impacts of climate change on food security, autonomous adaptations in mountainous region	Food, fibre and ecosystem products	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; technological/ infrastructural	Shallow	Youth	No	Poudel et al. (2017)
Asia	Autonomous adaptation strategies and perceptions of climate change among farmers in Himalayan region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based	Shallow	Low-income groups	Yes	Pradhan et al. (2015)
Asia	Climate-induced migration as an adaptation response in remote Himalayan region	Health, well-being and communities	Drought; precipitation variability	Behavioural/ cultural; institutional	Shallow	None	Yes	Prasain (2018)
Asia	Farmers' vulnerability to precipitation changes and adaptation-related responses (income diversification, asset disposal, water management, religious response)	Food, fibre and ecosystem products	Extreme precipitation and inland flooding; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	None	Yes	Pulhin et al. (2016)
Asia	Climate change risk mitigation strategies adopted by Himalayan farmers and impacts on household income, poverty levels and wheat yield	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based	Shallow	None	No	Rahut and Ali (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Cost-benefit analysis of climate-resilient agricultural practices in Himalayan region	Food, fibre and ecosystem products	General climate impacts; precipitation variability; drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Significant	None	Yes	Rai et al. (2018)
Asia	Comparing responses to water scarcity, climate-adaptive and equitable water management practices in two hill towns	Water and sanitation	Drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Rai et al. (2019)
Asia	Feminist intersectional approach to understanding climate change adaptation and gender issues	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	General climate impacts; drought; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women	Yes	Ravera et al. (2016)
Asia	Gendered implications of biodiversity-oriented adaptation-related responses to climate change among female farmers	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities	General climate impacts; extreme precipitation and inland flooding; precipitation variability; drought	Ecosystem-based; institutional; behavioural/ cultural	Shallow	None	Yes	Ravera et al. (2019)
Asia	Factors and challenges affecting adaptation across mountainous Himalayan region	Poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Technological/ infrastructural; behavioural/ cultural	Significant	None	Yes	Regmi et al. (2015)
Asia	Relationship between farmers' perceptions of water scarcity and responses	Food, fibre and ecosystem products; water and sanitation; health, well-being and communities	Extreme precipitation and inland flooding; drought	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	None	No	Rezaei et al. (2017)
Asia	Traditional agricultural knowledge as adaptation strategy to ensure food security despite water-related hazards (droughts, floods) and climatic variability in South Asia	Water and sanitation; food, fibre and ecosystem products; terrestrial and freshwater ecosystems	Drought; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Rivera-Ferre et al. (2016)
Asia	Determinants of climate-change- and adaptation-related responses by cereal-growing farmers in Eastern Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women	Yes	Rymbai and Sheikh (2018)
Asia	Nomadic knowledge of climate change held by local people residing in central Asian rangelands	Food, fibre and ecosystem products; health, well-being and communities	Increased frequency and intensity of extreme heat; drought; precipitation variability	Behavioural/ cultural; technological/ infrastructural	Significant	Indigenous	No	Saboohi et al. (2019)
Asia	Impacts of LK and perceptions of climate change on household-/ community-level responses	Health, well-being and communities; food, fibre and ecosystem products; poverty, livelihoods and sustainable development; water and sanitation	Extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat; drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Sada et al. (2014)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Prospects for ecosystem-based adaptation based on diverse forest-people interactions in Himalayan community forestry	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural; ecosystem-based	Moderate	None	Yes	Sapkota et al. (2019)
Asia	Social determinants of adaptation actions (relocation, occupational change, agricultural practices) in the Himalaya	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; water and sanitation; health, well-being and communities	Precipitation variability; drought; general climate impacts	Ecosystem-based; institutional; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups; indigenous	Yes	Sapkota et al. (2016)
Asia	Potential of IK for climate adaptation in Himalayan arid ecosystems	Health, well-being and communities; terrestrial and freshwater ecosystems; food, fibre and ecosystem products	General climate impacts; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	No data	No	Sarkar et al. (2015)
Asia	Adaptation and coping strategies to strengthen water security in the Himalaya, including autonomous responses and planned interventions	Water and sanitation; cities, settlements and key infrastructure; food, fibre and ecosystem products; health, well-being and communities; terrestrial and freshwater ecosystems; cities, settlements and key infrastructure	Drought; general climate impacts	Ecosystem-based; technological/ infrastructural; institutional; behavioural/ cultural	Shallow	Indigenous; low-income groups	Yes	Sen and Kansal (2019)
Asia	Adoption and efficacy of various household strategies for coping with floods	Water and sanitation; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Shah et al. (2017)
Asia	Adaptive responses among pastoralists in a high mountain plateau region in the Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; increased frequency and intensity of extreme heat	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Sharif (2019)
Asia	Influence of climate change on viability of cardamom farming, IKLK informing adaptation responses	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability	Behavioural/ cultural; institutional; technological/ infrastructural; ecosystem-based	Shallow	None	No	Sharma et al. (2016)
Asia	Failure of institutional adaptation projects implemented by international NGOs in Himalayan region	Poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural; institutional	Shallow	None	Yes	Sherpa (2015)
Asia	Farmers' adaptations to water scarcity induced by climate change and urbanisation	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability	Behavioural/ cultural; technological/ infrastructural; institutional	Moderate	No data	Yes	Shrestha et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Farmers' perceptions of climate change and adaptation measures undertaken by two ethnic communities in Southeast Asia	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	Ethnic minorities	Yes	Shrestha et al. (2017)
Asia	Successful local adaptive measures to improve food security among subsistence farming households	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities	Drought; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Shrestha and Nepal (2016)
Asia	Indigenous perceptions of climate-change-related issues and adoption of local adaptation strategies	Health, well-being and communities	General climate impacts; precipitation variability	Behavioural/ cultural	Significant	Indigenous	Yes	Shukla et al. (2016)
Asia	Influence of gender and wealth on farmers' perceptions of and adaptation to climate variability in Eastern Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat	Behavioural/ cultural; technological/ infrastructural	Shallow	Women; low-income groups; ethnic minorities	Yes	Singh et al. (2017)
Asia	Impact of government interventions (land conversion programmes) on agricultural practices	Food, fibre and ecosystem products	General climate impacts	Ecosystem-based; technological/ infrastructural	Moderate	None	Yes	Sjögersten et al. (2013)
Asia	Use of IK, discretely and combined with scientific knowledge, to inform climate adaptation decisions	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Ethnic minorities; indigenous	Yes	Son et al. (2019)
Asia	Relevance of gender in responses to climate change in a mountainous region of the Eastern Himalaya	Water and sanitation; food, fibre and ecosystem products	Drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Su et al. (2017)
Asia	Effects (and co-benefits) of climate-smart agriculture practices	Food, fibre and ecosystem products	General climate impacts; drought	Technological/ infrastructural; behavioural/ cultural	Significant	Low-income groups; indigenous	No	Subedi et al. (2019)
Asia	Implications of people's use of forest resources and experiences of climate change for adaptation practices in mountainous region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Suberi et al. (2018)
Asia	Use of artificial glacier technology to reduce smallholder farmers' risk from climate change impacts and enhance resilience to livelihood stresses	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability	Technological/ infrastructural; ecosystem-based	Moderate	Indigenous; low-income groups	No	Sudan and McKay (2015)

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Asia	Use of dynamic modelling to predict farmers' adoption of adaptive practices to enhance farming productivity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural	Shallow	None	No	Sugihardjo et al. (2018)
Asia	Farmers' perceptions of and adaptations to climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; increased frequency and intensity of extreme heat; general climate impacts; extreme precipitation and inland flooding; precipitation variability	Behavioural/ cultural; ecosystem-based	Shallow	No data	Yes	Sujakhu et al. (2016)
Asia	Factors responsible for degradation of communal land and adaptability of local management mechanisms for resource conservation	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	General climate impacts; precipitation variability;	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Tabassum et al. (2014)
Asia	Factors affecting maize farmers' household level adaptations to drought	Food, fibre and ecosystem products	drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups; women; ethnic minorities	Yes	Uy et al. (2015)
Asia	Autonomous adaptations and governing strategies applied by farming households in response to drought in Eastern Himalaya	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; water and sanitation; health, well-being and communities	Drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural; institutional	Moderate	None	Yes	van Dijk and Li (2015)
Asia	Adaptation strategies of migratory herders in alpine grasslands	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability	Behavioural/ cultural; ecosystem-based; technological/ infrastructural; institutional	Moderate	None	Yes	Wang et al. (2016a)
Asia	Perceptions of climate impacts and adaptation actions of households in Himalayan plateau region	Poverty, livelihoods and sustainable development	No data	Ecosystem-based; institutional; behavioural/ cultural	Shallow	None	Yes	Qin et al. (2017)
Asia	Climate vulnerability in terms of agriculture, review of national-scale policies to address climate change in South Asia	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; sea level rise; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat	Institutional; behavioural/ cultural; technological/ infrastructural; ecosystem-based	Moderate	None	Yes	Wang et al. (2017)
Asia	Dynamics of Himalayan pastoral systems influenced by climate and global changes using commons framework	Health, well-being and communities	Increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural; institutional	Shallow	None	Yes	Wang et al. (2014)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia		Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; drought; general climate impacts	Behavioural/ cultural; institutional	Significant	No data	Yes	Wang and Qin (2015)
Asia	Improved livestock genetics as climate-smart option to address food security in Central Asia	Food, fibre and ecosystem products	General climate impacts; drought; increased frequency and intensity of extreme heat	Ecosystem-based; behavioural/ cultural; institutional; technological/ infrastructural	Moderate	Low-income groups	No	Wilkes et al. (2017)
Asia	Challenges facing rangeland management systems, herders' perceptions of recent trends and adaptation responses	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	General climate impacts; increased frequency and intensity of extreme heat; precipitation variability; drought	Technological/ infrastructural; institutional; behavioural/ cultural	Shallow	None	Yes	Wu et al. (2015)
Asia	Climate risks experienced by mountain societies in Central Asia, and adaptation responses	Cities, settlements and key infrastructure; poverty, livelihoods and sustainable development; water and sanitation; food, fibre and ecosystem products	General climate impacts; drought; extreme precipitation and inland flooding; precipitation variability	Ecosystem-based; institutional; behavioural/ cultural; technological/ infrastructural	Moderate	No data	Yes	Xenarios et al. (2019)
Asia	Strategies to increase ecosystem and livelihood resilience to future change by improving linkages between conservation action and local adaptation efforts	Health, well-being and communities; terrestrial and freshwater ecosystems; food, fibre and ecosystem products; poverty, livelihoods and sustainable development; water and sanitation	Precipitation variability; increased frequency and intensity of extreme heat	Institutional; technological/ infrastructural	No data	Low-income groups	Yes	Xu and Grumbine (2014)
Asia	Range of farmers' adaptation choices in response to drought and tourism development	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities; cities, settlements and key infrastructure	Drought	Ecosystem-based; behavioural/ cultural; institutional; technological/ infrastructural	Shallow	Low-income groups	Yes	Yang et al. (2016)
Asia	Smallholder farmers' perceptions of climate change and adaptations to agricultural activities	Food, fibre and ecosystem products	Drought; precipitation variability; general climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Yu et al. (2014)
Asia	Farmers' knowledge of climate change and adoption of adaptation strategies	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural	Shallow	None	No	Yuliati and Primasari (2018)
Asia	Farmers' perceptions, beliefs, adaptation strategies and barriers associated with climate change, determinants of adaptation choices	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; behavioural/ cultural	No data	None	Yes	Zhai et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Asia	Mechanisms for adapting to economic and environmental changes	Food, fibre and ecosystem products	Drought; increased frequency and intensity of extreme heat	Ecosystem-based; technological/ infrastructural	Significant	None	Yes	Zhang et al. (2015b)
Asia	Traditional food knowledge applied as a strategy to safeguard food security during drought, influence on policymaking	Food, fibre and ecosystem products	Drought	Behavioural/ cultural; ecosystem-based	Moderate	None	Yes	Zhang et al. (2016a)
Asia	Farmers' responses to climate-induced drought and community-level water management strategies; public-private partnerships as mechanisms to build mountain farmers' resilience to drought	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought	Institutional; technological/ infrastructural; behavioural/ cultural; ecosystem-based	Significant	Low-income groups	Yes	Zhang et al. (2018)
Asia	Sustainable livelihood approach to examine smallholder farmers' risk perceptions and risk management strategies	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural	Shallow	Ethnic minorities	Yes	Zhang et al. (2019a)
Asia	Adaptation demands of different regions and different livelihood strategies among farmers, factors affecting adaptation demands	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Ecosystem-based; behavioural/ cultural	No data	Low-income groups	No	Zhang et al. (2019b)
Asia	Rural households' perceptions of and responses to hailstorms and drought	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities	Drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Zheng and Byg (2014)
Asia	Factors influencing proactive autonomous adaptation actions by rural households, determinants include climate risk perceptions and households' assessments of their adaptive capacity	Food, fibre and ecosystem products	Drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Moderate	None	Yes	Zheng and Dallimer (2016)
Asia; Africa	Assessment of agriculture information needs with respect to climate risk management among smallholder farmers	Food, fibre and ecosystem products	General climate impacts; drought; extreme precipitation and inland flooding	Behavioural/ cultural; institutional; technological/ infrastructural	Shallow	None	Yes	Ranjbar et al. (2019)
Asia; Europe	Impact of government-led watershed adaptation and development plan in rural region	Water and sanitation; poverty, livelihoods and sustainable development	Precipitation variability; sea level rise; general climate impacts; loss of Arctic sea ice; drought; extreme precipitation and inland flooding	Institutional; behavioural/ cultural; technological/ infrastructural; ecosystem-based	Significant	Low-income groups; women	Yes	Khan and Omprakash (2015)
Australia	Responses to changing climatic conditions among stakeholders in the tourism sector to maintain economic viability	No data	Extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Hughey and Becken (2014)

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Australia	Management actions to support climate adaptation implemented in context of sustainable forest management	Terrestrial and freshwater ecosystems	Increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based	Shallow	None	No	Keenan and Nitschke (2016)
Australia	Proposed adaptation strategies in Australian Alps	Health, well-being and communities; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; precipitation variability; general climate impacts	Institutional; behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	No data	Yes	Morrison and Pickering (2013a)
Australia	Perceptions of ski resort representatives about climate impacts on tourism industry, and associated adaptation strategies	Health, well-being and communities	No data	Technological/ infrastructural; behavioural/ cultural; institutional	Moderate	None	Yes	Morrison and Pickering (2013b)
Australia	Relationship between ground water irrigators' interpretations of climate change risks and implementation of adaptive water conservation practices	Water and sanitation	General climate impacts	Behavioural/ cultural	Shallow	No data	Yes	Sanderson and Curtis (2016)
Central and South America	Agro-ecological strategies (physical, social and organisational) to increase social resilience of farmers to respond to climate variability	Food, fibre and ecosystem products	Drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Moderate	No data	Yes	Acevedo-Osorio et al. (2017)
Central and South America	Agro-ecological transitions in cultivated mountain environments for agricultural adaptation to climate shocks	Food, fibre and ecosystem products	Extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Antonio et al. (2019)
Central and South America	Factors influencing disaster risk perception and corresponding response measures (relocation, reforestation, capacity building)	Poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; precipitation variability	Technological/ infrastructural; institutional; ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	Yes	Ardaya et al. (2017)
Central and South America	Strategies adopted by coffee producers in Central America to cope with droughts and crop losses due to coffee leaf rust	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability	Institutional; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Bacon et al. (2017)
Central and South America	Local people's perceptions of climate change and adaptations in rural Andes (reforestation, infrastructure, cropping changes)	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts; precipitation variability; extreme precipitation and inland flooding; drought	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Barrucand et al. (2017)
Central and South America	Sustainable agriculture techniques applied in response to climate change and socioeconomic stresses, conservation of ecosystem services	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; drought; precipitation variability	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups; ethnic minorities; indigenous	No	Borsdorf et al. (2013)

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Central and South America	Ecosystem-based solutions for climate adaptation among smallholder grain farmers in Central America	Food, fibre and ecosystem products	Drought; precipitation variability; extreme precipitation and inland flooding	Ecosystem-based	Moderate	None	Yes	Chain-Guadarrama et al. (2018)
Central and South America	Comparison of climate change vulnerabilities in agroforestry and conventional farming systems in South American region	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; drought	Ecosystem-based	Significant	Indigenous	Yes	Córdova et al. (2019)
Central and South America	Vulnerability assessment of traditional agriculturalists to climate variability; traditional and novel practices as adaptation strategies to cope with crop losses due to climate shocks	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought	Behavioural/ cultural; ecosystem-based	Moderate	Indigenous	Yes	de la Riva et al. (2013)
Central and South America	Impact of climate awareness on farmers' adaptation decisions in Central America and range of adaptive responses	Food, fibre and ecosystem products	General climate impacts; increased frequency and intensity of extreme heat; precipitation variability; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Moderate	None	Yes	de Sousa et al. (2018)
Central and South America	Comparing roles of international conservation projects and local organisations in increasing community resilience to climate change	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	General climate impacts; extreme precipitation and inland flooding; precipitation variability; drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Moderate	None	Yes	Doughty (2016)
Central and South America	Perceptions of livelihood diversification as strategy to cope with disturbances among smallholder coffee farmers in Central America	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural; institutional; technological/ infrastructural	Shallow	Low-income groups; indigenous	Yes	Gerlicz et al. (2019)
Central and South America	Community-based adaptation involving micro-watershed management and conservation of local maize varieties in post-conflict Central American region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities; terrestrial and freshwater ecosystems	General climate impacts; drought	Ecosystem-based; institutional; technological/ infrastructural; behavioural/ cultural	Moderate	Indigenous; low-income groups	No	Hellin et al. (2018)
Central and South America	Smallholder farmers' coping strategies for precipitation variability in the Andes	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Herrador-Valencia and Paredes (2016)
Central and South America	Challenges and opportunities for agroforestry initiatives as strategy for improving food and income security, ecosystem services, biodiversity, and adaptation to climate impacts	Food, fibre and ecosystem products	Drought; precipitation variability; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based	Moderate	None	Yes	Jacobi (2016)

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Central and South America	Cocoa farmers' responses to climate change, including agroforestry afforestation and engagement with certification programmes	Food, fibre and ecosystem products	General climate impacts	Ecosystem-based	Moderate	None	No	Jacobi et al. (2015)
Central and South America	Use of the sustainable livelihoods framework to assess influence of livelihood assets, risk perception and shocks on smallholder coffee farmers' decision to adopt agroforestry	Food, fibre and ecosystem products	General climate impacts; precipitation variability; drought; general climate impacts; extreme precipitation and inland flooding	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Jezeer et al. (2019)
Central and South America	Highland farmers' adaptive responses to climate-related shocks and precipitation variability	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought	Ecosystem-based; behavioural/ cultural	Significant	No data	No	Lennox and Gowdy (2014)
Central and South America	Implementation of adaptation responses to drought in a Southern Andean region	Cities, settlements and key infrastructure; water and sanitation; food, fibre and ecosystem products; cities, settlements and key infrastructure	Drought	Technological/ infrastructural; behavioural/ cultural; institutional	No data	None	Yes	Lillo-Ortega et al. (2019)
Central and South America	Watershed protection compensation programmes implemented collaboratively in two urban contexts	Terrestrial and freshwater ecosystems; cities, settlements and key infrastructure; water and sanitation; cities, settlements and key infrastructure	Precipitation variability	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Significant	None	Yes	Lindsay (2018)
Central and South America	Adaptation strategies adopted by Andean pastoralists in response to climatic and non-climatic changes	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	None	Yes	López-i-Gelats et al. (2015)
Central and South America	Role of diversification of crop varieties in farmers' adaptation to climate change in Andean region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; precipitation variability; drought; general climate impacts	Ecosystem-based; behavioural/ cultural	Significant	Indigenous	Yes	Meldrum et al. (2018)
Central and South America	Strategies employed by Andean communities and water user associations to adapt to shifting water availability, key determinants of adaptation	Water and sanitation; terrestrial and freshwater ecosystems	Drought; precipitation variability	Institutional; technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	Yes	Murtinho et al. (2013)
Central and South America	Role of external funding in supporting rural water organisations' adaptation to change	Water and sanitation	Precipitation variability	Institutional; technological/ infrastructural; ecosystem-based	No data	None	Yes	Murtinho (2016)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Central and South America	Local perceptions of climate risk and responses in Andean region	Food, fibre and ecosystem products	General climate impacts; precipitation variability	Institutional; ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Postigo (2014)
Central and South America	Potential of microfinance institutions for supporting ecosystem-based adaptation to climate change	Poverty, livelihoods and sustainable development	General climate impacts	Technological/ infrastructural; ecosystem-based; institutional	No data	Low-income groups	Yes	Rondón-Krummheuer et al. (2015)
Central and South America	Cost benefit analysis of potential climate-smart agriculture options in Central American region	Food, fibre and ecosystem products	General climate impacts; increased frequency and intensity of extreme heat; drought	Institutional; behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	Yes	Sain et al. (2017)
Central and South America	Potential of urban ecosystem-based measures for reducing landslide risk in an urban context, challenges to implementation	Cities, settlements and key infrastructure; poverty, livelihoods and sustainable development; water and sanitation	Extreme precipitation and inland flooding; precipitation variability	Ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	Yes	Sandholz et al. (2018)
Central and South America	Indigenous potato farmers' use of traditional knowledge and science in adaptation to climate change through crop variety selection	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; general climate impacts; precipitation variability	Behavioural/ cultural; ecosystem-based; institutional	Significant	Indigenous	Yes	Sayre et al. (2017)
Central and South America	Potential benefits of agroforestry systems for improving climate resilience of rural livelihoods in Central America	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought	Ecosystem-based	Shallow	Youth; women	Yes	Sibelet et al. (2019)
Central and South America	Changes in elevation of maize cultivation on volcano in South American highlands region	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Skarbø and VanderMolen (2016)
Central and South America	Participatory water management and policy as tool for facilitating knowledge of and adaptation to climate impacts on individuals and communities	Water and sanitation; food, fibre and ecosystem products	Extreme precipitation and inland flooding; drought; general climate impacts	Behavioural/ cultural	Significant	Indigenous	Yes	Stensrud (2016)
Central and South America	Climate-related risks and responses of farmers in four Andean communities with distinct agro-ecosystems over the past 20 years	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; extreme precipitation and inland flooding; precipitation variability; general climate impacts; drought	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Taboada et al. (2017)

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Central and South America	Adaptation responses of coffee farmers in central Andean region	Food, fibre and ecosystem products	General climate impacts; drought; precipitation variability; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based; technological/ infrastructural; institutional	Shallow	None	Yes	Turbay et al. (2015)
Central and South America	Use of landraces as mechanism for climate adaptation among smallholder farmers in two agro-ecosystems	Food, fibre and ecosystem products	General climate impacts; drought; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural	Significant	None	Yes	Vasconcelos et al. (2013)
Central and South America	Adaptation efforts of small-scale coffee farming systems in vulnerable agricultural landscapes in Central America	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat; drought	Behavioural/ cultural; ecosystem-based	Moderate	Low-income groups	Yes	Viguera et al. (2019)
Central and South America	Coffee farmers' diversified planting of tree species as buffer against temperature increases and rainfall variability	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	None	No	Viguera et al. (2019)
Central and South America	Smallholder coffee farmers' varietal adaptations to a climate-induced leaf rust outbreak	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Behavioural/ cultural; ecosystem-based	Significant	No data	Yes	Ward et al. (2017)
Central and South America; Asia; Europe	Systematic review of literature on climate adaptation in glaciated mountain regions across world	Health, well-being and communities; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding	Institutional; technological/ infrastructural; behavioural/ cultural; ecosystem-based	Moderate	Elderly; low-income groups; indigenous; women	Yes	McDowell et al. (2014)
Central and South America; Asia; Europe	Climate-related risks for communities affected by mountain cryosphere changes, and adaptation actions at multiple scales	Food, fibre and ecosystem products; water and sanitation; health, well-being and communities; cities, settlements and key infrastructure; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; drought; extreme precipitation and inland flooding	Institutional; technological/ infrastructural; behavioural/ cultural	Moderate	Migrants; low-income groups	Yes	Rasul et al. (2020)
Central and South America; Europe	Adaptive actions in water governance in Alps and Andes	Water and sanitation; terrestrial and freshwater ecosystems	Drought; precipitation variability	Institutional; technological/ infrastructural	No data	None	Yes	Hill (2013)
Europe	Adjustment in farming techniques in response to various changes in Northern European mountain community	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts; precipitation variability; extreme precipitation and inland flooding; drought	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	No	Daugstad (2019)

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Europe	Climate change awareness, perceptions and behaviour in summer ski tourism sector and its vulnerability to climate impacts	Terrestrial and freshwater ecosystems	Sea level rise; rising ocean temperature and ocean acidification; loss of Arctic sea ice; general climate impacts	Technological/ infrastructural; institutional; behavioural/ cultural	Shallow	None	No	Demiroglu et al. (2018)
Europe	Local 'bottom-up' adaptation actions in Tyrolean mountain agricultural system, triggered by climatic and non-climatic drivers	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; drought; precipitation variability; extreme precipitation and inland flooding; general climate impacts	Behavioural/ cultural; institutional; ecosystem-based; technological/ infrastructural	Moderate	Women	Yes	Grüneis et al. (2018)
Europe	Forest decision makers' perceptions of and responses to changing climatic conditions in Northern European region	Food, fibre and ecosystem products	No data	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Heltorp et al. (2018)
Europe	Perceptions of and responses to avalanche risk and infrastructure disruption; implications for lives, livelihoods and adaptive capacity	Cities, settlements and key infrastructure; health, well-being and communities	No data	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	Elderly; youth	Yes	Hovelsrud et al. (2018)
Europe	Collaborative implementation of sustainability principles in climate adaptation policies in four case studies in Alps	Water and sanitation	Extreme precipitation and inland flooding; general climate impacts; precipitation variability	Technological/ infrastructural; institutional	Shallow	None	Yes	Ingold and Balsiger (2015)
Europe	Effects of experimental tree thinning as adaptation strategy for reducing stress in drought-sensitive trees and improving resilience to climate shocks	Terrestrial and freshwater ecosystems	Drought; precipitation variability; general climate impacts	Ecosystem-based; institutional	No data	None	Yes	Lechuga et al. (2017)
Europe	Forest managers' and researchers' perceptions of importance of different adaptation options for responding to forest fires	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; drought	Ecosystem-based; behavioural/ cultural; technological/ infrastructural; institutional	Moderate	None	Yes	Raftoyannis et al. (2014)
Europe	LK applied to complement normative and technological risk management practices to improve resilience of climate-affected communities in an Alpine region	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural; institutional	Shallow	None	Yes	Reichel and Frömming (2014)
Europe	Reindeer herders' changing practices to improve livelihood flexibility and pasture access in response to climate change impacts	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural; ecosystem-based; institutional	Shallow	Indigenous	No	Risvoll and Hovelsrud (2016)
Europe	Role of trust in shaping citizens' perceptions and actions related to flood risk mitigation	Water and sanitation	Extreme precipitation and inland flooding	Behavioural/ cultural	Shallow	None	Yes	Seebauer and Babcicky (2018)

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Europe	Pastoral adaptation through grassland resource use and associated changes to human-environment interactions and indigenous practices	Food, fibre and ecosystem products; health, well-being and communities	Loss of Arctic sea ice; extreme precipitation and inland flooding; general climate impacts; precipitation variability	Behavioural/ cultural	Shallow	Indigenous; ethnic minorities	Yes	Takakura (2016)
Europe	Engagement of households in natural hazard management; household adaptations to impacts of global change in Alpine region	Terrestrial and freshwater ecosystems; health, well-being and communities	Drought; general climate impacts; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding; precipitation variability	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Significant	None	Yes	Thaler and Seebauer (2019)
Islands	Geographic extent and contributions of agricultural conservation practices for drought risk mitigation, incentivised by government support framework	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Significant	None	Yes	Álvarez-Berríos et al. (2018)
Islands	Assessment of conservation agriculture as a strategy for alleviating impacts of climate variations; farmers' perceptions	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Penot et al. (2018)
Islands	Disaster preparation and coping strategies for cyclone impacts among smallholder farmers	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; behavioural/ cultural	Shallow	Women	Yes	Rakotobe et al. (2016)
Islands	Assessment of adaptation planning in Caribbean region	Ocean and coastal ecosystems; water and sanitation; food, fibre and ecosystem products; health, well-being and communities	Extreme precipitation and inland flooding; precipitation variability; drought; sea level rise; general climate impacts	Institutional; behavioural/ cultural; ecosystem-based; technological/ infrastructural	No data	None	Yes	Thomas et al. (2019)
Islands; Europe	Responses of wine growers to rising temperatures and changing weather patterns in an island context	Food, fibre and ecosystem products	General climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Alonso and Liu (2013)
Islands; Europe	Access to livelihood assets as determinant of rural farming communities' adaptations to climate-related and socioeconomic change	Poverty, livelihoods and sustainable development; health, well-being and communities	Extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	Low-income groups	Yes	Currenti et al. (2019)
Africa	Improved soil management practices as adaptive response to climate change in East African region	Food, fibre and ecosystem products; health, well-being and communities	Drought	Technological/ infrastructural; ecosystem-based	Shallow	None	No	Abi et al. (2019)
Africa	Agricultural adaptations (calendar, cultivation techniques) to improve corn production in family farms	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat; precipitation variability	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	Yes	Aimé et al. (2016)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Role of trees in diversifying rural livelihoods as adaptation response to local environmental change	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Ecosystem-based; behavioural/ cultural	Significant	Low-income groups	Yes	Alemayehu and Bewket (2018)
Africa	Coping and adaptation strategies among smallholder farmers to mitigate impacts of climate change and variability in East African highland region	Terrestrial and freshwater ecosystems	Precipitation variability; drought	Behavioural/ cultural	Moderate	None	Yes	Alemayehu and Bewket (2017)
Africa	Role of agroforestry in climate-smart agriculture interventions to enhance agricultural yields among smallholder farmers	Food, fibre and ecosystem products	Drought; precipitation variability	Ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Amadu et al. (2020)
Africa	Index-based livestock insurance as means of financial support to low-income herders in the event of drought-induced livestock mortality	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural; institutional; technological/ infrastructural; ecosystem-based	Significant	Low-income groups	Yes	Amare et al. (2019)
Africa	Factors affecting smallholder farmers' adoption of adaptation options in East African region	Food, fibre and ecosystem products	General climate impacts; precipitation variability; drought	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	No data	Yes	Amare and Simane (2017)
Africa	Barriers to on-farm adoption of adaptive crop management measures	Food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural	Shallow	None	Yes	Amare et al. (2018)
Africa	Pastoral responses and gendered adaptations to land enclosure and fragmentation in East African region	Poverty, livelihoods and sustainable development	Drought; general climate impacts	Behavioural/ cultural	Shallow	Women	Yes	Archambault (2016)
Africa	Determinants of adaptation choices and their marginal effect on farmers based on farming practices, climate change awareness and income	Poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability	Behavioural/ cultural	Shallow	None	Yes	Asayehegn et al. (2017)
Africa	Adaptation measures employed by smallholder farmers practicing rainfed agriculture and determinants for adoption	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	Low-income groups	Yes	Asfaw et al. (2019)
Africa	Effect of farmers' climate perceptions on autonomous adaptation in East African watershed	Terrestrial and freshwater ecosystems; health, well-being and communities; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based; institutional; technological/ infrastructural	Shallow	None	Yes	Asrat and Simane (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Adaptation options adopted by small-scale farmers in West African region and plausible policy implications	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought; increased frequency and intensity of extreme heat; precipitation variability	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	Low-income groups	Yes	Awazi et al. (2019)
Africa	IK, perceptions and adaptation strategies for agropastoral households in a rural West African region	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	General climate impacts	Institutional; behavioural/ cultural	Shallow	Indigenous; low-income groups	Yes	Azibo and Kimengsi (2015)
Africa	Saffron producers' adoption of coping strategies in response to climate impacts in North African region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Increased frequency and intensity of extreme heat; precipitation variability; general climate impacts; extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	Elderly; women; youth	No	Aziz and Sadok (2015)
Africa	Participatory selection of tree fodder in indigenous silvo-pasture systems in East Africa	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based	Significant	None	No	Balehegn et al. (2015)
Africa	Determinants of coping strategies to flooding, influence of social and human capital on household decisions	Poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding	Behavioural/ cultural	Shallow	Low-income groups	Yes	Balgah et al. (2019)
Africa	Household socioeconomic determinants of climate change adaptation and their policy implications in West African context	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; general climate impacts; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women	Yes	Bate et al. (2019)
Africa	Maize-dependent smallholders' adaptations to climate change in East African country	Food, fibre and ecosystem products	Drought; precipitation variability	Technological/ infrastructural; ecosystem-based	Shallow	None	No	Bedeke et al. (2019)
Africa	Application of agricultural adaptation and perception (APP) model to identify determinants of adaptation (e.g., farmer perceptions)	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Technological/ infrastructural; ecosystem-based	Shallow	Migrants	Yes	Below et al. (2015)
Africa	Pastoralists' perceptions of climate change, livelihood diversification as adaptive response	Food, fibre and ecosystem products	Precipitation variability; increased frequency and intensity of extreme heat; drought	Behavioural/ cultural; ecosystem-based	Significant	No data	Yes	Berhanu and Beyene (2015)
Africa	Agricultural, economic and social adaptation strategies among households in two flood- and drought-prone communities in East Africa	Poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural; ecosystem-based; institutional	Shallow	None	Yes	Berman et al. (2015)
Africa	Farmer reflexivity in adaptive responses to precipitation variability	Poverty, livelihoods and sustainable development	Precipitation variability; drought; general climate impacts	Behavioural/ cultural; institutional; ecosystem-based; technological/ infrastructural	Shallow	Women; low-income groups	Yes	Bhatasara (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	An indigenous pastoralist community's interaction with and adaptation to changing landscape over time using traditional knowledge	Poverty, livelihoods and sustainable development	Precipitation variability; drought	Ecosystem-based; behavioural/ cultural	Significant	Ethnic minorities	Yes	Biagetti (2017)
Africa; Asia	Priorities and goals presented in national adaptation planning documents across semiarid regions of Africa, Asia, Latin America and Caribbean	Poverty, livelihoods and sustainable development; health, well-being and communities; water and sanitation; food, fibre and ecosystem products; ocean and coastal ecosystems; terrestrial and freshwater ecosystems	General climate impacts; drought	Institutional; ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Bizikova et al. (2015)
Africa	Large-scale survey of farmers in East African country to identify adaptation strategies, determinants of their adoption and impacts on food security	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; general climate impacts	Ecosystem-based; institutional; technological/ infrastructural	Shallow	Low-income groups	Yes	Brüssow et al. (2017)
Africa	Changing cultural narratives of livelihoods and environment following severe flood event in dryland East African region	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; water and sanitation	Drought; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based	Significant	None	Yes	Carabine et al. (2014)
Africa	Development of women's adaptive capacity using credit plus initiative; gender-specific challenges in relation to climate change	Poverty, livelihoods and sustainable development; health, well-being and communities	Drought; extreme precipitation and inland flooding	Institutional	Significant	Women	Yes	Caretta (2014)
Africa	Factors influencing adoption of land management practices associated with World Bank-financed project on climate-smart agriculture	Food, fibre and ecosystem products	No data	Ecosystem-based; behavioural/ cultural	Shallow	None	No	Cavanagh et al. (2017)
Africa	Effects of farmer training in soil and water conservation on practices, livelihoods and land-use intensity in East African highland region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women	Yes	Chesterman et al. (2019)
Africa	Smallholder farmers' adaptation to climate variability through land use management	Food, fibre and ecosystem products	General climate impacts; precipitation variability	Behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Cholo et al. (2018)
Africa	Participatory approach to understanding vulnerability of rural subsistence farmers to climate risk in East African context	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability	Institutional; behavioural/ cultural	Significant	Low-income groups	Yes	Clay and King (2019)

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Africa		Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; precipitation variability; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Women	Yes	Cooper and Wheeler (2017)
Africa	Climate change perceptions and adaptation strategies used by pastoralist communities in East African mountain communities	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Moderate	Ethnic minorities; low-income groups	Yes	Cuni-Sanchez et al. (2018)
Africa	Social and private profitability of two alternative state-supported tree-based adaptation techniques in traditional barley cropping/rangeland systems in North Africa	Poverty, livelihoods and sustainable development	Drought	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Daly-Hassen et al. (2019)
Africa	Impacts of interannual rainfall variability on agropastoralist communities and strategies for improving resilience in North African context	Terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; precipitation variability; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based	Moderate	None	Yes	Daoudi et al. (2013)
Africa	Use of scenarios to anticipate households' decisions regarding livelihood activities in response to future climate change in Southern Africa	Health, well-being and communities; poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Extreme precipitation and inland flooding; precipitation variability; drought	Behavioural/ cultural	Moderate	None	No	Dassanayake et al. (2018)
Africa	Adaptation strategies to climate change among crop farmers; socioeconomic characteristics of adopters	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Ecosystem-based; behavioural/ cultural	Shallow	Women; low-income groups	Yes	Dembele et al. (2019)
Africa	Linking climate data on rainfall with farmers' perceptions of impacts and associated coping strategies in East African context	Food, fibre and ecosystem products	Drought; general climate impacts; precipitation variability	Behavioural/ cultural; ecosystem-based	Shallow	No data	Yes	Diem et al. (2017)
Africa	Geopolitical approach to identifying links between rural development policies and climate change in Atlas Mountains	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; water and sanitation	Precipitation variability; general climate impacts	Institutional; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	El Jihad (2016)
Africa	Determinants of responses to climate change impacts on livestock (feed scarcity, heat stress, water shortages, pasture shortages)	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; precipitation variability; drought; extreme precipitation and inland flooding; general climate impacts	Behavioural/ cultural	Shallow	None	Yes	Feleke et al. (2016)
Africa	Climate-smart adaptation methods in rural East African region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts; precipitation variability	Behavioural/ cultural; technological/ infrastructural	Significant	Low-income groups	Yes	Fentie and Beyene (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Prospects for widespread adoption of drought-tolerant maize varieties as adaptation strategy for smallholder farmers	Food, fibre and ecosystem products	Drought; precipitation variability	Technological/ infrastructural; behavioural/ cultural; ecosystem-based; institutional	Shallow	Elderly	Yes	Fisher and Snapp (2014)
Africa	Participatory watershed management in response to watershed degradation and erosion in East African region	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; precipitation variability	Institutional; ecosystem-based	Shallow	Low-income groups; indigenous	Yes	Gebretsadik (2014)
Africa	Efficiency and effectiveness of clay pots compared with furrow irrigation	Food, fibre and ecosystem products	Drought	Technological/ infrastructural	Shallow	None	Yes	Gebru et al. (2017)
Africa	Traditional agroforestry practices and farm households' knowledge of tree management in diverse agroecology	Food, fibre and ecosystem products; health, well-being and communities; water and sanitation; poverty, livelihoods and sustainable development	General climate impacts; drought	Ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Gebru et al. (2019)
Africa	Gendered nature of climate change impacts and adaptations; variation among male- and female-headed households	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	General climate impacts	Institutional; behavioural/ cultural; ecosystem-based	Moderate	Women	Yes	Gorettie et al. (2019)
Africa	Recommendations for coffee farmers to improve climate adaptation through selection of tree species based on provision of ecosystem services; role of gender in adaptation	Food, fibre and ecosystem products	Drought; increased frequency and intensity of extreme heat	Ecosystem-based	Shallow	Low-income groups	No	Gram et al. (2018)
Africa	Coping mechanisms for livestock management in response to climate variability in East African context	Food, fibre and ecosystem products	Drought; precipitation variability	Behavioural/ cultural	Significant	None	Yes	Hailegiorgis et al. (2018)
Africa	Efficacy of pastoralist sedentarisation as an adaptive response to climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; extreme precipitation and inland flooding	Behavioural/ cultural	Significant	None	Yes	Haji and Legesse (2017)
Africa	Impacts of multiple climate stressors on urban poor communities and individual behavioural responses	Cities, settlements and key infrastructure	Extreme precipitation and inland flooding; general climate impacts; drought; increased frequency and intensity of extreme heat	Behavioural/ cultural	Shallow	Low-income groups	Yes	Hlahla and Hill (2018)
Africa	Measures to institutionalise climate responses in three non-metropolitan municipalities	Poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat	Institutional; behavioural/ cultural	Shallow	None	Yes	Hlahla et al. (2019)

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Africa	Key determinants of responses to precipitation variability	Poverty, livelihoods and sustainable development	Drought; precipitation variability; increased frequency and intensity of extreme heat	Technological/ infrastructural; ecosystem-based	Moderate	Women; low-income groups	Yes	Holler (2014)
Africa	Adaptation strategies (irrigation and new crop varieties) to floods, droughts and winds in Southern Africa	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	No data	Low-income groups	Yes	Joshua et al. (2016)
Africa	Smallholder farmers' perceptions of climate change and variability compared with observed meteorological data; farm-level adaptations	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; drought; precipitation variability; general climate impacts	Behavioural/ cultural; technological/ infrastructural	Moderate	None	No	Kahsay et al. (2019)
Africa	Sustainability of various institutions (formal and informal) under changing climate focusing on irrigation institutions in rural region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Institutional; technological/ infrastructural	Shallow	Indigenous; women	No	Kajembe et al. (2016)
Africa	Influence of changes in land use and patterns in soil transfers on natural resources, local adaptation strategies	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	Women	Yes	Karimoune et al. (2017)
Africa	Autonomous responses adopted by farmers to reduce food security risk to drought	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; health, well-being and communities; water and sanitation; poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Kassian et al. (2017)
Africa	Farmer perceptions on current climate variability and long-term changes, current adaptive strategies and potential barriers for further adaptation	Food, fibre and ecosystem products	Precipitation variability; drought; increased frequency and intensity of extreme heat	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	No data	Yes	Kassie et al. (2013)
Africa	Changes in management of group ranches motivated in part by climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based; institutional; technological/ infrastructural	Significant	None	Yes	Kibet et al. (2016)
Africa	Summary of field trials using a range of conservation agriculture responses to alter resilience	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	Drought; precipitation variability	Ecosystem-based; technological/ infrastructural	Moderate	Low-income groups	Yes	Kimaro et al. (2016)
Africa	Adoption of beekeeping as response to threatened food security in East African region	Food, fibre and ecosystem products	Precipitation variability; general climate impacts; increased frequency and intensity of extreme heat	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Kimaro et al. (2013)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Potential of terraces to support farmers' resilience to climate risks	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; precipitation variability	Behavioural/ cultural; ecosystem-based	Shallow	No data	Yes	Kosmowski (2018)
Africa	Herders' feeding strategies and perspectives on coping with food scarcity driven by climate change and urbanisation	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Koura et al. (2015)
Africa	Drivers of water shortages and adaptation strategies to climate change and variability in East African river basin	Food, fibre and ecosystem products; water and sanitation	Precipitation variability	Behavioural/ cultural; institutional; ecosystem-based; technological/ infrastructural	Shallow	Women;	Yes	Lalika et al. (2015)
Africa	Perceptions of climate change and coping strategies among pastoralist communities	Food, fibre and ecosystem products	Drought; general climate impacts; precipitation variability	Behavioural/ cultural	Shallow	ethnic minorities; migrants	Yes	Leal Filho et al. (2017)
Africa	East African potato farmers' use of irrigation and inter-cropping as a climate change adaptation strategy	Food, fibre and ecosystem products	Drought; general climate impacts	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	None	No	Lemessa et al. (2019)
Africa	Drivers and dynamics of livelihood and landscape change over a 30-year period in two sites in communal drylands in Southern Africa	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural; institutional	Shallow	Women; low-income groups	Yes	Masunungure and Shackleton (2018)
Africa	Crop diversification as coping strategy for addressing climate change impacts in East Africa	Food, fibre and ecosystem products	Precipitation variability	Behavioural/ cultural; institutional; technological/ infrastructural	Shallow	None	Yes	McCord et al. (2015)
Africa	Livestock farmers' perceptions of drought, its socioeconomic impacts and their adaptation strategies in East African region	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; general climate impacts	Behavioural/ cultural; institutional	Shallow	Low-income groups	No	Menghistu et al. (2018)
Africa	Institutional interplay between planned intervention and autonomous response efforts of farmers in East African region	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; general climate impacts; precipitation variability	Institutional; behavioural/ cultural; ecosystem-based	Significant	Low-income groups; women	Yes	Mersha and van Laerhoven (2018)
Africa	Differences in adaptation of male- and female-headed households in two drought-prone rural communities in East Africa	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; precipitation variability; general climate impacts	Behavioural/ cultural; institutional; ecosystem-based	Shallow	Women	Yes	Mersha and Van Laerhoven (2016)
Africa	Use of sand dams as potential adaptation measure for increasing availability of surface water resources in Southern Africa	Water and sanitation	Drought; extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; ecosystem-based; institutional	Significant	Low-income groups	No	Mhlanga (2014)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Climate change perception and adaptation responses (income diversification, changing agro-ecological practices) among farmers in East African region	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	General climate impacts; precipitation variability	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	No	Mihiretu et al. (2019)
Africa	Comparison of smallholder farmers' perceptions of climate change with collected meteorological data across seven agro-ecological zones of East Africa	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	No	Mkonda et al. (2018)
Africa	Household observation of changes in temperature and rainfall, and adaptive responses (crop and land management, livelihood diversification)	Food, fibre and ecosystem products	Drought; precipitation variability; increased frequency and intensity of extreme heat	Ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Moroda et al. (2018)
Africa	Climate change adaptive capacity of smallholder farmers and socioeconomic factors associated with farmer vulnerability	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural; institutional	No data	Low-income groups	Yes	Mpandeli (2014)
Africa	Farmers' perceptions of climate change, climate-related risks and adaptation strategies for managing risk associated with impacts on crop and livestock production	Poverty, livelihoods and sustainable development	Precipitation variability; drought; general climate impacts	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Mubiru et al. (2018)
Africa	Indigenous adaptation measures and IK systems applied in response to climate change in rural Southern African region	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Precipitation variability; drought; increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural; ecosystem-based	Shallow	Elderly; indigenous	No	Mugambiwa (2018)
Africa	Uptake of adaptation strategies among smallholder farmers and limitations to adoption	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; general climate impacts	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Mugi-Ngenga et al. (2016)
Africa	Small-scale farmers' responses to climate-induced drought in two cases with contrasting environmental and human features	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; water and sanitation	Drought; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	Low-income groups	Yes	Muita et al. (2016)
Africa	Influence of insecure housing on autonomous adaptation at the household level in informal settlement in East Africa	Poverty, livelihoods and sustainable development; water and sanitation	Extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural; institutional	Significant	Low-income groups	Yes	Mulligan et al. (2016)
Africa	Efficacy of interventions aimed at building pastoralists' resilience to climate change-related shocks; factors affecting household resilience	Poverty, livelihoods and sustainable development	Drought; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	Yes	Muricho et al. (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Vulnerability levels (particularly among women and children) and coping strategies of pastoralist communities in East Africa	Poverty, livelihoods and sustainable development; health, well-being and communities	General climate impacts; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Muriithi et al. (2017)
Africa	Factors affecting farmers' utilisation of rainwater harvesting and saving technologies in response to climate risks	Food, fibre and ecosystem products; water and sanitation; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability	Technological/ infrastructural; behavioural/ cultural; institutional	Moderate	Low-income groups	Yes	Muriu-Ng'ang'a et al. (2017)
Africa	Roles of local government and households in flood response in Southern African region	Water and sanitation; cities, settlements and key infrastructure	Extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural; institutional	Shallow	Low-income groups;	Yes	Musyoki et al. (2016)
Africa	Associations between smallholder farmer perceptions of climate change and household adaptation strategies adopted	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Significant	No data	Yes	Mutandwa et al. (2019)
Africa	Impacts of early alert and community involvement in disaster risk reduction in East African region	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; water and sanitation	Drought; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based; institutional; behavioural/ cultural	Moderate	Low-income groups	Yes	Nahayo et al. (2017)
Africa	Adaptations to seasonal variability in precipitation, including timing of planting choices, migration and adoption of agricultural innovations	Poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based	Shallow	Migrants	Yes	Ng'ang'a et al. (2016a)
Africa	Effects of natural environment and market accessibility on coping and adaptation strategies of pastoralists	Poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding	Behavioural/ cultural	Moderate	Low-income groups	Yes	Ng'ang'a et al. (2016b)
Africa	Adoption of adaptation practices among pastoralists and agropastoralists; influence of access to effective local institutions	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability	Ecosystem-based; institutional; behavioural/ cultural	Moderate	Indigenous	No	Ng'ang'a et al. (2016c)
Africa	Gendered adoption of adaptation actions within households; drivers of adoption of climate-smart agriculture	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; extreme precipitation and inland flooding; precipitation variability; general climate impacts	Technological/ infrastructural; ecosystem-based; institutional; behavioural/ cultural	Shallow	Low-income groups; women	Yes	Ngigi et al. (2017)
Africa	Community-based adaptation strategies for coping with droughts and floods in small watersheds	Food, fibre and ecosystem products; water and sanitation; poverty, livelihoods and sustainable development	Drought; general climate impacts; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Moderate	Low-income groups	Yes	Nguimalet (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Potential for promoting sorghum crop as a climate change adaptation strategy	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; general climate impacts; precipitation variability	Technological/ infrastructural; ecosystem-based	Shallow	None	Yes	Njeru Njeru et al. (2015)
Africa	Pastoralist adaptation strategies and need for improved weather/climate information to guide decision-making	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability; general climate impacts	Behavioural/ cultural; technological/ infrastructural; institutional	Shallow	Indigenous; women; Migrants	Yes	Nkuba et al. (2019)
Africa	Stocktaking of agroforestry practices in relation to climate perceptions in East African region	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; health, well-being and communities	General climate impacts	Ecosystem-based; behavioural/ cultural	Shallow	None	Yes	Nyaruai et al. (2018)
Africa	Farmer adoption of climate-smart agricultural practices and innovation after exposure to Farms of the Future approach	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems	Precipitation variability; general climate impacts; increased frequency and intensity of extreme heat; drought; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural; institutional	Moderate	Women; low-income groups	Yes	Nyasimi et al. (2017)
Africa	Agroforestry practices (agrosilvicultural, silvopastoral and agrosilvopastoral) among smallholder farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Precipitation variability; increased frequency and intensity of extreme heat; general climate impacts; drought	Ecosystem-based; behavioural/ cultural	Moderate	None	No	Nyong et al. (2020)
Africa	Adaptive responses to historical climate extremes (drought, heavy rain events); role of highland cooperative local development institution in supporting adaptive efforts	Poverty, livelihoods and sustainable development	Drought	Ecosystem-based; technological/ infrastructural; institutional	Significant	Ethnic minorities; women	No	Oettle and Koelle (2016)
Africa	Coping strategies (rainwater harvesting, tree planting) used by forest-based rural communities in response to climate variability and other changes	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products; health, well-being and communities	Precipitation variability; drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	Low-income groups	Yes	Ofoegbu et al. (2016)
Africa	Agro-weather tools employed in climate smart agriculture, and impacts of their use on adaptive capacity of farming communities	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought; increased frequency and intensity of extreme heat; precipitation variability	Technological/ infrastructural; behavioural/ cultural; institutional; ecosystem-based	Significant	Women; low-income groups	Yes	Oladele et al. (2019)
Africa	Role of collective action in enhancing local adaptation to climate variability	Poverty, livelihoods and sustainable development	General climate impacts; drought; precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	None	No	Ombogoh et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Drought characteristics and varied responses to drought stressors employed by East African pastoralists; limits to adaptation	Food, fibre and ecosystem products	Drought; precipitation variability; general climate impacts; increased frequency and intensity of extreme heat	Ecosystem-based; behavioural/ cultural; technological/ infrastructural	Moderate	Low-income groups; ethnic minorities; Migrants	Yes	Opiyo et al. (2015)
Africa	Factors affecting the climate change adaptive capacity in rural East African region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; drought	Behavioural/ cultural	Shallow	Ethnic minorities; migrants	Yes	Opiyo et al. (2016)
Africa	Role of IK in climate adaptation in Southern African highland region	Poverty, livelihoods and sustainable development	General climate impacts; drought; extreme precipitation and inland flooding; precipitation variability	Behavioural/ cultural; ecosystem-based	Shallow	Elderly	Yes	Palframan (2015)
Africa	Perceptions of effects of flood and drought on natural resource based livelihoods in arid East African region; integration of perceptions into larger-scale adaptation initiatives	Food, fibre and ecosystem products	Drought; extreme precipitation and inland flooding; general climate impacts	Behavioural/ cultural; ecosystem-based	Moderate	Low-income groups	Yes	Quandt and Kimathi (2017)
Africa	Agroforestry as adaptive response to build livelihood resilience	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding	Ecosystem-based; behavioural/ cultural	Shallow	None	No	Quandt et al. (2017)
Africa	Development of livelihood resilience through agroforestry and associated co-benefits (financial capital, improved quality of life, conservation) in semiarid region	Health, well-being and communities; Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought	Behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Quandt et al. (2019)
Africa	Coffee farmers' adoption of ecosystem-based adaptation in response to high temperatures and longer dry seasons; benefits of inter-cropping as a sustainable intensification option	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; increased frequency and intensity of extreme heat; precipitation variability; extreme precipitation and inland flooding	Ecosystem-based	Moderate	Low-income groups	Yes	Rahn et al. (2018)
Africa	IK and perceptions of climate change; development of adaptation processes to assist vulnerable rural communities	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; precipitation variability; drought	Behavioural/ cultural	No data	None	No	Rankoana (2016b)
Africa	Rituals used by rural women as a response to rainfall scarcity; indigenous coping structures to reduce vulnerability	Food, fibre and ecosystem products	Precipitation variability	Behavioural/ cultural	Shallow	Women; indigenous	No	Rankoana (2016a)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Farming communities' responses to precipitation variability and drought using rainwater harvesting and conservation techniques	Terrestrial and freshwater ecosystems; water and sanitation; food, fibre and ecosystem products	Drought; precipitation variability	Ecosystem-based; technological/ infrastructural; institutional	Significant	Low-income groups	Yes	Recha et al. (2015)
Africa	Efficacy of knowledge co-production process for reducing disaster risk and guide adaptation efforts	Health, well-being and communities	Drought; extreme precipitation and inland flooding	Institutional; ecosystem-based	Significant	None	Yes	Reyers et al. (2015)
Africa	Annual rainfall time series (1970–2011) as proxy for climate trends and effects of rainfall on farming in North African region	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Significant	Low-income groups; migrants	No	Rouabhi et al. (2019)
Africa	Different typologies and agricultural changes caused by climatic constraints experienced in recent decades in North African region	Poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	Elderly	Yes	Rouabhi et al. (2016)
Africa	Communities' coping responses for climate variation, influences of vulnerability and role of family planning as adaptive strategy to increase resilience	Poverty, livelihoods and sustainable development; health, well-being and communities	Drought	Behavioural/ cultural	Significant	Women; youth	Yes	Rovin et al. (2013)
Africa	Effect of adoption of soil conservation practices on farmers' technical efficiency and productivity	Food, fibre and ecosystem products	General climate impacts; drought	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	No	Salat and Swallow (2018)
Africa	Socioeconomic factors influencing agropastoral communities in response to climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; precipitation variability; drought	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women	Yes	Sangeda et al. (2013)
Africa	Water consumption and competition in three agroforestry coffee cultivation systems	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based	Shallow	None	Yes	Sarmiento-Soler et al. (2019)
Africa	Farmers' adaptation strategies and attitudes towards risk management practices; determinants of adaptation	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; increased frequency and intensity of extreme heat; general climate impacts; precipitation variability; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	Low-income groups	Yes	Shikuku et al. (2017)
Africa	Farming households' anxieties about climate change, vulnerability to climate change and food insecurity and potential adaptation options	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	Yes	Shisanya and Mafongoya (2016)
Africa	Effects of climate variability and factors determining indigenous climate adaptation strategies among smallholder farmers	Food, fibre and ecosystem products	Increased frequency and intensity of extreme heat; precipitation variability; drought	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Shumetie and Alemayehu (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Contributions of a community-based watershed development programme in reducing farmers' vulnerability to climate impacts in East African highland region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; drought; extreme precipitation and inland flooding; precipitation variability	Institutional; ecosystem-based	Moderate	Low-income groups	Yes	Siraw et al. (2018)
Africa	Framings and priorities of adaptation in East African country's climate policy and implications for role of local institutions and rural people in adaptation	Health, well-being and communities; poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; general climate impacts; extreme precipitation and inland flooding	Ecosystem-based; technological/ infrastructural; behavioural/ cultural; institutional	Significant	Low-income groups; ethnic minorities	Yes	Smucker et al. (2015)
Africa	Influence of social differences and inequalities on climate change adaptation among smallholder farmers	Food, fibre and ecosystem products; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability; general climate impacts; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women; low-income groups	Yes	Stefanovic et al. (2019)
Africa	Voluntary adoption of agricultural land management practices to reduce hazard exposure	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	General climate impacts; drought; extreme precipitation and inland flooding	Institutional; ecosystem-based; behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Sullivan-Wiley and Short Gianotti (2018)
Africa	Local climate change adaptation and coping mechanisms in livestock feeding systems in East African region	Food, fibre and ecosystem products	General climate impacts; drought	Behavioural/ cultural	Shallow	None	No	Syomiti et al. (2015)
Africa	Context-specific dimensions of socioecological vulnerability for smallholder farmers, including access to water resources, agricultural knowledge and inequalities among farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought	Behavioural/ cultural; technological/ infrastructural	Shallow	None	Yes	Teller (2016)
Africa	Smallholder farmers' perceptions of climate change, access to information; factors and barriers influencing adaptation strategies	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts;	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Moderate	Low-income groups	Yes	Tessema et al. (2013)
Africa	Determinants of non-technological adaptation responses, influence of farming experience versus financial resources and education	Food, fibre and ecosystem products	General climate impacts	Technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Tessema et al. (2018)
Africa	Climate adaptations adopted by rural households in East African region	Terrestrial and freshwater ecosystems; food, fibre and ecosystem products	Precipitation variability	Technological/ infrastructural; behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Tessema et al. (2019a)
Africa	Perceptions and adoption of crop switching to reduce damage from climate change	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural	Shallow	None	Yes	Tessema et al. (2019b)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Financial adaptation behaviour of maize-legume farm households facing climate shocks in rural East African region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; precipitation variability	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	Women; low-income groups	Yes	Tongruksawattana and Wainaina (2019)
Africa	Relationship between rainfall data and household self-reported harvest shocks and local (spatial) variability of harvest shocks and coping strategies	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Precipitation variability	Behavioural/ cultural; ecosystem-based; institutional	Shallow	None	No	Trærup (2012)
Africa	Influence of livelihoods and household characteristics on relationships between perceptions of drought and food insecurity and corresponding coping responses	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; general climate impacts	Behavioural/ cultural	Shallow	Low-income groups	Yes	Twongyirwe et al. (2019)
Africa	Variation in adoption of different adaptive strategies (livelihood diversification) among households due to gender and marital status	Poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat	Behavioural/ cultural	Shallow	Women	Yes	Van Aelst and Holvoet (2016)
Africa	Factors influencing adoption of household and individual level adaptation practices among small-scale farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; drought	Technological/ infrastructural; behavioural/ cultural; ecosystem-based; institutional	Shallow	Women	Yes	Van Aelst and Holvoet (2018)
Africa	Contributions of state and private actors to improved flood risk management in medium-scale West African city	Cities, settlements and key infrastructure	Extreme precipitation and inland flooding; general climate impacts	Institutional	Significant	Low-income groups	Yes	Vedeld et al. (2016)
Africa	Community-based adaptation and challenges for water resources management in East African highlands region	Water and sanitation	Precipitation variability	Ecosystem-based; behavioural/ cultural	Shallow	No data	No	Velempini et al. (2018)
Africa	Adoption of camel-rearing as means of adapting to climate change	Poverty, livelihoods and sustainable development	Drought	Behavioural/ cultural	Moderate	Indigenous	Yes	Volpato and King (2019)
Africa	Pastoralists' use of camels in cattle-dominated herds as adaptive strategy to mitigate food insecurity and cope with frequent droughts	Food, fibre and ecosystem products; health, well-being and communities	Drought; general climate impacts; increased frequency and intensity of extreme heat; precipitation variability	Behavioural/ cultural; ecosystem-based	Significant	No data	No	Wako et al. (2017)
Africa	Gender and wealth constraints to adaptive practices (autonomous responses) among pastoralists in East African region	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat; drought	Behavioural/ cultural; institutional; technological/ infrastructural	Shallow	Women; low-income groups	Yes	Wangui and Smucker (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Role of local rural organisations in framing responses to climate variability and change	Health, well-being and communities; food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts	Behavioural/ cultural; institutional; ecosystem-based; technological/ infrastructural	Shallow	Low-income groups	Yes	Washington-Ottombre and Pijanowski (2013)
Africa	Farmers' preferences for, and barriers to, adopting climate-smart agricultural practices	Poverty, livelihoods and sustainable development	Precipitation variability; drought; extreme precipitation and inland flooding; general climate impacts	Technological/ infrastructural; institutional; ecosystem-based	Shallow	Women	Yes	Wassie and Pauline (2018)
Africa	Determinants of choice and the effect of climate-smart agricultural practices on household food security among smallholder farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Shallow	Women; low-income groups	Yes	Wekesa et al. (2018)
Africa	Inefficacy of an institutional social protection programme for income diversification, including unintended negative impacts on natural resource use	Poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; drought	Behavioural/ cultural; institutional	Moderate	Low-income groups	No	Weldegebriel and Prowse (2013)
Africa	Smallholder farmers' perceptions of climate variability and diversification options pursued both within and outside agriculture	Food, fibre and ecosystem products	Drought; general climate impacts; precipitation variability	Ecosystem-based; technological/ infrastructural	Shallow	None	No	Weldegebriel and Prowse (2017)
Africa	Influence of normative practices and ideas of identity on changes in social and biophysical contexts and adaptation-relevant responses	Health, well-being and communities; poverty, livelihoods and sustainable development	Drought	Behavioural/ cultural	No data	Ethnic minorities; indigenous	Yes	Wernersson (2018)
Africa	Impact and drivers of adoption of landscape restoration and water harvesting as strategy to enhance resilience to climate/rainfall variability, assessment of planned interventions	Terrestrial and freshwater ecosystems; water and sanitation	Extreme precipitation and inland flooding; drought; general climate impacts	Ecosystem-based; technological/ infrastructural; institutional	Significant	No data	Yes	Woldearegay et al. (2018)
Africa	Barriers to range of adaptation strategies adopted by farming communities (livelihood diversification, altered agricultural practices, water management)	Poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding	Technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Yohannes et al. (2020)
Africa	Sociopsychological factors which contribute to agroforestry managers adopting sustainable agriculture practices	Food, fibre and ecosystem products	Drought	Ecosystem-based	Shallow	Low-income groups	Yes	Zeweld et al. (2018)
Africa	Enabling conditions for collaborative governance to facilitate local adaptation action	Health, well-being and communities; water and sanitation	Drought; extreme precipitation and inland flooding; general climate impacts	Institutional; behavioural/ cultural	Significant	Indigenous	Yes	Ziervogel et al. (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
Africa	Adaptation practices adopted by farmers in East African region to cope with climate change impacts using available on-farm technologies	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Precipitation variability; general climate impacts; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding; drought	Behavioural/ cultural; technological/ infrastructural	Shallow	Elderly	Yes	Zizinga et al. (2017)
Africa	Assessment of local communities' vulnerability and climate adaptation strategies using participatory action research	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	Drought; precipitation variability; general climate impacts	Behavioural/ cultural; ecosystem-based	Shallow	Low-income groups; elderly	Yes	Bele et al. (2014)
North America	Barriers to both intentional and incidental climate-adaptive forest management practices	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems	General climate impacts; drought	Ecosystem-based; behavioural/ cultural; institutional	Significant	Low-income groups	Yes	Boag et al. (2018)
North America	Grassroots adaptive responses of smallholder farmers in light of gendered vulnerabilities to climate change and water scarcity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities; water and sanitation	Drought; general climate impacts	Ecosystem-based; behavioural/ cultural	Shallow	Women	Yes	Buechler (2016)
North America	Perceptions of change in meteorological conditions, climate change and primary coping strategies in five municipalities with shared indigenous identity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Precipitation variability	Ecosystem-based	Shallow	Indigenous	Yes	Gonzalez Martínez et al. (2017)
North America	Role of farmer groups and neoliberal policy reforms in livelihood adaptation of smallholder maize farmers	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	No data	Ecosystem-based; institutional; behavioural/ cultural	No data	Low-income groups	Yes	Groenewald and Niehof (2015)
North America	Roles of human behavioural, institutional and technical factors in shaping responses to federal adaptation directives at sub-regional scales; managers' perceptions and opinions of climate adaptation	Terrestrial and freshwater ecosystems	General climate impacts	Ecosystem-based; institutional; behavioural/ cultural	Shallow	None	Yes	Hagerman (2016)
North America	Vulnerability of forest resources to climate change and potential adaptation strategies in forest management	Terrestrial and freshwater ecosystems	Drought; general climate impacts; increased frequency and intensity of extreme heat	Ecosystem-based	Moderate	None	Yes	Halofsky et al. (2016)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
North America	Systematic review of government-led climate change adaptation policies and initiatives at federal, territorial and community levels	Ocean and coastal ecosystems; poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems; health, well-being and communities	Loss of Arctic sea ice; general climate impacts; precipitation variability; extreme precipitation and inland flooding; sea level rise	Institutional; technological/ infrastructural; behavioural/ cultural; ecosystem-based	Moderate	Indigenous; elderly	Yes	Labbé et al. (2017)
North America	Perceptions of stakeholders involved with Rocky Mountain River watershed on shifting runoff cycles, their effects on social-ecological system and corresponding adaptation strategies	Terrestrial and freshwater ecosystems	Drought; general climate impacts; precipitation variability	Ecosystem-based; behavioural/ cultural	Significant	None	Yes	Lamborn and Smith (2019)
North America	Local development organisations and their contribution to climate change adaptation strategies; perspectives of women members	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; health, well-being and communities	Drought; precipitation variability; general climate impacts	Institutional; behavioural/ cultural	Moderate	Women; indigenous	Yes	Lookabaugh (2017)
North America	Household adaptive strategies in response to imposed caribou hunting limits	Poverty, livelihoods and sustainable development; food, fibre and ecosystem products	General climate impacts	Behavioural/ cultural; technological/ infrastructural	Significant	Low-income groups; indigenous	No	Martin (2015)
North America	Influence of local context on drought management responses implemented by resource managers	Terrestrial and freshwater ecosystems; health, well-being and communities	Drought; general climate impacts	Ecosystem-based; institutional; technological/ infrastructural; behavioural/ cultural	Moderate	Indigenous	No	McNeeley et al. (2016)
North America	Interactions between public (civil society) and private (individual) flood hazard mitigation efforts in watersheds	Terrestrial and freshwater ecosystems; cities, settlements and key infrastructure; health, well-being and communities	Extreme precipitation and inland flooding; precipitation variability; general climate impacts	Behavioural/ cultural; ecosystem-based; institutional; technological/ infrastructural	Significant	None	Yes	Milman and Warner (2016)
North America	Adaptation of maize production systems by rural communities	Food, fibre and ecosystem products	Drought; precipitation variability; increased frequency and intensity of extreme heat	Behavioural/ cultural	No data	Low-income groups	No	Munguía-Aldama et al. (2015)
North America	Implementation of Adaptive Silviculture for Climate Change project in two study sites, contributions of collaborative science-management partnership	Terrestrial and freshwater ecosystems	Drought; general climate impacts; precipitation variability	Ecosystem-based; institutional	Significant	None	Yes	Nagel et al. (2017)
North America	Promise and efficacy of ecosystem-based adaptation interventions applied at two field sites	Terrestrial and freshwater ecosystems; poverty, livelihoods and sustainable development	Extreme precipitation and inland flooding; general climate impacts; drought	Ecosystem-based; behavioural/ cultural; institutional	Shallow	Women	Yes	Newsham et al. (2018)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
North America	Individual actions (behavioural and psychological adaptations) taken by forest managers and users in response to forest dieback	Food, fibre and ecosystem products; terrestrial and freshwater ecosystems; health, well-being and communities	General climate impacts	Behavioural/ cultural; ecosystem-based	Shallow	None	Yes	Oakes et al. (2016)
North America	Processes of implementation of adaptation strategies	Terrestrial and freshwater ecosystems	Extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Ecosystem-based; institutional; technological/ infrastructural	Shallow	None	Yes	Picketts (2015)
North America	Process of producing local climate adaptation plan for small North American city	Cities, settlements and key infrastructure	Precipitation variability; extreme precipitation and inland flooding; drought	Institutional	No data	None	No	Picketts et al. (2013)
North America	Adaptation to climate change among ski resort companies relative to intensity of environmental adversity they face	Food, fibre and ecosystem products	Precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Institutional	No data	None	Yes	Rivera and Clement (2019)
North America	Livestock farmers' perceptions of and adaptations to current climate conditions	Food, fibre and ecosystem products	Precipitation variability; drought; increased frequency and intensity of extreme heat; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based	Shallow	Low-income groups	Yes	Rodas-Trejo et al. (2017)
North America	Skiers' willingness to change travel behaviour in response to climate-change-induced lack of snow	Health, well-being and communities	Increased frequency and intensity of extreme heat; general climate impacts	Behavioural/ cultural	Shallow	None	No	Rutty et al. (2015)
North America	Farmers' perceptions of climate-related economic and ecological risks, and their adaptation responses, following severe tropical storm event	Food, fibre and ecosystem products	Extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat; general climate impacts	Institutional; behavioural/ cultural; technological/ infrastructural	Moderate	None	Yes	Schattman et al. (2016)
North America	Farmers' perceptions and awareness of climate change and opinions on best climate response measures	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts; drought; extreme precipitation and inland flooding	Behavioural/ cultural; technological/ infrastructural; ecosystem-based	Shallow	None	No	Schattman et al. (2018)
North America	Determinants of adaptation practices adopted by smallholder coffee producers at household and community levels	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	Increased frequency and intensity of extreme heat; drought; extreme precipitation and inland flooding	Behavioural/ cultural; ecosystem-based; technological/ infrastructural	Shallow	None	Yes	Shinbrot et al. (2019)
North America	Findings of collaborative modelling research programme focused on river system	Water and sanitation; terrestrial and freshwater ecosystems	Drought; precipitation variability; extreme precipitation and inland flooding	Institutional; technological/ infrastructural	Moderate	None	Yes	Sterle et al. (2019)
North America	Drought adaptation in snow-fed inland river systems; changes in adaptation strategies and barriers encountered by local water managers	Terrestrial and freshwater ecosystems; water and sanitation; food, fibre and ecosystem products; cities, settlements and key infrastructure	Drought; increased frequency and intensity of extreme heat; precipitation variability	Institutional; behavioural/ cultural; technological/ infrastructural	Significant	None	Yes	Sterle and Singletary (2017)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
North America	Quantification of how firms respond to ecological uncertainty in ski resort industry, including adaptation-related responses	Water and sanitation; terrestrial and freshwater ecosystems	Precipitation variability; drought; general climate impacts	Ecosystem-based; behavioural/ cultural; institutional; technological/ infrastructural	Shallow	None	Yes	Tashman and Rivera (2016)
North America	Farmers' use of climate information services in contexts of extreme and unprecedented climatic events	Terrestrial and freshwater ecosystems; water and sanitation; food, fibre and ecosystem products	Drought	Technological/ infrastructural; ecosystem-based	Shallow	None	Yes	VanderMolen and Horangic (2018)
North America	Three case studies of trout stream adaptation (habitat restoration) due to climate-change-induced degradation	Terrestrial and freshwater ecosystems	General climate impacts; extreme precipitation and inland flooding; drought	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	No	Williams et al. (2015)
North America	Ranchers' responses to ongoing drought and relationship between ranchers' climate change beliefs and drought adaptation	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development; water and sanitation	Drought; precipitation variability; general climate impacts	Behavioural/ cultural; technological/ infrastructural; ecosystem-based; institutional	Shallow	Low-income groups	Yes	Yung et al. (2015)
North America; Asia; Europe	Effectiveness of voluntary programmes for achieving building retrofits	Cities, settlements and key infrastructure; terrestrial and freshwater ecosystems; cities, settlements and key infrastructure	General climate impacts	Technological/ infrastructural; behavioural/ cultural	Significant	None	Yes	van der Heijden (2015)
North America; Australia; Central and South America; Asia; Africa; Europe	Review of global literature on adaptation in glaciated mountain regions	Terrestrial and freshwater ecosystems	General climate impacts	Behavioural/ cultural; institutional; technological/ infrastructural	No data	Low-income groups; indigenous; women; migrants	No	McDowell et al. (2019)
North America; Central and South America	Adaptation strategies and responses in two different countries, focused on rural communities with and without institutional oversight	Food, fibre and ecosystem products; water and sanitation; health, well-being and communities; poverty, livelihoods and sustainable development	Drought; precipitation variability; extreme precipitation and inland flooding; general climate impacts	Ecosystem-based; institutional	Shallow	Indigenous	Yes	Campos et al. (2013)
North America; Central and South America	Autonomous strategies employed by Central American farmers in response to stressors, including climate variability	Poverty, livelihoods and sustainable development	Drought; extreme precipitation and inland flooding; general climate impacts; increased frequency and intensity of extreme heat	Behavioural/ cultural	Shallow	None	No	Eakin et al. (2014)
North America; Central and South America; Europe	People's perceptions of climate change and adaptation to glacier retreat in three countries	Food, fibre and ecosystem products; water and sanitation; health, well-being and communities	Drought; extreme precipitation and inland flooding	Technological/ infrastructural	No data	Indigenous; low-income groups	Yes	Orlove et al. (2019)

IPCC continental region	Article summary	Sector	Climatic stimuli	Response type	Depth of adaptation [a]	Equity targeting	Limits identified	Citation
North America; Europe	Farmers' perceptions of climate change; influence of cultural setting for determining management practices and adaptive capacity	Food, fibre and ecosystem products; poverty, livelihoods and sustainable development	General climate impacts; precipitation variability; increased frequency and intensity of extreme heat; drought; extreme precipitation and inland flooding	Technological/ infrastructural; ecosystem-based; behavioural/ cultural; institutional	Shallow	None	Yes	Campos et al. (2014)
North America; Europe	Storm water management practices in two urban areas, focusing on integration of green and blue infrastructure for river restoration	Cities, settlements and key infrastructure; water and sanitation; terrestrial and freshwater ecosystems	Extreme precipitation and inland flooding; precipitation variability; increased frequency and intensity of extreme heat	Technological/ infrastructural; ecosystem-based; behavioural/ cultural	Significant	Low-income groups	Yes	Perini and Sabbion (2016)
North America; Europe	Mechanisms for assisted migration as adaptation tool in forestry sectors of two countries	Poverty, livelihoods and sustainable development; terrestrial and freshwater ecosystems	Drought; extreme precipitation and inland flooding; increased frequency and intensity of extreme heat; precipitation variability	Ecosystem-based; technological/ infrastructural; behavioural/ cultural	Shallow	None	Yes	Sansilvestri et al. (2016)
North America; Islands; Central and South America; Asia; Europe	Effects of local participation in policy and planning on efficacy of climate change adaptive responses	Food, fibre and ecosystem products; health, well-being and communities	General climate impacts	Ecosystem-based; behavioural/ cultural; technological/ infrastructural; institutional	Moderate	Indigenous	Yes	Huntington et al. (2020)

a. The depth of a response relates to the degree to which a change reflects something new, novel and different from existing norms and practices.

SMCCP5.4 List of Articles Assessed for the Assessment of Key Risks in Mountain Regions

The body of evidence assessed to support the key risks in Section CCP5.3.2 is presented in Tables SMCCP5.18 to SMCCP5.21. For KR1 (people and infrastructures at risks from landslides and floods), Figure CCP5.5 shows the level of risk accrual for different IPCC climate reference regions at three warming levels. For KR2 (risks to livelihoods and the economy from changing water resources), Figure CCP5.6 shows the level of risk accrual for different IPCC reference regions for a given warming range.

The assessment underpinning both figures is based on a similar approach. A selection of publications under KR1 and KR2 in Tables SMCCP5.18 and SMCCP5.19 are entered in an Excel database (one database for each key risk). The selection is limited to publications for which warming levels and risk accrual can be assessed. Each paper is entered in a second spreadsheet and the following information is extracted: IPCC continental region, IPCC reference region, climate scenarios, time period, global warming level, climate impact drivers, magnitude, vulnerability and exposure. Each paper can have multiple entries. Per entry, the magnitude of the climate impact driver, vulnerability and exposure are reported as 1=*low*, 2=*medium*, 3=*high* based on evidence from each paper complemented by expert judgement of the author team. The risk is then calculated either (1) linearly, where risk = (climate impact driver) × (exposure) × (vulnerability); (2) extracted directly from the paper provided it can be inferred from the paper whether risks are *low*, *medium*, *high* or *very high*; (3) assigned based exclusively on expert judgement if not enough information is available to apply method (1) or (2). Risk indexes are then assigned from the numeric values shown in Figure SMCCP5.1.

The risk levels are then normalised and assigned a value between 0 and 1, assuming *low* = 0–0.25, *medium* = 0.26–0.5, *high* = 0.51–0.75, *very high* = 0.76–1. Levels are then averaged across multiple papers per IPCC sub-region (for the same warming level or warming range). In a second stage, additional aspects are considered when assessing a risk level for a particular sub-region based on the body of evidence and the expert judgement of the lead author team. These include the key risk criteria detailed in Chapter 16, namely:

i) Nature of adverse consequences for systems: magnitude, irreversibility, potential for thresholds/tipping points
ii) Uncertainty in adverse consequences (e.g., likelihood of serious consequences)
iii) Timing of risk (e.g., persistence, rate of change in risk)
iv) Ability to respond to the risk

and criteria for the definition of risk accrual in the burning embers (Chapter 16). Some caveats of the assessment include a) the use of global studies for certain regions and levels of warming which, in the absence of finer-resolution regional studies, make it impossible to precisely resolve impacts and risks in mountain regions; b) several

Risk index and corresponding level of risk

	0	1	2	3
0	0	0	0	0
1	0	1	2	3
2	0	2	4	6
3	0	3	6	9
4	0	4	8	12
6	0	6	12	18
9	0	9	18	27

Value	Risk
0	Low
1	Low
2	Low
3	Low
4	Med
5	Med
6	Med
8	Med
9	High
12	High
18	Very high
27	Very high

Figure SMCCP5.1 | Risk index and corresponding level of risk.

papers which reported results in the form of maps and graphics and the author team assessed the risks visually if quantitative data were not available in the publication. These limitations are, whenever possible, supplemented by the expert opinions of the author team and are reflected in the confidence level for the corresponding reference region.

Table SMCCP5.16 | Data used to generate Figure CCP5.5. The risk levels in Figures CCP5.5 and CCP5.6 are calculated by further disaggregating the data per Representative Concentration Pathways (RCPs), and time period (with corresponding level of global warming from pre-industrial) and assumptions on hazards (H), exposure (E) and vulnerability (V) level. Levels are between 0 and 1 and corresponds to *low* (0–0.25), *medium* (0.26–0.50), *high* (0.51–0.75) and *very high* (0.76–1). The risk is calculated either as H × E × V or manually based on assumptions in the paper or expert judgement of the author team. The data are further disaggregated per IPCC climate reference region (see AR6 WGI Atlas) and IPCC continental regions (e.g., Africa, Asia, Australasia, Central South America, Europe and North America). For a given region and reference, multiple entries imply different assumptions in terms of future vulnerability and exposure, which are averaged out in the final regional risk level. This is because for many regions there is little evidence to distinguish different exposure and vulnerability levels given that several studies assessed here are global. Conclusions on the final averaged risk level are also complemented by expert opinion of the lead and contributing authors.

Global warming level	IPCC continental region	IPCC reference region	Risk index	Risk level	Risk level (normalised)	Sub-region averaged risk level	References
GWL = 1.5°C GWL band = 1.3°C–1.7°C	Africa	SEAF	3	1	0.25	0.38	Hirabayashi et al. (2013) Hirabayashi et al. (2021) Zheng et al. (2021a) Merz et al. (2021) Motschmann et al. (2020) Schlögl and Matulla (2018) Beniston and Stoffel (2016)
	Africa	SEAF	6	2	0.5	0.38	
	Africa	NEAF	3	1	0.25	0.38	
	Africa	NEAF	6	2	0.5	0.38	
	Asia	EAS	6	2	0.5	0.63	
	Asia	EAS	9	3	0.75	0.63	
	Asia	SAS	6	2	0.5	0.67	
	Asia	SAS	9	3	0.75	0.67	
	Asia	SAS	12	3	0.75	0.67	
	Asia	TIB	6	2	0.5	0.50	
	Asia	WCA	6	2	0.5	0.50	
	Australasia	SAU	6	2	0.5	0.50	
	Australasia	NZ	6	2	0.5	0.50	
	Central South America	NWS	4	2	0.5	0.50	
	Central South America	NWS	6	2	0.5	0.50	
	Central South America	NWS	8	2	0.5	0.50	
	Europe	WCE	8	2	0.5	0.50	
	Europe	WCE	4	2	0.5	0.50	
	North America	WNA	4	2	0.5	0.50	
	North America	NWN	4	2	0.5	0.50	

Global warming level	IPCC continental region	IPCC reference region	Risk index	Risk level	Risk level (normalised)	Sub-region averaged risk level	References
GWL = 2°C–2.5°C	Africa	NEAF	12	3	0.75	0.75	Arnell and Gosling (2016); Hirabayashi et al. (2013); Hirabayashi et al. (2021); Merz et al. (2021); Wang et al. (2020); Reyer et al. (2017); Motschmann et al. (2020); Sezen et al. (2020)
	Africa	SEAF	6	2	0.5	0.50	
	Asia	EAS	12	3	0.75	0.88	
	Asia	EAS	18	4	1	0.88	
	Asia	SAS	12	3	0.75	0.88	
	Asia	SAS	18	4	1	0.88	
	Asia	TIB	18	4	1	1.00	
	Asia	WCA	12	3	0.75	0.75	
	Australasia	SAU	6	2	0.5	0.50	
	Australasia	NZ	6	2	0.5	0.50	
	Central South America	NWS	8	2	0.5	0.58	
	Central South America	NWS	12	3	0.75	0.58	
	Central South America	NWS	6	2	0.5	0.58	
	Europe	WCE	2	1	0.25	0.38	
	Europe	WCE	6	2	0.5	0.38	
	North America	NWN	6	2	0.5	0.50	
	North America	WNA	6	2	0.5	0.50	
GWL = 4°C	Africa	SEAF	6	2	0.5	0.625	Hirabayashi et al. (2013); Hirabayashi et al. (2021); Kirschbaum et al. (2020); Allen et al. (2016); Zheng et al. (2021a); Keller et al. (2019); Beniston and Stoffel (2016); Musselman et al. (2018)
	Africa	SEAF	9	3	0.75	0.625	
	Africa	NEAF	6	2	0.5	0.625	
	Africa	NEAF	9	3	0.75	0.625	
	Asia	EAS	9	3	0.75	0.88	
	Asia	EAS	18	4	1	0.88	
	Asia	SAS	12	3	0.75	0.86	
	Asia	SAS	12	3	0.75	0.86	
	Asia	SAS	27	4	1	0.86	
	Asia	SAS	18	4	1	0.86	
	Asia	SAS	12	3	0.75	0.86	
	Asia	SAS	9	3	0.75	0.86	
	Asia	SAS	18	4	1	0.86	
	Asia	SAS	12	3	0.75	0.86	
	Asia	SAS	18	4	1	0.86	
	Asia	TIB	12	3	0.75	0.79	
	Asia	TIB	12	3	0.75	0.79	
	Asia	TIB	27	4	1	0.79	
	Asia	TIB	18	4	1	0.79	
	Asia	TIB	12	3	0.75	0.79	
	Asia	TIB	6	2	0.5	0.79	
	Asia	WCA	12	3	0.75	0.75	
	Central South America	NWS	6	2	0.5	0.63	
	Central South America	NWS	9	3	0.75	0.63	
	Europe	WCE	6	2	0.5	0.50	

Global warming level	IPCC continental region	IPCC reference region	Risk index	Risk level	Risk level (normalised)	Sub-region averaged risk level	References
GWL = 4°C	Europe	WCE	12	3	0.75	0.50	
	Europe	WCE	1	1	0.25	0.50	
	North America	WNA	6	2	0.5	0.50	
	North America	NWN	6	2	0.5	0.50	

Table SMCCP5.17 | Data used to generate Figure CCP5.6. The risk levels in Figures CCP5.5 and CCP5.6 are calculated by further disaggregating the data per RCPs, and time period (with corresponding level of global warming from pre-industrial) and assumptions on hazards (H), exposure (E) and vulnerability (V) level. Levels are between 0 and 1 and correspond to *low* (0–0.25), *medium* (0.26–0.50), *high* (0.51–0.75) and *very high* (0.76–1). The risk is calculated either as H × E × V or manually based on assumptions in the paper or expert judgement of the author team. The data are further disaggregated per IPCC climate reference region (see AR6 WGI Atlas (Gutiérrez et al., 2021) and IPCC continental regions (e.g., Africa, Asia, Australasia, Central South America, Europe and North America). For a given region and reference, multiple entries imply different assumptions in terms of future vulnerability and exposure, which are averaged out in the final regional risk level. This is because there is for many regions only scant evidence to distinguish across different exposure and vulnerability levels given that several studies assessed here are global. Conclusions on the final averaged risk level are also complemented by expert opinion of the lead and contributing authors.

IPCC continental region	IPCC reference region	Risk index	Risk level	Risk level (normalised)	Sub-region averaged risk level	References
Africa	CAF	2	1	0.25	0.25	
Africa	NEAF	2	1	0.25	0.42	
Africa	NEAF	6	2	0.5	0.42	
Africa	SAH	1	1	0.25	0.25	
Africa	SAH	2	1	0.25	0.25	
Africa	SAH	2	1	0.25	0.25	
Africa	SEAF	2	1	0.25	0.41	
Africa	SEAF	6	2	0.5	0.41	
Africa	WAFS	2	1	0.25	0.41	
Africa	WAFS	6	2	0.5	0.41	
Africa	WAF	2	1	0.25	0.41	
Africa	WAF	6	2	0.5	0.41	
Asia	ARP	8	2	0.5	0.58	
Asia	ARP	12	3	0.75	0.58	Immerzeel et al. (2020)
Asia	EAS	8	2	0.5	0.66	Viviroli et al. (2020)
Asia	EAS	18	4	1	0.66	Munia et al. (2020)
Asia	ESB	4	2	0.5	0.58	Strasser et al. (2019)
Asia	ESB	12	3	0.75	0.58	Fuhrer et al. (2014)
Asia	ESB	8	2	0.5	0.58	Drenkhan et al. (2018)
Asia	SAE	4	2	0.5	0.50	Drenkhan et al. (2019)
Asia	SAE	6	2	0.5	0.50	Reyer et al. (2017)
Asia	SAE	8	2	0.5	0.50	Huang et al. (2021)
Asia	SAS	18	4	1	0.95	
Asia	SAS	9	3	0.75	0.95	
Asia	SAS	27	4	1	0.95	
Asia	TIB	18	4	1	0.75	
Asia	TIB	8	2	0.5	0.75	
Asia	WCA	18	4	1	0.70	
Asia	WCA	9	3	0.75	0.70	
Asia	WCA	8	2	0.5	0.70	
Asia	WCA	12	3	0.75	0.70	
Australia	SAU	4	2	0.5	0.50	
Central South America	NES	1	1	0.25	0.41	

IPCC continental region	IPCC reference region	Risk index	Risk level	Risk level (normalised)	Sub-region averaged risk level	References
Central South America	NES	6	2	0.5	0.41	
Central South America	NES	4	2	0.5	0.41	
Central South America	NWS	18	3	0.75	0.72	
Central South America	NWS	27	3	0.75	0.72	
Central South America	NWS	4	2	0.5	0.72	
Central South America	NWS	18	3	0.75	0.72	
Central South America	NWS	8	2	0.5	0.72	
Central South America	SES	1	1	0.25	0.41	
Central South America	SES	6	2	0.5	0.41	
Central South America	SES	4	2	0.5	0.41	
Central South America	SWS	18	4	1	0.56	
Central South America	SWS	1	1	0.25	0.56	
Central South America	SWS	6	2	0.5	0.56	
Central South America	SWS	4	2	0.5	0.56	
Europe	WCE	2	1	0.25	0.30	
Europe	WCE	8	2	0.5	0.30	
Europe	WCE	18	3	0.75	0.30	
Europe	WCE	9	3	0.75	0.30	
Europe	WCE	12	3	0.75	0.30	
Europe	WCE	2	1	0.25	0.30	
Europe	EEU	2	1	0.25	0.25	
Europe	MED	8	2	0.5	0.44	
Europe	MED	1	1	0.25	0.44	
Europe	MED	6	2	0.5	0.44	
Europe	MED	4	2	0.5	0.44	
North America	CNA	2	1	0.25	0.25	
North America	NCA	4	2	0.5	0.50	
North America	NCA	6	2	0.5	0.50	
North America	NWN	8	2	0.5	0.31	
North America	NWN	2	1	0.25	0.31	
North America	WNA	8	2	0.5	0.50	
North America	WNA	4	2	0.5	0.50	

Table SMCCP5.18 | Evidence and literature to support key risk narratives in Section CCP5.3.2. KR1*: People and infrastructures at risks from landslides and floods*

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Kirschbaum et al. (2020)	High Mountain Asia	Increase of 30–70% potential landslide activity in transition zone between Himalayas and Tibetan plateau near China–Nepal border	RCP8.5	2061–2100	SSP1, SSP2, SSP3, SSP4, SSP5	SSP1, SSP2, SSP3, SSP4, SSP5	NA	Percentage of population impacted by landslide activity	Majority of population will experience increased exposure, 10–13% of population will be impacted by >20% increase in landslide activity
Tezuka et al. (2014)	Japan	Not specified	SRES B1, A2, A1B	2050	NA	NA	NA	Economic losses (on agricultural land, residential areas, traffic zones and golf courses) in US$	Loss of >1200 billion US$ for Q100 event; damage from present day Q50 event will equal damage from Q30 event in 2050; greatest potential economic losses under B1, followed by A2 and then A1B; nearly linear relationship between increase in extreme rainfall and increase in potential economic loss
Schlögl and Matulla (2018)	Central Europe	2021–2050: overall increase in landslides; strong increase in Vosges, Black Forest, Swabian Jura, Jura Mountain Northern Limestone Alps, Alpine foreland in Austria and Bavaria, Bohemian Forest; even more pronounced increase for 2071–2100	SRES A1B	2021–2050, 2071–2100	NA	Higher vulnerability at higher elevation because of decrease in redundant structural elements (i.e., only one access road to remote villages)	NA	Trans-European transport networks affected by increased landslide activity	Most trans-European transport networks (in AT, BE, CZ, FR, DE, LI, LU, NL and CH) are likely to be affected by increased landslide activity; in particular affected: Rhine–Danube corridor, Scandinavian Mediterranean corridor, Rhine–Alpine corridor, North Sea–Mediterranean corridor, North Sea–Baltic corridor.
Das et al. (2013)	USA (California, Sierra Nevada)	Larger flood magnitudes by end of 2100; Q50 flood magnitude increases by 30–90% in Northern and by 50–100% in Southern Sierra	SRES A2 and B1	2001–2049 and 2051–2099	NA	Dense communities and infrastructure	Future possibilities: structural: e.g., flood reserve volume in key reservoirs	Events that exceed security threshold of present-day infrastructure	Flood magnitudes larger than present-day Q50 events will exceed infrastructure security threshold, with infrastructure being affected more regularly than in Q50 events in future
Stäubli et al. (2018)	Global	Increase in frequency for HKH, Andes and African mountains; no trend in Alps and Central Asia; floods and mass movement disasters are most frequent and imply highest relative threat for mountain people	NA	1985–2014	NA	NA	NA	Number of deaths and of affected people	Increasing number of affected people but stable number of fatalities

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Keller et al. (2019)	Central Europe (Switzerland, Emme River)	NA	RCP8.5 (used for RCM scaling)	2070–2099	NA	NA	NA	Flood losses in millions of CHF	Damage and restoration costs projected to decrease for smallest estimate and increase 7-fold for highest estimates; maximum flood loss is estimated to be 240 million CHF for seasonal and WG scaling, and 370 million CHF for RCM scaling; overall uncertainty amounts to 670 million CHF for Q100
Felder et al. (2018)	Central Europe (Switzerland, Aare river)	NA	continuing as from 1979–2013	1979–2013	NA	NA	Flood defences with capacity for Q80–Q100 events	Billion CHF flood loss from buildings	Several extreme event scenario led to flow discharges higher than capacity and flood losses in 0.1–3 billion CHF range
Hirabayashi et al. (2013)	Global	Frequency of occurrence increases across large areas of South Asia, Southeast Asia, Northeast Eurasia, eastern and low-latitude Africa and South America (42% of the cells); and decreases in northern and eastern Europe, Anatolia, Central Asia, central North America and sourthern South America (18% of the cells)	RCP2.6, RCP4.5, RCP6.0 and RCP8.5	2071–2100	NA	NA	NA	Exposure of people	Flood exposure increases by 4–14% depending on RCP (exposure of people) 27 million people with 2°C increase and 62.93 million people with 4.6°C increase
Alfieri et al. (2015)	Europe (EU-28 countries with Norway and Republic of Macedonia but without Malta and Cyprus)	Frequency of flood peaks with high return period is projected to increase in most of Europe, even in regions where overall frequency of severe discharge peaks is projected to decrease	RCP8.5	2006–2100 with segments 2006–2035, 2036–2065 and 2066–2095 corresponding to 2020, 2050 and 2080	SSP5 and SSP3	NA	Present-day flood protection (e.g., dams and reservoirs)	People affected and damage in billions of Euros	Average annual people affected by 2050: 500,000–640,000 people (+131% to +196%); by 2080: 540,000–950,000 people (+150% to +340%); average annual damage by 2050: 20–40 billion Euro (+277% to +655%); by 2080: 30–100 billion Euro (+466% to +1787%)

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Gariano et al. (2015)	Europe (Italy, Calabria)	Less cumulative rainfall event was necessary to trigger landslides in recent period (1981–2010) than in preceding period (1951–1980)	No projections for future	1921–2010 with 30-year segments of 1921–1950, 1951–1980 and 1981–2010	Statistical data from national censuses; exposure has increased	NA	NA	Change in impact and risk for population	Higher exposure in recent period; impact on population increased in area hosting 18.5% of population and decreased in area hosting 20.8% of population; risk to population increased for 24% of population and decreased for 19.1% of population; 42.5% of regional population experienced increased impact or risk and 47.5% decreased impact or risk
Haque et al. (2016)	Europe	Increase in fatal landslides, mainly consistent with increases in extreme rainfall events; significant upward trend especially in last 5 years in Austria, Italy and Turkey	No projections for future	1995–2014	Most places in some Central European and Mediterranean countries (CH, AT, SL, IT, ES, Bosnia, FYROM and Eastern Turkey) have highly exposed populations	NA	Role of risk mitigation unknown; potential: many countries already have or are preparing inventory maps, susceptibility mapsconclusions	casualties and economic loss	average casualties per year: 108 ± 82; total annual economic losses in Europe: 4.7 billion Euro (only private insurance companies, no public-sector costs); economic losses will likely continue to grow
Hattermann et al. (2014)	Central Europe (Germany)	Flood hazard increases for most scenarios; relatively strong flood increase until end of this century for A1B and B1; considerable decrease of return interval of Q50 floods can be expected until end of this century (REMO A1B: 17 years, CCLM A1B1: 19 years)	SRES A1B, B1 and A2	2011–2040, 2041–2070, 2071–2100	Not specified; no change considered for modelling	Not specified; no change considered for modelling	Not considered	Economic losses from damage to buildings and small enterprises (according to insurance)	Flood losses are likely to increase significantly under climate change in Germany; annual flood damages in Germany (almost 500 million Euro for reference period 1961–2000) are expected to double on average until end of 21 century; CCLM A1B: 3-fold increase for 2071–2100, 2-fold increase for 2011–2040
Hattermann et al. (2016)	Central Europe (Germany)	Tendency remains as in original study	SRES A1B, RCP4.5 and RCP8.5	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged	Increase of +300% for RCP8.5 by end of century; increase of +200% for ENSEMBLES scenario

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Arnell and Gosling (2016)	Global	Increases in flood magnitude across humid tropical Africa, South and East Asia, much of South America, and in high-latitude Asia and North America;decreases in flood magnitude around Mediterranean, in Southwest Africa, Central America, Central Europe and European parts of Russia, e.g., under HadCM3 climate model pattern, current Q100 flood would occur twice as often across 40% of world and over 60% of Southeast Asia, Central Africa, Eastern Europe and Canada	SRES A1B, B1 and A2	2050	NA	NA	Assumption that there is no protection against flooding	People who experience change of exposure	Range across all 21 climate models under A1B in 2050 in estimated numbers of people exposed to a doubling of flood frequency is 31–449 million people, or a change in risk of –9% to +376%; for HadCM3 in 2050 the people exposed to a doubling in flood frequency will be 323 million for B1, 450 million for A1B and 570 million for A2; only 75 million people will experience decrease in flood frequency; global flood risk increases by 122% under B1 and by 187% under A1B
Gariano and Guzzetti (2016)	Global	Expected increase in shallow landslides with increase in rainstorms	NA	NA	NA	NA	Several measures are suggested, including mix of hard and soft measures	People at risk	Increase in number of people exposed to landslide risk where rainfall events increase (specifically to mountain)
Allen et al. (2016)	India	Far-reaching outburst floods and increase in flood hazard level and 7-fold increase in frequency; lakes expand and form closer towards steep heat walls and from these points impact of falling ice and rock might trigger outburst events; increase in level of flood hazard from high to very high	Deglaciated scenarios	NA	Exposure as presence of people and infrastructure, livelihoods etc.; lower exposure and vulnerability in mountain regions in north with higher pockets within; current level for future	Social vulnerability index; lower exposure and vulnerability in mountain regions in north with higher pockets within; current level for future	Low regret, measures in areas already affected, such as raising awareness, developing disaster response strategies; consider long planning horizons in infrastructure development (in case of emerging or new threats)	People and infrastructures at risks from glacial lake outburst floods (GLOFs)	3-fold increase in downstream area that could be affected by hazards which may affect agricultural activities and essential transportation links; slight increase in risk levels to inhabitants and to infrastructures
Sezen et al. (2020)	Central Europe	Seasonal decrease in rain-on-snow floods at higher altitudes, increase in flood frequency, increase in flood magnitude for most severe events	RCP4.5	2011–2040, 2041–2070, 2071–2100; reference period: 1981–2010	NA	NA	NA	NA	No clear estimation of risks associated with hazard changes; conclusions mainly based on changes in hazard

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Zheng et al. (2021a)	Hindu Kush-Himalaya, Tibetan Plateau and surrounding (Third Pole)	13'000 new glacial lake, combined area of 1510 km^2 and combined volume of 50 km^3 leading to 3-fold increase in GLOF hazard. Increase in frequency more significant than magnitude.	RCP2.6, RCP4.5, RCP8.5 and ice-free scenario	2050, 2100	No change from current level	No change from current level	NA	People and infrastructures at risk from GLOFs	1.7× to 2.5× increase in risk values between present and future risk to settlements and infrastructures, with highest risk in Karakorum, then Pamir, Western and Central Himalaya, which translates to greater risk for Indus, Tarim, Amu Darya and Ganges river basins; Indus River basins will be most dangerous basins (high risk); amplification of risks to transboundary settlements
Beniston and Stoffel (2016)	Central Europe (Alps)	ROS events could increase by almost 50% with temperatures 2°C–4°C warmer than today, before declining when temperatures exceed 4°C	RCP2.6 scenario by 2050 and a RCP8.5 scenario by 2100	From middle to end of century	NA	NA	NA	People and infrastructures at risk	Risk to people and infrastructures from ROS is already high now and can increase before declining for higher warming (>4°C)
Motschmann et al. (2020)	Andes, Peru, Cordillera Blanca	21 (25) lakes could form under RCP2.6 (RCP8.5) scenario, 6 of which would be a result of further growth of existing lakes and 15 would be new lakes	RCP2.6 and RCP8.5	2050	Extent of potentially affected areas is not expected to change, but people will be at risk from more lakes; an increase in population and industrial and agricultural activities, especially considering increased amount of water stored in lakes, would significantly affect exposure and possibly vulnerability of GLOFs	An increase in population and industrial and agricultural activities, especially considering increased amount of water stored in lakes, would significantly affect exposure and possibly vulnerability of GLOFs	NA	People and infrastructure at risk	In future, number of lakes susceptible to outburst will increase from five lakes at present to three additional lakes in future scenarios for Huaraz; Carhuaz, which currently is at risk from three lakes, is influenced by three additional lakes in RCP2.6 and another three lakes in RCP8.5; Caraz is currently exposed to outbursts of one lake, but another newly formed lake in RCP2.6 would add to risk in future
Reyer et al. (2017)	Central Asia	Changes in precipitation regimes; increase in GLOF potential and increase in size and number of moraine-dammed lakes	2°C GWL	Not specified	Not specified	Not specified	Not specified	People and infrastructure at risk due to floods and landslides	Increased risk for important road transport networks from floods and landslides; however, this review contains results based on previously published literature

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Musselman et al. (2018)	North America	Rain-on-snow events with flood potential becoming more frequent at higher elevations	RCP8.5	2071–2100	Not specified	Not specified	Flood control and reservoir management accounting for future runoff regime changes	Flood risk	20–200% increase in flood risk in Sierra Nevada, Colorado River and Canadian Rocky Mountains; this analysis focuses mainly on hazard conditions, but reference is made to potential threats to metropolitan regions
Merz et al. (2021)	Global	River floods	1.5°C, 2°C and 3°C GWL	2030, 2055	SSP5	SSP5		Population affected globally and direct economic damage	Risks extrapolated from global regions to mountains based on expert opinion and mainly looking at findings in Figures 7a and 7b.
Wang et al. (2020)	China	Floods driven by precipitation extremes	1.5°C, 2°C	1950–2095	SSP1, SSP2, SSP3	SSP1, SSP2, SSP3		Percentage of population and land area exposed to 5 d precipitation extremes; highest sensitivity is found in Tibetan Plateau	Increase in exposure of both population and land to extreme precipitation between 20% and 43% in Western arid (semiarid) zone and Qinghai Tibetan Plateau

Table SMCCP5.19 | Evidence and literature to support key risk narratives in Section CCP5.3.2. KR2: *Risks to livelihoods and the economy from changing water resources.*

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Mishra et al. (2020)	High mountain Asia (Karakoram: Hunza sub-basin; Central Himalayan region: Trishuli sub-basin)	Increase in river flow at Trishuli (Nepal) and decrease in Naltar (Karakoram); reduction of winter low-flow period because of earlier spring melt and later accumulation of snowpack; reduced summer river flow; overall expected effect: longer high-flow season but with lower streamflow intensity	RCP4.5 and RCP8.5	2020–2099	Water-based economies support livelihoods of millions of people; projected increase in electricity demand of 8.34% by 2017; supply increases less	NA	NA	Change in hydropower production	Hydropower plants in both regions expected to benefit from increased flow during peak-water period; high summertime inflow volatility not expected to impact power production because lowest historical summertime flow rates far exceed turbine flow rate maximums; power production in storage-type power plants of similar capacity in Trishuli (Nepal) would increase by 15%, and climate change impacts are negligible
Immerzeel et al. (2020)	Global	NA	RCP4.5	2000–2050	SSP2; more than 250 million people live in water towers and more than 1.6 billion people live in areas receiving water from water towers, which is about 22% of global population	Present: Very high vulnerability of Indus: projected 50% increase in population by 2050; projected 8× increase in GDP; projected 1.9°C increase in average annual temperature; projected 0.2% increase in average annual precipitation; nearly all important Water Tower Units (WTUs) in Asia are also highly vulnerable; in South America, vulnerability is less than for Asia, and drivers are variable (precipitation decrease, population growth, economic growth); in North America, vulnerabilities are related to population growth and temperature increase	Integrated in terms of government effectiveness in calculation of vulnerability	Water tower index (WTI) ranges from 0 to 1 (the higher the more important)	Upper Indus basin (WTI = 1) is most critical water tower globally (densely populated, intensively irrigated); it is unlikely that the Indus can sustain this pressure; in North America, the Fraser (WTI = 0.62) and Columbia (WTI = 0.58) river basins are the most critical WTUs; in South America, the Cordillera Principal, the Cordillera Patagónica Sur and the Patagonian Andes are key WTUs; in Europe, the Alps are the most relevant water-supplying mountain range, meeting demand of Rhone (WTI = 0.45), Po (WTI = 0.39) and Rhine (WTI = 0.32) basins

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Strasser et al. (2019)	Central Europe (Austria: Brixental in Tyrol)	Only considering CC: reduction of streamflow by –25% (A1B) and –69% (RCP8.5) by end of 21st century; including land use change: reduction of streamflow by –35% (A1B) and –77% (RCP8.5) by end of 21st century	A1B and RCP8.5	2020–2100	NA	Storylines of land use: A adapted (low), B economic exploitation and abandonment (high) and C (withdrawal and abandonment) (medium to high)	Ecological adaptation assumed for one of the three storylines	NA	Less water is available for human activities such as hydropower generation, irrigation or other uses, with massive consequences for economic and living conditions
Biemans et al. (2019)	South Asia (Indo-Gangetic Plain)	Peak discharge expected to shift by up to 1 month earlier	No future projections	NA	48 million people living in Indus, Ganges and Brahmaputra mountains and 129 million people living downstream substantially depend on snow and glacier melt for their livelihoods; food produced by meltwater equivalent to caloric intake of 38 million people	High vulnerability due to big water availability mismatch over time and space: 70% of precipitation falls in June–September period	NA	NA	Meltwater is essential for agriculture and very important for energy production, drinking water in urban areas and industry
Fuhrer et al. (2014)	European Alps (Switzerland: Rhone catchment)	Declining trend in water budget with large interannual variability, mean increase in seasonal irrigation water requirement (by 4–16%), increase in cattle water consumption	A1B	1951–2050	High exposure as area suffers from rain-shadow effect during summer, and irrigation is important in agriculture	High as mountain agriculture is already not competitive with agriculture in lowland areas	NA	Change in agricultural sustainability	Higher water demand may exceed supply during springtime and summer (especially in more elevated locations with livestock production), increasing expenses of higher requirements for irrigation water.

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Hoy and Katel (2019)	Himalaya (Bhutan)	Annual precipitation increase of 20–25%. Seasonal precipitation increase in monsoonal months and decrease in dry winter season	A1B	1980–2069	High exposure: >60% of Bhutanese population are subsistence farmers dependent on natural resources; water is major Bhutanese economic resource; 45% of Bhutan's GDP comes from hydropower, and water demand is expected to rise in future; Bhutan's river system is fed by snow melt and glaciers	NA	None assumed; potential: (a) acquisition of new meteorological equipment for monitoring, (b) educating university students in climatology and its applications and (c) building up home-grown expertise and research in situ	Loss of livelihoods and loss for local economy	Affected: energy and hydropower sectors, as well as domestic water production and irrigation requirements for agriculture; declining crop yields due to water sources going dry result in food scarcity and declining incomes with negative effects on human health and life expectancy
Halofsky et al. (2017)	USA (Rocky Mountains)	In 2080s, median flow date is expected to be over 20 d earlier, and summer flows are projected to decline by 20–40% in most locations in Rocky Mountains; altered timing and quantity of summer flow are expected to cause shortages of surface water in locations where demand is high in summer months; discharge from natural springs and seeps may be reduced, and drought and flood events may increase	RCP4.5 and RCP8.5	Up to 2100	High; increasing population already stresses limited water resources	High? Rates of return on livestock in West are already very low (2%); rangeland managers have limited financial resources and limited options to diversify livelihoods	Adaptation: none assumed; potential: livelihood diversification (e.g., recreation), increasing implementation of current practices that improve watershed function (e.g., restoring and protecting riparian systems and wetlands), reducing water use and increasing efficiency	Change in economic profitability	Decreased water supply and increased drought and flood events will affect water quantity and quality and water for livestock; reduction in downstream domestic water yields; increased treatment costs and greater dependence on groundwater intakes of municipal systems; livestock operations may be rendered unprofitable
McDowell and Hess (2012)	Andes (Bolivia: Palca)	Water shortages, delayed rainy season with less precipitation overall and reductions in stream flow; Mururata glacier is likely to disappear before 2040	NA	NA	High: smallholder agriculture is primary source of income (70%); complete dependence on glacier water for agriculture	High: historically marginalised (Aymara communities), institutional failure to provide access to physical capital, 80% live in extreme poverty, land scarcity, lack of knowledge	None assumed; low potential: abandon or reduce highland production and focus on irrigated cash crops	Loss of livelihoods	Water shortages have begun to compromise agricultural production, loss of subsistence food source, loss of livelihoods expected

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Bekchanov and Lamers (2016)	Central Asia (Uzbekistan)	Reduction in downstream water supply by at least 10% (–20%) by 2050 (based on literature)	NA	2050	High: irrigated agriculture plays pivotal role in livelihoods of majority of population of Uzbekistan (60% of 31.5 million) and is major source of income for local economy	High: especially in downstream regions with heavy reliance on irrigated agricultural production	None assumed; potential: low, groundwater use (limited because expensive and energy-intensive), reservoirs (may reduce downstream irrigation water availability), improving irrigation efficiencies	Loss of employment, loss of national income	Reduction of irrigated areas by 241,000–374,000 ha (6.3–9.7%), increase in unemployment by 712,000–868,000 people (7.9–9.6%), loss of national income of 461–588 million US$ (3.6–4.3%)
Gaudard et al. (2013)	Central Europe (Swiss Alps, Rhone River: Mauvoisin)	18% water inflow by 2091–2100 (based on Gabbi et al. 2012)	A1B (based on Gabbi et al. 2012)	2091–2100, reference period 2001–2010	NA	NA	Assumed: optimisation of hydraulic head and optimisation of turbine schedule with respect to prices	Loss of revenue	Production will grow by 4% for period 2041–2050 and decline by 16% for period 2091–2100 in all scenarios
Tiwari and Joshi (2015)	Himalayas (India, Uttarakhand, Ramgad catchment)	52% annual rainwater decrease; 34% decrease in annual rainy days, depletion of water resources in region	No future projections	2001–2013	High: subsistence agriculture is main source of rural livelihoods—22,085 inhabitants in 2013	High: marginalisation, dependency on natural resources, poverty, food insecurity, poor community health, especially high for women, as men often out-migrate	adaptation potential: medium, usage of highly productive and agriculturally prosperous valleys and mid-slopes, varying agroclimatic zones from valleys to higher elevations, diversification of agriculture, concentration on tourism	NA	83% of villages face great water scarcity; irrigated area has declined 14–30%, and irrigated agriculture has decreased 25%; decrease in per capita food productivity has led to annual food deficits of 67%; reduction in consumption of essential food commodities (e.g., rice, sugar) by 30–45%; reduction of livelihood opportunities by 34%

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Viviroli et al. (2020)	Global	2.5-fold increase in lowland water consumption between 1961 and 2050 (SSP2–RCP6.0)	RCP4.5 and RCP6.0	1961–2050	SSP1, SSP2, SSP3	Depending on sector; lowland water resources have become increasingly dependent on mountain areas; mountain areas could become even more important to support food production in future, especially in regions like India, Egypt and Southern Africa	None made; potential: distribution of mountain surpluses only among lowland areas that show deficit (balancing out implies highly targeted, widespread transfers that would probably require considerable discharge capacity)	Change in dependence on mountain runoff; change in percentage of areas equipped for irrigation that are located in regions depending on essential runoff contributions	Critical dependence on mountain runoff: 1960: 0.2 billion (7%) , 2050: 1.5 billion people (24% of world's lowland population); dependence of essential mountain runoff contribution: 1960s: 0.6 billion (23%), 2000s: 1.8 billion (39%), 2040s: 2.3–2.7 billion (39–40%); dependence on essential but insufficient contribution: 2040s: 1.3–1.6 billion (22–24%); important agricultural areas equipped for irrigation: 2001–2010: 68% located in regions that depend on essential runoff contributions from mountains, 34% with low blue water sustainability, 2041–2050: 56% located in regions depending on mountain runoff and unsustainably using blue water (e.g., 86% for North Dry hydrobelt);
Drenkhan et al. (2018)	Andes, Peru, Vilcanota-Urubamba basin	Glacier:1988–2016: –20.5% volume, –37.3% area; 2031–2060: –40.7% (RCP2.6) and –44.9% (RCP8.5) area; 2070–2100: –41.4% (RCP2.6) and –92.7% (RCP8.5) area lake:1988–2016: +9.7% volume, +15.5% area, +18.3% numberby 2100: +3.2% (RCP2.6) and +6% (RCP8.5) area; +4.6% or 0.032 km^3 (RCP2.6) and +5.9% or0.041 km^3 (RCP8.5) volume	RCP2.6 and RCP8.5	Current: 1988–2016; future: 2050 and 2100	838,500 people inhabiting basin	High vulnerability of people in this rural region due to traditional livelihoods, low socioeconomic and high poverty levels (discussed in paper)	NA	Loss of potable water	Loss of 1.499 km^3 potable water corresponds to ~37 years of Cuzco's water supply;implications for future 2100: potential water release from glaciers corresponds to volume of ~30 years (RCP2.6: 2.820 km3) or 58 years (RCP8.5: 5.492 km3) to supply Cuzco's water (1% annual pop. growth; 1,033,181 inhabitants in 2100; unchanged water demand); potential increase in lake water volume of 0.062 km^3 for 1988–2016 and additional 0.032 km^3 (RCP2.6) or 0.041 km3 (RCP8.5) until 2100 do not at all outweigh potential loss of freshwater from glacier melt runoff

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Drenkhan et al. (2019)	Andes, Peru, Vilcanota-Urubamba basin	glacier:1988–2016: reduction of glacier water volume of 20.5% from 8.122 km3 (7.310 km3) to 6.457 km3 (5.811 km3)2031–2060: area reduction of 40.7% (RCP2.6) and 44.9% (RCP8.5)2070–2100: area reduction of 41.4% (RCP2.6) and 92.7%(RCP8.5) lake:1988–2016: increase of 9.7% from 0.637 km3 to 0.699 km3by 2050: volume increase of 0.032 km3 (4.6%) and 0.037 km3 (5.3%) by 2100: volume increase of 0.032 km3 (4.6%) and 0.041 km3 (5.9%)	RCP2.6 and RCP8.5	Current: 1988–2016; future: 2050 and 2100	High as there is also precipitation decrease, water-intensive agriculture is expanding (besides others due to export-crop markets) leading to a doubling of irrigated areas, and urbanisation and population are growing; census 2017: 838,500 people inhabit basin	Higher vulnerability than Peruvian average; 44.5% of inhabitants without access to public drinking water network; considerable water leakages in water provision system	None assumed; potential: low-medium; large projects have low social acceptance and lead to strong social conflicts; decentralised options could be more effective and at least compensate for a certain fraction of glacier water; increase in efficiency in water distribution and irrigation systems needed; coordination within and among stakeholders essential (need for transparency, trust, information exchange, joint workshops etc.)	change in streamflow	2–11% (7–14%) reduction of river discharge until 2050 (2100). Hotspots:02-PT: 12,500 highly exposed inhabitants, strong vulnerabilities, substantial glacier contribution to river streamflow (JJA: 19.9%, DJF: 4.7%)04-AST and 05-RH: a few hundred people, medium vulnerability; water shortages of several months represent a clear risk for hydropower production; high glacier contribution to streamflow (JJA: 14.9% and 12.7%, DJF: 7.0% and 3.9%, respectively) is crucial, particularly for dry-season water supply
Wijngaard et al. (2018)	South Asia (Indus, Ganges and Brahmaputra)	Surface water availability projected to increase for both RCPs (stronger in RCP8.5), with exception of Indus basin, which shows an opposite trend	RCP4.5RCP8.5	1981–2010 versus 2011–2100	SSP1, SSP3	SSP1, SSP3	NA	Annual blue water gap	Climate change will only mitigate water gap, whereas climate change + socioeconomic development will enhance water gap; overall unmet demand is 83 $km^3\ yr^{-1}$, 35 $km^3\ yr^{-1}$ in Indus and Ganges respectively in reference scenarios; there is no gap in Brahmaputra; by end of century:RCP45-SSP1 = water gap decrease of 21% and RCP85-SSP3 = water gap increase of 7% for Indus basin; RCP45-SSP1 = water gap decrease of 23%; RCP85-SSP3 = water gap increase of 14%

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Motschmann et al. (2020)	Andes, Peru, Cordillera Blanca, Quillcay catchment	Glacier shrinkage will lead to negative water balance during future dry seasons; from 2012 to end of 21st century, total annual water supply of 262 Mm^3 will decrease by 22 Mm^3 to 77 Mm^3 due to glacier retreat;monthly water balance loss (including extraction by mines and environmental base flow) rises substantially and fluctuates between –8% and –96% for RCP2.6 and between –27% and –336% for RCP8.5	RCP2.6 and RCP8.5	Hydrological model: 1980–2015 vs. 2050; ice loss: 2012 vs. end of 21st century	High; in addition to livestock and commercial and manual labour, revenues in Quillcay catchment are mainly based on agriculture	NA	NA	Change in water availability	Risks of declines in crop productivity, basic household food security and greater uncertainty about agricultural cycles; decreasing water availability may lead to monetary agricultural losses of 18 million US$ (220 million US$) for wheat or 50 million US$ (617 million US$) for potato production in RCP2.6 (RCP8.5)
Munia et al. (2020)	Global	Changes in local runoff and natural inflows	RCP2.6 and RCP6.0	Mid-century	SSS1, SSP3	SSP1, SSP3	NA	Water stress	Populations under water stress increase by 50% under SSP1-RCP2.6 and double under RCP6.0-SSP3; stress level increases everywhere under SSP3-RCP6.0 except in some basins in Northern Africa; moderate to chronic stress relevant to mountain regions are observed in part of High Mountain Asia, e.g., Central Asia

Table SMCCP5.20 | Evidence and literature to support the key risk narratives in Section CCP5.3.2. KR3: *Risks of ecosystem change and species extinction.*

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Morueta-Holme et al. (2015)	Andes, Ecuador, Chimborazo	>400 m elevation glacier retreat	No projections	1802–2013	High: presence of high-elevation endemic species with no scope to disperse to higher altitudes or latitudes	High: human-dispersed species shifting upward from elevations <3800 m strengthens concerns that immigration of widespread generalist species may come at cost of high-elevation endemic species	NA	Change of species distribution and increase in elevation limits of plants	Observed/expected shift rate ratio for glacier retreat and vegetation response of 1.6 for overall vegetation; upward shift of upper vegetation limit (seed plants) of >500 m; upward shift of gentianes and pajonal vegetation zones and expansion of pajonal-type vegetation also at lower elevations; average upward shift in upper range limits of individual taxa of 675 m at species level and 565 m at genus level (32 and 27 m per decade)
Kidane et al. (2019)	Africa, Ethiopia, Bale Mountains	NA	Temperature increase of 2°C, 3°C and 4°C for 21st century based on optimistic to pessimistic scenarios from IPCC	21st century, not specified	High: no spacious high summits that provide space for upward shift of species; many endemic species; Bale Mountains are among 34 biodiversity hotspots and listed by UNESCO as tentative World Heritage Site and biosphere reserve	NA	None made; low potential: conservation management strategies not only within areas of national park but also in buffer zone surrounding park; acknowledgement of local people and their socioeconomic situation; addressing issues related to intensified grazing, large-scale land grabbing and agricultural expansion	Potential endemic species altitudinal range shift	Climate change endangers a significant part of the unique Afroalpine flora, and intensified land use activities may further exacerbate situation; estimated altitudinal range shifts cause potential local extinction of 8.7% of all endemic species at 2°C temperature increase and of about 36% at 3°C–4°C temperature increase
Dulle et al. (2016)	Africa, Tanzania, Mt. Kilimanjaro	2.6°C increase in mean minimum temperature	No projections	1991–2011	Low: survey was carried out between 1900 and 2600 m asl, which means that the observed species could potentially disperse additional 3000 m higher on Mt Kilimanjaro	High: tropical montane species tend to have narrow thermal tolerances and are therefore expected to be particularly vulnerable to climate change	none made	Change in abundance of understorey bird species	Overall increase of 13% in mean abundance, especially for generalists; abundance changes of up to >100% on southern slope at high elevation; abundance at lower elevation remained relatively stable; forest specialists and insectivores remained stable; mean species abundance increased regardless of species temperature preferences

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Shrestha and Shrestha (2019)	Nepal	Not specified for past	RCP 6.0 for 2050; projected average temperature increase of 1.3°C by mid-century (2046–2065) and 2.2°C by late 21st century (2081–2100)	Reference period for current time: 1970–2000; future period 2050; survey period: 2013–2018	High: estimated cost of US$ 1.4 billion due to biological invasions to Nepal's agricultural sector	High: Nepal is ranked among the countries most vulnerable to biological invasions and climate change	None made; medium potential: monitoring and management of invasive alien plants (IAPs); early detection and preventive actions should focus on mountainous areas of country	Change in extent and intensity of climatically suitable regions for IAPs	For future scenario, climatically suitable regions for 75% of IAPs will expand, in contrast to contraction of climatically suitable regions for remaining 25% of IAPs, niche extent and invasion hotspots will expand by 2% and 5%; there will be an expansion towards high-elevation mountainous regions (with greater change above 2000 m asl)
Kissel et al. (2019)	U.S. Pacific Northwest	NA	NA	NA	NA	NA	NA	NA	62% chance of extinction of Cascades by 2080s because of compounding negative effects on early and late life history stages; by 2080s, our models predict that larval mortality will increase by 17%, and adult survival will decrease by 7%
Albrich et al. (2020)	European Alps, Austria, Tyrol, Stubai Valley	Not specified for past	GCM-RCM combination of HadGEM2-ES and CLMcom-CCLM4-8-17 for RCP8.5 by end of 21st century	Reference period for current time: 1961–2014	NA	High: life in mountains is strongly temperature limited, which puts mountain ecosystems at particular risk of severe climate change impacts	NA	Change in forest size structure and species composition	Without buffering effect of topographic complexity, critical transitions occurred even at +1°C and +2°C; beyond a warming of 2.3°C critical transitions of forest composition and size structure occurred in all simulated scenarios; hysteresis can be expected in driver-state relationships, with forest size structure and species composition differing between warming and cooling trajectories; however, even under most extreme climate forcings, no more than 2% of current forest area would transition to non-forest

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Moret et al. (2016)	Andes, Ecuador, Pichincha volcano	Air temperature has increased by 0.68°C since 1939 (literature)	Literature: projected temperature increase of 4°C at highest elevations by end of 21st century	Comparison of survey periods in 1880, 1985/86 and 2013/15	High: limited elevation for upward dispersal	High: low dispersal ability of wingless beetles; high vulnerability of stenotopic organisms	NA	Change in high-altitude Carabidae beetle community distribution	The most specialised stenotopic species experienced an important upslope shift (ca. 300m) between 1880 and 1985; for at least one stenotopic and wingless species this resulted in an area reduction of more than 90%; 1985/86–2013/14: 100 m upward shift of lower limit of superparamo ground beetle community; among more generalist species, a wide spectrum of upward shift rates was recorded between 1985/86 and 2013/14, presumably as result of differences in ecological and climatic tolerance at species level; local extinctions likely to occur during coming century in 4 mountains that peak below 5000 m and possess small suitable habitats in their summit areas
Avalos and Hernández (2015)	Andes, central Bolivia to southeastern Peru, Yungas ecoregion	Not specified for past	A2 and A1B	Projected for 2080–2099	High: high number of endemic birds	High: species already threatened by deforestation, roads, mining activities, fires and hydrocarbon projects	NA	Change in distribution of restricted range species	Great majority of species studied (91%) may suffer reduction in geographic range; average geographic range reduction (63%) is not far from projections for range-restricted birds of northern Andes in Colombia for 2050 (33–43%). Most species with small ranges may be very threatened; probability of suitable conditions for almost every bird species is projected to fall in protected areas under 2 dispersal conditions, dropping to 10% of geographic range of at least 10 species, and making them prone to be total gap species (= no protection in their ranges).

Table SMCCP5.21 | Evidence and literature to support the key risk narratives in Section CCP5.3.2. KR4*: Risk of intangible losses and loss of cultural values.*

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Jurt et al. (2015)	Central Europe (Italian Alps: Trafoi, Stilfs, Sulden)	NA	Continuing as currently	NA	Exposure of whole community	Community's vulnerability is exacerbated by their wish for independence from Italian government and their dependency on tourism as their main economic and community activity	Low (strategies to rely less on glaciers, e.g., heating not based on hydropower)	Loss of identity, culture, well-being and self-reliance	1200 people in 3 villages at loss of identity, culture and self-reliance; shrinking glaciers cause loss of sense of community through shared memories and history as glaciers were part of stage of the World War I; sadness caused by loss of what feels like 'home'; loss of felt independence as glaciers are a position of separation from Italian government; loss of well-being due to uncertainty and fear of the future.
Jurt et al. (2015)	Andes (Peru, Cordillera Blanca: Siete Imperios)	NA	Continuing as currently	NA	Exposure of whole community	Main economic activity is subsistence agropastoralism; community's belief that glaciers are source of all water in Peru; management of glacier water canals as important community activity that will be lost if glaciers disappear	No adaptation assumptions; low potential: glacier stories and legends strengthen intergenerational ties, memories from past may help keep community together	Loss of identity, culture and self-reliance	800 inhabitants of Siete Imperios at risk of losing their traditions and rituals including glaciers, increasingly being involved in water conflicts and feeling concerned about the future.
Jurt et al. (2015)	North America (USA, North Cascades: Glacier, Concrete)	NA	Continuing as currently	NA	Exposure of whole community	Vulnerability is exacerbated by the fact that main economic activity is recreation and tourism and lack of information about current CC processes and impacts on environment	Medium potential: focus on summer tourism, transformation of identity	loss of traditions and self-reliance	1300 people at risk of loss of traditions and self-reliance due to glacier shrinkage; nostalgia because ice skating is no longer possible on rivers
Diemberger et al. (2015)	Himalaya (Tibet Autonomous Region, People's Republic of China)	NA	NA	NA	NA	Hazard vulnerability exacerbated by dependency on pastoralism, herding and high-altitude farming as main economic activity; risk vulnerability exacerbated by strong cultural beliefs and perception of mountains and glaciers as deities and sacred	Present: low responsive capacity due to limited mobility, decreased availability of human labour caused by changes in sociopolitical structures (migration to urban centres, fragmentation and privatisation of land); low potential: rituals and religious predictions	Loss of peace of mind and well-being	Perception of climatic hazard events as a reaction to bad 'moral climate' (i.e., meteorological events are tightly linked to human morality and fortune) causes distress and loss of peace of mind and well-being

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Vander Naald (2020)	North America (USA, Alaska: Juneau)	NA	a) Continuing as currently, b) limited GHG reduction, c) extensive global GHG reduction	2015–2075	NA	Mendenhall Glacier is one of main attractions in and around Juneau	Present and potential: none mentioned	Loss of recreational ecosystem service of glaciers	Loss of recreational activity of glacier viewing; drop in visitations to Mendenhall Glacier visitor centre (at present 600,000 yr^{-1})
Bosson et al. (2019)	Global	NA	RCP2.6, RCP4.5, RCP8.5	2017–2100	NA	NA	Present: classification of World Heritage Sites as 'in danger'; potential: not specified, but low	Loss of World Heritage (Outstanding Universal Value)	Loss of 33–60% World Heritage glacier ice and complete glacier extinction in 8–20 of 46 World Heritage Sites; causing loss of integrity and value of many World Heritage Sites
Vuille et al. (2018)	Tropical Andes	NA	RCP4.5 and RCP8.5	21st century	NA	Multiple stressors increase vulnerability; limited infrastructure and lack of access to financial and technological resources exacerbate vulnerability, e.g., inefficient or deficient water channel and irrigation structures	Medium potential: low-regret and robust measures due to lacking data; bottom-up participatory approaches; current example: diversification of tourism (e.g., shift from skiing and hiking to cave paintings and dinosaur footprints; CC observation sites and museums)	Loss of glaciers and their hydrological contributions; inner tropical sites will be most affected with, e.g., Antizana Glacier, which will be lost by end of century	Increasing conflicts about water demand, decrease of glacier tourism, increase of hiking tourism in some region due to better accessibility without glaciers, significant emotional impacts, reduction of traditional rituals (to protect glaciers)
Demiroglu et al. (2018)	Europe (Norway)	NA	Not specified	21st century	50–65 days of less snow, more crevasses, rockfalls and permafrost melt	NA	Medium (snow making, snow farming, shading, covering of glaciers, indoor skiing, moving higher, diversification)	Loss of well-being	Loss of one of most popular recreational summer activities in three most popular summer ski areas in Norway
Cunsolo Willox et al. (2013)	North America (Canada, Nunatisavut: Rigolet)	NA	NA	NA	Activities that define Inuit culture, identity and spirituality rely on presence of stable, thick and extensive ice and snow conditions throughout 7–8 months of year	Inuits are an ethnic minority, 40% of Rigolet's inhabitants are <25 years old, economic and financial stability is strongly based on activities related to land and climate	Low (teaching of transitioning skills, strengthening of mental health services)	Loss of well-being	Strong emotional responses to loss of access to land and activities that define Inuit culture, identity and spirituality; the 259 inhabitants of Rigolet are at risk; increase in violence, conflict, suicide, drug abuse and mental health problems

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Kervyn et al. (2015)	Equatorial Africa (Uganda and Cameroon)	NA	NA	NA	NA	Strong dependency on agricultural land on hillslopes; high population density and uncontrolled urban sprawl, deforestation and forest clearing for agriculture and construction	High (engineering measures, land use planning, risk zone mapping, displacement, afforestation, diversification of livelihood base)	Loss of livelihood and well-being, loss of sites with high ecological, cultural and aesthetic value; loss of lives (>500 in Uganda 2010–2012, dozens in Cameroon)	Stigmatisation of households affected by landslides due to cultural interpretation that landslides are consequence of misbehaviour, psychological consequences like fear during rainy season and frustration, also loss of fertile soil and productivity and thus livelihood base
Quijano Vodniza and García García (2018)	Andes (Colombia, Pasto)	NA	NA	NA	All communities	Indigenous Quillacinga communities are an ethnic minority; they are strongly connected with their land, mother earth and cosmos	NA	Loss of cultural identity, disintegration of community, loss of well-being	Loss of sacred link to territory; discrimination of Indigenous People who move to cities as they can no longer grow their traditional crops; climate change is interpreted as a break with cosmos caused by violation of natural relations between humans and cosmos
Sherry et al. (2018)	Himalaya (Nepal, Dolakha District)	NA	NA	NA	High: strong place attachment leads people to come back to valley despite natural hazard risks; Tsho Rolpa is one of the most potentially dangerous glacier lakes in Himalaya with impact on areas up to 100 km downstream	Deep attachment to irreplaceable physical, social and cultural dimensions of their valley; lacking basic provisions (e.g., education, medical care); remoteness of valley; belief that sentiment environment and deities protect them from natural disasters; GLOF is no longer taken that seriously due to media exaggerating the threat, false alarms etc.	Lowering of Tsho Rolpa by 3.5 m in 1990s, but not considered sufficient; EWS, but only functioned for a short time, lacking follow-up and communication; place attachment and sense of community can facilitate actions for disaster risk reduction	Loss of cultural identity, loss of sense of community and loss of well-being	Loss of landscape that constitutes a symbolic home (emotional place attachment) is source of self-understanding and well-being for around 450 people; Rowaling Valley is source of great pride and has cultural, historical and symbolic meaning that defines community, i.e., strong emotional place attachment

Reference	Geographic region	Hazard consequences	Climate scenario(s) and/or global warming level(s)	Time period	Socioeconomic or ecological conditions supporting exposure level	Socioeconomic or ecological conditions supporting vulnerability level	Adaptation assumptions	Risk metric	Risk consequence, quantitative or qualitative
Motschmann et al. (2020)	Andes, Peru, Cordillera Blanca	Predicted glacier area for end of 21st century: 260 km^2 (RCP2.6) to 7 km^2 (RCP8.5)	RCP2.6 and RCP8.5	Present vs. end of 21st century	Close proximity of people to mountains and glaciers; peaks are visible from almost everywhere, and in many regions people have close ties with mountains and glaciers	See exposure: probably high	NA	People's perception of glacier retreat and water scarcity	Climate and cryosphere change impacts can lead to specific changes in people's cultural understanding of environment; ice loss and concern about mountains' fate could create impacts on identity, spirituality, lifestyle, tradition, recreation, tourism, livelihoods, income, social relations and political conflicts and may cause cultural loss and damage

References

Abi, M., A. Kessler, P. Oosterveer and D. Tolossa, 2019: Adapting the current mass mobilization approach in Ethiopia to enhance its impact on sustainable land management: Lessons from the Sago-kara watershed. *J. Environ. Manag.*, **248**, 109336, doi:10.1016/j.jenvman.2019.109336.

Acevedo-Osorio, Á., A. Angarita Leiton, M.V. León Durán and K.L. Franco Quiroga, 2017: Sustentabilidad y variabilidad climática: accionnes agroecológicas participativas de adaptación y resiliencia socioecológica en la región alto-Andina Colombiana. *luaz*, **44**, 6–26, doi:10.17151/luaz.2017.44.2.

Adam, H.N., D.J. Kjosavik and N. Shanmugaratnam, 2018: Adaptation trajectories and challenges in the Western Ghats: A case study of Attappady, south India. *J Rural Stud*, **61**, 1–11, doi:10.1016/j.jrurstud.2018.05.002.

Adhikari, S., 2018: Drought impact and adaptation strategies in the mid-hill farming system of western Nepal. *Environments*, **5**(9), 101, doi:10.3390/environments5090101.

Adhikari, S., H. Baral and C. Nitschke, 2018a: Adaptation to climate change in Panchase mountain ecological regions of Nepal. *Environments*, **5**(3), 42, doi:10.3390/environments5030042.

Adhikari, S.P., K.P. Timsina and J. Lamichhane, 2018b: Adoption and impact of rain water harvesting technology on rural livelihoods: The case of Makwanpur district, Nepal. *Rural. Ext. Innov. Syst. J.*, **14**(1), 8.

Afifi, T., E. Liwenga and L. Kwezi, 2014: Rainfall-induced crop failure, food insecurity and out-migration in Same-Kilimanjaro, Tanzania. *Clim. Dev.*, **6**, 53–60, doi:10.1080/17565529.2013.826128.

Aimé, F.R., et al., 2016: Adaptations of the Agricultural Calendar and Agricultural Techniques to Climate Change in the Highlands of Cameroon. In: *Agricultural Adaptation to Climate Change* [Bryant, C.R., M. A. Sarr and K. Délusca)](eds.)]. Springer International Publishing, Cham, pp. 199–224. ISBN 978-3319313924.

Akwen, N.S., 2017: "Not Migrating After All": Young Farmers and Climate Change Adaptation in Cameroon. In: *Beyond Agricultural Impacts: Multiple Perspectives on Climate Change in Africa*. [Zinyengere, N., T. F. Theodory, M. Gebreyes and C. I. Speranza (eds.)]. Academic Press, London, UK, pp. 193–220. ISBN 978-0128126240.

Al-Kalbani, M.S., et al., 2016: Integrated environmental assessment to explore water resources management in Al Jabal Al Akhdar, Sultanate of Oman. *Reg. Environ. Change*, **16**(5), 1345–1361, doi:10.1007/s10113-015-0864-4.

Albrich, K., W. Rammer and R. Seidl, 2020: Climate change causes critical transitions and irreversible alterations of mountain forests. *Glob. Change Biol.*, **26**(7), 4013–4027, doi:10.1111/gcb.15118.

Alemayehu, A. and W. Bewket, 2017: Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environ.*, **22**(7), 825–839, doi:10.1080/13549839.2017.1290058.

Alemayehu, A. and W. Bewket, 2018: Trees and rural households' adaptation to local environmental change in the central highlands of Ethiopia. *J. Land. Use Sci.*, **13**(1–2), 130–145, doi:10.1080/1747423X.2018.1465137.

Alfieri, L., L. Feyen, F. Dottori and A. Bianchi, 2015: Ensemble flood risk assessment in Europe under high end climate scenarios. *Glob. Environ. Change*, **35**, 199–212, doi:10.1016/j.gloenvcha.2015.09.004.

Allen, S.K., S.C. Cox and I.F. Owens, 2011: Rock avalanches and other landslides in the central Southern Alps of New Zealand: A regional study considering possible climate change impacts. *Landslides*, **8**(1), 33–48, doi:10.1007/s10346-010-0222-z.

Allen, S.K., S. Gruber and I.F. Owens, 2009: Exploring steep bedrock permafrost and its relationship with recent slope failures in the Southern Alps of New Zealand. *Permafr. Periglac. Process.*, **20**(4), 345–356, doi:10.1002/ppp.658.

Allen, S.K. and C. Huggel, 2013: Extremely warm temperatures as a potential cause of recent high mountain rockfall. *Glob. Planet. Change*, **107**, 59–69, doi:10.1016/j.gloplacha.2013.04.007.

Allen, S.K., et al., 2016: Glacial lake outburst flood risk in Himachal Pradesh, India: an integrative and anticipatory approach considering current and future threats. *Nat. Hazards*, **84**(3), 1741–1763, doi:10.1007/s11069-016-2511-x.

Alonso, A.D. and Y. Liu, 2013: Climate change in the wine sector of an ultra-peripheral European region: a case study. *Agroecol. Sustain. Food Syst.*, **37**(3), 291–315, doi:10.1080/10440046.2012.712089.

Altea, L., 2020: Perceptions of climate change and its impacts: a comparison between farmers and institutions in the Amazonas Region of Peru. *Clim. Dev.*, **12**(2), 134–146, doi:10.1080/17565529.2019.1605285.

Álvarez-Berríos, N.L., et al., 2018: Correlating drought conservation practices and drought vulnerability in a tropical agricultural system. *Renew. Agric. Food Syst.*, **33**(3), 279–291, doi:10.1017/S174217051800011X.

Amadu, F.O., D.C. Miller and P.E. McNamara, 2020: Agroforestry as a pathway to agricultural yield impacts in climate-smart agriculture investments: evidence from southern Malawi. *Ecol. Econ.*, **167**(C), 106443, doi:10.1016/j.ecolecon.2019.106443.

Amare, A. and B. Simane, 2017: Determinants of smallholder farmers' decision to adopt adaptation options to climate change and variability in the Muger Sub basin of the Upper Blue Nile basin of Ethiopia. *Agric. Food Secur.*, **6**(1), 64, doi:10.1186/s40066-017-0144-2.

Amare, A., et al., 2019: Index-based livestock insurance to manage climate risks in Borena zone of southern Oromia, Ethiopia. *Clim. Risk Manag.*, **25**, 100191, doi:10.1016/j.crm.2019.100191.

Amare, Z.Y., J.O. Ayoade, I.O. Adelekan and M.T. Zeleke, 2018: Barriers to and determinants of the choice of crop management strategies to combat climate change in Dejen district, Nile basin of Ethiopia. *Agric. Food Secur.*, **7**(1), 37, doi:10.1186/s40066-018-0188-y.

Antonio, G.J.Y., et al., 2019: The adoption of green manure processes applied to vegetable cultivation systems in mountainous environments of Rio de Janeiro State, Brazil. *Open Agric.*, **4**(1), 446–451, doi:10.1515/opag-2019-0042.

Archambault, C.S., 2016: Re-creating the commons and re-configuring Maasai women's roles on the rangelands in the face of fragmentation. *Int. J. Commons*, **10**(2), 728, doi:10.18352/ijc.685.

Ardaya, A.B., M. Evers and L. Ribbe, 2017: What influences disaster risk perception? Intervention measures, flood and landslide risk perception of the population living in flood risk areas in Rio de Janeiro state, Brazil. *Int. J. Disaster Risk Reduct.*, **25**, 227–237, doi:10.1016/j.ijdrr.2017.09.006.

Arnell, N.W. and S.N. Gosling, 2016: The impacts of climate change on river flood risk at the global scale. *Clim. Change*, **134**(3), 387–401, doi:10.1007/s10584-014-1084-5.

Arriagada, P., B. Dieppois, M. Sidibe and O. Link, 2019: Impacts of climate change and climate variability on hydropower potential in data-scarce regions subjected to multi-decadal variability. *Energies*, **12**(14), 2747, doi:10.3390/en12142747.

Aryal, S., G. Cockfield and T.N. Maraseni, 2016: Perceived changes in climatic variables and impacts on the transhumance system in the Himalayas. *Clim. Dev.*, **8**(5), 435–446, doi:10.1080/17565529.2015.1040718.

Aryal, S., T.N. Maraseni and G. Cockfield, 2014: Sustainability of transhumance grazing systems under socio-economic threats in Langtang, Nepal. *J. Mt. Sci.*, **11**(4), 1023–1034, doi:10.1007/s11629-013-2684–2687.

Asayehegn, K., L. Temple, B. Sanchez and A. Iglesias, 2017: Perception of climate change and farm level adaptation choices in central Kenya. *Cah. Agric.*, **26**(2), 25003, doi:10.1051/cagri/2017007.

Asfaw, A., B. Simane, A. Bantider and A. Hassen, 2019: Determinants in the adoption of climate change adaptation strategies: evidence from rainfed-dependent smallholder farmers in north-central Ethiopia (Woleka sub-basin). *Environ. Dev. Sustain.*, **21**(5), 2535–2565, doi:10.1007/s10668-018-0150-y.

Ashraf, M. and J.K. Routray, 2013: Perception and understanding of drought and coping strategies of farming households in north-west Balochistan. *Int. J. Disaster Risk Reduct.*, **5**, 49–60, doi:10.1016/j.ijdrr.2013.05.002.

Asrat, P. and B. Simane, 2018: Farmers' perception of climate change and adaptation strategies in the Dabus watershed, North-West Ethiopia. *Ecol Process*, **7**(1), 7, doi:10.1186/s13717-018-0118-8.

Aubry-Wake, C., et al., 2015: Measuring glacier surface temperatures with ground-based thermal infrared imaging. *Geophys. Res. Lett.*, **42**(20), 8489–8497, doi:10.1002/2015GL065321.

Avalos, V.R. and J. Hernández, 2015: Projected distribution shifts and protected area coverage of range-restricted Andean birds under climate change. *Glob. Ecol. Conserv.*, **4**, 459–469, doi:10.1016/j.gecco.2015.08.004.

Awazi, N.P., M.N. Tchamba and T.M.-L. Avana, 2019: Climate change resiliency choices of small-scale farmers in Cameroon: determinants and policy implications. *J. Environ. Manag.*, **250**, 109560, doi:10.1016/j.jenvman.2019.109560.

Ayala, I., et al., 2020: Glacier runoff variations since 1955 in the Maipo River Basin, in the semiarid Andes of central Chile. *Cryosphere*, **14**, 2005–2027, doi:10.5194/tc-2019-233.

Azadi, Y., M. Yazdanpanah and H. Mahmoudi, 2019: Understanding smallholder farmers' adaptation behaviors through climate change beliefs, risk perception, trust, and psychological distance: Evidence from wheat growers in Iran. *J. Environ. Manag.*, **250**, 109456, doi:10.1016/j.jenvman.2019.109456.

Azibo, B.R. and J.N. Kimengsi, 2015: Building an indigenous agro-pastoral adaptation framework to climate change in sub-saharan africa: experiences from the north west region of Cameroon. *Procedia Environ. Sci.*, **29**, 126–127, doi:10.1016/j.proenv.2015.07.214.

Aziz, L. and W. Sadok, 2015: Strategies used by the saffron producers of Taliouine (Morocco) to adapt to climate change. *Rev. Geogr. Alp.*, 103–102, doi:10.4000/rga.2902.

Bacon, C.M., W.A. Sundstrom, I.T. Stewart and D. Beezer, 2017: Vulnerability to cumulative hazards: Coping with the coffee leaf rust outbreak, drought, and food insecurity in Nicaragua. *World Dev.*, **93**, 136–152, doi:10.1016/j.worlddev.2016.12.025.

Balehegn, M., L.O. Eik and Y. Tesfay, 2015: Silvopastoral system based on *Ficus thonningii* : an adaptation to climate change in northern Ethiopia. *Afr. J. Range Forage Sci.*, **32**(3), 183–191, doi:10.2989/10220119.2014.942368.

Balgah, R.A., H.N. Bang and S.A. Fondo, 2019: Drivers for coping with flood hazards: Beyond the analysis of single cases. *Jàmbá J. Disaster Risk Stud.*, **11**(1), doi:10.4102/jamba.v11i1.678.

Ballesteros-Cánovas, J.A., et al., 2018: Climate warming enhances snow avalanche risk in the Western Himalayas. *Proc. Natl. Acad. Sci. U. S. A.*, **115**(13), 3410–3415, doi:10.1073/pnas.1716913115.

Bangura, K.S., K. Lynch and J.A. Binns, 2012: Coping with the impacts of weather changes in rural Sierra Leone. *Int. J. Sustain. Dev. World Ecol.*, **20**(1), 20–31, doi:10.1080/13504509.2012.740511.

Baraer, M., et al., 2012: Glacier recession and water resources in Peru's Cordillera Blanca. *J. Glaciol.*, **58**(207), 134–150, doi:10.3189/2012JoG11J186.

Bard, A., et al., 2015: Trends in the hydrologic regime of Alpine rivers. *J. Hydrol.*, **529**, 1823–1837, doi:10.1016/j.jhydrol.2015.07.052.

Barkhordarian, A., et al., 2018: Observed warming over northern South America has an anthropogenic origin. *Clim. Dyn.*, **51**(5–6), 1901–1914, doi:10.1007/s00382-017-3988-z.

Barrett, T., G. Feola, M. Khusnitdinova and V. Krylova, 2017: Adapting agricultural water use to climate change in a post-soviet context: Challenges and opportunities in southeast Kazakhstan. *Hum. Ecol.*, **45**(6), 747–762, doi:10.1007/s10745-017-9947-9.

Barrucand, M.G., C. Giraldo Vieira and P.O. Canziani, 2017: Climate change and its impacts: perception and adaptation in rural areas of Manizales, Colombia. *Clim. Dev.*, **9**(5), 415–427, doi:10.1080/17565529.2016.1167661.

Bastakoti, R.C., L. Bharati, U. Bhattarai and S.M. Wahid, 2017a: Agriculture under changing climate conditions and adaptation options in the Koshi Basin. *Clim. Dev.*, **9**(7), 634–648, doi:10.1080/17565529.2016.1223594.

Bastakoti, R.C., L. Bharati, U. Bhattarai and S.M. Wahid, 2017b: Agriculture under changing climate conditions and adaptation options in the Koshi Basin. *Clim. Dev.*, **9**(7), 634–648, doi:10.1080/17565529.2016.1223594.

Basu, M., S. Hoshino and S. Hashimoto, 2015: Many issues, limited responses: Coping with water insecurity in rural India. *Water Resour. Rural. Dev.*, **5**, 47–63, doi:10.1016/j.wrr.2015.07.001.

Batbaatar, A., P. Apichayakul and S. Tantanee, 2018: Stakeholders' perspectives towards effective climate change adaptation on the Mongolian livestock sector. *IOP Conf. Ser. Earth Environ. Sci.*, **129**, 12031, doi:10.1088/1755-1315/129/1/012031.

Bate, B., J. Kimengsi and S. Amawa, 2019: Determinants and policy implications of farmers' climate adaptation choices in rural Cameroon. *Sustainability*, **11**(7), 1921, doi:10.3390/su11071921.

Batumike, R., et al., 2021: Climate change and hunter-gatherers in montane eastern DR Congo. *Clim. Dev.*, 1–12, doi:10.1080/17565529.2021.1930987.

Baul, T.K. and M. A. McDonald, 2014: Agro-biodiversity management: using indigenous knowledge to cope with climate change in the middle-hills of Nepal. *Agric. Res.*, **3**(1), 41–52, doi:10.1007/s40003-014-0096-8.

Beaudin, L. and J.C. Huang, 2014: Weather conditions and outdoor recreation: A study of New England ski area. *Ecol. Econ.*, **106**, 56–68, doi:10.1016/j.ecolecon.2014.07.011.

Bedeke, S., et al., 2019: Adoption of climate change adaptation strategies by maize-dependent smallholders in Ethiopia. *NJAS Wageningen J. Life Sci.*, **88**, 96–104, doi:10.1016/j.njas.2018.09.001.

Begum, A. and R. Mahanta, 2017: Adaptation to climate change and factors affecting it in Assam. *Indian J. Agric. Econ.*, **72**(3), 446–455.

Bekchanov, M. and J.P.A. Lamers, 2016: Economic costs of reduced irrigation water availability in Uzbekistan (Central Asia). *Reg. Environ. Change*, **16**(8), 2369–2387, doi:10.1007/s10113-016-0961-z.

Bele, M.Y., D.J. Sonwa and A.M. Tiani, 2014: Local communities vulnerability to climate change and adaptation strategies in Bukavu in DR Congo. *J. Environ. Dev.*, **23**(3), 331–357, doi:10.1177/1070496514536395.

Below, T.B., J.C. Schmid and S. Sieber, 2015: Farmers' knowledge and perception of climatic risks and options for climate change adaptation: a case study from two Tanzanian villages. *Reg. Environ. Change*, **15**(7), 1169–1180, doi:10.1007/s10113-014-0620-1.

Beniston, M., et al., 2018: The European mountain cryosphere: a review of its current state, trends, and future challenges. *Cryosphere*, **12**(2), 759–794, doi:10.5194/tc-12-759-2018.

Beniston, M. and M. Stoffel, 2016: Rain-on-snow events, floods and climate change in the Alps: Events may increase with warming up to 4°C and decrease thereafter. *Sci. Total. Environ.*, **571**, 228–236, doi:10.1016/j.scitotenv.2016.07.146.

Berghuijs, W.R., S.T. Allen, S. Harrigan and J.W. Kirchner, 2019: Growing spatial scales of synchronous river flooding in Europe. *Geophys. Res. Lett.*, **46**(3), 1423–1428, doi:10.1029/2018GL081883.

Berhanu, W. and F. Beyene, 2015: Climate variability and household adaptation strategies in southern Ethiopia. *Sustainability*, **7**(6), 6353–6375, doi:10.3390/su7066353.

Berman, R.J., C.H. Quinn and J. Paavola, 2015: Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: implications for adapting to future climate change. *Clim. Dev.*, **7**(1), 71–84, doi:10.1080/17565529.2014.902355.

Bessette-Kirton, E.K. and J.A. Coe, 2020: A 36-year record of rock avalanches in the Saint Elias mountains of Alaska, with implications for future hazards. *Front. Earth Sci.*, **8**, 293, doi:10.3389/feart.2020.00293.

Bhatasara, S., 2017: Towards a sociology of adaptation to rainfall variability in rural Zimbabwe: The case of Charewa in Mutoko. *Fudan J. Hum. Soc. Sci.*, **10**(4), 547–568, doi:10.1007/s40647-017-0177-8.

Bhatta, G.D., et al., 2017: Agricultural innovation and adaptation to climate change: empirical evidence from diverse agro-ecologies in South Asia. *Environ. Dev. Sustain.*, **19**(2), 497–525, doi:10.1007/s10668-015-9743-x.

Bhatta, L.D., B.E.H. van Oort, N.E. Stork and H. Baral, 2015: Ecosystem services and livelihoods in a changing climate: Understanding local adaptations in the Upper Koshi, Nepal. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.*, **11**(2), 145–155, doi:10.1080/21513732.2015.1027793.

Bhattarai, B., R. Beilin and R. Ford, 2015: Gender, agrobiodiversity, and climate change: A study of adaptation practices in the Nepal Himalayas. *World Dev.*, **70**, 122–132, doi:10.1016/j.worlddev.2015.01.003.

Biagetti, S., 2017: Resilience in a mountain range: The case of the Tadrart Acacus (southwest Libya). *Nomad. People.*, **21**(2), 268–285, doi:10.3197/np.2017.210205.

Biemans, H., et al., 2019: Importance of snow and glacier meltwater for agriculture on the Indo-Gangetic Plain. *Nat. Sustain.*, **2**(7), 594–601, doi:10.1038/s41893-019-0305-3.

Biggs, E.M., N. Gupta, S.D. Saikia and J.M. A. Duncan, 2018: The tea landscape of Assam: Multi-stakeholder insights into sustainable livelihoods under a changing climate. *Environ. Sci. Policy*, **82**, 9–18, doi:10.1016/j.envsci.2018.01.003.

Biggs, E.M., et al., 2013: Agricultural adaptation to climate change: observations from the Mid-Hills of Nepal. *Clim. Dev.*, **5**(2), 165–173, doi:10.1080/17565529.2013.789791.

Biglari, T., H. Maleksaeidi, F. Eskandari and M. Jalali, 2019: Livestock insurance as a mechanism for household resilience of livestock herders to climate change: Evidence from Iran. *Land Use Policy*, **87**, 104043, doi:10.1016/j.landusepol.2019.104043.

Bizikova, L., J.-E. Parry, J. Karami and D. Echeverria, 2015: Review of key initiatives and approaches to adaptation planning at the national level in semi-arid areas. *Reg. Environ. Change*, **15**(5), 837–850, doi:10.1007/s10113-014-0710-0.

Boag, A.E., et al., 2018: Climate change beliefs and forest management in eastern Oregon: implications for individual adaptive capacity. *Ecol. Soc.*, **23**(4), art1, doi:10.5751/ES-10355-230401.

Bocchiola, D., 2014: Long term (1921–2011) hydrological regime of Alpine catchments in Northern Italy. *Adv. Water. Resour.*, **70**, 51–64, doi:10.1016/j.advwatres.2014.04.017.

Boisier, J.P., R. Rondanelli, R.D. Garreaud and F. Muoz, 2016: Anthropogenic and natural contributions to the Southeast Pacific precipitation decline and recent megadrought in central Chile. *Geophys. Res. Lett.*, **43**(1), 413–421, doi:10.1002/2015GL067265.

Bomuhangi, A., et al., 2016: Local communities' perceptions of climate variability in the Mt. Elgon region, eastern Uganda. *Cogent Environ. Sci.*, **2**(1), 1168276, doi:10.1080/23311843.2016.1168276.

Borsdorf, A., M. Mergili and L.A. Ortega, 2013: La Reserva de la Biósfera Cinturón Andino, Colombia: ¿Una región modelo de estrategias de adaptación al cambio climático y el desarrollo regional sustentable? *Rev. Geogr. Norte Gd.*, **55**, 7–18, doi:10.4067/S0718-34022013000200002.

Bosson, J.B., M. Huss and E. Osipova, 2019: Disappearing world heritage glaciers as a keystone of nature conservation in a changing climate. *Earths Future*, **7**(4), 469–479, doi:10.1029/2018EF001139.

Bradley, R.S., M. Vuille, H.F. Diaz and W. Vergara, 2006: Threats to water supplies in the tropical andes. *Science*, **312**(5781), 1755–1756, doi:10.1126/science.1128087.

Brahney, J., B. Menounos, X. Wei and P.J. Curtis, 2017: Determining annual cryosphere storage contributions to streamflow using historical hydrometric records. *Hydrol. Process.*, **31**(8), 1590–1601, doi:10.1002/hyp.11128.

Brandt, R., R. Kaenzig and S. Lachmuth, 2016: Migration as a Risk Management Strategy in the Context of Climate Change: Evidence from the Bolivian Andes. In: *Migration, Risk Management and Climate Change: Evidence and Policy Responses*. [Milan, A., B. Schraven, K. Warner and N. Cascone (eds.)]. Springer, Cham, Switzerland, pp. 43–61. ISBN 978-3319429229.

Braun, M.H., et al., 2019: Constraining glacier elevation and mass changes in South America. *Nat. Clim. Change*, **9**(2), 130–136, doi:10.1038/s41558-018-0375-7.

Brown, D.G., et al., 2013: Responses to climate and economic risks and opportunities across national and ecological boundaries: changing household strategies on the Mongolian plateau. *Environ. Res. Lett.*, **8**(4), 45011, doi:10.1088/1748-9326/8/4/045011.

Brüssow, K., A. Faße and U. Grote, 2017: Implications of climate-smart strategy adoption by farm households for food security in Tanzania. *Food Sec.*, **9**(6), 1203–1218, doi:10.1007/s12571-017-0694-y.

Buckel, J., J.C. Otto, G. Prasicek and M. Keuschnig, 2018: Glacial lakes in Austria—Distribution and formation since the Little Ice Age. *Glob. Planet. Change*, **164**, 39–51, doi:10.1016/j.gloplacha.2018.03.003.

Buechler, S., 2016: Gendered vulnerabilities and grassroots adaptation initiatives in home gardens and small orchards in Northwest Mexico. *Ambio*, **45**(S3), 322–334, doi:10.1007/s13280-016-0832-3.

Buendia, C., et al., 2016: Runoff trends driven by climate and afforestation in a Pyrenean basin. *Land Degrad. Dev.*, **27**(3), 823–838, doi:10.1002/ldr.2384.

Burger, F., et al., 2019: Interannual variability in glacier contribution to runoff from a high-elevation Andean catchment: understanding the role of debris cover in glacier hydrology. *Hydrol. Process.*, **33**(2), 214–229, doi:10.1002/hyp.13354.

Burke, A., 2004: From plains to inselbergs: species in special habitats as indicators for climate change? *J. Biogeogr.*, **31**(5), 831–841.

Burman, A., 2017: The political ontology of climate change: moral meteorology, climate justice, and the coloniality of reality in the Bolivian Andes. *J. Polit. Ecol.*, **24**(1), 921–930, doi:10.2458/v24i1.20974.

Burnham, M. and Z. Ma, 2017: Climate change adaptation: factors influencing Chinese smallholder farmers' perceived self-efficacy and adaptation intent. *Reg. Environ. Change*, **17**(1), 171–186, doi:10.1007/s10113-016-0975-6.

Burnham, M. and Z. Ma, 2018: Multi-scalar pathways to smallholder adaptation. *World Dev.*, **108**, 249–262, doi:10.1016/j.worlddev.2017.08.005.

Callo-Concha, D., 2018: Farmer perceptions and climate change adaptation in the west africa Sudan Savannah: Reality check in Dassari, Benin, and Dano, Burkina Faso. *Climate*, **6**(2), 44, doi:10.3390/cli6020044.

Campbell, B., 2017: Encountering climate change: dialogues of human and non-human relationships within Tamang moral ecology and climate policy discourses. *Eur. Bull. Himal. Res.*, **49**, 59–87.

Campos, M., D. Herrador, C. Manuel and M.K. McCall, 2013: *Adaptation Strategies to Climate Change in Two Rural Communities in Mexico and El Salvador*. 4.

Campos, M., M.K. McCall and M. González-Puente, 2014: Land-users' perceptions and adaptations to climate change in Mexico and Spain: commonalities across cultural and geographical contexts. *Reg. Environ. Change*, **14**(2), 811–823, doi:10.1007/s10113-013-0542-3.

Carabine, E.A., J. Wainwright and C. Twyman, 2014: Narratives of a Drought: Exploring Resilience in Kenya's Drylands. In: *Advances in Social Simulation*. [Kamiński, B. and G. Koloch (eds.)]. Springer, Berlin, Heidelberg, pp. 307–317. ISBN 97836423982859783642398292.

Carbutt, C. and T.J. Edwards, 2015: Plant–soil interactions in lower–upper montane systems and their implications in a warming world: a case study from the Maloti-Drakensberg Park, southern Africa. *Biodiversity*, **16**(4), 262–277, doi:10.1080/14888386.2015.1116409.

Caretta, M. A., 2014: "Credit plus" microcredit schemes: a key to women's adaptive capacity. *Clim. Dev.*, **6**(2), 179–184, doi:10.1080/17565529.2014.886990.

Carlson, B.Z., et al., 2017: Observed long-term greening of alpine vegetation—A case study in the French alps. *Environ. Res. Lett.*, **12**(11), 114006, doi:10.1088/1748-9326/aa84bd.

Carmona, A.M. and G. Poveda, 2014: Detection of long-term trends in monthly hydro-climatic series of Colombia through empirical mode decomposition. *Clim. Change*, **123**(2), 301–313, doi:10.1007/s10584-013-1046-3.

Castino, F., B. Bookhagen and M.R. Strecker, 2016: River-discharge dynamics in the Southern Central Andes and the 1976–77 global climate shift. *Geophys. Res. Lett.*, **43**(22), 11679–11687, doi:10.1002/2016GL070868.

Castino, F., B. Bookhagen and M.R. Strecker, 2017: Rainfall variability and trends of the past six decades (1950–2014) in the subtropical NW Argentine Andes. *Clim. Dyn.*, **48**(3–4), 1049–1067, doi:10.1007/s00382-016-3127-2.

Cavanagh, C.J., A.K. Chemarum, P.O. Vedeld and J.G. Petursson, 2017: Old wine, new bottles? Investigating the differential adoption of 'climate-smart' agricultural practices in western Kenya. *J. Rural. Stud.*, **56**, 114–123, doi:10.1016/j.jrurstud.2017.09.010.

Chain-Guadarrama, A., et al., 2018: Adaptación basada en Ecosistemas en pequeñas fincas de granos básicos en Guatemala y Honduras. *Agron. Mesoam.*, **29**(3), 571, doi:10.15517/ma.v29i3.32678.

Chakraborty, R., A.S. Daloz, M. Kumar and A.P. Dimri, 2019: Does awareness of climate change lead to worry? Exploring community perceptions through parallel analysis in rural Himalaya. *Mt. Res. Dev.*, **39**(2), R35–R54, doi:10.1659/mrd-journal-d-19-00012.1.

Chang Kee, J., et al., 2018: Accumulation of heavy metals in native Andean plants: potential tools for soil phytoremediation in Ancash (Peru). *Environ. Sci. Pollut. Res.*, **25**(34), 33957–33966, doi:10.1007/s11356-018-3325-z.

Chedid, M., J.-F. Tourrand, L.S. Jaber and S.K. Hamadeh, 2018: Farmers' perception to change and adaptation strategies of small ruminant systems in the West Bekaa of Lebanon. *Small Rumin. Res.*, **167**, 16–21, doi:10.1016/j.smallrumres.2018.07.025.

Chen, A., et al., 2018: Glacier variations and rising temperature in the Mt. Kenya since the last glacial maximum. *J. Mt. Sci.*, **15**, 1268–1282, doi:10.1007/s11629-017-4600-z.

Chen, F., et al., 2021: Annual 30 m dataset for glacial lakes in High Mountain Asia from 2008 to 2017. *Earth Syst. Sci. Data*, **13**(2), 741–766, doi:10.5194/essd-13-741-2021.

Chengappa, P.G., C.M. Devika and C.S. Rudragouda, 2017: Climate variability and mitigation: perceptions and strategies adopted by traditional coffee growers in India. *Clim. Dev.*, **9**(7), 593–604, doi:10.1080/17565529.2017.1318740.

Chepkoech, W., et al., 2018: Farmers' perspectives Impact of climate change on African indigenous vegetable production in Kenya. *Int. J. Clim. Chang. Strateg. Manag.*, **10**, 551–579, doi:10.1108/IJCCSM-07-2017-0160.

Chesterman, N.S., et al., 2019: The effects of trainings in soil and water conservation on farming practices, livelihoods, and land-use intensity in the Ethiopian highlands. *Land Use Policy*, **87**, 104051, doi:10.1016/j.landusepol.2019.104051.

Chhetri, N., M. Subedi and S. Ghimire, 2013: Niche-based responses in addressing the climatic constraints to farm production: analogues to climate-change adaptation in Nepal. *Clim. Dev.*, **5**(2), 174–181, doi:10.1080/17565529.2013.789790.

Chhogyel, N., L. Kumar, Y. Bajgai and M.K. Hasan, 2020: Perception of farmers on climate change and its impacts on agriculture across various altitudinal zones of Bhutan Himalayas. *Int. J. Environ. Sci. Technol.*, **17**, 3607–3620, doi:10.1007/s13762-020-02662-8.

Choden, K., R.J. Keenan and C.R. Nitschke, 2020: An approach for assessing adaptive capacity to climate change in resource dependent communities in the Nikachu watershed, Bhutan. *Ecol. Indic.*, **114**(1140), 106293, doi:10.1016/j.ecolind.2020.106293.

Cholo, T., L. Fleskens, D. Sietz and J. Peerlings, 2018: Is land fragmentation facilitating or obstructing adoption of climate adaptation measures in Ethiopia? *Sustainability*, **10**(7), 2120, doi:10.3390/su10072120.

CIESIN, 2018: *Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11, 4* [Center for International Earth Science Information Network, C. U. N. S. D. a. A. C. S. (ed.)]. CIESIN, Palisades, NY, USA, doi:10.7927/H4JW8BX5. (accessed 16/10/2020).

Clay, N. and B. King, 2019: Smallholders' uneven capacities to adapt to climate change amid Africa's 'green revolution': Case study of Rwanda's crop intensification program. *World Dev.*, **116**, 1–14, doi:10.1016/j.worlddev.2018.11.022.

Coe, J.A., E.K. Bessette-Kirton and M. Geertsema, 2018: Increasing rock-avalanche size and mobility in Glacier Bay National Park and Preserve, Alaska detected from 1984 to 2016 Landsat imagery. *Landslides*, **15**, 393–407, doi:10.1007/s10346-017-0879-7.

Cook, S.J., et al., 2016: Glacier change and glacial lake outburst flood risk in the Bolivian Andes. *Cryosphere*, **10**, 2399–2413, doi:10.5194/tc-10-2399-2016.

Cooper, S.J. and T. Wheeler, 2017: Rural household vulnerability to climate risk in Uganda. *Reg. Environ. Change*, **17**(3), 649–663, doi:10.1007/s10113-016-1049-5.

Cordero, R.R., et al., 2019: Dry-season snow cover losses in the andes (18°–40°S) driven by changes in large-scale climate modes. *Sci. Rep.*, **9**, 16945, doi:10.1038/s41598-019-53486-7.

Córdova, R., N.J. Hogarth and M. Kanninen, 2019: Mountain farming systems' exposure and sensitivity to climate change and variability: Agroforestry and conventional agriculture systems compared in Ecuador's indigenous territory of Kayambi people. *Sustainability*, **11**(9), 2623, doi:10.3390/su11092623.

Cornish, P.S., et al., 2015: Improving crop production for food security and improved livelihoods on the East India Plateau II. Crop options, alternative cropping systems and capacity building. *Agric. Syst.*, **137**, 180–190, doi:10.1016/j.agsy.2015.02.011.

Cox, S.C., et al., 2015: Rock avalanche on 14 July 2014 from Hillary Ridge, Aoraki/Mount Cook, New Zealand. *Landslides*, **12**(2), 395–402, doi:10.1007/s10346-015-0556-7.

Cramer, W. et al., 2014: Detection and attribution of observed impacts. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change.* [Field, C. B., V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 979–1037.

Cuesta, F., et al., 2019: New land in the Neotropics: a review of biotic community, ecosystem, and landscape transformations in the face of climate and glacier change. *Reg. Environ. Change*, **19**(6), 1623–1642, doi:10.1007/s10113-019-01499-3.

Cullen, N.J., et al., 2013: A century of ice retreat on Kilimanjaro: the mapping reloaded. *Cryosphere*, **7**, 419–431, doi:10.5194/tc-7-419-2013.

Cuni-Sanchez, A., et al., 2018: Climate change and pastoralists: perceptions and adaptation in montane Kenya. *Clim. Dev.*, **11**(6), 513–524, doi:10.1080/17565529.2018.1454880.

Cunsolo Willox, A., et al., 2013: Climate change and mental health: An exploratory case study from Rigolet, Nunatsiavut, Canada. *Clim. Change*, **121**(2), 255–270, doi:10.1007/s10584-013-0875-4.

Currenti, R., et al., 2019: Adaptation to climate change in an interior pacific island village: a case study of Nawairuku, Ra, Fiji. *Hum. Ecol.*, **47**(1), 65–80, doi:10.1007/s10745-019-0049-8.

Dahlke, H.E., et al., 2012: Contrasting trends in floods for two sub-arctic catchments in northern Sweden – does glacier presence matter? *Hydrol. Earth Syst. Sci.*, **16**(7), 2123–2141, doi:10.5194/hess-16-2123-2012.

Dalal, N., et al., 2018: People's perception to climate change in remote himalayan mountains and rainfall variability in the Kailash sacred landscape-India. *J. Climatol. Weather Forecast.*, **6**(2), 1000231, doi:10.4172/2332-2594.1000231.

Daly-Hassen, H., M. Annabi and C. King-Okumu, 2019: Social and private profitability of tree-based adaptation options to climate change in a dryland area of Tunisia. *New Medit*, **18**(2), 89–104, doi:10.30682/nm1902 f.

Dangi, M.B., et al., 2018: Impacts of environmental change on agroecosystems and livelihoods in Annapurna Conservation Area, Nepal. *Environ. Dev.*, **25**, 59–72, doi:10.1016/j.envdev.2017.10.001.

Dangles, O., et al., 2017: Ecosystem sentinels for climate change? Evidence of wetland cover changes over the last 30 years in the tropical Andes. *PLoS ONE*, **12**(5), e175814, doi:10.1371/journal.pone.0175814.

Daoudi, A., S. Terranti, R.F. Hammouda and S. Bédrani, 2013: Adaptation to drought in the Algerian steppe: The case of productive strategies of

Hadj Mechri agro-pastoralists. *Cah. Agric.*, **22**(4), 303–310, doi:10.1684/agr.2013.0629.

Das, T., et al., 2013: Increases in flood magnitudes in California under warming climates. *J. Hydrol.*, **501**, 101–110, doi:10.1016/j.jhydrol.2013.07.042.

Dassanayake, W., S. Mohapatra, M.K. Luckert and W. Adamowicz, 2018: Households' responses to climate change: contingent behavior evidence from rural South Africa. *Envir. Dev. Econ.*, **23**(1), 37–62, doi:10.1017/S1355770X17000328.

Daugstad, K., 2019: Resilience in mountain farming in Norway. *Sustainability*, **11**(12), 3476, doi:10.3390/su11123476.

de la Barrera, F., et al., 2018: Megafires in Chile 2017: monitoring multiscale environmental impacts of burned ecosystems. *Sci. Total Environ.*, **637–638**, 1526–1536, doi:10.1016/j.scitotenv.2018.05.119.

de la Riva, M.V., A. Lindner and J. Pretzsch, 2013: Assessing adaptation – climate change and indigenous livelihood in the Andes of Bolivia. *J. Agric. Rural Dev. Trop. Subtrop.*, **114**(2), 109–122.

de Sousa, K., et al., 2018: How climate awareness influences farmers' adaptation decisions in Central America? *J. Rural Stud.*, **64**, 11–19, doi:10.1016/j.jrurstud.2018.09.018.

Defang, N.J., F.A. Amungwa and I. Manu, 2017: Farmers' perception of climate change and adaptation options in southwest Cameroon. *Int. J. Rural. Dev. Environ. Health Res.*, **1**(3), 102–115, doi:10.22161/ijreh.1.3.11.

Deléglise, C., et al., 2019: A method for diagnosing summer mountain pastures' vulnerability to climate change, developed in the French alps. *Mt. Res. Dev.*, **39**(2), D27–D41, doi:10.1659/MRD-JOURNAL-D-18-00077.1.

Delisle, S. and S. Turner, 2016: 'The weather is like the game we play': Coping and adaptation strategies for extreme weather events among ethnic minority groups in upland northern Vietnam: Ethnic minority coping/adapting to extreme weather. *Asia Pac. Viewp.*, **57**(3), 351–364, doi:10.1111/apv.12131.

Dembele, Y.M., L.A. Akinbile and O.O. Aminu, 2019: Adaptation strategies to climate change among cereal crop farmers in Kita, Kayes region of Mali. *J. Agric. Ext.*, **23**(3), 107, doi:10.4314/jae.v23i3.9.

Demiroglu, O.C., H. Dannevig and C. Aall, 2018: Climate change acknowledgement and responses of summer (glacier) ski visitors in Norway. *Scand. J. Hosp. Tour.*, **18**(4), 419–438, doi:10.1080/15022250.2018.1522721.

Dendup, T., 2018: Agricultural transformation in Bhutan: from peasants to entrepreneurial farmers. *Asian J. Agric. Ext. Econ. Sociol.*, **23**(3), 1–8, doi:10.9734/AJAEES/2018/40289.

Deng, Y., M. Wang and R. Yousefpour, 2017: How do people's perceptions and climatic disaster experiences influence their daily behaviors regarding adaptation to climate change? — A case study among young generations. *Sci. Total Environ.*, **581–582**, 840–847, doi:10.1016/j.scitotenv.2017.01.022.

Devkota, R.P., et al., 2017: Climate change and adaptation strategies in Budhi Gandaki River Basin, Nepal: a perception-based analysis. *Clim. Change*, **140**(2), 195–208, doi:10.1007/s10584-016-1836-5.

Dey, T., et al., 2018: Climate change perceptions and response strategies of forest fringe communities in Indian Eastern Himalaya. *Environ. Dev. Sustain.*, **20**(2), 925–938, doi:10.1007/s10668-017-9920-1.

Dhungana, N., et al., 2018: Local people's perception and awareness of climate change: a case study from community forests in Lamjung District, Western Nepal. *Banko*, **28**(2), 60–71, doi:10.3126/banko.v28i2.24189.

Dhyani, S. and D. Dhyani, 2016: Strategies for Reducing Deforestation and Disaster Risk: Lessons from Garhwal Himalaya, India. In: *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice. Advances in Natural and Technological Hazards Research* [Renaud, F., K. Sudmeier-Rieux, M. Estrella and N.U.(eds.)]. Springer, Cham, Switzerland, pp. 507–528. ISBN 978-3319436333.

Diaz, H.F. and N.E. Graham, 1996: Recent changes in tropical freezing heights and the role of sea surface temperature. *Nature*, **383**(6596), 152–155, doi:10.1038/383152a0.

Diem, J.E., et al., 2017: Comparison of measured multi-decadal rainfall variability with farmers' perceptions of and responses to seasonal changes in western Uganda. *Reg. Environ. Change*, **17**(4), 1127–1140, doi:10.1007/s10113-016-0943-1.

Diemberger, H., A. Hovden and E.T. Yeh, 2015: The Honour of the Snow-Mountains is the Snow: Tibetan Livelihoods in a Changing Climate. In: *The High-Mountain Cryosphere: Environmental Changes and Human Risks* [Huggel, C., M. Carey, J. Clague and A. Kääb(eds.)]. Cambridge University Press, Cambridge, pp. 249–271. ISBN 978-1107588653.

Dong, S., S.L. Yi and Z.L. Yan, 2016: Maintaining the Human–Natural Systems of Pastoralism in the Himalayas of South Asia and China. In: *Building Resilience of Human-Natural Systems of Pastoralism in the Developing World* [Dong, S., K.-A.S. Kassam, J.F. Tourrand and R.B. Boone(eds.)] Vol.93, Springer International Publishing, Cham, pp. 319–30732. ISBN 978-3319307305.

Dorji, N., et al., 2016: Climatic trends, risk perceptions and coping strategies of smallholder cattle farmers in some villages of Bhutan. *Livest. Res. Rural. Dev.*, **28**(11), 18.

Doughty, C.A., 2016: Building climate change resilience through local cooperation: a Peruvian Andes case study. *Reg. Environ. Change*, **16**(8), 2187–2197, doi:10.1007/s10113-015-0882-2.

Drenkhan, F., et al., 2015: The changing water cycle: Climatic and socioeconomic drivers of water-related changes in the Andes of Peru. *Wiley Interdiscip. Rev. Water*, **2**(6), 715–733, doi:10.1002/wat2.1105.

Drenkhan, F., L. Guardamino, C. Huggel and H. Frey, 2018: Current and future glacier and lake assessment in the deglaciating Vilcanota-Urubamba basin, Peruvian Andes. *Glob. Planet. Change.*, **169**(November 2017), 105–118, doi:10.1016/j.gloplacha.2018.07.005.

Drenkhan, F., C. Huggel, L. Guardamino and W. Haeberli, 2019: Managing risks and future options from new lakes in the deglaciating Andes of Peru: the example of the Vilcanota-Urubamba basin. *Sci. Total Environ.*, **665**, 465–483, doi:10.1016/j.scitotenv.2019.02.070.

Dudley, R.W., et al., 2017: Trends in snowmelt-related streamflow timing in the conterminous United States. *J. Hydrol. Reg. Stud.*, **547**, 208–221, doi:10.1016/j.jhydrol.2017.01.051.

Duethmann, D., et al., 2015: Attribution of streamflow trends in snow and glacier melt-dominated catchments of the Tarim River, Central Asia. *Water Resour. Res.*, **51**(6), 4727–4750, doi:10.1002/2014WR016716.

Dulle, H.I., et al., 2016: Changes in abundances of forest understorey birds on Africa's highest mountain suggest subtle effects of climate change. *Divers. Distrib.*, **22**(3), 288–299, doi:10.1111/ddi.12405.

Dussaillant, I., et al., 2019: Two decades of glacier mass loss along the Andes. *Nat. Geosci.*, **21**, 5143, doi:10.1038/s41561-019-0432-5.

Eakin, H., et al., 2014: Adaptation in a multi-stressor environment: perceptions and responses to climatic and economic risks by coffee growers in Mesoamerica. *Environ. Dev. Sustain.*, **16**(1), 123–139, doi:10.1007/s10668-013-9466-9.

Eastin, M.D., et al., 2014: Intra- and interseasonal autoregressive prediction of dengue outbreaks using local weather and regional climate for a tropical environment in Colombia. *Am J Trop Med Hyg*, **91**(3), 598–610, doi:10.4269/ajtmh.13-0303.

Eckert, N., et al., 2017: Temporal trends in avalanche activity in the French Alps and subregions: from occurrences and runout altitudes to unsteady return periods. *J. Glaciol.*, **59**(213), 93–114, doi:10.3189/2013JoG12J091.

El Jihad, M.-D., 2016: Climate change and rural development in the middle Atlas mountains and fringe areas (Morocco). *Rev. Geogr. Alp.*, 104–104, doi:10.4000/rga.3465.

El Mujtar, V.A., et al., 2011: Temporal progression trends of cypress mortality at permanent plots in a national forest reserve of Austrocedrus chilensis (Patagonia, Argentina). *For. Syst.*, **20**(2), 209–217.

Emmer, A., et al., 2020: 70 years of lake evolution and glacial lake outburst floods in the Cordillera Blanca (Peru) and implications for the future. *Geomorphology*, **365**, 1–11, doi:10.1016/j.geomorph.2020.107178.

Engelhardt, M., et al., 2017: Modelling 60 years of glacier mass balance and runoff for Chhota Shigri Glacier, Western Himalaya, Northern India. *J. Glaciol.*, **63**(240), 618–628, doi:10.1017/jog.2017.29.

Ensor, J.E., et al., 2019: Asking the right questions in adaptation research and practice: Seeing beyond climate impacts in rural Nepal. *Environ. Sci. Policy*, **94**, 227–236, doi:10.1016/j.envsci.2019.01.013.

Esham, M. and C. Garforth, 2013: Agricultural adaptation to climate change: insights from a farming community in Sri Lanka. *Mitig. Adapt. Strateg. Glob. Change*, **18**(5), 535–549, doi:10.1007/s11027-012-9374-6.

Fabricant, N., 2013: Good living for whom? Bolivia's climate justice movement and the limitations of indigenous Cosmovisions. *Lat. Am. Caribb. Ethn. Stud.*, **8**(2), 159–178, doi:10.1080/17442222.2013.805618.

Fahad, S., et al., 2018: Empirical analysis of factors influencing farmers crop insurance decisions in Pakistan: Evidence from Khyber Pakhtunkhwa province. *Land Use Policy*, **75**, 459–467, doi:10.1016/j.landusepol.2018.04.016.

Falk, M., 2010: A dynamic panel data analysis of snow depth and winter tourism. *Tour. Manag.*, **31**(6), 912–924, doi:10.1016/j.tourman.2009.11.010.

Falk, M. and M. Vieru, 2016: Demand for downhill skiing in subarctic climates. *Scand. J. Hosp. Tour.*, **17**(4), 388–405, doi:10.1080/15022250.2016.1238780.

Faulon, M. and I. Sacareau, 2020: Tourism, social management of water and climate change in an area of high altitude: the everest massif in Nepal. *J. Alp. Res. Rev. Geogr. Alp.*, **108**(1), doi:10.4000/rga.6779.

Faye, C.M., 2019: Positive effect of climate change on water resources enhancement in Africa: case of Gambia river basin (Senegal). *Hydrol. Sci. Water*, 1–15, doi:10.5772/intechopen.79715.

Felder, G., et al., 2018: From global circulation to local flood loss: coupling models across the scales. *Sci. Total Environ.*, **635**, 1225–1239, doi:10.1016/j.scitotenv.2018.04.170.

Feleke, F.B., M. Berhe, G. Gebru and D. Hoag, 2016: Determinants of adaptation choices to climate change by sheep and goat farmers in Northern Ethiopia: the case of Southern and Central Tigray, Ethiopia. *SpringerPlus*, **5**(1), 1692, doi:10.1186/s40064-016-3042-3.

Fentie, A. and A.D. Beyene, 2019: Climate-smart agricultural practices and welfare of rural smallholders in Ethiopia: Does planting method matter? *Land Use Policy*, **85**, 387–396, doi:10.1016/j.landusepol.2019.04.020.

Feola, G., 2015: Societal transformation in response to global environmental change: a review of emerging concepts. *Ambio*, **44**(5), 376–390, doi:10.1007/s13280-014-0582-z.

Feola, G., 2017: Adaptive institutions? Peasant institutions and natural models facing climatic and economic changes in the Colombian Andes. *J. Rural Stud.*, **49**, 117–127, doi:10.1016/j.jrurstud.2016.10.007.

Fernández-Giménez, M. E., B. Batkhishig, B. Batbuyan and T. Ulambayar, 2015: Lessons from the Dzud: Community-based rangeland management increases the adaptive capacity of Mongolian herders to winter disasters. *World Dev*, **68**, 48–65, doi:10.1016/j.worlddev.2014.11.015.

Feroze, S.M., L.I.P. Ray, K.J. Singh and R. Singh, 2019: Pastoral yak rearing system is changing with change in climate: an exploration of North Sikkimin Eastern Himalaya. *Clim. Change*, **157**(3), 483–498, doi:10.1007/s10584-019-02551-1.

Feurdean, A., et al., 2016: Tree and timberline shifts in the northern Romanian Carpathians during the holocene and the responses to environmental changes. *Quat. Sci. Rev.*, **134**, 100–113, doi:10.1016/j.quascirev.2015.12.020.

Few, R., A. Martin and N. Gross-Camp, 2017: Trade-offs in linking adaptation and mitigation in the forests of the Congo Basin. *Reg. Environ. Change*, **17**, 851–863, doi:10.1007/s10113-016-1080-6.

Field, H.R., W.H. Armstrong and M. Huss, 2021: Gulf of Alaska ice-marginal lake area change over the Landsat record and potential physical controls. *The Cryosphere.*, **15**, 3255–3278, doi: 10.5194/tc-15-3255-2021

Fierro, P.T., J.J. Kulemeyer, L.C. Lupo and S. Giralt, 2016: Historia ambiental de la Laguna Seca, Tartagal Salta, Noroeste Argentino. *Rev. Bras. Paleontol.*, **19**(2), 325–340, doi:10.4072/rbp.2016.2.14.

Fischer, L., et al., 2012: On the influence of topographic, geological and cryospheric factors on rock avalanches and rockfalls in high-mountain areas. *Nat. Hazards Earth Syst. Sci.*, **12**, 241–254, doi:10.5194/nhess-12-241-2012.

Fisher, M. and S. Snapp, 2014: Smallholder farmers' perceptions of drought risk and adoption of modern maize in southern Malawi. *Exp. Agric.*, **50**(4), 533–548, doi:10.1017/S0014479714000027.

Fleming, S.W. and H.E. Dahlke, 2014: Modulation of linear and nonlinear hydroclimatic dynamics by mountain glaciers in Canada and Norway: Results from information-theoretic polynomial selection. *Can. Water Resour. J.*, **39**(3), 324–341, doi:10.1080/07011784.2014.942164.

Florczyk, A., et al., 2019: *GHSL Data Package 2019*. [Union, P. O. o. t. E. (ed.)].https://publications.jrc.ec.europa.eu/repository/handle/JRC117104. Accessed 2021 . (Luxembourg).

Forsyth, T. and N. Evans, 2013: What is autonomous adaption? Resource scarcity and smallholder agency in Thailand. *World Dev.*, **43**, 56–66, doi:10.1016/j.worlddev.2012.11.010.

Fowler, H.J. and D.R. Archer, 2006: Conflicting signals of climatic change in the upper Indus basin. *J. Climate*, **19**, 4276–4293, doi:10.1175/JCLI3860.1.

Froude, M.J. and D.N. Petley, 2018: Global fatal landslide occurrence from 2004 to 2016. *Nat. Hazards Earth Syst. Sci.*, **18**(8), 2161–2181, doi:10.5194/nhess-18-2161-2018.

Fu, Q., et al., 2017: Effects of land use and climate change on ecosystem services in central Asia's arid regions: a case study in Altay prefecture, China. *Sci. Total. Environ.*, **607–608**, 633–646, doi:10.1016/j.scitotenv.2017.06.241.

Fuhrer, J., P. Smith and A. Gobiet, 2014: Implications of climate change scenarios for agriculture in alpine regions—a case study in the Swiss Rhone catchment. *Sci. Total Environ.*, **493**, 1232–1241, doi:10.1016/j.scitotenv.2013.06.038.

Furu, P. and D.K. Van, 2013: Health impacts of climate and environmental change: awareness and challenges to adaptation. In: *On the Frontiers of Climate and Environmental Change* [Bruun, O. and T. Casse(eds.)]. Springer, Berlin, Heidelberg, pp. 195–217. ISBN 9783642358036978364235804 3.

Fyfe, J.C., et al., 2017: Large near-term projected snowpack loss over the western United States. *Nat Commun*, **8**, 14996, doi:10.1038/ncomms14996.

Gadek, B., et al., 2017: Snow avalanche activity in Żleb Żandarmerii in a time of climate change (Tatra Mts., Poland). *Catena*, **158**, 201–212, doi:10.1016/j.catena.2017.07.005.

Gagné, K., 2016: Cultivating ice over time: on the idea of timeless knowledge and places in the Himalayas. *Anthropologica*, **58**(2), 193–210.

Gallart, F. and P. Llorens, 2004: Observations on land cover changes and water resources in the headwaters of the Ebro catchment, Iberian Peninsula. *Phys. Chem. Earth*, **29**(11–12), 769–773, doi:10.1016/j.pce.2004.05.004.

Gao, J., 2020: *Global 1-km Downscaled Population Base Year and Projection Grids Based on the Shared Socioeconomic Pathways, Revision 01*. [(SEDAC), N. S. D. a. A. C. (ed.)].https://sedac.ciesin.columbia.edu/data/set/popdynamics-1-km-downscaled-pop-base-year-projection-ssp-2000-2100-rev01. Accessed 2021 . (Palisades, NY, USA).

Gardelle, J., Y. Arnaud and E. Berthier, 2011: Contrasted evolution of glacial lakes along the Hindu Kush Himalaya mountain range between 1990 and 2009. *Glob. Planet. Change.*, **75**(1–2), 47–55, doi:10.1016/j.gloplacha.2010.10.003.

Gariano, S.L. and F. Guzzetti, 2016: Landslides in a changing climate. *Earth Sci. Rev.*, **162**, 227–252, doi:10.1016/j.earscirev.2016.08.011.

Gariano, S.L., O. Petrucci and F. Guzzetti, 2015: Changes in the occurrence of rainfall-induced landslides in Calabria, southern Italy, in the 20th century. *Nat. Hazards Earth Syst. Sci.*, **15**(10), 2313–2330, doi:10.5194/nhess-15-2313-2015.

Garreaud, R.D., C. Alvarez-Garreton and J.A. Barichivich, 2017: The 2010–2015 megadrought in central Chile: Impacts on regional hydroclimate and vegetation. *Hydrol. Earth Syst. Sci.*, **21**(12), 6307–6327, doi:10.5194/hess-21-6307-2017.

Garreaud, R.D., et al., 2020: The Central Chile Mega Drought (2010–2018): A climate dynamics perspective. *Int. J. Climatol.*, **40**(1), 421–439, doi:10.1002/joc.6219.

Gartzia, M., F. Pérez-Cabello, G. Bueno and C. Alados, 2016: Physiognomic and physiologic changes in mountain grasslands in response to environmental

and anthropogenic factors. *Appl. Geogr.*, **66**, 1–11, doi:10.1016/j.apgeog.2015.11.007.

Gaudard, L., M. Gilli and F. Romerio, 2013: Climate change impacts on hydropower management. *Water Resour. Manag.*, **27**(15), 5143–5156, doi:10.1007/s11269-013-0458-1.

Gebremicael, T.G., et al., 2013: Trend analysis of runoff and sediment fluxes in the Upper Blue Nile basin: A combined analysis of statistical tests, physically-based models and landuse maps. *J. Hydrol. Reg. Stud.*, **482**, 57–68, doi:10.1016/j.jhydrol.2012.12.023.

Gebretsadik, Z.M., 2014: Watershed degradation and the growing risk of erosion in Hawassa-Zuria District, Southern Ethiopia: Watershed degradation and erosion in Hawassa-Zuria District. *J. Flood Risk Manag.*, **7**(2), 118–127, doi:10.1111/jfr3.12033.

Gebru, A.A., et al., 2017: Evaluating water productivity of tomato, pepper and Swiss chard under clay pot and furrow irrigation technologies in semi-arid areas of northern Ethiopia. *Int. J. Water*, **12**(1), 12.

Gebru, B.M., S.W. Wang, S.J. Kim and W.-K. Lee, 2019: Socio-ecological niche and factors affecting agroforestry practice adoption in different agroecologies of southern Tigray, Ethiopia. *Sustainability*, **11**(13), 3729, doi:10.3390/su11133729.

Geertsema, M., J.J. Clague, J.W. Schwab and S.G. Evans, 2006: An overview of recent large catastrophic landslides in northern British Columbia, Canada. *Eng. Geol.*, **83**, 120–143, doi:10.1016/j.enggeo.2005.06.028.

Gentle, P. and R. Thwaites, 2016: Transhumant pastoralism in the context of socioeconomic and climate change in the mountains of Nepal. *Mt. Res. Dev.*, **36**(2), 173–182, doi:10.1659/MRD-JOURNAL-D-15-00011.1.

Gentle, P., et al., 2018: Household and community responses to impacts of climate change in the rural hills of Nepal. *Clim. Change*, **147**, 267–282, doi:10.1007/s10584-017-2124-8.

Gerardeaux, E., M. Giner, A. Ramanantsoanirina and J. Dusserr, 2012: Positive effects of climate change on rice in Madagascar. *Agron. Sustain. Dev.*, **32**, 619–627, doi:10.1007/s13593-011-0049-6.

Gergan, M.D., 2017: Living with earthquakes and angry deities at the Himalayan borderlands. *Ann. Am. Assoc. Geogr.*, **107**(2), 490–498, doi:10.1080/24694452.2016.1209103.

Gerlicz, A., et al., 2019: Use and perceptions of alternative economic activities among smallholder coffee farmers in Huehuetenango and El Quiché departments in Guatemala. *Agroecol. Sustain. Food Syst.*, **43**(3), 310–328, doi:10.1080/21683565.2018.1532480.

Ghaderi, Z., M. Khoshkam and J.C. Henderson, 2014: From snow skiing to grass skiing: implications of climate change for the ski industry in Dizin, Iran. *Anatolia*, **25**(1), 96–107, doi:10.1080/13032917.2013.829507.

Giacona, F., et al., 2018: Avalanche activity and socio-environmental changes leave strong footprints in forested landscapes: A case study in the Vosges medium-high mountain range. *Ann. Glaciol.*, **59**(77), 111–133, doi:10.1017/aog.2018.26.

Gillett, N.P., et al., 2016: The Detection and Attribution Model Intercomparison Project (DAMIP v1.0) contribution to CMIP6. *Geosci. Model Dev.*, **9**(10), 3685–3697, doi:10.5194/gmd-9-3685-2016.

Gioli, G., T. Khan, S. Bisht and J. Scheffran, 2014a: Migration as an adaptation strategy and its gendered implications: a case study from the upper Indus basin. *Mt. Res. Dev.*, **34**(3), 255–265, doi:10.1659/MRD-JOURNAL-D-13-00089.1.

Gioli, G., T. Khan and J. Scheffran, 2014b: Climatic and environmental change in the Karakoram: making sense of community perceptions and adaptation strategies. *Reg. Environ. Change*, **14**(3), 1151–1162, doi:10.1007/s10113-013-0550-3.

Gippner, O., S. Dhakal and B.K. Sovacool, 2013: Microhydro electrification and climate change adaptation in Nepal: socioeconomic lessons from the Rural Energy Development Program (REDP). *Mitig. Adapt. Strateg. Glob. Change*, **18**(4), 407–427, doi:10.1007/s11027-012-9367-5.

Gong, Y., et al., 2018: The role of social capital for farmers' climate change adaptation in Lancang River basin in China. *Clim. Change*, **149**(1), 75–89, doi:10.1007/s10584-017-2057-2.

Gongbuzeren, L. Huntsinger and W. Li, 2018: Rebuilding pastoral social-ecological resilience on the Qinghai-Tibetan Plateau in response to changes in policy, economics, and climate. *Ecol. Soc.*, **23**(2), art21, doi:10.5751/ES-10096-230221.

Gonzalez Martínez, S.L.G., et al., 2017: The phenomenon of climate change on the perception of Purépecha indigenous community of the municipality of Chilchota, Michoacan, Mexico. *Rev. Int. Contam. Ambient.*, 641–653, doi:10.20937/RICA.2017.33.04.08.

Gorettie, N.N., N.J. Justine and B. Allan, 2019: Impacts of Climate Change on Small Holder Households in Mt. Elgon Region of Uganda: Does Gender Matter? In: *Agriculture and Ecosystem Resilience in Sub Saharan Africa* [Bamutaze, Y., S. Kyamanywa, B.R. Singh, G. Nabanoga and R. Lal(eds.)]. Springer International Publishing, Cham, pp. 673–690. ISBN 9783030129736978303012973 6978303012973.

Goyol, S. and C.H. Pathirage, 2018: Farmers perceptions of climate change related events in Shendam and Riyom, Nigeria. *Economies*, **6**(4), 70, doi:10.3390/economies6040070.

Grab, S., J. Linde and H. De Lemos, 2017: Some attributes of snow occurrence and snowmelt/sublimation rates in the Lesotho Highlands: environmental implications. *Water SA*, **43**(2), 333–347, doi:10.4314/wsa.v43i2.16.

Grab, S.W. and J. Knigh, 2018: Southern African montane environments. In: *Southern African Landscapes and Environmental Change* [Holmes, P.J. and J. Boardman(eds.)]. Routledge, London. ISBN 978-1315537979.

Gram, G., P. Vaast, J. van der Wolf and L. Jassogne, 2018: Local tree knowledge can fast-track agroforestry recommendations for coffee smallholders along a climate gradient in Mount Elgon, Uganda. *Agrofor. Syst.*, **92**(6), 1625–1638, doi:10.1007/s10457-017-0111-8.

Groenewald, S.F. and A. Niehof, 2015: Social limitations of maize farmers' adaptation to neoliberal policy reform in Mexico. *Lat. Am. Res. Rev.*, **50**(4), 197–218, doi:10.1353/lar.2015.0051.

Grossmann, M., 2008: The Kilimanjaro Aquifer. In: *Conceptualizing cooperation on Africa's transboundary groundwater resources* [Scheumann, W. and E. Herrfahrdt-Pähle(eds.)]. Deutsches Institut für Entwicklungspolitik, Bonn, Germany, pp. 87–124. ISBN 978-3889853646.

Grüneis, H., et al., 2018: Why do we not pick the low-hanging fruit? Governing adaptation to climate change and resilience in Tyrolean mountain agriculture. *Land Use Policy*, **79**, 386–396, doi:10.1016/j.landusepol.2018.08.025.

Gunathilaka, R.P.D., J.C.R. Smart and C.M. Fleming, 2018: Adaptation to climate change in perennial cropping systems: Options, barriers and policy implications. *Environ. Sci. Policy*, **82**, 108–116, doi:10.1016/j.envsci.2018.01.011.

Gutiérrez, J.M., et al., 2021: Atlas. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

Hagenstad, M., E. Burakowski and R. Hill, 2018: *The economic contributions of winter sports in a changing climate. Protect our winters, Boulder, CO, USA, 80 pp.* https://scholars.unh.edu/cgi/viewcontent.cgi?article=1190&context=ersc. Accessed 2021.

Hagerman, S.M., 2016: Governing adaptation across scales: Hotspots and hesitancy in Pacific Northwest forests. *Land Use Policy*, **52**, 306–315, doi:10.1016/j.landusepol.2015.12.034.

Hailegiorgis, A., A. Crooks and C. Cioffi-Revilla, 2018: An agent-based model of rural households' adaptation to climate change. *J. Artif. Soc. Soc. Simul.*, **21**(4), 4, doi:10.18564/jasss.3812.

Haji, J. and B. Legesse, 2017: Impact of sedentarization program on the livelihood and food security of Ethiopian pastoralists. *J. Arid Environ.*, **136**, 45–53, doi:10.1016/j.jaridenv.2016.10.007.

Halloy, S.R.P., 2002: Variations in community structure and growth rates of high-Andean plants with climatic fluctuations. *Mt. Biodivers. Glob. Assess.*, 227–239.

Halofsky, J., et al., 2016: Developing and implementing climate change adaptation options in forest ecosystems: a case study in southwestern Oregon, USA. *Forests*, **7**(12), 268, doi:10.3390/f7110268.

Halofsky, J.E., T.W. Warziniack, D.L. Peterson and J.J. Ho, 2017: Understanding and managing the effects of climate change on ecosystem services in the Rocky Mountains. *Mt. Res. Dev.*, **37**(3), 340–352, doi:10.1659/MRD-JOURNAL-D-16-00087.1.

Hamilton, L.C., et al., 2003: Warming winters and New Hampshire's lost ski areas: an integrated case study. *Int. J. Sociol. Soc. Policy*, **23**(10), 52–73, doi:10.1108/01443330310790309.

Hänggi, P. and R. Weingartner, 2011: Inter-annual variability of runoff and climate within the Upper Rhine River basin, 1808–2007. *Hydrol. Sci. J.*, **56**(1), 34–50, doi:10.1080/02626667.2010.536549.

Hansen, G. and W. Cramer, 2015: Global distribution of observed climate change impacts. *Nat. Clim. Change*, **5**(3), 182–185, doi:10.1038/nclimate2529.

Hansen, G. and D. Stone, 2016: Assessing the observed impact of anthropogenic climate change. *Nat. Clim. Change*, **6**(5), 532–537, doi:10.1038/nclimate2896.

Hansen, G., et al., 2016: Linking local impacts to changes in climate: a guide to attribution. *Reg. Environ. Change*, **16**(2), 527–541, doi:10.1007/s10113-015-0760-y.

Haque, U., et al., 2016: Fatal landslides in Europe. *Landslides*, **13**(6), 1545–1554, doi:10.1007/s10346-016-0689-3.

Harris, R.M.B., T. Remenyi and N.L. Bindoff, 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. 202 pp.

Harrison, S., et al., 2018: Climate change and the global pattern of moraine-dammed glacial lake outburst floods. *Cryosphere*, **12**, 1195–1209.

Hartter, J., et al., 2012: Patterns and perceptions of climate change in a biodiversity conservation hotspot. *PLoS One*, **7**(2), e32408, doi:10.1371/journal.pone.0032408.

Hastenrath, S. and A. Ames, 1995: Diagnosing the imbalance of Yanamarey glacier in the Cordillera Blanca of Peru. *J. Geophys. Res. Atmos.*, **100**(D3), 5105–5112.

Hattermann, F.F., et al., 2016: Brief communication: an update of the article "modelling flood damages under climate change conditions-a case study for Germany". *Nat. Hazards Earth Syst. Sci.*, **16**(7), 1617–1622, doi:10.5194/nhess-16-1617-2016.

Hattermann, F.F., et al., 2014: Modelling flood damages under climate change conditions-a case study for Germany. *Nat. Hazards Earth Syst. Sci.*, **14**(12), 3151–3169, doi:10.5194/nhess-14-3151-2014.

Heikkinen, A., 2017: Climate change in the Peruvian Andes: A case study on small-scale farmers' vulnerability in the Quillcay river basin. *Iberoam. Nord. J. Lat. Am. Caribb. Stud.*, **46**(1), 77–88, doi:10.16993/iberoamericana.211.

Hellin, J., B.D. Ratner, R. Meinzen-Dick and S. Lopez-Ridaura, 2018: Increasing social-ecological resilience within small-scale agriculture in conflict-affected Guatemala. *Ecol. Soc.*, **23**(3), art5, doi:10.5751/ES-10250-230305.

Heltorp, K.M. A., A. Kangas and H.F. Hoen, 2018: Do forest decision-makers in Southeastern Norway adapt forest management to climate change? *Scand. J. For. Res.*, **33**(3), 278–290, doi:10.1080/02827581.2017.1362463.

Hemp, A., 2005: Climate change-driven forest fires marginalize the impact of ice cap wasting on Kilimanjaro. *Glob. Change Biol.*, **11**(7), 1013–1023, doi:10.1111/j.1365-2486.2005.00968.x.

Herrador-Valencia, D. and M. Paredes, 2016: Cambio climático y agricultura de pequeña escala en los Andes ecuatorianos: Un estudio sobre percepciones locales y estrategias de adaptación. *J. Lat. Am. Geogr.*, **15**(2), 101–121, doi:10.1353/lag.2016.0021.

Hill, M., 2013: Adaptive capacity of water governance: cases from the Alps and the Andes. *Mt. Res. Dev.*, **33**(3), 248, doi:10.1659/MRD-JOURNAL-D-12-00106.1.

Hirabayashi, Y., et al., 2013: Global flood risk under climate change. *Nat. Clim. Change*, **3**(9), 816–821, doi:10.1038/nclimate1911.

Hirabayashi, Y., et al., 2021: Global exposure to flooding from the new CMIP6 climate model projections. *Sci. Rep.*, **11**, 3740, doi:10.1038/s41598-021-83279-w.

Hirota, I., 2018: Multiple risk management during agricultural production shortages in a mountain village in northern Laos—Roles of forest resources, livestock and the market economy. *IOP Conf. Ser. Earth Environ. Sci.*, **200**, 12001, doi:10.1088/1755-1315/200/1/012001.

Hlahla, S. and T.R. Hill, 2018: Responses to climate variability in urban poor communities in Pietermaritzburg, KwaZulu-natal, South Africa. *SAGE Open*, **8**(3), 215824401880091, doi:10.1177/2158244018800914.

Hlahla, S., A. Nel and T.R. Hill, 2019: Assessing municipal-level governance responses to climate change in KwaZulu-Natal, South Africa. *J. Environ. Plan. Manag.*, **62**(6), 1089–1107, doi:10.1080/09640568.2018.1466693.

Hoang, M.H., et al., 2014: Farmer portfolios, strategic diversity management and climate-change adaptation – implications for policy in Vietnam and Kenya. *Clim. Dev.*, **6**(3), 216–225, doi:10.1080/17565529.2013.857588.

Hock, R., G. Rasul, C. Adler, B. Cáceres, S. Gruber, Y. Hirabayashi, M. Jackson, A. Kääb, S. Kang, S. Kutuzov, Al. Milner, U. Molau, S. Morin, B. Orlove, and H. Steltzer, 2019: High Mountain Areas. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*. [Pörtner, H. O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama and N. M. Weyer (eds.)], pp. 133–202.

Holler, J., 2014: Is sustainable adaptation possible? Determinants of adaptation on Mount Kilimanjaro. *Prof. Geogr.*, **66**(4), 526–537, doi:10.1080/00330124.2014.922015.

Hong, N.B. and M. Yabe, 2017: Improvement in irrigation water use efficiency: a strategy for climate change adaptation and sustainable development of Vietnamese tea production. *Environ. Dev. Sustain.*, **19**(4), 1247–1263, doi:10.1007/s10668-016-9793-8.

Hoogendoorn, G., L. Stockigt, J. Saarinen and J.M. Fitchett, 2021: Adapting to climate change: the case of snow-based tourism in Afriski, Lesotho. *Afr. Geogr. Rev.*, **40**(1), 92–104, doi:10.1080/19376812.2020.1773878.

Hopping, K. A., E.T. Yeh, Gaerrang and R.B. Harris, 2018: Linking people, pixels, and pastures: A multi-method, interdisciplinary investigation of how rangeland management affects vegetation on the Tibetan Plateau. *Appl. Geogr.*, **94**, 147–162, doi:10.1016/j.apgeog.2018.03.013.

Hou, L., J. Huang and J. Wang, 2017: Early warning information, farmers' perceptions of, and adaptations to drought in China. *Clim. Change*, **141**(2), 197–212, doi:10.1007/s10584-017-1900-9.

Hovelsrud, G.K., M. Karlsson and J. Olsen, 2018: Prepared and flexible: local adaptation strategies for avalanche risk. *Cogent Soc. Sci.*, **4**(1), 1460899, doi:10.1080/23311886.2018.1460899.

Hoy, A. and O. Katel, 2019: Status of Climate Change and Implications to Ecology and Community Livelihoods in the Bhutan Himalaya. In: *Environmental Change in the Himalayan Region: Twelve Case Studies* [Saikia, A. and P. Thapa(eds.)]. Springer International Publishing, Cham, Switzerland, pp. 23–45. ISBN 978-3030033620.

Huang, Z., et al., 2021: Global assessment of future sectoral water scarcity under adaptive inner-basin water allocation measures. *Sci. Total. Environ.*, **783**, 146973, doi:10.1016/j.scitotenv.2021.146973.

Huggel, C., et al., 2015: How useful and reliable are disaster databases in the context of climate and global change? A comparative case study analysis in Peru. *Nat. Hazards Earth Syst. Sci.*, **15**(3), 475–485, doi:10.5194/nhess-15-475-2015.

Hughey, K.F.D. and S. Becken, 2014: Understanding climate coping as a basis for strategic climate change adaptation – The case of Queenstown-Lake

Wanaka, New Zealand. *Glob. Environ. Chang.*, **27**, 168–179, doi:10.1016/j.gloenvcha.2014.03.004.

Huntington, H.P., et al., 2020: How small communities respond to environmental change: Patterns from tropical to polar ecosystems. *Ecol. Soc.*, **22**(3), 9, doi:10.5751/ES-09171-220309.

Huss, M. and R. Hock, 2018: Global-scale hydrological response to future glacier mass loss. *Nat. Clim. Change*, **8**(2), 135–140, doi:10.1038/s41558-017-0049-x.

Hussain, A., N.K. Agrawal and I. Leikanger, 2016: Action for Adaptation: Bringing climate change science to policy makers—a synthesis report of a conference held in Islamabad on 23–25 July 2015. *Food Sec.*, **8**, 285–289, doi:10.1007/s12571-015-0529-7.

Hussain, A., B. Mahapatra and G. Rasul, 2019: Adaptation in Mountain Agriculture: Food Security in the Hindu-Kush Himalayan (HKH) Region. In: *Status of Climate Change Adaptation in Asia and the Pacific* [Alam, M., J. Lee and P. Sawhney(eds.)]. Springer, Cham, Switzerland, pp. 211–236. ISBN 978-3319993478.

Hussain, A., et al., 2018: Climate change-induced hazards and local adaptations in agriculture: a study from Koshi River Basin, Nepal. *Nat. Hazards*, **91**(3), 1365–1383, doi:10.1007/s11069-018-3187-1.

Imfeld, N., et al., 2019: Summertime precipitation deficits in the southern Peruvian highlands since 1964. *Int. J. Climatol.*, **39**(11), 4497–4513, doi:10.1002/joc.6087.

Immerzeel, W.W., et al., 2020: Importance and vulnerability of the world's water towers. *Nature*, **577**, 364–369, doi:10.1038/s41586-019-1822-y.

Inaigem, 2018: *Inventario Nacional de Glaciares—Las Cordilleras Glaciares del Perú*. INAIGEM, http://repositorio.inaigem.gob.pe/handle/INAIGEM/169. (348 pp).

Ingold, K. and J. Balsiger, 2015: Sustainability principles put into practice: case studies of network analysis in Swiss climate change adaptation. *Reg. Environ. Change*, **15**(3), 529–538, doi:10.1007/s10113-013-0575-7.

Ingty, T., 2017: High mountain communities and climate change: adaptation, traditional ecological knowledge, and institutions. *Clim. Change*, **145**(1–2), 41–55, doi:10.1007/s10584-017-2080-3.

Iribarren Anacona, P., A. Mackintosh and K. Norton, 2015: Reconstruction of a glacial lake outburst flood (GLOF) in the Engaño Valley, Chilean Patagonia: Lessons for GLOF risk management. *Sci. Total. Environ.*, **527–528**, 1–11, doi:10.1016/j.scitotenv.2015.04.096.

Iribarren Anacona, P., et al., 2018: Dynamics of an outburst flood originating from a small and high-altitude glacier in the Arid Andes of Chile. *Nat. Hazards*, **94**, 93–119, doi:10.1007/s11069-018-3376-y.

Jacob, M., et al., 2015: North Ethiopian afro-alpine tree line dynamics and forest-cover change since the early 20th century. *Land Degrad. Dev.*, **26**(7), 654–664, doi:10.1002/ldr.2320.

Jacobi, J., 2016: Agroforestry in Bolivia: opportunities and challenges in the context of food security and food sovereignty. *Envir. Conserv.*, **43**(4), 307–316, doi:10.1017/S0376892916000138.

Jacobi, J., et al., 2015a: Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. *Renew. Agric. Food Syst.*, **30**(2), 170–183, doi:10.1017/S174217051300029X.

Jacobi, J., et al., 2015b: Farm resilience in organic and nonorganic cocoa farming systems in Alto Beni, Bolivia. *Agroecol. Sustain. Food Syst.*, **39**(7), 798–823, doi:10.1080/21683565.2015.1039158.

Jawid, A. and M. Khadjavi, 2019: Adaptation to climate change in Afghanistan: Evidence on the impact of external interventions. *Econ. Anal. Policy.*, **64**, 64–82, doi:10.1016/j.eap.2019.07.010.

Jezeer, R.E., et al., 2019: Influence of livelihood assets, experienced shocks and perceived risks on smallholder coffee farming practices in Peru. *J. Environ. Manag.*, **242**, 496–506, doi:10.1016/j.jenvman.2019.04.101.

Jiménez, L., et al., 2019: Ecosystem responses to climate-related changes in a mediterranean alpine environment over the last ~180 years. *Ecosystems*, **22**(3), 563–577, doi:10.1007/s10021-018-0286-5.

Jochner, M., H. Bugmann, M. Nötzli and C. Bigler, 2017: Among-tree variability and feedback effects result in different growth responses to climate change at the upper treeline in the Swiss alps. *Ecol. Evol.*, **7**(19), 7937–7953, doi:10.1002/ece3.3290.

Joshi, A., et al., 2019: Climate change in Lamjung District, Nepal: meteorological evidence, community perceptions, and responses. *Environ. Res. Commun.*, **1**(3), 31004, doi:10.1088/2515-7620/ab1762.

Joshi, B., W. Ji and N.B. Joshi, 2017: Farm households' perception on climate change and adaptation practices: A case from mountain district of Nepal. *Int. J. Clim. Chang. Strateg. Manag.*, **9**(4), 433–445, doi:10.1108/IJCCSM-07-2016-0099.

Joshi, S., et al., 2013: Herders' perceptions of and responses to climate change in northern Pakistan. *Environ. Manage.*, **52**(3), 639–648, doi:10.1007/s00267-013-0062-4.

Joshua, M.K., et al., 2016: Climate change in semi-arid Malawi: Perceptions, adaptation strategies and water governance. *Jàmbá J. Disaster Risk Stud.*, **8**(3), 10, doi:10.4102/jamba.v8i3.255.

Jurt, C., et al., 2015: Cultural Values of Glaciers. In: *The High Mountain Cryosphere: Environmental Changes and Human Risks* [Huggel, C., M. Carey, J.J. Clague and A. Kääb(eds.)]. Cambridge University Press, Cambridge, pp. 90–106. ISBN 978-1107588653.

Kaenzig, R., M. Rebetez and G. Serquet, 2016: Climate change adaptation of the tourism sector in the Bolivian Andes. *Tour. Geogr.*, **18**(2), 111–128, doi:10.1080/14616688.2016.1144642.

Kahsay, H.T., D.D. Guta, B.S. Birhanu and T.G. Gidey, 2019: Farmers' perceptions of climate change trends and adaptation strategies in semiarid highlands of eastern Tigray, northern Ethiopia. *Adv. Meteorol.*, **2019**, 3849210, doi:10.1155/2019/3849210.

Kajembe, G.C., et al., 2016: Institutional Sustainability in the Face of Climate Change: Empirical Insights from Irrigation Institutions in the Iringa Rural District, Tanzania. In: *Climate Change and Multi-Dimensional Sustainability in African Agriculture* [Lal, R., et al.(ed.)]. Springer International Publishing, Cham, pp. 23–41. ISBN 9783319412368978331941236897833194123 82.

Kapos, V., et al., 2000: Developing a Map of the World's Mountain Forests. In: *Forests in Sustainable Mountain Development: a State of Knowledge Report for 2000. Task Force on Forests in Sustainable Mountain Development* [Price, M.F. and N. Butt(eds.)]. CABI, Wallingford, UK, pp. 4–18. ISBN 978-0851994468.

Karagulle, D., et al., 2017: Modeling global Hammond landform regions from 250-m elevation data. *Trans. GIS*, **21**(5), 1040–1060, doi:10.1111/tgis.12265.

Karapinar, B. and G. Özertan, 2020: Yield implications of date and cultivar adaptation to wheat phenological shifts: a survey of farmers in Turkey. *Clim. Change*, **158**(3), 453–472, doi:10.1007/s10584-019-02532-4.

Karimi, V., E. Karami and M. Keshavarz, 2018: Climate change and agriculture: Impacts and adaptive responses in Iran. *J. Integr. Agric.*, **17**(1), 1–15, doi:10.1016/S2095-3119(17)61794-5.

Karimoune, S., O. K. S. Tanko and H. Issiaka, 2017: Climate variabilities and evolution of soil occupation in the Timia oasis in the Agadez Region, Niger. *Geo-Eco-Trop*, **41**(3), 359-374.

Kassian, L.M., et al., 2017: Implication of climate change and variability on stream flow in Iringa region, Tanzania. *J. Water Clim. Chang.*, **8**(2), 336–347, doi:10.2166/wcc.2016.238.

Kassie, B.T., et al., 2013: Adapting to climate variability and change: Experiences from cereal-based farming in the central rift and Kobo valleys, Ethiopia. *Environ. Manage.*, **52**(5), 1115–1131, doi:10.1007/s00267-013-0145-2.

Kattumuri, R., D. Ravindranath and T. Esteves, 2017: Local adaptation strategies in semi-arid regions: study of two villages in Karnataka, India. *Clim. Dev.*, **9**(1), 36–49, doi:10.1080/17565529.2015.1067179.

Keenan, R.J. and C. Nitschke, 2016: Forest management options for adaptation to climate change: a case study of tall, wet eucalypt forests in Victoria's Central Highlands region. *Aust. For.*, **79**(2), 96–107, doi:10.1080/00049158.2015.1130095.

Keller, L., et al., 2019: Large ensemble flood loss modelling and uncertainty assessment for future climate conditions for a Swiss pre-alpine catchment. *Sci. Total. Environ.*, **693**, doi:10.1016/j.scitotenv.2019.07.206.

Kervyn, M., et al., 2015: Landslide resilience in Equatorial Africa: Moving beyond problem identification! *Belgeo*, **1**, 0–22, doi:10.4000/belgeo.15944.

Keshavarz, M. and E. Karami, 2014: Farmers' decision-making process under drought. *J. Arid Environ.*, **108**, 43–56, doi:10.1016/j.jaridenv.2014.03.006.

Keshavarz, M., H. Maleksaeidi and E. Karami, 2017: Livelihood vulnerability to drought: A case of rural Iran. *Int. J. Disaster Risk Reduct.*, **21**, 223–230, doi:10.1016/j.ijdrr.2016.12.012.

Khan, M. and M. Omprakash, 2015: Adaptation through watershed management in the changing climate. *Glob. NEST J.*, **18**(1), 11–24, doi:10.30955/gnj.001378.

Khanal, P., et al., 2019a: Perceived climate change impacts and adaptation strategy of indigenous community (Chepangs) in rural mid-hills of Nepal. *For. J. Inst. For. Nepal*, **16**, 48–61, doi:10.3126/forestry.v16i0.28353.

Khanal, U. and C. Wilson, 2019: Derivation of a climate change adaptation index and assessing determinants and barriers to adaptation among farming households in Nepal. *Environ. Sci. Policy*, **101**, 156–165, doi:10.1016/j.envsci.2019.08.006.

Khanal, U., C. Wilson, V.-N. Hoang and B. Lee, 2018a: Farmers' adaptation to climate change, its determinants and impacts on rice yield in Nepal. *Ecol. Econ.*, **144**, 139–147, doi:10.1016/j.ecolecon.2017.08.006.

Khanal, U., C. Wilson, V.-N. Hoang and B. Lee, 2019b: Impact of community-based organizations on climate change adaptation in agriculture: empirical evidence from Nepal. *Environ. Dev. Sustain.*, **21**(2), 621–635, doi:10.1007/s10668-017-0050-6.

Khanal, U., C. Wilson, B. Lee and V.-N. Hoang, 2018b: Do climate change adaptation practices improve technical efficiency of smallholder farmers? Evidence from Nepal. *Clim. Change*, **147**(3), 507–521, doi:10.1007/s10584-018-2168-4.

Kharumnuid, P., I.S. Rao, V. Sudharani and S. Kumar, 2018: Farm level adaptation practices of potato growing farmers in East Khasi Hills district of Meghalaya, India. *J. Environ. Biol.*, **39**(5), 575–580, doi:10.22438/jeb/39/5/MRN-639.

Kibet, S., M. Nyangito, L. MacOpiyo and D. Kenfack, 2016: Tracing innovation pathways in the management of natural and social capital on Laikipia Maasai Group Ranches, Kenya. *Pastoralism*, **6**(1), 16, doi:10.1186/s13570-016-0063-z.

Kidane, Y.O., M.J. Steinbauer and C. Beierkuhnlein, 2019: Dead end for endemic plant species? A biodiversity hotspot under pressure. *Glob. Ecol. Conserv.*, **19**, e670–e670, doi:10.1016/j.gecco.2019.e00670.

Kimaro, A.A., et al., 2016: Is conservation agriculture 'climate-smart' for maize farmers in the highlands of Tanzania? *Nutr. Cycl. Agroecosyst.*, **105**(3), 217–228, doi:10.1007/s10705-015-9711-8.

Kimaro, J., S. Liseki, W. Mareale and C. Mrisha, 2013: Enhancing rural food security through improved beekeeping in Northern Tanzania. *Livest. Res. Rural. Dev.*, **25**(12), 222.

King, O., A. Bhattacharya, R. Bhambri and T. Bolch, 2019: Glacial lakes exacerbate Himalayan glacier mass loss. *Sci. Rep.*, **9**, 18145, doi:10.1038/s41598-019-53733-x.

Kinoti, K.D., C.M. Jackson and M.J. Muthoni, 2018: Dynamics of climate change adaptations on horticultural land use practices around Mt. Kenya east region. *Am. J. Environ. Prot.*, **7**(1), 1–6, doi:10.11648/j.ajep.20180701.11.

Kirschbaum, D., S.B. Kapnick, T. Stanley and S. Pascale, 2020: Changes in extreme precipitation and landslides over high mountain Asia. *Geophys. Res. Lett.*, **47**(4), 1–9, doi:10.1029/2019GL085347.

Kissel, A.M., W.J. Palen, M. E. Ryan and M.J. Adams, 2019: Compounding effects of climate change reduce population viability of a montane amphibian. *Ecol. Appl.*, **29**(2), 1–12, doi:10.1002/eap.1832.

Klein, J.A., et al., 2014: Unexpected climate impacts on the Tibetan Plateau: local and scientific knowledge in findings of delayed summer. *Glob. Environ. Chang.*, **28**, 141–152, doi:10.1016/j.gloenvcha.2014.03.007.

Konchar, K.M., et al., 2015: Adapting in the shadow of Annapurna: a climate tipping point. *J.. Ethnobiol.*, **35**(3), 449–471, doi:10.2993/0278-0771-35.3.449.

Kormann, C., T. Francke, M. Renner and A. Bronstert, 2015: Attribution of high resolution streamflow trends in Western Austria – an approach based on climate and discharge station data. *Hydrol. Earth Syst. Sci.*, **19**(3), 1225–1245, doi:10.5194/hess-19-1225-2015.

Körner, C., J. Paulsen and E.M. Spehn, 2011: A definition of mountains and their bioclimatic belts for global comparisons of biodiversity data. *Alp. Bot.*, **121**, doi:10.1007/s00035-011-0094-4.

Kosmowski, F., 2018: Soil water management practices (terraces) helped to mitigate the 2015 drought in Ethiopia. *Agric. Water Manag.*, **204**, 11–16, doi:10.1016/j.agwat.2018.02.025.

Koura, I.B., L.H. Dossa, B.D. Kassa and M. Houinato, 2015: Adaptation of periurban cattle production systems to environmental changes: Feeding strategies of herdsmen in southern Benin. *Agroecol. Sustain. Food Syst.*, **39**(1), 83–98, doi:10.1080/21683565.2014.953662.

Kriegel, D., et al., 2013: Changes in glacierisation, climate and runoff in the second half of the 20th century in the Naryn basin, Central Asia. *Glob. Planet. Change*, **110**, 51–61, doi:10.1016/j.gloplacha.2013.05.014.

Krishnaswamy, J., R. John and S. Joseph, 2014: Consistent response of vegetation dynamics to recent climate change in tropical mountain regions. *Glob. Change Biol.*, **20**(1), 203–215, doi:10.1111/gcb.12362.

Krysanova, V., et al., 2015: Analysis of current trends in climate parameters, river discharge and glaciers in the Aksu River basin (Central Asia). *Hydrol. Sci. J.*, **60**(4), 566–590, doi:10.1080/02626667.2014.925559.

Kundzewicz, Z.W., et al., 2014: Flood risk and climate change: global and regional perspectives. *Hydrol. Sci. J.*, **59**(1), 1–28, doi:10.1080/02626667.2013.857411.

Kundzewicz, Z.W., et al., 2015: Analysis of changes in climate and river discharge with focus on seasonal runoff predictability in the Aksu River Basin. *Environ. Earth Sci.*, **73**(2), 501–516, doi:10.1007/s12665-014-3137-5.

Kundzewicz, Z.W., I. Pin'skwar and G.R. Brakenridge, 2018: Changes in river flood hazard in Europe: A review. *Hydrol. Res.*, **49**(2), 294–302, doi:10.2166/nh.2017.016.

Kusters, K. and N. Wangdi, 2013: The costs of adaptation: changes in water availability and farmers' responses in Punakha district, Bhutan. *Int. J. Glob. Warm.*, **5**(4), 387, doi:10.1504/IJGW.2013.057287.

La Frenierre, J. and B.G. Mark, 2017: Detecting patterns of climate change at Volcán Chimborazo, Ecuador, by integrating instrumental data, public observations, and glacier change analysis. *Ann. Am. Assoc. Geogr.*, **107**(4), 979–997, doi:10.1080/24694452.2016.1270185.

Labaj, A.L., N. Michelutti and J.P. Smol, 2018: Cladocera in shallow lakes from the Ecuadorian Andes show little response to recent climate change. *Hydrobiologia*, **822**(1), 203–216, doi:10.1007/s10750-018-3681-1.

Labbé, J., J.D. Ford, M. Araos and M. Flynn, 2017: The government-led climate change adaptation landscape in Nunavut, Canada. *Environ. Rev.*, **25**(1), 12–25, doi:10.1139/er-2016-0032.

Lalika, M.C.S., P. Meire, Y.M. Ngaga and L. Chang'a, 2015: Understanding watershed dynamics and impacts of climate change and variability in the Pangani River Basin, Tanzania. *Ecohydrol. Hydrobiol.*, **15**(1), 26–38, doi:10.1016/j.ecohyd.2014.11.002.

Lamborn, C.C. and J.W. Smith, 2019: Human perceptions of, and adaptations to, shifting runoff cycles: a case-study of the Yellowstone River (Montana, USA). *Fish. Res.*, **216**, 96–108, doi:10.1016/j.fishres.2019.04.005.

Lavado Casimiro, W.S., et al., 2012: Trends in rainfall and temperature in the Peruvian Amazon-Andes basin over the last 40 years (1965–2007). *Hydrol. Process.*, **27**, 2944–2957, doi:10.1002/hyp.9418.

Leal Filho, W., et al., 2017: Climate change responses among the Maasai community in Kenya. *Clim. Change*, **145**(1–2), 71–83, doi:10.1007/s10584-017-2087-9.

Leal Filho, W., et al., 2020: Introducing experiences from African pastoralist communities to cope with climate change risks, hazards and extremes:

Fostering poverty reduction. *Int. J. Disaster Risk Reduct.*, **50**, 101738, doi:10.1016/j.ijdrr.2020.101738.

Lechuga, V., et al., 2017: Managing drought-sensitive forests under global change. Low competition enhances long-term growth and water uptake in Abies pinsapo. *For. Ecol. Manag.*, **406**, 72–82, doi:10.1016/j.foreco.2017.10.017.

Leclerc, C., C. Mwongera, P. Camberlin and V. Moron, 2014: Cropping system dynamics, climate variability, and seed losses among east African smallholder farmers: a retrospective survey. *Weather. Clim. Soc.*, **6**(3), 354–370, doi:10.1175/WCAS-D-13-00035.1.

Lemessa, S.D., M.D. Watebaji and M. A. Yismaw, 2019: Climate change adaptation strategies in response to food insecurity: The paradox of improved potato varieties adoption in eastern Ethiopia. *Cogent Food Agric.*, **5**(1), doi:10.1080/23311932.2019.1640835.

Lennox, E. and J. Gowdy, 2014: Ecosystem governance in a highland village in Peru: Facing the challenges of globalization and climate change. *Ecosyst. Serv.*, **10**, 155–163, doi:10.1016/j.ecoser.2014.08.007.

Leroy, D., 2019: Farmers' perceptions of and adaptations to water scarcity in Colombian and Venezuelan Paramos in the context of climate change. *Mt. Res. Dev.*, **39**(2), R21–R34, doi:10.1659/MRD-JOURNAL-D-18-00062.1.

Li, C., et al., 2013a: Local farmers' perceptions of climate change and local adaptive strategies: a case study from the middle Yarlung Zangbo river valley, Tibet, China. *Environ. Manage.*, **52**(4), 894–906, doi:10.1007/s00267-013-0139-0.

Li, H., J. Gupta and M.P. Van Dijk, 2013b: China's drought strategies in rural areas along the Lancang River. *Water Policy*, **15**(1), 1–18, doi:10.2166/wp.2012.050.

Li, J., et al., 2017a: Assessing vulnerability of giant pandas to climate change in the Qinling Mountains of China. *Ecol. Evol.*, **7**(11), 4003–4015, doi:10.1002/ece3.2981.

Li, S., et al., 2015: Farmers' initiative on adaptation to climate change in the Northern Agro-pastoral Ecotone. *Int. J. Disaster Risk Reduct.*, **12**, 278–284, doi:10.1016/j.ijdrr.2015.02.002.

Li, X., et al., 2017b: Patterns of herders' adaptation to changes in social–ecological systems across northern China's grasslands over the past three decades. *Rangel. J.*, **39**(4), 317, doi:10.1071/RJ16070.

Liao, C. and D. Fei, 2017: Sedentarization as constrained adaptation: evidence from pastoral regions in far northwestern China. *Hum. Ecol.*, **45**(1), 23–35, doi:10.1007/s10745-016-9872-3.

Lillo-Ortega, G., et al., 2019: On the evaluation of adaptation practices: a transdisciplinary exploration of drought measures in Chile. *Sustain. Sci.*, **14**(4), 1057–1069, doi:10.1007/s11625-018-0619-5.

Lindsay, A., 2018: Social learning as an adaptive measure to prepare for climate change impacts on water provision in Peru. *J. Environ. Stud. Sci.*, **8**(4), 477–487, doi:10.1007/s13412-017-0464-3.

Liu, K., et al., 2018: Farmers' perceptions and adaptation behaviours concerning land degradation: A theoretical framework and a case-study in the Qinghai-Tibetan Plateau of China. *Land Degrad. Dev.*, **29**(8), 2460–2471, doi:10.1002/ldr.3011.

Lookabaugh, L., 2017: Talking about the weather in Chiapas, Mexico: rural women's approaches to climate change adaptation: the latin americanist, march 2017. *Lat. Am.*, **61**(1), 61–80, doi:10.1111/tla.12101.

López-i-Gelats, F., et al., 2015: Adaptation strategies of Andean pastoralist households to both climate and non-climate changes. *Hum. Ecol.*, **43**, 267–282, doi:10.1007/s10745-015-9731-7.

López-Moreno, J.I., et al., 2011: Impact of climate evolution and land use changes on water yield in the ebro basin. *Hydrol. Earth Syst. Sci.*, **15**(1), 311–322, doi:10.5194/hess-15-311-2011.

Loria, N. and S.K. Bhardwaj, 2016: Farmers' response and adaptation strategies to climate change in low-hills of Himachal Pradesh in India. *Nat. Environ. Pollut. Technol.*, **15**(3), 895–901.

Lubetkin, K.C., A. LeRoy Westerling and L.M. Kueppers, 2017: Climate and landscape drive the pace and pattern of conifer encroachment into subalpine meadows. *Ecol. Appl.*, **27**(6), 1876–1887, doi:10.1002/eap.1574.

Luh, J., et al., 2017: Expert assessment of the resilience of drinking water and sanitation systems to climate-related hazards. *Sci. Total. Environ.*, **592**, 334–344, doi:10.1016/j.scitotenv.2017.03.084.

M'mboroki, K., S. Wandiga and S.O. Oriaso, 2018: Climate change impacts detection in dry forested ecosystem as indicated by vegetation cover change in —Laikipia, of Kenya. *Environ. Monit. Assess.*, **190**, 255, doi:10.1007/s10661-018-6630-6.

Macchi, M., A.M. Gurung and B. Hoermann, 2015: Community perceptions and responses to climate variability and change in the Himalayas. *Clim. Dev.*, **7**(5), 414–425, doi:10.1080/17565529.2014.966046.

Mach, K.J., M.D. Mastrandrea, P.T. Freeman and C.B. Field, 2017: Unleashing expert judgment in assessment. *Glob. Environ. Change*, **44**, 1–14, doi:10.1016/j.gloenvcha.2017.02.005.

Maleksaeidi, H., et al., 2016: Discovering and characterizing farm households' resilience under water scarcity. *Environ. Dev. Sustain.*, **18**(2), 499–525, doi:10.1007/s10668-015-9661-y.

Mallucci, S., B. Majone and A. Bellin, 2019: Detection and attribution of hydrological changes in a large Alpine river basin. *J. Hydrol.*, **575**, 1214–1229, doi:10.1016/j.jhydrol.2019.06.020.

Malmros, J.K., et al., 2018: Snow cover and snow-albedo changes in the central Andes of Chile and Argentina from daily MODIS observations (2000–2016). *Remote. Sens. Environ.*, **209**, 240–252, doi:10.1016/j.rse.2018.02.072.

Mark, B.G., et al., 2017: Glacier loss and hydro-social risks in the Peruvian Andes. *Glob. Planet. Change*, **159**, 61–76, doi:10.1016/j.gloplacha.2017.10.003.

Marke, T., F. Hanzer, M. Olefs and U. Strasser, 2018: Simulation of past changes in the Austrian snow cover 1948–2009. *J. Hydrometeorol.*, **19**(10), 1529–1545, doi:10.1175/JHM-D-17-0245.1.

Martin, S., 2015: Indigenous social and economic adaptations in northern Alaska as measures of resilience. *Ecol. Soc.*, **20**(4), art8, doi:10.5751/ES-07586-200408.

Marty, C., A.-M. Tilg and T. Jonas, 2017: Recent evidence of large-scale receding snow water equivalents in the European Alps. *J. Hydrometeorol.*, **18**(4), 1021–1031, doi:10.1175/JHM-D-16-0188.1.

Masih, I., S. Uhlenbrook, S. Maskey and V. Smakhtin, 2011: Streamflow trends and climate linkages in the Zagros Mountains, Iran. *Clim. Change*, **104**(2), 317–338, doi:10.1007/s10584-009-9793-x.

Masiokas, M.H., et al., 2020: A review of the current state and recent changes of the Andean cryosphere. *Front. Earth Sci.*, **8**, doi:10.3389/feart.2020.00099.

Masiokas, M.H., et al., 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. *J. Climate*, **19**(24), 6334–6352, doi:10.1175/JCLI3969.1.

Masunungure, C. and S. Shackleton, 2018: Exploring long-term livelihood and landscape change in two semi-arid sites in southern Africa: Drivers and consequences for social–ecological vulnerability. *Land*, **7**(2), 50, doi:10.3390/land7020050.

Mbue, N.I., D. Bitondo and B.R. Azibo, 2016: Climate variability and change in the Bamenda Highlands of North Western Cameroon: Perceptions, impacts and coping mechanisms. *Br. J. Appl. Sci. Technol.*, **12**(5), 1–8, doi:10.9734/BJAST/2016/21818.

McCord, P.F., M. Cox, M. Schmitt-Harsh and T. Evans, 2015: Crop diversification as a smallholder livelihood strategy within semi-arid agricultural systems near Mount Kenya. *Land Use Policy*, **42**, 738–750, doi:10.1016/j.landusepol.2014.10.012.

McDowell, G., et al., 2019: Adaptation action and research in glaciated mountain systems: Are they enough to meet the challenge of climate change? *Glob. Environ. Change*, **54**, 19–30, doi:10.1016/j.gloenvcha.2018.10.012.

McDowell, G., E. Stephenson and J. Ford, 2014: Adaptation to climate change in glaciated mountain regions. *Clim. Change*, **126**(1), 77–91, doi:10.1007/s10584-014-1215-z.

McDowell, G., et al., 2021: Closing the adaptation gap in mountains. *Mt. Res. Dev.*, **41**(3), A1-A10, doi:10.1659/MRD-JOURNAL-D-21-00033.1.

McDowell, J.Z. and J.J. Hess, 2012: Accessing adaptation: multiple stressors on livelihoods in the Bolivian highlands under a changing climate. *Glob. Environ. Change*, **22**(2), 342–352, doi:10.1016/j.gloenvcha.2011.11.002.

McNeeley, S.M., T.A. Beeton and D.S. Ojima, 2016: Drought risk and adaptation in the interior United States: Understanding the importance of local context for resource management in times of drought. *Weather Clim. Soc.*, **8**(2), 147–161, doi:10.1175/WCAS-D-15-0042.1.

McPhillips, D., P.R. Bierman and D.H. Rood, 2014: Millennial-scale record of landslides in the Andes consistent with earthquake trigger. *Nat. Geosci.*, **7**(12), 925–930, doi:10.1038/ngeo2278.

Meena, R.K., et al., 2019: Local perceptions and adaptation of indigenous communities to climate change: Evidences from High Mountain Pangi valley of Indian Himalayas. *Indian J. Tradit. Knowl.*, **18**(1), 58–67.

Mekonnen, D.F., Z. Duan, T. Rientjes and M. Disse, 2018: Analysis of combined and isolated effects of land-use and land-cover changes and climate change on the upper Blue Nile River basin's streamflow. *Hydrol. Earth Syst. Sci.*, **22**(12), 6187–6207, doi:10.5194/hess-22-6187-2018.

Meldrum, G., et al., 2018: Climate change and crop diversity: farmers' perceptions and adaptation on the Bolivian Altiplano. *Environ. Dev. Sustain.*, **20**(2), 703–730, doi:10.1007/s10668-016-9906-4.

Menghistu, H.T., T.T. Mersha and A.Z. Abraha, 2018: Farmers' perception of drought and its socioeconomic impact: the case of Tigray and Afar regions of Ethiopia. *J. Appl. Anim. Res.*, **46**(1), 1023–1031, doi:10.1080/09712119.2018.1450752.

Mergili, M., J.P. Müller and J.F. Schneider, 2013: Spatio-temporal development of high-mountain lakes in the headwaters of the Amu Darya River (Central Asia). *Glob. Planet. Change*, **107**, 13–24, doi:10.1016/j.gloplacha.2013.04.001.

Merrey, D.J., et al., 2018: Evolving high altitude livelihoods and climate change: a study from Rasuwa District, Nepal. *Food Sec.*, **10**(4), 1055–1071, doi:10.1007/s12571-018-0827-y.

Mersha, A.A. and F. Van Laerhoven, 2016: A gender approach to understanding the differentiated impact of barriers to adaptation: responses to climate change in rural Ethiopia. *Reg. Environ. Change*, **16**(6), 1701–1713, doi:10.1007/s10113-015-0921-z.

Mersha, A.A. and F. van Laerhoven, 2018: The interplay between planned and autonomous adaptation in response to climate change: Insights from rural Ethiopia. *World Dev.*, **107**, 87–97, doi:10.1016/j.worlddev.2018.03.001.

Merz, B., et al., 2021: Causes, impacts and patterns of disastrous river floods. *Nat. Rev. Earth Environ.*, **2**(9), 592–609, doi:10.1038/s43017-021-00195-3.

Mhlanga, N., 2014: Sand dams: A sustainable solution for water scarce regions. *International Water Power & Dam Construction*, 24–26.

Michelutti, N., et al., 2015: Climate change forces new ecological states in tropical Andean lakes. *PLoS ONE*, **10**(2), e115338, doi:10.1371/journal.pone.0115338.

Mihiretu, A., E.N. Okoyo and T. Lemma, 2019: Determinants of adaptation choices to climate change in agro-pastoral dry lands of Northeastern Amhara, Ethiopia. *Cogent Environ. Sci.*, **5**(1), doi:10.1080/23311843.2019.1636548.

Mili, B., A. Barua and S. Katyaini, 2017: Climate change and adaptation through the lens of capability approach: A case study from Darjeeling, Eastern Himalaya. In: *Natural Resources Management: Concepts, Methodologies, Tools, and Applications* [Information Resources Management Association (ed.)]. IGI Global, Hershey, Pennsylvania, USA, pp. 1351–1365.

Milman, A. and B.P. Warner, 2016: The interfaces of public and private adaptation: Lessons from flooding in the Deerfield River Watershed. *Glob. Environ. Change*, **36**, 46–55, doi:10.1016/j.gloenvcha.2015.11.007.

Miserendino, M.L., et al., 2018: Biotic diversity of benthic macroinvertebrates at contrasting glacier-fed systems in Patagonia mountains: The role of environmental heterogeneity facing global warming. *Sci. Total. Environ.*, **622–623**, 152–163, doi:10.1016/j.scitotenv.2017.11.320.

Mishra, S.K., et al., 2020: Differential impact of climate change on the hydropower economics of two river basins in high mountain Asia. *Front. Environ. Sci.*, **8**, 26, doi:10.3389/fenvs.2020.00026.

Mkonda, M.Y., X. He and E.S. Festin, 2018: Comparing smallholder farmers' perception of climate change with meteorological data: experience from seven agroecological zones of Tanzania. *Weather Clim. Soc.*, **10**(3), 435–452, doi:10.1175/WCAS-D-17-0036.1.

Mölg, N., et al., 2021: Inventory and evolution of glacial lakes since the Little Ice Age: lessons from the case of Switzerland. *Earth Surf. Process. Landf.*, **46**(13), 2551–2564, doi:10.1002/ESP.5193.

Mölg, T., et al., 2012: Limited forcing of glacier loss through land-cover change on Kilimanjaro. *Nat. Clim. Change*, **2**, 254–258, doi:10.1038/nclimate1390.

Molina, A., et al., 2015: Multidecadal change in streamflow associated with anthropogenic disturbances in the tropical Andes. *Hydrol. Earth Syst. Sci.*, **19**(10), 4201–4213, doi:10.5194/hess-19-4201-2015.

Møller, L.R., et al., 2019: Empirically based analysis of households coping with unexpected shocks in the central Himalayas. *Clim. Dev.*, **11**(7), 597–606, doi :10.1080/17565529.2018.1518812.

Morán-Tejeda, E., et al., 2016: Climate trends and variability in Ecuador (1966–2011). *Int. J. Climatol.*, **36**(11), 3839–3855, doi:10.1002/joc.4597.

Morán-Tejeda, E., et al., 2018: Recent evolution and associated hydrological dynamics of a vanishing tropical Andean glacier: Glaciar de Conejeras, Colombia. *Hydrol. Earth Syst. Sci.*, **22**(10), 5445–5461, doi:10.5194/hess-22-5445-2018.

Morán-Tejeda, E., et al., 2014: Streamflow timing of mountain rivers in Spain: Recent changes and future projections. *J. Hydrol. Reg. Stud.*, **517**, 1114–1127, doi:10.1016/j.jhydrol.2014.06.053.

Moret, P., M.Á. Aráuz, M. Gobbi and Á. Barragán, 2016: Climate warming effects in the tropical Andes: first evidence for upslope shifts of Carabidae (Coleoptera) in Ecuador. *Insect Conserv. Divers.*, **9**(4), 342–350, doi:10.1111/icad.12173.

Moret, P., Á. Barragn, E. Moreno and F. Cauvy, 2020: When the ice has gone: Colonisation of equatorial glacier forelands by ground beetles (Coleoptera: Carabidae). *Neotrop. Entomol.*, **49**(2), 213–226, doi:10.1007/s13744-019-00753-x.

Moroda, G.T., D. Tolossa and N. Semie, 2018: Perception and adaptation strategies of rural people against the adverse effects of climate variability: A case study of Boset District, East Shewa, Ethiopia. *Environ. Dev.*, **27**, 2–13, doi:10.1016/j.envdev.2018.07.005.

Morrison, C. and C. Pickering, 2013a: Limits to climate change adaptation: Case study of the Australian alps: climate change adaptation in Australian alps. *Geogr. Res.*, **51**(1), 11–25, doi:10.1111/j.1745-5871.2012.00758.x.

Morrison, C. and C.M. Pickering, 2013b: Perceptions of climate change impacts, adaptation and limits to adaption in the Australian Alps: the ski-tourism industry and key stakeholders. *J. Sustain. Tour.*, **21**(2), 173–191, doi:10.1080/09669582.2012.681789.

Morueta-Holme, N., et al., 2015: Strong upslope shifts in Chimborazo's vegetation over two centuries since Humboldt. *Proc. Natl. Acad. Sci.*, **112**(41), 12741–12745, doi:10.1073/pnas.1509938112.

Mostowik, K., et al., 2019: Runoff trends in a changing climate in the Eastern Carpathians (Bieszczady Mountains, Poland). *Catena*, **182**, 104174, doi:10.1016/j.catena.2019.104174.

Motschmann, A., et al., 2020: Losses and damages connected to glacier retreat in the Cordillera Blanca, Peru. *Clim. Change*, **162**(2), 1–22, doi:10.1007/s10584-020-02770-x.

Mourey, J. and L. Ravanel, 2017: Evolution of access routes to high mountain refuges of the mer de glace basin (Mont Blanc Massif, France). An example of adapting to climate change effects in the alpine high mountains. *J. Alp. Res.*, **105**(4), doi:10.4000/rga.3790.

Mourey, J., et al., 2019: Access routes to high mountain huts facing climate-induced environmental changes and adaptive strategies in the Western Alps since the 1990s. *Nor. J. Geogr.*, **73**(4), 215–228, doi:10.1080/00291951.2019.1689163.

Moyer, A.N., R.D. Moore and M.N. Koppes, 2016: Streamflow response to the rapid retreat of a lake-calving glacier. *Hydrol. Process.*, **30**(20), 3650–3665, doi:10.1002/hyp.10890.

Mpandeli, S., 2014: Managing climate risks using seasonal climate forecast information in Vhembe district in Limpopo province, South Africa. *J. Sustain. Dev.*, **7**(5), 68, doi:10.5539/jsd.v7n5p68.

Mubiru, D.N., et al., 2018: Climate trends, risks and coping strategies in smallholder farming systems in Uganda. *Clim. Risk Manag.*, **22**, 4–21, doi:10.1016/j.crm.2018.08.004.

Mugambiwa, S.S., 2018: Adaptation measures to sustain indigenous practices and the use of indigenous knowledge systems to adapt to climate change in Mutoko rural district of Zimbabwe. *Jàmbá J. Disaster Risk Stud.*, **10**(1), doi:10.4102/jamba.v10i1.388.

Mugi-Ngenga, E.W., et al., 2016: Household's socio-economic factors influencing the level of adaptation to climate variability in the dry zones of Eastern Kenya. *J. Rural Stud.*, **43**, 49–60, doi:10.1016/j.jrurstud.2015.11.004.

Muita, R.R., F. van Ogtrop, P. Ampt and R.W. Vervoort, 2016: Managing the water cycle in Kenyan small-scale maize farming systems: Part 1. Farmer perceptions of drought and climate variability: Managing the water cycle in Kenyan small-scale maize farming systems. *Wiley Interdiscip. Rev. Water*, **3**(1), 105–125, doi:10.1002/wat2.1118.

Mukwada, G. and D. Manatsa, 2018: Spatiotemporal analysis of the effect of climate change on vegetation health in the DrakensbergMountain region of South Africa. *Environ. Monit. Assess.*, **190**(6), 358, doi:10.1007/s10661-018-6660-0.

Mulinde, C., et al., 2019: Perceived climate risks and adaptation drivers in diverse coffee landscapes of Uganda. *NJAS Wageningen J. Life Sci.*, **88**, 31–44, doi:10.1016/j.njas.2018.12.002.

Müller, J., J. Dame and M. Nüsser, 2020: Urban mountain waterscapes: the transformation of hydro-social relations in the Trans-Himalayan town Leh, Ladakh, India. *Water*, **12**(6), 1698, doi:10.3390/w12061698.

Mulligan, J., et al., 2017: Community-responsive adaptation to flooding in Kibera, Kenya. *Proc. Inst. Civ. Eng. Eng. Sustain.*, **170**(5), 268–280, doi:10.1680/jensu.15.00060.

Munguía-Aldama, J., F. Sánchez-Plata, I. Vizcarra-Bordi and M. Rivas-Guevara, 2015: Strategies for maize production facing the impacts of climate change. *RCS (Ve),* **21**, 538–547.

Munia, H.A., et al., 2020: Future transboundary water stress and its drivers under climate change: a global study. *Earths Future*, **8**(7), doi:10.1029/2019EF001321.

Muntifering, J.R., et al., 2019: Hartmann's mountain zebra resource selection and movement behavior within a large unprotected landscape in northwest Namibia. *Endang. Species Res.*, **38**, 159–170, doi:10.3354/esr00941.

Muricho, D.N., D.J. Otieno, W. Oluoch-Kosura and M. Jirström, 2019: Building pastoralists' resilience to shocks for sustainable disaster risk mitigation: Lessons from West Pokot County, Kenya. *Int. J. Disaster Risk Reduct.*, **34**, 429–435, doi:10.1016/j.ijdrr.2018.12.012.

Muriithi, G.M., et al., 2017: Assessment of vulnerability levels and coping strategies of pastoral communities to climate variability and change: A case study of the West Pokot, Kenya. *Livest. Res. Rural. Dev.*, **29**(9), 183.

Muriu-Ng'ang'a, F.W., M. Mucheru-Muna, F. Waswa and F.S. Mairura, 2017: Socio-economic factors influencing utilisation of rain water harvesting and saving technologies in Tharaka South, Eastern Kenya. *Agric. Water Manag.*, **194**, 150–159, doi:10.1016/j.agwat.2017.09.005.

Murtinho, F., 2016: What facilitates adaptation? An analysis of community-based adaptation to environmental change in the Andes. *Int. J. Commons*, **10**(1), 119–141, doi:10.18352/ijc.585.

Murtinho, F., H. Eakin, D. López-Carr and T.M. Hayes, 2013: Does external funding help adaptation? Evidence from community-based water management in the Colombian Andes. *Environ. Manage.*, **52**(5), 1103–1114, doi:10.1007/s00267-013-0156-z.

Musselman, K.N., et al., 2018: Projected increases and shifts in rain-on-snow flood risk over western North America. *Nat. Clim. Change*, **8**(9), 808–812, doi:10.1038/s41558-018-0236-4.

Musyoki, A., R. Thifhulufhelwi and F.M. Murungweni, 2016: The impact of and responses to flooding in Thulamela Municipality, Limpopo Province, South Africa. *Jàmbá J. Disaster Risk Stud.*, **8**(2), 10, doi:10.4102/jamba.v8i2.166.

Mutandwa, E., B. Hanyani-Mlambo and J. Manzvera, 2019: Exploring the link between climate change perceptions and adaptation strategies among smallholder farmers in Chimanimani district of Zimbabwe. *Int. J. Soc. Econ.*, **46**(7), 850–860, doi:10.1108/IJSE-12-2018-0654.

Mutaqin, D.J., 2019: Determinants of farmers' decisions on risk coping strategies in rural west Java. *Climate*, **7**(1), 7, doi:10.3390/cli7010007.

Muttaqin, Z., A. Yulianti and Karmanah, 2019: Climate village program (ProKlim) in Simurugul Sub-Village, Margawati Village, Garut Kota Sub-Regency, Garut Regency, West Java Province, Indonesia. *IOP Conf. Ser. Earth Environ. Sci.*, **299**, 12046, doi:10.1088/1755-1315/299/1/012046.

Mwakaje, A.G., 2013: The impact of climate change and variability on agro-pastoralists' economy in Tanzania. *Environ. Econ.*, **4**(1), 30–38.

Nagel, L.M., et al., 2017: Adaptive silviculture for climate change: a national experiment in manager-scientist partnerships to apply an adaptation framework. *J. For.*, **115**(3), 167–178, doi:10.5849/jof.16-039.

Nahayo, L., et al., 2017: Early alert and community involvement: approach for disaster risk reduction in Rwanda. *Nat. Hazards*, **86**(2), 505–517, doi:10.1007/s11069-016-2702-5.

Namgay, K., J.E. Millar, R.S. Black and T. Samdup, 2014: Changes in transhumant agro-pastoralism in Bhutan: a disappearing livelihood? *Hum. Ecol.*, **42**, 779–792, doi:10.1007/s10745-014-9684-2.

Nasir, M.J., A.S. Khan and S. Alam, 2018: Climate change and agriculture: an overview of farmers perception and adaptations in Balambat Tehsil, District Dir Lower, Pakistan. *S J. Agric.*, **34**(1), doi:10.17582/journal.sja/2018/34.1.85.92.

Negi, V.S., et al., 2017: Climate change impact in the Western Himalaya: people's perception and adaptive strategies. *J. Mt. Sci.*, **14**(2), 403–416, doi:10.1007/s11629-015-3814-1.

Nematchoua, M.K., P. Ricciardi, J.A. Orosa and C. Buratti, 2018: A detailed study of climate change and some vulnerabilities in Indian Ocean: A case of Madagascar island. *Sustain. Cities Soc.*, **41**, 886–898, doi:10.1016/j.scs.2018.05.040.

Newsham, A., et al., 2018: Ecosystems-based adaptation: Are we being conned? Evidence from Mexico. *Glob. Environ. Change*, **49**, 14–26, doi:10.1016/j.gloenvcha.2018.01.001.

Ng'ang'a, S.K., et al., 2016a: Migration and self-protection against climate change: A case study of Samburu county, Kenya. *World Dev.*, **84**, 55–68, doi:10.1016/j.worlddev.2016.04.002.

Ng'ang'a, S.K., et al., 2016b: Livestock wealth and social capital as insurance against climate risk: A case study of Samburu County in Kenya. *Agric. Syst.*, **146**, 44–54, doi:10.1016/j.agsy.2016.04.004.

Ng'ang'a, S.K., M.T. Van Wijk, M.C. Rufino and K.E. Giller, 2016c: Adaptation of agriculture to climate change in semi-arid Borena, Ethiopia. *Reg. Environ. Change*, **16**(8), 2317–2330, doi:10.1007/s10113-016-0940-4.

Ngigi, M.W., U. Mueller and R. Birner, 2017: Gender differences in climate change adaptation strategies and participation in group-based approaches: An intra-household analysis from rural Kenya. *Ecol. Econ.*, **138**, 99–108, doi:10.1016/j.ecolecon.2017.03.019.

Nguimalet, C.-R., 2018: Comparison of community-based adaptation strategies for droughts and floods in Kenya and the Central African Republic. *Water Int.*, **43**(2), 183–204, doi:10.1080/02508060.2017.1393713.

Nie, Y., et al., 2017: A regional-scale assessment of Himalayan glacial lake changes using satellite observations from 1990 to 2015. *Remote. Sens. Environ.*, **189**, 1–13, doi:10.1016/j.rse.2016.11.008.

Nightingale, A.J., 2018: The socioenvironmental state: Political authority, subjects, and transformative socionatural change in an uncertain world. *Environ. Plan. E Nat. Space*, **1**, 688–711, doi:10.1177/2514848618816467.

Nizami, A., J. Ali and M. Zulfiqar, 2019: Climate change, hydro-meteorological hazards and adaptation for sustainable livelihood in Chitral Pakistan. *Sarhad J. Agric.*, **35**(2), doi:10.17582/journal.sja/2019/35.2.432.441.

Njeru, P.N.M., et al., 2015: Integrating Farmers and Scientific Methods for Evaluating Climate Change Adaptation Options in Embu County. In: *Adapting African Agriculture to Climate Change* [Leal Filho, W., A.O. Esilaba, K.P.C. Rao and G. Sridhar(eds.)]. Springer International Publishing, Cham, pp. 185–197. ISBN 9783319129990978331913000 2.

Nkuba, M., et al., 2019: The effect of climate information in pastoralists' adaptation to climate change: A case study of Rwenzori region, Western Uganda. *Int. J. Clim. Chang. Strateg. Manag.*, **11**(4), 442–464, doi:10.1108/IJCCSM-10-2018-0073.

Nsengiyumva, P., 2019: African mountains in a changing climate: Trends, impacts, and adaptation solutions. *Mt. Res. Dev.*, **39**(2), 1–8, doi:10.1659/MRD-JOURNAL-D-19-00062.1.

Nyaruai, M. A., J. K. Musingi and B. N. Wambua, 2018: The potential of agroforestry as an adaptation strategy to mitigate the impacts of climate change: A Case Study Of Kiine Community, Kenya. *Nusantara Bioscience*, **10**(3), 170–177, doi:10.13057/nusbiosci/n100307.

Nyasimi, M., et al., 2017: Adoption and dissemination pathways for climate-smart agriculture technologies and practices for climate-resilient livelihoods in Lushoto, northeast Tanzania. *Climate*, **5**(3), 63, doi:10.3390/cli5030063.

Nyong, A.P., T.M. Ngankam and T.L. Felicite, 2020: Enhancement of resilience to climate variability and change through agroforestry practices in smallholder farming systems in Cameroon. *Agrofor. Syst.*, **94**(3), 687–705, doi:10.1007/s10457-019-00435-y.

O'Neil, H.C.L., T.D. Prowse, B.R. Bonsal and Y.B. Dibike, 2017: Spatial and temporal characteristics in streamflow-related hydroclimatic variables over western Canada. Part 1: 1950–2010. *Hydrol. Res.*, **48**(4), 915–931, doi:10.2166/nh.2016.057.

Oakes, L.E., N.M. Ardoin and E.F. Lambin, 2016: "I know, therefore I adapt?" Complexities of individual adaptation to climate-induced forest dieback in Alaska. *Ecol. Soc.*, **21**(2), art40, doi:10.5751/ES-08464-210240.

Oettle, N. and B. Koelle, 2016: Poverties and Wealth: Perceptions, Empowerment, and Agency in Sustainable Land Management. In: *Land Restoration*. Elsevier, Amsterdam, pp. 383–404. ISBN 978-0128012314.

Ofoegbu, C., P.W. Chirwa, J. Francis and F.D. Babalola, 2016: Assessing forest-based rural communities' adaptive capacity and coping strategies for climate variability and change: The case of Vhembe district in south Africa. *Environ. Dev.*, **18**, 36–51, doi:10.1016/j.envdev.2016.03.001.

Oladele, O., et al., 2019: Adoption of agro-weather information sources for climate smart agriculture among farmers in Embu and Ada'a districts of Kenya and Ethiopia. *Inf. Dev.*, **35**(4), 639–654, doi:10.1177/0266666918779639.

Ombogoh, D.B., et al., 2018: Enhancing adaptation to climate variability in the East African highlands: a case for fostering collective action among smallholder farmers in Kenya and Uganda. *Clim. Dev.*, **10**(1), 61–72, doi:10.1080/17565529.2016.1174665.

Onyekuru, A.N. and R. Marchant, 2014: Climate change impact and adaptation pathways for forest dependent livelihood systems in Nigeria. *Afr. J. Agric. Res.*, **9**(24), 1819–1832, doi:10.5897/AJAR2013.8315.

Opiyo, F., et al., 2015: Drought adaptation and coping strategies among the Turkana pastoralists of northern Kenya. *Int. J. Disaster Risk Sci.*, **6**(3), 295–309, doi:10.1007/s13753-015-0063-4.

Opiyo, F., et al., 2016: Determinants of perceptions of climate change and adaptation among Turkana pastoralists in northwestern Kenya. *Clim. Dev.*, **8**(2), 179–189, doi:10.1080/17565529.2015.1034231.

Orlove, B., et al., 2019: Framing climate change in frontline communities: anthropological insights on how mountain dwellers in the USA, Peru, and Italy adapt to glacier retreat. *Reg. Environ. Change*, **19**(5), 1295–1309, doi:10.1007/s10113-019-01482-y.

Oruonye, E.D. and A.A. Adebayo, 2015: An assessment of the level of farmers awareness and adaptation to climate change in northern Taraba state, Nigeria. *J. Soc. Sci. Res.*, **1**(7), 79–85.

Oxfam, Jassogne, L., P. Laderach and P. van Asten, 2013: *The Impacts of Climate Change on Coffee in Uganda: Lessons From a Case Study in the Rwenxori Mountains*. CIAT, IITA-Uganda, Oxfam, Oxford, UK. 16 pp.

Pabón-Caicedo, J., 2012: Cambio Climático en Colombia: Tendencias en la segunda mitad sel siglo XX y Escenarios posibles para el siglo XXI. *Rev. Acad. Colomb. Cienc. Ex. Fís. Nat.*, **36**(139), 261–278.

Pabón-Caicedo, J.D., et al., 2020: Observed and projected hydroclimate changes in the andes. *Front. Earth Sci.*, **8**, doi:10.3389/feart.2020.00061.

Padigala, B., 2015: Social Capital and Local Institutions: A Perspective to Assess Communities Adaptation Potential to Climate Change. In: *Handbook of Climate Change Adaptation* [Leal Filho, W.(ed.)]. Springer, Berlin, Heidelberg, pp. 1927–1950. ISBN 9783642386695978364238669597836423867 01.

Paerregaard, K., 2013: Bare rocks and fallen angels: environmental change, climate perceptions and ritual practice in the Peruvian Andes. *Religions*, **4**(2), 290–305, doi:10.3390/rel4020290.

Paerregaard, K., 2018: The climate-development nexus: using climate voices to prepare adaptation initiatives in the Peruvian Andes. *Clim. Dev.*, **10**(4), 360–368, doi:10.1080/17565529.2017.1291400.

Palanisami, K., K.R. Kakumanu, C.R. Ranganathan and N. Udaya Sekhar, 2015: Farm-level cost of adaptation and expected cost of uncertainty associated with climate change impacts in major river basins in India. *Int. J. Clim. Chang. Strateg. Manag.*, **7**(1), 76–96, doi:10.1108/IJCCSM-04-2013-0059.

Palframan, A., 2015: "In common nature": an ethnography of climate adaptation in the Lesotho Highlands. *Local Environ.*, **20**(12), 1531–1546, doi:10.1080/13549839.2014.911268.

Panayotov, M., et al., 2016: Climate extremes during high competition contribute to mortality in unmanaged self-thinning Norway spruce stands in Bulgaria. *For. Ecol. Manag.*, **369**, 74–88, doi:10.1016/j.foreco.2016.02.033.

Pandey, A., N. Pradhan, S. Chaudhari and R. Ghate, 2017a: Withering of traditional institutions? An institutional analysis of the decline of migratory pastoralism in the rangelands of the Kailash Sacred Landscape, western Himalayas. *Environ. Sociol.*, **3**(1), 87–100, doi:10.1080/23251042.2016.1272179.

Pandey, R., et al., 2017b: Agroecology as a climate change adaptation strategy for smallholders of Tehri-Garhwal in the Indian Himalayan region. *Small-scale For.*, **16**, 53–63, doi:10.1007/s11842-016-9342-1.

Pandey, R., et al., 2018: Climate change adaptation in the western-Himalayas: Household level perspectives on impacts and barriers. *Ecol. Indic.*, **84**, 27–37, doi:10.1016/j.ecolind.2017.08.021.

Pandey, S.S., G. Cockfield and T.N. Maraseni, 2016: Assessing the roles of community forestry in climate change mitigation and adaptation: A case study from Nepal. *For. Ecol. Manag.*, **360**, 400–407, doi:10.1016/j.foreco.2015.09.040.

Pandit, A., et al., 2016: Community Perceptions and Responses to Climate Variability: Insights from the Himalayas. In: *Climate Change Adaptation Strategies – An Upstream-downstream Perspective* [Salzmann, N., C. Huggel, S.U. Nussbaumer and G. Ziervogel(eds.)]. Springer International Publishing, Cham, pp. 179–194. ISBN 9783319407715978331940771 5.

Paprotny, D., A. Sebastian, O. Morales-Nápoles and S.N. Jonkman, 2018: Trends in flood losses in Europe over the past 150 years. *Nat. Commun.*, **9**(1), 1–12, doi:10.1038/s41467-018-04253-1.

Paraiso, A.A., et al., 2012: Perceptions and adaptations of beekepers and honey hunters to climate change: the case of the communes of Nattitingou and Tanguieta in northwest of Benin. *Afr.Crop. Sci. J.*, **20**, 523–532.

Paranunzio, R., et al., 2016: Climate anomalies associated with the occurrence of rockfalls at high-elevation in the Italian Alps. *Nat. Hazards Earth Syst. Sci.*, **16**(9), 2085–2106, doi:10.5194/nhess-16-2085-2016.

Parraguez-Vergara, E., J.R. Barton and G. Raposo-Quintana, 2016: Impacts of climate change in the andean foothills of Chile: economic and cultural vulnerability of indigenous Mapuche livelihoods. *J. Dev. Soc.*, **32**(4), 454–483, doi:10.1177/0169796X16667874.

Pellicciotti, F., A. Bauder and M. Parola, 2010: Effect of glaciers on streamflow trends in the Swiss Alps. *Water Resour. Res.*, **46**(10), doi:10.1029/2009WR009039.

Penot, E., V. Fevre, P. Flodrops and H.M. Razafimahatratra, 2018: Conservation Agriculture to buffer and alleviate the impact of climatic variations in Madagascar: farmers' perception. *Cah. Agric.*, **27**(2), 25003, doi:10.1051/cagri/2018009.

Peñuelas, J., et al., 2017: Impacts of global change on mediterranean forests and their services. *Forests*, **8**(12), 463, doi:10.3390/f8120463.

Pepin, N., et al., 2015: Elevation-dependent warming in mountain regions of the world. *Nat. Clim. Change*, **5**(5), 424–430, doi:10.1038/nclimate2563.

Pepin, N.C., et al., 2014: Measuring and modeling the retreat of the summit ice fields on Kilimanjaro, east Africa. *Arct. Antarct. Alp. Res.*, **46**, 905–917, doi:10.1657/1938-4246-46.4.905.

Perini, K. and P. Sabbion, 2016: Green-blue infrastructure in urban areas, the case of the Bronx River (NYC) and Paillon (Nice). *TECHNE J. Technol. Archit. Environ.*, **11**, 97–103, doi:10.13128/TECHNE-18407.

Petley, D.N., 2010: On the impact of climate change and population growth on the occurrence of landslides in Asia. *Q. J. Eng. Geol. Hydrogeol.*, **43**(4), 487–496, doi:10.1144/1470-9236/09-001.

Petley, D.N., et al., 2007: Trends in landslide occurence in Nepal. *Nat. Hazards*, **43**(1), 23–44, doi:10.1007/s11069-006-9100-3.

Phillips, M., et al., 2017: Rock slope failure in a recently deglaciated permafrost rock wall at Piz Kesch (Eastern Swiss Alps), February 2014. *Earth Surf. Process. Landf.*, **42**(3), 426–438, doi:10.1002/esp.3992.

Picketts, I. M., 2015: Practitioners, priorities, plans, and policies: assessing climate change adaptation actions in a Canadian community. *Sustainability Science*, **10**(3), 503–513, doi:10.1007/s11625-014-0271-7.

Picketts, I.M., J. Curry, S.J. Déry and S.J. Cohen, 2013: Learning with practitioners: climate change adaptation priorities in a Canadian community. *Clim. Change*, **118**(2), 321–337, doi:10.1007/s10584-012-0653-8.

Piya, L., K.L. Maharjan and N.P. Joshi, 2013: Determinants of adaptation practices to climate change by Chepang households in the rural Mid-Hills of Nepal. *Reg. Environ. Change*, **13**(2), 437–447, doi:10.1007/s10113-012-0359-5.

Polk, M.H., et al., 2017: Exploring hydrologic connections between tropical mountain wetlands and glacier recession in Peru's Cordillera Blanca. *Appl. Geogr.*, **78**, 94–103, doi:10.1016/j.apgeog.2016.11.004.

Postigo, J.C., 2014: Perception and resilience of Andean populations facing climate change. *J. Ethnobiol.*, **34**(3), 383–400, doi:10.2993/0278-0771-34.3.383.

Poudel, D.D., 2015: Factors associated with farm-level variation, and farmers' perception and climate change adaptation in smallholder mixed-farming livestock production system in Nepal. *Int. J. Environ. Sustain. Dev.*, **14**(3), 231, doi:10.1504/IJESD.2015.070134.

Poudel, D.D. and T.W. Duex, 2017: Vanishing springs in Nepalese mountains: assessment of water sources, farmers' perceptions, and climate change adaptation. *Mt. Res. Dev.*, **37**(1), 35, doi:10.1659/MRD-JOURNAL-D-16-00039.1.

Poudel, J.M., 2018: Pond becomes a lake: challenges posed by climate change in the Trans-Himalayan regions of Nepal. *J. For. Livelihood*, **16**(1), 87–102, doi:10.3126/jfl.v16i1.22884.

Poudel, S., S. Funakawa and H. Shinjo, 2017: Household perceptions about the impacts of climate change on food security in the mountainous region of Nepal. *Sustainability*, **9**(4), 641, doi:10.3390/su9040641.

Poulsen, C. and T. Hoffman, 2015: Changes in the distribution of indigenous forest in Table Mountain National Park during the 20th century. *S. Afr. Bot.*, **101**, 49–56, doi:10.1016/j.sajb.2015.05.002.

Powell, R.F., 2013: *Long-Term Vegetation Change in the Cape of Good Hope Section of Table Mountain National Park, in Response to Climate, Fire and Land Use*. University of Cape Town, Cape Town, South Africa.

Pradhan, N.S., S. Sijapati and S.R. Bajracharya, 2015: Farmers' responses to climate change impact on water availability: insights from the Indrawati Basin in Nepal. *Int. J. Water Resour. Dev.*, **31**(2), 269–283, doi:10.1080/07900627.2015.1033514.

Prasain, S., 2018: Climate change adaptation measure on agricultural communities of Dhye in Upper Mustang, Nepal. *Clim. Change*, **148**(1), 279–291, doi:10.1007/s10584-018-2187-1.

Prinz, R., et al., 2018: Mapping the loss of Mt. Kenya's glaciers: An example of the challenges of satellite monitoring of very small glaciers. *Geosciences*, **8**(5), 174, doi:10.3390/geosciences8050174.

Prinz, R., et al., 2016: Climatic controls and climate proxy potential of Lewis glacier, Mt. Kenya. *Cryosphere*, **10**, 133–148, doi:10.5194/tc-10-133-2016.

Pröbstl-Haider, U., K. Dabrowska and W. Haider, 2016: Risk perception and preferences of mountain tourists in light of glacial retreat and permafrost degradation in the Austrian Alps. *J. Outdoor Recreat. Tour.*, **13**, 66–78, doi:10.1016/j.jort.2016.02.002.

Pröbstl-Haider, U., C. Hödl, K. Ginner and F. Borgwardt, 2020: Climate change: Impacts on outdoor activities in the summer and shoulder seasons. *J. Outdoor Recreat. Tour.*, **100344**, doi:10.1016/j.jort.2020.100344. In Press.

Puenayán Irua, Z.P., 2011: Percepción del cambio climático para los pastos del resguardo Panán, Nariño, Colombia. In: *Perspectivas culturales del clima* [Ulloa, A.(ed.)]. ILSA/Universidad Nacional de Colombia, Bogota, Colombia, pp. 275–313. ISBN 978-9587197358.

Pulhin, J., R.J. Peras, F. Pulhin and D. Gevaña, 2016: Farmers' adaptation to climate variability: assessment of effectiveness and barriers based on local experience in southern Philippines. *J. Environ. Sci. Manag.*, **2016,** 1–14.

Qin, Z., et al., 2017: Adaptation needs of farmers to climate change in an ecologically vulnerable alpine region: take Gannan Plateau for example. *Acta Ecol. Sin.*, **37**(5), doi:10.5846/stxb201510112054.

Quandt, A. and Y.A. Kimathi, 2017: Perceptions of the effects of floods and droughts on livelihoods: lessons from arid Kenya. *Int. J. Clim. Chang. Strateg. Manag.*, **9**(3), 337–351, doi:10.1108/IJCCSM-11-2014-0132.

Quandt, A., H. Neufeldt and J.T. McCabe, 2017: The role of agroforestry in building livelihood resilience to floods and drought in semiarid Kenya. *Ecol. Soc.*, **22**(3), art10, doi:10.5751/ES-09461-220310.

Quandt, A., H. Neufeldt and J.T. McCabe, 2019: Building livelihood resilience: what role does agroforestry play? *Clim. Dev.*, **11**(6), 485–500, doi:10.1080/17565529.2018.1447903.

Quijano Vodniza, A.J. and L.E. García García, 2018: Effects of climate change on the Quillacingas ethnic group. *Rev. Luna Azul*, **47**(47), 196–220, doi:10.17151/luaz.2019.47.11.

Quintero-Herrera, L.L., et al., 2015: Potential impact of climatic variability on the epidemiology of dengue in Risaralda, Colombia, 2010–2011. *J. Infect. Public Health*, **8**(3), 291–297, doi:10.1016/j.jiph.2014.11.005.

Rabatel, A., et al., 2018: Toward an imminent extinction of Colombian glaciers? *Geogr. Ann. Ser. A Phys. Geogr.*, **100**(1), 75–95, doi:10.1080/04353676.2017.1383015.

Raftoyannis, Y., et al., 2014: Perceptions of forest experts on climate change and fire management in European mediterranean forests. *IForest Biogeosci. For.*, **7**(1), 33–41, doi:10.3832/ifor0817-006.

Raghuvanshi, M.S., et al., 2017: Struggle from subsistence to sustainability and threat to local biodiversity under changing climate: A case study on Ladakh folk agriculture. *Clim. Chang. Environ. Sustain.*, **5**(1), 59, doi:10.5958/2320-642x.2017.00006.0.

Rahn, E., et al., 2018: Opportunities for sustainable intensification of coffee agro-ecosystems along an altitudinal gradient on Mt. Elgon, Uganda. *Agric. Ecosyst. Environ.*, **263**, 31–40, doi:10.1016/j.agee.2018.04.019.

Rahut, D.B. and A. Ali, 2017: Coping with climate change and its impact on productivity, income, and poverty: Evidence from the Himalayan region of Pakistan. *Int. J. Disaster Risk Reduct.*, **24**, 515–525, doi:10.1016/j.ijdrr.2017.05.006.

Rai, R.K., L.D. Bhatta, U. Acharya and A.P. Bhatta, 2018: Assessing climate-resilient agriculture for smallholders. *Environ. Dev.*, **27**, 26–33, doi:10.1016/j.envdev.2018.06.002.

Rai, R.K., et al., 2019: Economics of climate adaptive water management practices in Nepal. *Heliyon*, **5**(5), e1668, doi:10.1016/j.heliyon.2019.e01668.

Rakotobe, Z.L., et al., 2016: Strategies of smallholder farmers for coping with the impacts of cyclones: A case study from Madagascar. *Int. J. Disaster Risk Reduct.*, **17**, 114–122, doi:10.1016/j.ijdrr.2016.04.013.

Ramos García, C., A.D. Tenorio and F. Muñoz Yule, 2011: Ciclos naturales, ciclos culturales: percepción y conocimientos tradicionales de los nasas frente al cambio climático en Toribio, Cauca, Colombia. In: *Perspectivas culturales del clima* [Ulloa, A.(ed.)]. ILSA/Universidad Nacional de Colombia, Bogota, Colombia,, pp. 247–273. ISBN 978-9587197358.

Ranjbar, Z., M. Chizari, H. Sadighi and H. Farhadian, 2019: Extension services and behavioral strategies of farmers to deal with risk. *International Journal of Scientific & Technology Research*, **8**(8), 269–274.

Rankoana, S., 2016a: Perceptions of climate change and the potential for adaptation in a rural community in Limpopo province, South Africa. *Sustainability*, **8**(8), 672, doi:10.3390/su8080672.

Rankoana, S.A., 2016b: Rainfall scarcity and its impacts on subsistence farming: the role of gender and religious rituals in adaptation to change. *Agenda*, **30**(3), 124–131, doi:10.1080/10130950.2016.1259867.

Raoul, K., 2015: Can glacial retreat lead to migration? A critical discussion of the impact of glacier shrinkage upon population mobility in the Bolivian Andes. *Popul. Environ.*, **36**(4), 480–496, doi:10.1007/s11111-014-0226-z.

Rasmussen, M.B., 2019: Rewriting conservation landscapes: protected areas and glacial retreat in the high Andes. *Reg. Environ. Change*, **19**(5), 1371–1385, doi:10.1007/s10113-018-1376-9.

Rasul, G., B. Pasakhala, A. Mishra and S. Pant, 2020: Adaptation to mountain cryosphere change: issues and challenges. *Clim. Dev.*, **12**(4), 297–309, doi:10.1080/17565529.2019.1617099.

Ravanel, L. and P. Deline, 2011: Climate influence on rockfalls in high-Alpine steep rockwalls: The north side of the Aiguilles de Chamonix (Mont Blanc massif) since the end of the "Little Ice Age". *Holocene*, **21**(2), 357–365, doi:10.1177/0959683610374887.

Ravanel, L., F. Magin and P. Deline, 2017: Impacts of the 2003 and 2015 summer heatwaves on permafrost-affected rock-walls in the Mont Blanc massif. *Sci. Total. Environ.*, **609**, 132–143, doi:10.1016/j.scitotenv.2017.07.055.

Ravera, F., et al., 2016: Gender perspectives in resilience, vulnerability and adaptation to global environmental change. *Ambio*, **45**(3), 235–247, doi:10.1007/s13280-016-0842-1.

Ravera, F., et al., 2019: Gendered agrobiodiversity management and adaptation to climate change: differentiated strategies in two marginal rural areas of India. *Agric. Hum. Values*, **36**(3), 455–474, doi:10.1007/s10460-018-09907-w.

Rawat, J.S., et al., 2016: Perennial to ephemeral transformation of a lesser Himalayan watershed. *Curr. Sci.*, **111**(4), 686–693, doi:10.18520/cs/v111/i4/686-693.

Recha, C.W., M.N. Mukopi and J.O. Otieno, 2015: Socio-economic determinants of adoption of rainwater harvesting and conservation techniques in semi-arid Tharaka sub-county, Kenya. *Land Degrad. Dev.*, **26**(7), 765–773, doi:10.1002/ldr.2326.

Reggiani, P., B. Mukhopadhyay, T.H.M. Rientjes and A. Khan, 2017: A joint analysis of river runoff and meteorological forcing in the Karakoram, upper Indus Basin. *Hydrol. Process.*, **31**(2), 409–430, doi:10.1002/hyp.11038.

Reggiani, P. and T.H.M. Rientjes, 2015: A reflection on the long-term water balance of the Upper Indus Basin. *Hydrol. Res.*, **46**(3), 446–462, doi:10.2166/nh.2014.060.

Regmi, B.R., C. Star, A. Paudyal and R.C. Karki, 2015: Strengthening Climate Change Adaptation in Nepal: Needs and Perspectives. In: *Climate Change in the Asia-Pacific Region* [Leal Filho, W.(ed.)]. Springer International Publishing, Cham, pp. 245–262. ISBN 9783319149370978331914937 0.

Reichel, C. and U. U. Frömming, 2014: Participatory mapping of local disaster risk reduction knowledge: an example from Switzerland. *Int. J. Disaster Risk Sci.*, **5**(1), 41–54, doi:10.1007/s13753-014-0013-6.

Reinfelds, I., et al., 2014: Hydrospatial assessment of streamflow yields and effects of climate change: Snowy Mountains, Australia. *J. Hydrol. Reg. Stud.*, **512**, 206–220, doi:10.1016/j.jhydrol.2014.02.038.

Reyer, C.P.O., et al., 2017: Climate change impacts in Central Asia and their implications for development. *Reg. Environ. Change*, **17**(6), 1639–1650, doi:10.1007/s10113-015-0893-z.

Reyers, B., et al., 2015: Navigating complexity through knowledge coproduction: Mainstreaming ecosystem services into disaster risk reduction. *Proc. Natl. Acad. Sci.*, **112**(24), 7362–7368, doi:10.1073/pnas.1414374112.

Rezaei, A., M. Salmani, F. Razaghi and M. Keshavarz, 2017: An empirical analysis of effective factors on farmers adaptation behavior in water scarcity conditions in rural communities. *Int. Soil Water Conserv. Res.*, **5**(4), 265–272, doi:10.1016/j.iswcr.2017.08.002.

Risvoll, C. and G.K. Hovelsrud, 2016: Pasture access and adaptive capacity in reindeer herding districts in Nordland, Northern Norway. *Polar J.*, **6**(1), 87–111, doi:10.1080/2154896X.2016.1173796.

Rivera, J. and V. Clement, 2019: Business adaptation to climate change: American ski resorts and warmer temperatures. *Bus. Strat. Env.*, **28**(7), 1285–1301, doi:10.1002/bse.2316.

Rivera-Ferre, M.G., et al., 2016: Local agriculture traditional knowledge to ensure food availability in a changing climate: revisiting water management practices in the Indo-Gangetic Plains. *Agroecol. Sustain. Food Syst.*, **40**(9), 965–987, doi:10.1080/21683565.2016.1215368.

Rodas-Trejo, J., et al., 2017: Impacts and adaptations to the effects of climate change: A case study in a cattle community in Chiapas, Mexico. *Rev. Electron. Vet.*, **18,** 10.

Rolando, J.L., et al., 2017: Key ecosystem services and ecological intensification of agriculture in the tropical High-Andean Puna as affected by land-use and climate changes. *Agric. Ecosyst. Environ.*, **236**, 221–233, doi:10.1016/j.agee.2016.12.010.

Rondón-Krummheuer, A., C. Gruening and C. Jungfleisch, 2015: Microfinance for ecosystem-based adaptation (MEbA) in Peru and Colombia. *Enterp. Dev. Microfinance*, **26**(3), 274–291, doi:10.3362/1755-1986.2015.024.

Rood, S.B., et al., 2017: Increasing discharge from the Mackenzie river system to the Arctic Ocean. *Hydrol. Process.*, **31**(1), 150–160, doi:10.1002/hyp.10986.

Rose, A.N., et al., 2020: *LandScan 2019* [Laboratory, O. R. N. (ed.)]. Oak Ridge, Tennessee, USA.

Rottler, E., T. Francke, G. Bürger and A. Bronstert, 2020: Long-term changes in central European river discharge for 1869–2016: impact of changing snow covers, reservoir constructions and an intensified hydrological cycle. *Hydrol. Earth Syst. Sci.*, **24**(4), 1721–1740, doi:10.5194/hess-24-1721-2020.

Rouabhi, A., M. Hafsi and P. Monneveux, 2019: Climate change, its perception by farmers and effects on the farming systems in the region of Setif (Algeria). *J. Agric. Environ. Int. Dev.*, **113**(1), doi:10.12895/jaeid.20191.928.

Rouabhi, A., A. Mekhlouf, S. Mokhneche and N. Elkolli, 2016: Farming transitions under socioeconomic and climatic constraints in the southern part of Sétif, Algeria. *J. Agric. Environ. Int. Dev.*, **110**(1), doi:10.12895/jaeid.20161.429.

Rovin, K., K. Hardee and A. Kidanu, 2013: Linking population, fertility, and family planning with adaptation to climate change: perspectives from Ethiopia. *Afr. J. Reprod. Health*, **17**(3), 15–29.

Ruiz, L., et al., 2017: Recent geodetic mass balance of Monte Tronador glaciers, northern Patagonian Andes. *Cryosphere*, **11**(1), 619–634, doi:10.5194/tc-11-619-2017.

Rutty, M., et al., 2015: The geography of skier adaptation to adverse conditions in the Ontario ski market: Geography of skier adaptation. *Can. Geogr.*, **59**(4), 391–403, doi:10.1111/cag.12220.

Rymbai, D. and F.M. Sheikh, 2018: The insight of agricultural adaptation to climate change: a case of rice growers in Eastern Himalaya, India. *Int. J. Biometeorol.*, **62**(10), 1833–1845, doi:10.1007/s00484-018-1586-3.

Saalu, F.N., S. Oriaso and B. Gyampoh, 2020: Effects of a changing climate on livelihoods of forest dependent communities: Evidence from Buyangu community proximal to Kakamega tropical rain forest in Kenya. *Int. J. Clim. Chang. Strateg. Manag.*, **12**, 1–21, doi:10.1108/IJCCSM-01-2018-0002.

Saavedra, F.A., S.K. Kampf, S.R. Fassnacht and J.S. Sibold, 2018: Changes in Andes snow cover from MODIS data, 2000–2016. *Cryosphere*, **12**(3), 1027–1046, doi:10.5194/tc-12-1027-2018.

Saboohi, R., et al., 2019: Nomads' indigenous knowledge and their adaptation to climate changes in Semirom City in Central Iran. *Theor. Appl. Climatol.*, **137**(1–2), 1377–1384, doi:10.1007/s00704-018-2665-4.

Sada, R., A. Shrestha, A. Kumar Shukla and L. Anna Melsen, 2014: People's experience and facts of changing climate: impacts and responses. *Int. J. Clim. Chang. Strateg. Manag.*, **6**(1), 47–62, doi:10.1108/IJCCSM-04-2013-0047.

Said, M., H.C. Komakech, L.K. Munishi and A.N.N. Muzuka, 2019: Evidence of climate change impacts on water, food and energy resources around Kilimanjaro, Tanzania. *Reg. Environ. Change*, **19**, 2521–2534, doi:10.1007/s10113-019-01568-7.

Sain, G., et al., 2017: Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. *Agric. Syst.*, **151**, 163–173, doi:10.1016/j.agsy.2016.05.004.

Salat, M. and B. Swallow, 2018: Resource use efficiency as a climate smart approach: case of smallholder maize farmers in Nyando, Kenya. *Environments*, **5**(8), 93, doi:10.3390/environments5080093.

Salick, J., B. Staver and R. Hart, 2020: Indigenous Knowledge and Dynamics among Himalayan Peoples, Vegetation, and Climate Change. In: *Changing Climate, Changing Worlds: Local Knowledge and the Challenges of Social and Ecological Change* [Welch-Devine, M., A. Sourdril and B.J. Burke(eds.)]. Springer, Cham, Switzerland, pp. 55–69. ISBN 978-3030373115.

Salim, E. and L. Ravanel, 2020: Last chance to see the ice: visitor motivation at Montenvers-Mer-de-Glace, French Alps. *Tour. Geogr.*, doi:10.1080/14616688.2020.1833971.

Sanderson, M.R. and A.L. Curtis, 2016: Culture, climate change and farm-level groundwater management: An Australian case study. *J. Hydrol. Reg. Stud.*, **536**, 284–292, doi:10.1016/j.jhydrol.2016.02.032.

Sandholz, S., W. Lange and U. Nehren, 2018: Governing green change: Ecosystem-based measures for reducing landslide risk in Rio de Janeiro. *Int. J. Disaster Risk Reduct.*, **32**, 75–86, doi:10.1016/j.ijdrr.2018.01.020.

Sangeda, A., D. Maleko and E.J. Mtengeti, 2013: Socio-economic and ecological dimensions of climate variability and change for agro-pastoral communities in central Tanzania. *Livest. Res. Rural. Dev.*, **25,** 209. .

Sansilvestri, R., N. Frascaria-Lacoste and J. Fernández-Manjarrés, 2016: One option, two countries, several strategies: subjacent mechanisms of assisted migration implementation in Canada and France: Implementation issues of assisted migration. *Restor. Ecol.*, **24**(4), 489–498, doi:10.1111/rec.12343.

Santofimia, E., et al., 2017: Acid rock drainage in Nevado Pastoruri glacier area (Huascarán National Park, Perú): hydrochemical and mineralogical characterization and associated environmental implications. *Environ. Sci. Pollut. Res.*, **24**(32), 25243–25259, doi:10.1007/s11356-017-0093-0.

Sapkota, P., R.J. Keenan and H.R. Ojha, 2019: Co-evolving dynamics in the social-ecological system of community forestry—prospects for ecosystem-based adaptation in the Middle Hills of Nepal. *Reg. Environ. Change*, **19**(1), 179–192, doi:10.1007/s10113-018-1392-9.

Sapkota, P., R.J. Keenan, J.-A. Paschen and H.R. Ojha, 2016: Social production of vulnerability to climate change in the rural middle hills of Nepal. *J. Rural Stud.*, **48**, 53–64, doi:10.1016/j.jrurstud.2016.09.007.

Sarkar, S., et al., 2015: Assessing the potential of Indigenous Technological Knowledge (ITK) for adaptation to climate change in the Himalayan and Arid ecosystems. *Indian J. Tradit. Knowl.*, **14**(2), 7.

Sarmiento-Soler, A., et al., 2019: Water use of Coffea arabica in open versus shaded systems under smallholder's farm conditions in Eastern Uganda. *Agric For Meteorol*, **266–267**, 231–242, doi:10.1016/j.agrformet.2018.12.006.

Satgé, F., et al., 2017: Role of climate variability and human activity on Poopó lake droughts between 1990 and 2015 assessed using remote sensing data. *Remote Sens.*, **9**(3), 218, doi:10.3390/rs9030218.

Sayre, M., T. Stenner and A. Argumedo, 2017: You can't grow potatoes in the sky: Building resilience in the face of climate change in the potato park of Cuzco, Peru. *Cult. Agric. Food Environ.*, **39**(2), 100–108, doi:10.1111/cuag.12100.

Schattman, R.E., D. Conner and V.E. Méndez, 2016: Farmer perceptions of climate change risk and associated on-farm management strategies in Vermont, northeastern United States. *Elem. Sci. Anthr.*, **4**, 131, doi:10.12952/journal.elementa.000131.

Schattman, R.E., V.E. Méndez, S.C. Merrill and A. Zia, 2018: Mixed methods approach to understanding farmer and agricultural advisor perceptions of climate change and adaptation in Vermont, United States. *Agroecol. Sustain. Food Syst.*, **42**(2), 121–148, doi:10.1080/21683565.2017.1357667.

Schauwecker, S., et al., 2014: Climate trends and glacier retreat in the Cordillera Blanca, Peru, revisited. *Glob. Planet. Change*, **119**, 85–97, doi:10.1016/j.gloplacha.2014.05.005.

Schlögl, M. and C. Matulla, 2018: Potential future exposure of European land transport infrastructure to rainfall-induced landslides throughout the 21st century. *Nat. Hazards Earth Syst. Sci.*, **18**(4), 1121–1132, doi:10.5194/nhess-18-1121-2018.

Schumacher, B.L., 2018: *Farmer Perceptions of Climate Change and Variability in Villages Adjacent to the Udzungwa Mountains National Park, Tanzania*. UC Santa Barbara, Santa Barbara, USA.

Seebauer, S. and P. Babcicky, 2018: Trust and the communication of flood risks: comparing the roles of local governments, volunteers in emergency services, and neighbours: Trust and the communication of flood risks. *J. Flood Risk Manag.*, **11**(3), 305–316, doi:10.1111/jfr3.12313.

Seiler, C., R.W.A. Hutjes and P. Kabat, 2013: Climate variability and trends in bolivia. *J. Appl. Meteorol. Climatol.*, **52**(1), 130–146, doi:10.1175/JAMC-D-12-0105.1.

Seim, A., et al., 2016: Climate change increases drought stress of juniper trees in the mountains of central asia. *PLoS ONE*, **11**(4), e153888, doi:10.1371/journal.pone.0153888.

Seimon, T.A., et al., 2007: Upward range extension of Andean anurans and chytridiomycosis to extreme elevations in response to tropical deglaciation. *Glob. Change Biol*, **13**(1), 288–299.

Sen, S.M. and A. Kansal, 2019: Achieving water security in rural Indian Himalayas: A participatory account of challenges and potential solutions. *J. Environ. Manag.*, **245**, 398–408, doi:10.1016/j.jenvman.2019.05.132.

Sezen, C., M. Šraj, A. Medved and N. Bezak, 2020: Investigation of rain-on-snow floods under climate change. *Appl. Sci.*, **10**(4), doi:10.3390/app10041242.

Shah, A.A., J. Ye, M. Abid and R. Ullah, 2017: Determinants of flood risk mitigation strategies at household level: a case of Khyber Pakhtunkhwa (KP) province, Pakistan. *Nat. Hazards*, **88**(1), 415–430, doi:10.1007/s11069-017-2872-9.

Sharif, J., 2019: CLIMATE CHANGE PERCEPTIONS AND ADAPTIVE ACTIONS BY PASTORAL COMMUNITY ON THE TIBETAN PLATEAU, CHINA. *Appl. Ecol. Environ. Res.*, **17**(4), doi:10.15666/aeer/1704_79878009.

Sharma, G., et al., 2016: Declining large-cardamom production systems in the Sikkim Himalayas: Climate change impacts, agroeconomic potential, and revival strategies. *Mt. Res. Dev.*, **36**(3), 286–298, doi:10.1659/MRD-JOURNAL-D-14-00122.1.

Sharma, R.K. and D.G. Shrestha, 2016: Climate perceptions of local communities validated through scientific signals in Sikkim Himalaya, India. *Environ Monit. Assess.*, **188**, 578, doi:10.1007/s10661-016-5582-y.

Shen, Y.-J., et al., 2018: Trends and variability in streamflow and snowmelt runoff timing in the southern Tianshan Mountains. *J. Hydrol.*, **557**, 173–181, doi:10.1016/j.jhydrol.2017.12.035.

Sherpa, P.Y., 2015: Institutional Climate Change Adaptation Efforts Among the Sherpas of the Mount Everest Region, Nepal. In: *Research in Economic Anthropology* [Wood, D.C.(ed.)]. Emerald Group Publishing Limited, Bingley, pp. 1–23. ISBN 9781785603179781785603600.

Sherry, J., A. Curtis, E. Mendham and E. Toman, 2018: Cultural landscapes at risk: exploring the meaning of place in a sacred valley of Nepal. *Glob. Environ. Change*, **52**(July), 190–200, doi:10.1016/j.gloenvcha.2018.07.007.

Shijin, W. and Q. Dahe, 2015: Mountain inhabitants' perspectives on climate change, and its impacts and adaptation based on temporal and spatial characteristics analysis: a case study of Mt. Yulong Snow, Southeastern

Tibetan Plateau. *Environ. Hazards*, **14**(2), 122–136, doi:10.1080/17477891.2014.1003776.

Shikuku, K.M., et al., 2017: Smallholder farmers' attitudes and determinants of adaptation to climate risks in East Africa. *Clim. Risk Manag.*, **16**, 234–245, doi:10.1016/j.crm.2017.03.001.

Shinbrot, X.A., et al., 2019: Smallholder farmer adoption of climate-related adaptation strategies: The importance of vulnerability context, livelihood assets, and climate perceptions. *Environ. Manage.*, **63**(5), 583–595, doi:10.1007/s00267-019-01152-z.

Shisanya, S. and P. Mafongoya, 2016: Adaptation to climate change and the impacts on household food security among rural farmers in uMzinyathi District of Kwazulu-Natal, South Africa. *Food Sec.*, **8**(3), 597–608, doi:10.1007/s12571-016-0569-7.

Shrestha, A., D. Roth and D. Joshi, 2018: Flows of change: dynamic water rights and water access in peri-urban Kathmandu. *Ecol. Soc.*, **23**(2), art42, doi:10.5751/ES-10085-230242.

Shrestha, R., N. Chaweewan and S. Arunyawat, 2017: Adaptation to climate change by rural ethnic communities of northern Thailand. *Climate*, **5**(3), 57, doi:10.3390/cli5030057.

Shrestha, R.P. and N. Nepal, 2016: An assessment by subsistence farmers of the risks to food security attributable to climate change in Makwanpur, Nepal. *Food Sec.*, **8**(2), 415–425, doi:10.1007/s12571-016-0554-1.

Shrestha, U.B. and B.B. Shrestha, 2019: Climate change amplifies plant invasion hotspots in Nepal. *Divers. Distrib.*, **25**(10), 1599–1612, doi:10.1111/ddi.12963.

Shugar, D.H., et al., 2020: Rapid worldwide growth of glacial lakes since 1990. *Nat. Clim. Chang.*, **10**(10), 939–945, doi:10.1038/s41558-020-0855-4.

Shukla, G., A. Kumar, N.A. Pala and S. Chakravarty, 2016: Farmers perception and awareness of climate change: a case study from Kanchandzonga Biosphere Reserve, India. *Environ. Dev. Sustain.*, **18**(4), 1167–1176, doi:10.1007/s10668-015-9694-2.

Shukla, R., A. Agarwal and K. Sachdeva, 2019: Climate change perception: an analysis of climate change and risk perceptions among farmer types of Indian Western Himalayas. *Clim. Change*, **152**, 103–119, doi:10.1007/s10584-018-2314-z.

Shumetie, A. and M. Alemayehu, 2017: Effect of climate variability on crop income and indigenous adaptation strategies of households. *Int. J. Clim. Chang. Strateg. Manag.*, **10**(4), doi:10.1108/IJCCSM-04-2016-0039.

Sibelet, N., K.E. Posada and I. A. Gutiérrez-Montes, 2019: Agroforestry systems provide firewood for livelihood improvement in Guatemala. *Bois For. Trop.*, **340**, doi:10.19182/bft2019.340.a31692.

Simmons, R.E., et al., 2004: Climate change and birds: perspectives and prospects from southern Africa. *J. Afr. Ornithol.*, **75**(4), 295–308, doi:10.2989/00306520409485458.

Singh, D., et al., 2014: Severe precipitation in Northern India in June 2013: causes, historical context, and changes in probability. *Bull. Am. Meteorol. Soc.*, **95**(9), 558–561, doi:10.1175/1520-0477-95.9.S1.1.

Singh, R.K., et al., 2017: Perceptions of climate variability and livelihood adaptations relating to gender and wealth among the Adi community of the Eastern Indian Himalayas. *Appl. Geogr.*, **86**, 41–52, doi:10.1016/j.apgeog.2017.06.018.

Siraw, Z., M. Adnew Degefu and W. Bewket, 2018: The role of community-based watershed development in reducing farmers' vulnerability to climate change and variability in the northwestern highlands of Ethiopia. *Local Environ.*, **23**(12), 1190–1206, doi:10.1080/13549839.2018.1541344.

Sjögersten, S., et al., 2013: Responses to climate change and farming policies by rural communities in northern China: A report on field observation and farmers' perception in dryland north Shaanxi and Ningxia. *Land Use Policy*, **32**, 125–133, doi:10.1016/j.landusepol.2012.09.014.

Skansi, M.D.L.M., M. Brunet, et al., 2013: Warming and wetting signals emerging from analysis of changes in climate extreme indices over South America. *Glob. Planet. Change*, **100**, 295–307, doi:10.1016/j.gloplacha.2012.11.004.

Skarbø, K. and K. VanderMolen, 2016: Maize migration: key crop expands to higher altitudes under climate change in the Andes. *Clim. Dev.*, **8**(3), 245–255, doi:10.1080/17565529.2015.1034234.

Smucker, T.A., et al., 2015: Differentiated livelihoods, local institutions, and the adaptation imperative: Assessing climate change adaptation policy in Tanzania. *Geoforum*, **59**, 39–50, doi:10.1016/j.geoforum.2014.11.018.

Sokratov, S.A., Y.G. Seliverstov and A.L. Shnyparkov, 2014: Assessment of the economic risk for the ski resorts of changes in snow cover duration. *Ice Snow*, **54**(3), 100–106, doi:10.15356/2076-6734–2014-3-100-106.

Son, H.N., D.T.L. Chi and A. Kingsbury, 2019: Indigenous knowledge and climate change adaptation of ethnic minorities in the mountainous regions of Vietnam: A case study of the Yao people in Bac Kan Province. *Agric. Syst.*, **176**, 102683, doi:10.1016/j.agsy.2019.102683.

Spandre, P., et al., 2019: Climate controls on snow reliability in French Alps ski resorts. *Sci Rep.*, **9**, 8043, doi:10.1038/s41598-019-44068-8.

Spies, M., 2019: Mixed manifestations of climate change in high mountains: insights from a farming community in northern Pakistan. *Clim. Dev.*, **12**(10), 1–12, doi:10.1080/17565529.2019.1701974.

Sreelash, K., et al., 2018: Impact of rainfall variability on river hydrology: a case study of southern western Ghats, India. *J. Geol. Soc. India*, **92**(5), 548–554, doi:10.1007/s12594-018-1065-9.

Stäubli, A., et al., 2018: Analysis of Weather- and Climate-Related Disasters in Mountain Regions Using Different Disaster Databases. In: *Climate Change, Extreme Events and Disaster Risk Reduction* [Mal, S., R. Singh and C. Huggel(eds.)]. Springer, Cham, Switzerland, pp. 17–41. ISBN 978-3319564692.

Stefanovic, J.O., et al., 2019: Adaption to climate change: a case study of two agricultural systems from Kenya. *Clim. Dev.*, **11**(4), 319–337, doi:10.1080/17565529.2017.1411241.

Stensrud, A.B., 2016: Climate change, water practices and relational worlds in the Andes. *Ethnos*, **81**(1), 75–98, doi:10.1080/00141844.2014.929597.

Stensrud, A.B., 2019: "You cannot contradict the engineer": Disencounters of modern technology, climate change, and power in the Peruvian Andes. *Crit. Anthropol.*, **39**(4), 420–438, doi:10.1177/0308275x18821164.

Sterle, K., B.J. Hatchett, L. Singletary and G. Pohll, 2019: Hydroclimate variability in snow-fed river systems: local water managers' perspectives on adapting to the new normal. *Bull. Am. Meteorol. Soc.*, **100**(6), 1031–1048, doi:10.1175/BAMS-D-18-0031.1.

Sterle, K. and L. Singletary, 2017: Adapting to variable water supply in the Truckee-Carson river system, western USA. *Water*, **9**(10), 768, doi:10.3390/w9100768.

Stevens-Rumann, C.S., et al., 2018: Evidence for declining forest resilience to wildfires under climate change. *Ecol. Lett.*, **21**(2), 243–252, doi:10.1111/ele.12889.

Stewart, I.T., D.R. Cayan and M.D. Dettinger, 2005: Changes toward earlier streamflow timing across western North America. *J. Clim.*, **18**, 1136–1155, doi:10.1175/JCLI3321.1.

Stiles, F.G. and L. a. Rosselli, 2017: Changes over 26 years in the avifauna of the Bogotá region, Colombia: Has climate change become important? *Front. Ecol. Evol.*, **5**(JUN), doi:10.3389/fevo.2017.00058.

Stoffel, M., 2010: Magnitude-frequency relationships of debris flows—A case study based on field surveys and tree-ring records. *Geomorphology*, **116**(1–2), 67–76, doi:10.1016/j.geomorph.2009.10.009.

Stoffel, M., et al., 2008: Unraveling the patterns of late Holocene debris-flow activity on a cone in the Swiss Alps: Chronology, environment and implications for the future. *Glob. Planet. Change*, **60**(3–4), 222–234, doi:10.1016/j.gloplacha.2007.03.001.

Stoffel, M. and C. Huggel, 2012: Effects of climate change on mass movements in mountain environments. *Prog. Phys. Geogr.*, **36**(3), 421–439, doi:10.1177/0309133312441010.

Stone, D., et al., 2013: The challenge to detect and attribute effects of climate change on human and natural systems. *Clim. Change*, **121**(2), 381–395, doi:10.1007/s10584-013-0873-6.

Stone, D.A. and G. Hansen, 2016: Rapid systematic assessment of the detection and attribution of regional anthropogenic climate change. *Clim. Dyn.*, **47**(5–6), 1399–1415, doi:10.1007/s00382-015-2909-2.

Strasser, U., et al., 2019: Storylines of combined future land use and climate scenarios and their hydrological impacts in an Alpine catchment (Brixental/Austria). *Sci. Total. Environ.*, **657**, 746–763, doi:10.1016/j.scitotenv.2018.12.077.

Strouth, A. and S. McDougall, 2021: Historical landslide fatalities in British Columbia, Canada: trends and implications for risk management. *Front. Earth Sci.*, **9**, 22, doi:10.3389/feart.2021.606854.

Stuart-Smith, R.F., G.H. Roe, S. Li and M.R. Allen, 2021: Increased outburst flood hazard from Lake Palcacocha due to human-induced glacier retreat. *Nat. Geosci.*, **14**(2), 85–90, doi:10.1038/s41561-021-00686-4.

Su, Y., et al., 2017: Gendered responses to drought in Yunnan Province, China. *Mt. Res. Dev.*, **37**(1), 24–34, doi:10.1659/MRD-JOURNAL-D-15-00041.1.

Subedi, R., et al., 2019: Climate-smart practices for improvement of crop yields in mid-hills of Nepal. *Cogent Food Agric.*, **5**(1), doi:10.1080/23311932.2019.1631026.

Suberi, B., et al., 2018: People's perception of climate change impacts and their adaptation practices in Khotokha valley, Wangdue, Bhutan. *Indian J. Tradit. Knowl.*, **17**(1), 9.

Sudan, F.K. and J. McKay, 2015: Climate Adaptation and Governance and Small-Scale Farmers' Vulnerability Through Artificial Glacier Technology: Experiences from the Cold Desert of Leh in North-West Himalaya, India. In: *Managing Water Resources under Climate Uncertainty* [Shrestha, S., A.K. Anal, P.A. Salam and M. van der Valk(eds.)]. Springer International Publishing, Cham, pp. 319–342. ISBN 9783319104669978331910467 6.

Sugihardjo, J. Sutrisno, P. Setyono and Suntoro, 2018: Dynamic models of farmers adaptation to climate change (case of rice farmers in Cemoro Watershed, Central Java, Indonesia). *IOP Conf. Ser. Earth Environ. Sci.*, **142**, 12051, doi:10.1088/1755-1315/142/1/012051.

Sujakhu, N.M., et al., 2019: Assessing the livelihood vulnerability of rural indigenous households to climate changes in central Nepal, Himalaya. *Sustainability*, **11**(10), 2977, doi:10.3390/su11102977.

Sujakhu, N.M., et al., 2016: Farmers' perceptions of and adaptations to changing climate in the Melamchi valley of Nepal. *Mt. Res. Dev.*, **36**(1), 15–30, doi:10.1659/MRD-JOURNAL-D-15-00032.1.

Sullivan-Wiley, K. A. and A.G. Short Gianotti, 2018: Pursuing productivity gains and risk reduction in a multi-hazard landscape: A case study from eastern Uganda. *Land Use Policy*, **79**, 671–683, doi:10.1016/j.landusepol.2018.08.035.

Syomiti, M. et al., 2015: The adaptive and coping strategies of pastoralists to climate change in Baringo, Laikipia and Nyeri Counties of Kenya. *Livestock Research for Rural Development*, **27**(12), 248.

Tabassum, I., F. Rahman and F. Haq, 2014: Dynamics of communal land degradation and its implications in the arid mountains of pakistan: A study of District Karak, Khyber Pakhtunkuwa. *J. Mt. Sci.*, **11**(2), 485–495, doi:10.1007/s11629-013-2771-9.

Taboada, C., et al., 2017: Can warmer be better? Changing production systems in three Andean ecosystems in the face of environmental change. *J. Arid Environ.*, **147**, 144–154, doi:10.1016/j.jaridenv.2017.08.005.

Takakura, H., 2016: Limits of pastoral adaptation to permafrost regions caused by climate change among the Sakha people in the middle basin of Lena River. *Polar Sci.*, **10**(3), 395–403, doi:10.1016/j.polar.2016.04.003.

Tao, H., et al., 2011: Trends of streamflow in the Tarim River Basin during the past 50 years: Human impact or climate change? *J. Hydrol. Reg. Stud.*, **400**(1–2), 1–9, doi:10.1016/j.jhydrol.2011.01.016.

Tashman, P. and J. Rivera, 2016: Ecological uncertainty, adaptation, and mitigation in the U.S. ski resort industry: Managing resource dependence and institutional pressures: Ecological uncertainty, adaptation, and mitigation. *Strat. Mgmt. J.*, **37**(7), 1507–1525, doi:10.1002/smj.2384.

Tatem, A.J., 2017: WorldPop, open data for spatial demography. *Sci. Data*, **4**, 170004, doi:10.1038/sdata.2017.4.

Taylor, S.J., et al., 2015: The Drakensberg Escarpment as the Great Supplier of Water to South Africa. In: *Mountain Ice and Water, Investigations of the Hydrologic Cycle in Alpine Environments* [Greenwood, G.B. and J.F. Shroder(eds.)]. Elsevier, Amsterdam, Netherlands, pp. 1–41. ISBN 978-0444637871.

Teller, A.S., 2016: Moving the conversation on climate change and inequality to the local. *Sociol. Dev.*, **2**(1), 25–50, doi:10.1525/sod.2016.2.1.25.

Teng, M., et al., 2020: The impacts of climate changes and human activities on net primary productivity vary across an ecotone zone in northwest China. *Sci. Total. Environ.*, **714**, 136691, doi:10.1016/j.scitotenv.2020.136691.

Tesfaye, A. and A. Alemayehu, 2021: Climate Change and Variability on Food Security of Rural Household: Central Highlands, Ethiopia. In: *African Handbook on Climate Change Adaptation* [Oguge, N., D. Ayal, L. Adeleke and I. da Silva(eds.)]. Springer, Heidelberg, Berlin, New York, pp. 379–395. ISBN 978-3030451066.

Tessema, Y.A., C.S. Aweke and G.S. Endris, 2013: Understanding the process of adaptation to climate change by small-holder farmers: the case of east Hararghe Zone, Ethiopia. *Agric. Econ.*, **1**(1), 13, doi:10.1186/2193-7532-1-13.

Tessema, Y.A., J. Joerin and A. Patt, 2018: Factors affecting smallholder farmers' adaptation to climate change through non-technological adjustments. *Environ. Dev.*, **25**, 33–42, doi:10.1016/j.envdev.2017.11.001.

Tessema, Y.A., J. Joerin and A. Patt, 2019a: Climate change as a motivating factor for farm-adjustments: Rethinking the link. *Clim. Risk Manag.*, **23**, 136–145, doi:10.1016/j.crm.2018.09.003.

Tessema, Y.A., J. Joerin and A. Patt, 2019b: Crop switching as an adaptation strategy to climate change: the case of Semien Shewa Zone of Ethiopia. *Int. J. Clim. Chang. Strateg. Manag.*, **11**(3), 358–371, doi:10.1108/IJCCSM-05-2018-0043.

Tezuka, S., et al., 2014: Estimation of the effects of climate change on flood-triggered economic losses in Japan. *Int. J. Disaster Risk Reduct.*, **9**, 58–67, doi:10.1016/j.ijdrr.2014.03.004.

Thaler, T. and S. Seebauer, 2019: Bottom-up citizen initiatives in natural hazard management: Why they appear and what they can do? *Environ. Sci. Policy*, **94**, 101–111, doi:10.1016/j.envsci.2018.12.012.

Thomas, A., et al., 2019: Climate change adaptation planning in practice: insights from the Caribbean. *Reg. Environ. Change*, **19**(7), 2013–2025, doi:10.1007/s10113-019-01540-5.

Tiwari, P.C. and B. Joshi, 2015: Climate change and rural out-migration in Himalaya. *Change Adapt. Socio-Ecol. Syst.*, **2**(1), 8–25, doi:10.1515/cass-2015-0002.

Tiyo, C.E., F.L. Orach-Meza and E.L. Edroma, 2015: Understanding small-scale farmers' perception and adaption strategies to climate change impacts: Evidence from two agro-ecological zones bordering national parks of Uganda. *J. Agric. Sci.*, **7**(10), 253–259, doi:10.5539/jas.v7n10p253.

Tongruksawattana, S. and P. Wainaina, 2019: Climate shock adaptation for Kenyan maize-legume farmers: choice, complementarities and substitutions between strategies. *Clim. Dev.*, **11**(8), 710–722, doi:10.1080/17565529.2018.1562862.

Trærup, S., 2012: Coping with rainfall variability in Northern Tanzania. *Environ. Res. J.*, **6**, 431–449.

Triglav Čekada, M., D. Radovan, B. Lipuš and D. Mongus, 2020: Very small glaciers as geoheritage: combining a spatio-temporal visualisation of their development and related effects of climate change. *Geoheritage*, **12**(4), 85, doi:10.1007/s12371-020-00511-1.

Tuladhar, D., A. Dewan, M.J. Kuhn and R. Corner, 2019: The influence of rainfall and land use/land cover changes on river discharge variability in the mountainous catchment of the Bagmati river. *Water*, **11**(12), 2444, doi:10.3390/w11122444.

Tume, S.J.P., J.N. Kimengsi and Z.N. Fogwe, 2019: Indigenous knowledge and farmer perceptions of climate and ecological changes in the Bamenda highlands of Cameroon: Insights from the Bui plateau. *Climate*, **7**, 138, doi:10.3390/cli7120138.

Tupaz Pastás, D.F. and N.Y. Guzmán, 2011: Tiempo y clima en la visión andina del pueblo de los pastos, Colombia y Ecuador. In: *Perspectivas culturales del clima* [Ulloa, A.(ed.)]. ILSA/Universidad Nacional de Colombia, Bogota, Colombia, pp. 315–328. ISBN 978-9587197358.

Turbay, S., et al., 2015: Adaptación a la variabilidad climática entre los caficultores de las cuencas de los ríos Porce y Chinchiná, Colombia. *Investig. Geogr.*, **0**(85), doi:10.14350/rig.42298.

Twagiramarla, F., C.U. Tolo and N. Zinyengere, 2017: Adaptation to and Coping Strategies for Climate Change and Variability by Rural Farmers in Kigezi Highlands, Uganda. In: *Beyond Agricultural Impacts: Multiple Perspectives on Climate Change in Africa* [Zinyengere, N., T.F. Theodory, M. Gebreyes and C.I. Speranza(eds.)]. Academic Press, London, UK, pp. 55–75.

Twongyirwe, R., et al., 2019: Perceived effects of drought on household food security in South-western Uganda: Coping responses and determinants. *Weather. Clim. Extrem.*, **24**, 100201, doi:10.1016/j.wace.2019.100201.

Ukamaka, D.M. and N.L. Eberechukwu, 2018: Indigenous climate change adaptation strategies used by Honey Producers in rural communities of Enugu State, Nigeria. *J. Agric. Ext.*, **22**(2), doi:10.4314/jae.v22i2.16.

Ullah, H., A. Rashid, G. Liu and M. Hussain, 2018: Perceptions of mountainous people on climate change, livelihood practices and climatic shocks: A case study of Swat District, Pakistan. *Urban Clim.*, **26**, 244–257, doi:10.1016/j.uclim.2018.10.003.

Uy, T.C., B. Limnirankul and Y. Chaovanapoonphol, 2015: Factors impact on farmers' adaptation to drought in maize production in highland area of central Vietnam. *Agric. Agric. Sci. Procedia*, **5**, 75–82, doi:10.1016/j.aaspro.2015.08.011.

Van Aelst, K. and N. Holvoet, 2016: Intersections of gender and marital status in accessing climate change adaptation: evidence from rural Tanzania. *World Dev.*, **79**, 40–50, doi:10.1016/j.worlddev.2015.11.003.

Van Aelst, K. and N. Holvoet, 2018: Climate change adaptation in the Morogoro Region of Tanzania: women's decision-making participation in small-scale farm households. *Clim. Dev.*, **10**(6), 495–508, doi:10.1080/17565529.2017.1318745.

van der Heijden, J., 2015: Voluntary programmes for building retrofits: opportunities, performance and challenges. *Build. Res. Inf.*, **43**(2), 170–184, doi:10.1080/09613218.2014.959319.

van Dijk, M.P. and H. Li, 2015: Climate Change Policies and Adaptive Behavior of Farmers in Southern China. In: *Research in Economic Anthropology* [Wood, D.C.(ed.)]. Emerald Group Publishing Limited, Bingley, pp. 155–175. ISBN 97817856036179781785603600.

Vander Naald, B., 2020: Examining tourist preferences to slow glacier loss: evidence from Alaska. *Tour. Recreat. Res.*, **45**(1), 107–117, doi:10.1080/02508281.2019.1606978.

VanderMolen, K. and A. Horangic, 2018: Implications of regulatory drought for farmer use of climate information in the Klamath basin. *Weather Clim. Soc.*, **10**(2), 269–274, doi:10.1175/WCAS-D-17-0078.1.

Vedeld, T., A. Coly, N.M. Ndour and S. Hellevik, 2016: Climate adaptation at what scale? Multi-level governance, resilience, and coproduction in Saint Louis, Senegal. *Nat. Hazards*, **82**(2), 173–199, doi:10.1007/s11069-015-1875-7.

Veh, G., et al., 2019: Unchanged frequency of moraine-dammed glacial lake outburst floods in the Himalaya. *Nat. Clim. Chang.*, **9**, 379–383, doi:10.1038/s41558-019-0437-5.

Velempini, K., T.A. Smucker and K.R. Clem, 2018: Community-based adaptation to climate variability and change: mapping and assessment of water resource management challenges in the North Pare highlands, Tanzania. *Afr. Geogr. Rev.*, **37**(1), 30–48, doi:10.1080/19376812.2016.1229203.

Verfaillie, D., et al., 2018: Multi-component ensembles of future meteorological and natural snow conditions for 1500 m altitude in the Chartreuse mountain range, Northern French Alps. *Cryosphere*, **12**(4), 1249–1271, doi:10.5194/tc-12-1249-2018.

Vicente-Serrano, S.M., et al., 2015: Spatio-temporal variability of droughts in Bolivia: 1955–2012. *Int. J. Climatol.*, **35**(10), 3024–3040, doi:10.1002/joc.4190.

Viguera, B., et al., 2019: Percepciones de cambio climático y respuestas adaptativas de pequeños agricultores en dos paisajes guatemaltecos. *Agron. Mesoam.*, 313–331, doi:10.15517/am.v30i2.33938.

Viviroli, D., et al., 2020: Increasing dependence of lowland populations on mountain water resources. *Nat. Sustain.*, **3**(11), 917–928, doi:10.1038/s41893-020-0559-9.

Volpato, G. and E. G. King, 2019: From cattle to camels: trajectories of livelihood adaptation and social-ecological resilience in a Kenyan pastoralist community. *Reg. Environ Change*, **19**(3), 849–865, doi:10.1007/s10113-018-1438-z.

Vuille, M., R.S. Bradley, M. Werner and F. Keimig, 2003: 20th century climate change in the tropical Andes: observations and model results. *Clim. Change*, **59**(1–2), 75–99, doi:10.1023/A:1024406427519.

Vuille, M., et al., 2018: Rapid decline of snow and ice in the tropical Andes – impacts, uncertainties and challenges ahead. *Earth Sci. Rev.*, **176**, 195–213, doi:10.1016/j.earscirev.2017.09.019.

Vuille, M., et al., 2015: Impact of the global warming hiatus on Andean temperature. *J. Geophys. Res. Atmos.*, **120**, 1–13, doi:10.1002/2015JD023126.

Wagner, S., et al., 2021: Impact of climate change on the production of Coffea arabica at Mt. Kilimanjaro, Tanzania. *Agric. Food Secur.*, **11**(1), 53, doi:10.3390/agriculture11010053.

Waha, K., et al., 2018: Agricultural diversification as an important strategy for achieving food security in Africa. *Glob. Change Biol.*, **24**(8), 3390–3400, doi:10.1111/gcb.14158.

Wako, G., M. Tadesse and A. Angassa, 2017: Camel management as an adaptive strategy to climate change by pastoralists in southern Ethiopia. *Ecol. Process*, **6**(1), 26, doi:10.1186/s13717-017-0093-5.

Walter, F., et al., 2020: Direct observations of a three million cubic meter rock-slope collapse with almost immediate initiation of ensuing debris flows. *Geomorphology*, **351**, 106933, doi:10.1016/j.geomorph.2019.106933.

Wang, G., et al., 2020: Double increase in precipitation extremes across China in a 1.5°C/2.0°C warmer climate. *Sci. Total Environ.*, **746**, 140807, doi:10.1016/j.scitotenv.2020.140807.

Wang, J., Y. Wang, S. Li and D. Qin, 2016a: Climate adaptation, institutional change, and sustainable livelihoods of herder communities in northern Tibet. *Ecol. Soc.*, **21**(1), art5, doi:10.5751/ES-08170-210105.

Wang, S., Y. He and X. Song, 2010: Impacts of climate warming on Alpine glacier tourism and adaptive measures: A case study of Baishui Glacier No. 1 in Yulong Snow Mountain, Southwestern China. *J. Earth Sci.*, **21**(2), 166–178, doi:10.1007/s12583-010-0015–2.

Wang, S. and D. Qin, 2015: Mountain inhabitants' perspectives on climate change, and its impacts and adaptation based on temporal and spatial characteristics analysis: a case study of Mt. Yulong Snow, Southeastern Tibetan Plateau. *Environ. Hazards*, **14**(2), 122–136, doi:10.1080/17477891.2014.1003776.

Wang, W., X. Zhao, H. Li and Q. Zhang, 2021: Will social capital affect farmers' choices of climate change adaptation strategies? Evidences from rural households in the Qinghai-Tibetan Plateau, China. *J. Rural Stud.*, **83**(4), 127–137, doi:10.1016/j.jrurstud.2021.02.006.

Wang, X., et al., 2016b: Attribution of runoff decline in the Amu Darya river in central asia during 1951–2007. *J. Hydrometeorol.*, **17**(5), 1543–1560, doi:10.1175/JHM-D-15-0114.1.

Wang, Y., J. Wang, S. Li and D. Qin, 2014: Vulnerability of the Tibetan pastoral systems to climate and global change. *Ecol. Soc.*, **19**(4), 8, doi:10.5751/es-06803-190408.

Wang, Y., et al., 2017: The evaluation of famers' climate change adaptation strategies in high-frigid ecological vulnerable region: a case of Gannan Plateau. *Acta Ecol. Sin.*, **37**(7), doi:10.5846/stxb201601210146.

Wangchuk, K. and J. Wangdi, 2018: Signs of climate warming through the eyes of yak herders in northern Bhutan. *Mt. Res. Dev.*, **38**, 45–52, doi:10.1659/mrd-journal-d-17-00094.1.

Wangui, E.E. and T.A. Smucker, 2018: Gendered opportunities and constraints to scaling up: a case study of spontaneous adaptation in a pastoralist community in Mwanga District, Tanzania. *Clim. Dev.*, **10**(4), 369–376, doi:10.1080/17565529.2017.1301867.

Ward, R., D. Gonthier and C. Nicholls, 2017: Ecological resilience to coffee rust: Varietal adaptations of coffee farmers in Copán, Honduras. *Agroecol. Sustain. Food Syst.*, 1–18, doi:10.1080/21683565.2017.1345033.

Washington-Ottombre, C. and B.C. Pijanowski, 2013: Rural organizations and adaptation to climate change and variability in rural Kenya. *Reg. Environ. Change*, **13**(3), 537–550, doi:10.1007/s10113-012-0343-0.

Wassie, A. and N. Pauline, 2018: Evaluating smallholder farmers' preferences for climate smart agricultural practices in Tehuledere District, northeastern Ethiopia: Evaluating smallholder farmers' preferences. *Singapore J Trop. Geo.*, **39**(2), 300–316, doi:10.1111/sjtg.12240.

Wasson, R.J., et al., 2013: A 1000-year history of large floods in the Upper Ganga catchment, central Himalaya, India. *Quat. Sci. Rev.*, **77**, 156–166, doi:10.1016/j.quascirev.2013.07.022.

Wekesa, B.M., O.I. Ayuya and J.K. Lagat, 2018: Effect of climate-smart agricultural practices on household food security in smallholder production systems: micro-level evidence from Kenya. *Agric. Food Secur.*, **7**(1), 80, doi:10.1186/s40066-018-0230-0.

Weldegebriel, Z. B. and M. Prowse, 2013: Climate-change adaptation in Ethiopia: To what extent does social protection influence livelihood diversification? *Dev. Policy Rev.*, **31**(s2), o35–o56, doi:10.1111/dpr.12038.

Weldegebriel, Z. B. and M. Prowse, 2017: Climate variability and livelihood diversification in northern Ethiopia: a case study of Lasta and Beyeda districts. *Geogr. J.*, **183**(1), 84–96, doi:10.1111/geoj.12178.

Welling, J., Þ. Árnason and R. Ólafsdóttir, 2020: Implications of climate change on nature-based tourism demand: a segmentation analysis of glacier site visitors in southeast Iceland. *Sustainability*, **12**(13), 5338, doi:10.3390/su12135338.

Wernersson, J., 2018: Rethinking identity in adaptation research: Performativity and livestock keeping practices in the Kenyan drylands. *World Dev.*, **108**, 283–295, doi:10.1016/j.worlddev.2018.02.010.

Wijngaard, R.R., et al., 2018: Climate change vs. socio-economic development: understanding the future South Asian water gap. *Hydrol. Earth Syst. Sci.*, **22**(12), 6297–6321, doi:10.5194/hess-22-6297-2018.

Wilkes, A., et al., 2017: Is cross-breeding with indigenous sheep breeds an option for climate-smart agriculture? *Small Rumin. Res.*, **147**, 83–88, doi:10.1016/j.smallrumres.2016.12.036.

Williams, J.E., et al., 2015: Climate change adaptation and restoration of western trout streams: opportunities and strategies. *Fisheries*, **40**(7), 304–317, doi:10.1080/03632415.2015.1049692.

Wilson, R., et al., 2018: Glacial lakes of the Central and Patagonian Andes. *Glob. Planet. Change*, **162**, 275–291, doi:10.1016/j.gloplacha.2018.01.004.

Woldearegay, K., et al., 2018: Fostering Food Security and Climate Resilience Through Integrated Landscape Restoration Practices and Rainwater Harvesting/Management in Arid and Semi-arid Areas of Ethiopia. In: *Rainwater-Smart Agriculture in Arid and Semi-Arid Areas* [Leal Filho, W. and J. de Trincheria Gomez(eds.)]. Springer International Publishing, Cham, pp. 37–57. ISBN 97833196623819783319662398.

Wood, S.A. and R.O. Mendelsohn, 2014: The impact of climate change on agricultural net revenue: a case study in the Fouta Djallon, West Africa. *Envir. Dev. Econ.*, **20**, 20–36, doi:10.1017/S1355770X14000084.

Wrathall, D.J., et al., 2014: Migration amidst climate rigidity traps: resource politics and social–ecological possibilism in Honduras and Peru. *Ann. Assoc. Am. Geogr.*, **104**(2), 292–304, doi:10.1080/00045608.2013.873326.

Wu, N., et al., 2014: Livelihood diversification as an adaptation approach to change in the pastoral Hindu-Kush Himalayan region. *J. Mt. Sci.*, **11**(5), 1342–1355, doi:10.1007/s11629-014-3038-9.

Wu, X., et al., 2015: Local perceptions of rangeland degradation and climate change in the pastoral society of Qinghai-Tibetan Plateau. *Rangel. J.*, **37**(1), 11, doi:10.1071/RJ14082.

Xenarios, S., et al., 2019: Climate change and adaptation of mountain societies in Central Asia: uncertainties, knowledge gaps, and data constraints. *Reg. Environ. Change*, **19**(5), 1339–1352, doi:10.1007/s10113-018-1384-9.

Xu, J. and R.E. Grumbine, 2014: Integrating local hybrid knowledge and state support for climate change adaptation in the Asian Highlands. *Clim. Change*, **124**, 93–104, doi:10.1007/s10584-014-1090-7.

Yager, K., et al., 2019: Socio-ecological dimensions of Andean pastoral landscape change: bridging traditional ecological knowledge and satellite image analysis in Sajama National Park, Bolivia. *Reg. Environ. Change*, **19**(5), 1353–1369, doi:10.1007/s10113-019-01466-y.

Yang, H., et al., 2016: Land-use response to drought scenarios and water policy intervention in Lijiang, SW China. *Land Use Policy*, **57**, 377–387, doi:10.1016/j.landusepol.2016.05.027.

Yeh, E.T., Y. Nyima, K. A. Hopping and J.A. Klein, 2014: Tibetan pastoralists' vulnerability to climate change: a political ecology analysis of snowstorm coping capacity. *Hum. Ecol.*, **42**(1), 61–74, doi:10.1007/s10745-013-9625-5.

Yeh, E.T., et al., 2017: Pastoralist decision-making on the Tibetan plateau. *Hum. Ecol.*, **45**(3), 333–343, doi:10.1007/s10745-017-9891-8.

Yohannes, Z., M. Teshome and M. Belay, 2020: Adaptive capacity of mountain community to climate change: case study in the Semien Mountains of Ethiopia. *Environ. Dev. Sustain.*, **22**(4), 3051–3077, doi:10.1007/s10668-019-00334-3.

Yu, Q., et al., 2014: Interpretation of climate change and agricultural adaptations by local household farmers: a case study at Bin County, northeast China. *J. Integr. Agric.*, **13**(7), 1599–1608, doi:10.1016/S2095-3119(14)60805-4.

Yucel, I., A. Güventürk and O.L. Sen, 2015: Climate change impacts on snowmelt runoff for mountainous transboundary basins in eastern Turkey. *Int. J. Climatol.*, **35**(2), 215–228, doi:10.1002/joc.3974.

Yuliati, Y. and D.A. Primasari, 2018: Farmers' adaptation to climate change in the Tengger Mountains (case study in Ngadas Village, Poncokusumo District, Malang Regency, East Java, Indonesia). *Asian J. Microbiol. Biotechnol. Environ. Sci.*, **20**, 757–763.

Yung, L., et al., 2015: Drought adaptation and climate change beliefs among working ranchers in montana. *WeatherM Clim. Soc.*, **7**(4), 281–293, doi:10.1175/WCAS-D-14-00039.1.

Zampieri, M., E. Scoccimarro, S. Gualdi and A. Navarra, 2015: Observed shift towards earlier spring discharge in the main Alpine rivers. *Sci. Total. Environ.*, **503–504**, 222–232, doi:10.1016/j.scitotenv.2014.06.036.

Zemp, M., et al., 2019: Global glacier mass changes and their contributions to sea-level rise from 1961 to 2016. *Nature*, **568**, 382–386, doi:10.1038/s41586-019-1071-0.

Zeweld, W., et al., 2018: Impacts of socio-psychological factors on actual adoption of sustainable land management practices in dryland and water stressed areas. *Sustainability*, **10**(9), 2963, doi:10.3390/su10092963.

Zhai, S., et al., 2018: Climate change and Chinese farmers: perceptions and determinants of adaptive strategies. *J. Integr. Agric.*, **17**(4), 949–963, doi:10.1016/S2095-3119(17)61753-2.

Zhang, G., et al., 2015a: An inventory of glacial lakes in the Third Pole region and their changes in response to global warming. *Glob. Planet. Change*, **131**, 148–157, doi:10.1016/j.gloplacha.2015.05.013.

Zhang, L., et al., 2016a: Ethnobotanical study of traditional edible plants used by the Naxi people during droughts. *J Ethnobiol. Ethnomed.*, **12**(1), 39, doi:10.1186/s13002-016-0113-z.

Zhang, L., J. Hu, Y. Li and N.S. Pradhan, 2018: Public-private partnership in enhancing farmers' adaptation to drought: Insights from the Lujiang Flatland in the Nu River (Upper Salween) valley, China. *Land Use Policy*, **71**, 138–145, doi:10.1016/j.landusepol.2017.11.034.

Zhang, L., Y. Tang and B. Liu, 2015b: Changes in agricultural system as farmers adapt to economic-social and climatic changes in the min upriver rural

areas in western Sichuan, southwestern China. *J. Mt. Sci.*, **12**(3), 747–758, doi:10.1007/s11629-014-3386-5.

Zhang, Q., et al., 2010: Climate changes and their impacts on water resources in the arid regions: a case study of the Tarim River basin, China. *Stoch. Environ. Res. Risk Assess.*, **24**(3), 349–358, doi:10.1007/s00477-009-0324-0.

Zhang, Q., H. Xue, X. Zhao and H. Tang, 2019a: Linking livelihood assets of smallholder households to risk management strategies: an empirical study in China. *Environ. Hazards*, **18**(3), 191–211, doi:10.1080/17477891.2018.1538866.

Zhang, X., et al., 2016b: Restoration of High-Altitude Peatlands on the Ruoergai Plateau (Northeastern Tibetan Plateau, China). In: *In Peatland Restoration and Ecosystem Services: Science, Policy and Practice* [Bonn, A., H. Joosten, M. Evans, R. Stoneman and T. Allott(eds.)]. Cambridge University, Cambridge, UK, pp. 234–252.

Zhang, Y., et al., 2019b: Identifying refugia and corridors under climate change conditions for the Sichuan snub-nosed monkey (Rhinopithecus roxellana) in Hubei Province, China. *Ecol. Evol.*, **9**(4), 1680–1690, doi:10.1002/ece3.4815.

Zheng, G., et al., 2021a: Increasing risk of glacial lake outburst floods from future Third Pole deglaciation. *Nat. Clim. Chang.*, **11**, 411–417, doi:10.1038/s41558-021-01028-3.

Zheng, G., et al., 2021b: Numerous unreported glacial lake outburst floods in the Third Pole revealed by high-resolution satellite data and geomorphological evidence. *Sci. Bull.*, **66**(13), 1270–1273, doi:10.1016/j.scib.2021.01.014.

Zheng, Y. and A. Byg, 2014: Coping with climate change: households' response strategies to drought and hailstorm in Lijiang, China. *Environ. Hazards*, **13**(3), 211–228, doi:10.1080/17477891.2014.902799.

Zheng, Y. and M. Dallimer, 2016: What motivates rural households to adapt to climate change? *Clim. Dev.*, **8**(2), 110–121, doi:10.1080/17565529.2015.1005037.

Zhu, R., H. Zheng, B.F.W. Croke and A.J. Jakeman, 2020: Quantifying climate contributions to changes in groundwater discharge for headwater catchments in a major Australian basin. *Sci. Total. Environ.*, **729**, 138910, doi:10.1016/j.scitotenv.2020.138910.

Ziervogel, G., L. Pasquini and J. Lee, 2019: Understanding the Role of Networks in Stimulating Adaptation Actions on the Ground: Examples from Two African Case Studies. In: *University Initiatives in Climate Change Mitigation and Adaptation* [Leal Filho, W. and R. Leal-Arcas(eds.)]. Springer International Publishing, Cham, pp. 57–75. ISBN 978331989589597833198959 01.

Zimmer, A., et al., 2018: Time lag between glacial retreat and upward migration alters tropical alpine communities. *Perspect. Plant Ecol. Evol. Syst.*, **30**(October 2016), 89–102, doi:10.1016/j.ppees.2017.05.003.

Zizinga, A., et al., 2017: Analysis of farmer's choices for climate change adaptation practices in south-western Uganda, 1980–2009. *Climate*, **5**(4), 89, doi:10.3390/cli5040089.

Zou, S., et al., 2019: Human and natural impacts on the water resources in the Syr Darya river basin, Central Asia. *Sustainability*, **11**(11), 3084, doi:10.3390/su11113084.