Chapter 15: Small Islands

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SM15.1 Key Risks

Table SM15.1: Summary of adaptation options to key risks identified for small islands

Key Risks	Risk-oriented adaptation options	Evidence and Agreement	Degree of implementation with illustrative small island examples	Key enablers	Reduces exposure and vulnerability: yes/no with illustrative examples	Overarching adaptation options supporting implementation and success	Co-benefits	Disbenefits
Key Risk 1. Loss of marine and coastal biodiversity and ecosystem services	**EbA measures (15.4.4).** Marine Protected Areas (MPAs), including paired terrestrial and marine protected areas aimed at preventing marine ecosystem degradation, and enhancing climate resilience ((Bates et al., 2019; Carlson et al., 2019).	Medium evidence, low agreement (with regard to CC adaptation and benefits)	Widespread across small island regions. Some of the largest MPAs globally have been designated around small islands (e.g. Chagos, Hawaii, Galapagos, Cook Islands, Pitcairn). Some advocated for climate resilience purposes, e.g. Pacific islands (McLeod et al., 2019), including Fiji and Papua New Guinea (Le Cornu et al., 2018).	Strong governance and sufficient financial resources to allow for adequate management and enforcement (Schleicher et al., 2019)	Restricting human activities through Marine Protected Areas (MPAs) is assumed to create more resilient biological communities with a greater capacity to resist and recover following climate events. Yet species protected from activities such as fishing can also be vulnerable to climate stressors – the 'Protection Paradox' (see (Bates et al., 2019)).		Secondary benefits for marine biodiversity and coastal economies. Support to food supply. Increased human health and well-being.	
	EbA measures (15.4.4). Active restoration of	Limited evidence,	Replanting of mangroves or	Adaptation taxes and levies imposed on	Active intervention in the form of habitat recreation is assumed to enhance resilience of		Improve water	

	coastal and marine ecosystems (e.g., coral reefs, mangrove forests and seagrass meadows)	low agreement (with regard to long-term success)	seagrasses and transplantation of corals is becoming common practice in small islands although often only at small scale. For example, artificial reefs are found in the Maldives (Fabian et al., 2013) and in Mauritius (Duvat et al., 2020a); beach nourishment in Tuvalu (Onaka et al., 2017) and Mauritius (Onaka et al., 2015); vegetation planting in Fiji (Veitayaki and Holland, 2017) and Sicilly (Alagna et al., 2019). Coral reefs and seagrass are among the most expensive ecosystems to restore.	tourism can provide funding for restoration and protection, e.g. in the British Virgin Islands. Blue bonds are an innovative ocean financing instrument whereby funds raised in international markets are earmarked exclusively for projects deemed 'ocean-friendly' (e.g. Seychelles and Grenada). In the Seychelles, coral restoration programmes and mangrove reforestation are promoted through public-private partnerships, generating opportunities for wetland-tourism (Khan and Amelie, 2015).	natural ecosystems, thereby reducing their vulnerability.		quality; reduction in coastal erosion and flood risks since vegetated habitats (and intact coral reefs) help to dissipate wave energy and to protect coastlines; economic benefits.	

			Mangrove restoration projects were typically the largest and the least expensive per hectare. The overall success of restoration projects is variable, in particular success of seagrass replanting is typically relatively low (~38%) worldwide (Bayraktarov et al., 2016).					
	Hard protection (15.5.1). Hard shoreline structures sometimes designed to also enhance marine biodiversity	Medium evidence, medium agreement	Artificial reefs have been increasingly used in small islands to support reef restoration and reduce beach erosion, e.g. in the Maldives (Fabian et al., 2013), in Mauritius (Duvat et al., 2020a), in Antigua (Cummings et al., 2015).	Adaptation taxes and levies imposed on tourism can provide funding for restoration and protection e.g. British Virgin Islands. In the Caribbean, fiscal instruments are used such as environmental taxes and levies but there is limited evidence of direct reinvestment in conservation and management (Attzs et al., 2014; CANARI, 2019)	Uncertainty on reduction of exposure and vulnerability of marine ecosystems. Usually implemented in order to reduce exposure of human assets/infrastructure, with secondary benefits for marine and coastal biodiversity. Sometimes left as substrates for passive colonisation by marine species (e.g. fish and corals), elsewhere has been introduced alongside active transplantation of coral colonies.		Support to food supply. Secondary benefits for coastal economies (can be a tourism asset in it's own right). Increased human health and well-being.	

	Diversifying Livelihoods (15.5.6). Diversifying fisheries livelihoods (e.g. to aquaculture and tourism), changing fishing grounds and/or target species	Limited to medium evidence, medium agreement	Examples in the Caribbean and Pacific: wide range of activities ranging from diversification of livelihoods to changing fishing grounds and target species e.g. to take pressure off vulnerable coastal species, e.g. in Antigua, Domican Republic, and Efate (Vanuatu) (Blair and Momtaz, 2018; Lemahieu et al., 2018; Karlsson and McLean, 2020; Turner et al., 2020).	Improved governance/cooperation – e.g. a regional strategy to improve coastal fisheries management in a changing climate. Weather insurance to facilitate recovery after an extreme event and enhance resilience, e.g. in Saint Lucia and Grenada via the Caribbean Oceans and Aquaculture Sustainability Facility (Sainsbury et al., 2019)	Yes in both Antiqua and Vanuatu (Blair and Momtaz, 2018). New fishing areas in Vanuatu (Blair and Momtaz, 2018) and fishermen go further off-shore in Madacascar (Lemahieu et al., 2018)and Domican Republic (Karlsson and McLean, 2020). A directed switch from targeting vulnerable inshore reef fish, to targeting less sensitive offshore pelagic species, e.g. in Dominica (Pinnegar et al., 2019). Active switch to aquaculture (away from fisheries) to diversify incomes and spread risks e.g. Caribbean (Thomas et al., 2019), Solomon Islands (Dey et al., 2016) including a move toward seaweed farming (e.g. St Lucia).		Sustainably managed fisheries, improved food and income security. Greater economic and societal resilience.	
	Reef to Ridge ecosystem management (Figure 15.4). Improved land use as a key driver of marine ecosystem health: better management of forests, nutrients and waste	Limited evidence, medium agreement	Mostly in the Caribbean and Pacific, where ridge-to-reef studies are currently focused (e.g., (Brown et al., 2017; Delevaux et	Improved governance	Better management of forests, nutrients and waste water in upland catchments reduces the exposure of coral reefs to human degradation, thereby enhancing their resilience, e.g. Hāʻena and Kaʻūpūlehu in the Hawaiian Archipelago (Delevaux et al., 2018b), American Samoa (Comeros-Raynal et al., 2017).		Improved ecosystem protection services, e.g. against flooding, erosion, landslides, mudflows; improved	

	water in upstream catchments		al., 2018a; Delevaux et al., 2018b)); however, not so much within the Indo-Pacific islands (Rude et al., 2016; Brown et al., 2017). Better forest management in upstream catchments (and thereby control of sediment run off) can greatly benefit coral reef condition around islands e.g. Kubulau District, Fiji (Delevaux et al., 2018a), Raja Ampat, Indonesia (Rude et al., 2016).				biodiversity; improved human health outcomes; improved livelihoods	
Key Risk 3. Loss of terrestrial biodiversity and ecosystem services	**Decreased deforestation (15.5.4)**	Limited to medium evidence, high agreement	Mostly in the Caribbean region and Pacific, e.g. in Papua New Guinea (Jupiter et al., 2014), Fiji (Hidalgo et al., 2021),	National Determined Contributions, external funding (e.g. International NGOs), engagement of local landowners, gender sensitive participation, resolution of land ownership governance issues, long-term	**Some examples:** e.g. increase in forest extent, social benefits in pilot but limited by barriers in implementation (Buckwell et al., 2019), increased acreage forested (SPCR, 2011), reduction in human exposure to natural disasters (hurricanes, landslides), improvement in vulnerability assessment scores UNDP, 2012 #1532}	Mainstreaming into national policies (Robinson, 2017), filling data gaps e.g. flora and fauna baseline data (Voccia, 2011; Klöck	Increased connectivity between forest fragments (Buckwell et al., 2019), sustainable livelihoods (SPCR,	Little evidence that disbenefits have been considered in adaptation actions more generally (Robinson, 2017)

			Jamaica (SPCR, 2011) (UNDP, 2012), Hispaniola (GIZ, 2011)	approaches to account for recovery between extreme weather events and disturbance, maintained connectivity between social and ecological systems, ensured long-term funding (Jupiter et al., 2014), economic incentive for tree planting (Hidalgo et al., 2021)		and Finch, 2019), Integrated island management and cross-sectorial (Jupiter et al., 2014), regular monitoring and evaluation (Mercer et al., 2012); long-term sustainability, greater recognition of importance of diverse range of ecosystems, especially terrestrial (McNamara et al., 2020)	2011), reduced soil erosion UNDP, 2012 #1532}, reduced emissions UNDP, 2012 #1532}, improved soil health (GIZ, 2011), decreased poverty (GIZ, 2011), improved livelihoods and environmental awareness, improved water supply, health and sanitation (Hidalgo et al., 2021); supports global mitigation via carbon sequestration in both forest and soils	
	EbA: Increased reforestation (native species - towards habitat	Medium evidence, high	Relatively widespread e.g.	Locally driven projects tend to yield effective adaptation when	**Some examples:** e.g. Fiji (Daigneault et al., 2016), but generally limited evidence and tendency for lack of sustainability of projects,		Increased DRR, fewer floods and	

	connnectivity, heterogeneity and diversity) (15.5.4)	agreement	Dominican Republic (Monty et al., 2016); Jamaica (SPCR, 2011); Fiji (Daigneault et al., 2016); Tuvalu, Tonga, Samoa (Beyerl et al., 2018); Timor-Leste (Mercer et al., 2014), Micronesia (Hagedoorn et al., 2019).	externally driven (Klöck and Finch, 2019), embedding adaptation within disaster risk reduction e.g. ecosystem-based DRR (Mercer et al., 2014; Monty et al., 2016), NDC, funding, technical assistance, supply materials, provision of land, awareness raising, enforcement of policies from governments and NGOs (Beyerl et al., 2018), sense of shared responsibility (Beyerl et al., 2018), inclusion of Indigenous knowledge and local knowledge (Nalau et al., 2018), social capital (Hagedoorn et al., 2019).	investment in expensive pilot projects (Jupiter et al., 2014) and lack of long term monitoring.		landslides (Mercer et al., 2014), reduced erosion, increased human health and well-being (Beyerl et al., 2018) (Nalau et al., 2018), increased quality of ecosystem services (Nalau et al., 2018), increased adaptive capacity (Hagedoorn et al., 2019); supports global mitigation via carbon sequestration in both forest and soils	
	EbA: Agroforestry and other silvicultural/agroecological practices (e.g. climate-smart agriculture) instead of intensive agriculture and plantation forestry (15.5.4)	Medium evidence, high agreement	Widespread in the Caribbean and Pacific e.g. Samoa (Chong, 2014), Vanuatu (Buckwell et al., 2019),	Locally funded initiatives implemented by NGOs outperformed those with international funding or implemented by governments and universities, integrated	**Limited examples:** some increases in adaptive capacity (Tomlinson and Rhiney, 2017)		Improvement in climate change awareness, increase local well-being and improved non-climate	

			Pacific Islands (McLeod et al., 2019; McNamara et al., 2020), Jamaica (Tomlinson and Rhiney, 2017)	with EbA initiatives outperformed those focused on land loss, NDC, shared access and benefit (McNamara et al., 2020), local knowledge e.g. farmers knowledge of crop drought resistance and irrigation, although some local knowledge is counter to SDGs (Beckford, 2018), farmers, private sector for developing technology, financing and investing in local solutions, importance of data (Voccia, 2011). Success of EbA depends on enabling national political, socioeconomic and institutional conditions (Chong, 2014), training (Tomlinson and Rhiney, 2017).			issues, improve gender equity (McNamara et al., 2020), improved productivity and livelihoods, increased well-being (Buckwell et al., 2019)	
	Watershed management/conservation (reforestation, slope revegetation, etc) (15.5.4)	Medium evidence, high agreement	Widespread e.g. Samoa (Chong, 2014); Pacific Islands (McNamara et al., 2020); Jamaica, Haiti and Grenada (Mercer et al., 2012); Micronesia	Locally funded initiatives implemented by NGOs outperformed those with international funding or implemented by governments and universities, integrated with EbA initiatives outperformed those focused on land loss, shared access and	Some evidence e.g. improved water security (McLeod et al., 2019), reduced adaptation costs, slope stabilisation (Mercer et al., 2012), reduced vulnerability to drought (McLeod et al., 2019)		Disaster Risk Reduction, Increased water security and quality, greater resiliency to and recovery from wildfires, reduced run-	

			(McLeod et al., 2019).	benefit (McNamara et al., 2020), **but** watershed management less socially and politically acceptable than engineering solutions (Enríquez-de-Salamanca, 2018), communication and trust between stakeholders, sustainable financing mechanisms (Mercer et al., 2012), island remoteness barrier to logistical implementation (McLeod et al., 2019).			off and sedimentation, improvement in climate change awareness, increased local well-being and financial stability (McNamara et al., 2020)	
	Ridge-to-Reef ecosystem management (Figure 15.4) - Improved landuse as a key driver of terrestrial ecosystem health	Medium evidence, high agreement	See above	See above	Limited but slowly increasing evidence to date			
	Increasing the connectivity of Protected Areas (PAs) across elevation/climatic gradients to faciltate climate driven redistribution of species via establishment of: (i) new PAs; (ii) forested migration corridors across elevation/climatic gradients or (iii) improving landscape connectivity by permanent protection of	Very limited evidence, high agreement	Low degree of new implementations due to chronic terrain limitations combined with competition from human land use needs (especially at low altitudes). However there is currently large variation in terrestrial	(i) Conservation of larger areas of forest habitat surrounding (especially source) PAs; (ii) reforestation of degraded areas to facilitate forest corridors; (iii) increasing and enforcement of forest cover **<u>within</u>** PAs (e.g. (Scriven et al., 2015)), (iv) intra and inter governmental/island policies towards the coordination of	Yes: especially if landscape connectivity is improved (both protected and non-protected land). E.g. setting up of migration corridors to facilitate movement of species along elevation gradients from isolated low altitiude to high altitude PA (e.g. (Scriven et al., 2015))		Disaster Risk Reduction, Improved water security, improved coastal ecosystem health, greater resiliency and recovery from wildfires, reduced	May facilitate movement of Invasive Alien Species

	stepping stones (Figure 15.4)		PA coverage among islands (e.g. Caribbean: ~70% of Guadeloupe vs 1.3% of Barbados) (Gould et al., 2020; Mouillot et al., 2020).	conservation actions/partnerships among multiple PAs **and other non-PA natural habitat areas** within a given insular region (Monahan and Theobald, 2018; Maharaj et al., 2019); incorporation of 'Other Effective area-based Cobservation Measures' (OECMs)			pollution and runoff around water sources, facilitates development of Ridge-to-Reef PAs (e.g. Yap and Chuuk of Federated States of Micronesia) (McLeod et al., 2019).	
	Eradication of Invasive Alien Species (IAS) on islands (15.3.3.3)	Robust evidence, high agreement	Widespread degree of implementation with > 700 islands (e.g. (Jones et al., 2016)	(i) Integration of changing climate conditions within ongoing prevention, control and eradication strategies by incorporating models of current and future distributions of IAS (Courchamp et al., 2014; Vorsino et al., 2014) (ii) prevention via ongoing vigilance and biosecurity via quarantine, control and monitoring of incoming cargo and goods into islands (Silva-Rocha et al., 2015)	Yes: positive demographic and distributional responses of native species (596 populations), including within IUCN's threatened (critically endangered, endangered and vulnerable categories) following eradication of IAS (including 123 recolonizations by formerly extirpated species) (Jones et al., 2016)		Food security, protection of ecosystem health and services, increased livelihood security	A few native species may be harmed during eradication process - but usually temporary - and alleviates once eradication process is completed (Jones et al., 2016)
KR4. Water insecurity	Rainwater Harvesting (15.3.4.3)	Robust evidence, high	Widespread across small islands.	Socio-cultural & financial - cultural practices and poverty - people may not have	Yes - Heavy reliance on aquifers and rainwater harvesting in small islands, particularly atolls, coupled with overcrowding, population growth, and	Integrated Water Resource	Biodiversity (watershed protection); Health	Dependent on mode of implementation. Nothing

		agreement	Specific examples in the Caribbean - Jamaica (Aladenola et al., 2016); Barbuda (Mycoo, 2018b); In the Pacific (Quigley et al., 2016); Micronesia (Bailey et al., 2018); Solomon Islands (Chan et al., 2020).	the resources to build or purchase more tanks to increase their capacity to store water (McCubbin et al., 2015).	contamination increase the risk of waterborne disease (McIver et al., 2014).	Management - use management and integrated water resources policy implementation (Gohar et al., 2019). Governance - whole-of-island approaches foster integrated management practices in small islands (Remling and Veitayaki, 2016).	(WASH); Economic (reduced dependence on public supply); Food security	mentioned in the chapter.
	Desalination (15.6.1)	Limited evidence, high agreement	Relatively limited e.g. Maldives (Shakeela and Becken, 2015); Grenada (Peters, 2019)	Financial - Not explicitly mentioned in the chapter. These general references are possible options: Governance, financial arrangements and human resource capacity [are key] to the successful implement adaptation actions on the ground (Cvitanovic et al., 2016; Scobie, 2016; Beckford, 2018; Ha'apio et al., 2019). In Mauritius, a lack of financial resources for climate change adaptation has been recognised as a specific	Yes - In Barbados, where groundwater is relied upon for food production, urban use, and environmental needs, higher food prices are expected in the future if informed land use management and integrated water resources policy implementation are not put in place to manage groundwater in the short term, even with modest climate change threats (Gohar et al., 2019).		Health (WASH); Economic (reduced dependence on public supply)	Energy intensive (carbon footprint)

				impediment in district council level (Williams et al., 2020).				
	Reforestation (15.5.4)	Medium evidence, high agreement	Examples in the Caribbean and Pacific: Caribbean (McMillen et al., 2016; Mycoo and Donovan, 2017; Wang et al., 2017; McLeod et al., 2019; Nanni et al., 2019); Papua New Guinea (Jupiter et al., 2014); Fiji (Hidalgo et al., 2021).	Governance - whole-of-island approaches foster integrated management practices in small islands (Remling and Veitayaki, 2016).	Yes - in the Seychelles, reforestation is promoted through public-private partnerships, generating opportunities for wetland-tourism (Khan and Amelie, 2015). Growing evidence suggests high resilience of forest habitats (Keppel et al., 2014; Luke et al., 2017), especially within intact forest ecosystems to hurricanes and cyclones (Goulding et al., 2016).		Economic (agroforestry); Biodiversity (watershed restoration); Food security; disaster risk reduction (DRR)	Dependent on mode of implementation. Nothing mentioned in the chapter.
	Protected Area Management (terestrial) (15.5.4)	Medium evidence, high agreement	Widespread across small islands e.g. Samoa (Chong, 2014); Pacific Islands (McNamara et al., 2020); Jamaica, Haiti and Grenada (Mercer et al., 2012); Micronesia (McLeod et al., 2019).	Financial/governance - the success of protected areas is undermined by weak governance due in part to limited financial resources which undermine management and the enforcement of regulations governing activity within them (Schleicher et al., 2019).	Yes - Terrestrial protected areas have shown that forest conservation and rehabilitation yield better (socio-ecological) outcomes as forests stabilize soils and prevent erosion and sequester groundwater pollutants (Carlson et al., 2019) (low to medium evidence, high agreement).		Biodiversity (forest conservation); disaster risk reduction (DRR)	Dependent on mode of implementation. Nothing mentioned in the chapter.

Key Risk 5. Destruction of settlements and infrastructure - N.B.: works for submergence of reef islands, at least for those islands that host large communities and human assets	**Hard protection (15.5.1)**	Limited evidence, medium agreement (with regard to climate change adaptation and success)	Widespread in both urban and rural areas on islands, e.g. Barbados (Mycoo, 2014, French Polynesia {Salmon, 2019) **(Duvat et al., 2020b)**, Maldives (Naylor, 2015; Brown et al., 2020), Samoa (Crichton and Esteban, 2018).	External funding (Mycoo, 2018a; Nunn and Kumar, 2018). Social and cultural: hard protection often meets the preference of inhabitants because it is viewed as a 'true' and permanent solution providing value for money, e.g. in the Maldives (Shaig, 2011), in Samoa (Hills et al., 2013), in Comoros (Betzold and Mohamed, 2017). Political-institutional: e.g. supported by the centralization of power at the highest levels of government in favour of hard protection in the Maldives (Ratter et al., 2019); business-as-usual unidirectional approach of coastal risks is in favour of hard protection on Reunion Island (Magnan and Duvat, 2018). Technical, i.e. requires materials and technical skills to be available locally: maladaptive structures showing poor design in the Bahamas (Petzold et al., 2018), Maldives (Kench, 2012), Kiribati (Duvat, 2013) and	Reduces exposure in some places, e.g. Male', Maldives (Duvat et al., 2021) but not in others, e.g. South Tarawa, Kiribati (Duvat, 2013), Puerto Rico (Jackson et al., 2012); increases vulnerability (Nunn et al., 2021)	Limited monitoring and evaluation. What works in short term may not in the long term.	Limited evidence of co-benefits	Beach loss, e.g. in Hawaii (Romine and Fletcher, 2013 and Papua New Guinea {Mann, 2014); erosion acceleration, e.g. on Male' Atoll, Maldives (Rasheed et al., 2020) and in the Bahamas (Petzold et al., 2018); nearby ecosystem degradation through material extraction from reef flat and/or upper beach and/or sand dune, e.g. in South Tarawa, Kiribati (Biribo and Woodroffe, 2013; Duvat, 2013); modeling projects increased SLR impacts

				Samoa (Crichton and Esteban, 2018).				in areas modified by coastal engineering, e.g. on Male' Atoll, Maldives (Rasheed et al., 2020)
	Accommodation (15.5.2)	Limited evidence (with regard to climate change adaptation and success)	Relatively limited (e.g. local initiatives in Philippines and Indonesia (Jamero et al., 2017; Esteban et al., 2020)	Technological, financial, institutional, social and cultural (e.g. limited success despite incentives in French Polynesia; (Magnan et al., 2018))	Limited evidence to date		Maintains the functionalities of coastal systems and allows their maintenance through landward migration under SLR	
	Advance with land raising and/or through the creation of artificial islands (15.5.2)	Limited evidence with regard to climate change adaptation (e.g. driven by population growth in the Maldives; (Naylor, 2015)	Limited, e.g. Hulhumale', Maldives (Brown et al., 2020)	Technological, financial, institutional, social and cultural; has a higher potential in urban (compared to rural) areas	Yes where high standard, as in Hulhumale', Maldives (Brown et al., 2020)		Offers new land for economic development, e.g. in the Maldives (Hinkel et al., 2018); generate revenues through sale or lease of land in urban areas, e.g. in the Maldives (Bisaro et al., 2019).	Widespread ecosystem destruction, increased negative impacts of SLR in some places (Parnell and Smithers, 2020)

	Migration, including planned resettlement (15.5.3)	Limited evidence, low agreement (with regard to climate change adaptation)	Village-scale planned resettlement cases supported by government policy/legislation e.g. Warraber Island, Torres Strait (Parnell and Smithers, 2020), Vunidogoloa and Denimanu villages, Fiji (Piggott-McKellar et al., 2019)	Often seen as a last resort option due to high economic and socio-cultural cost (McNamara and Des Combes, 2015); Key enablers: participatory inclusion of all social groups in decision making required (e.g. Fiji, (Piggott-McKellar et al., 2019)); financial, especially for small and remote communities (e.g. Torres Strait, Australia; (Parnell and Smithers, 2020) Solomon Islands (Albert et al., 2018)), social-cultural connections (e.g. Fiji, (Piggott-McKellar et al., 2019)), strong governance frameworks, enabling legislation, land availability or ownership (e.g. Torres Strait Islands, Australia; (Parnell and Smithers, 2020), Solomon Islands, (Albert et al., 2018; Bertana, 2020)) and conditions in receiving locations; technical support; residents are generally reluctant to retreat as a result of place attachment and high uncertainties on	Limited examples of successful resettlement that reduces both exposure and vulnerability; reduced exposure locally - e.g. on Nuatambu Island, Solomon Islands (Albert et al., 2018); has created new vulnerabilities at some locations by, for example, bearing significant economic cost, impacting social capital, reducing access to services (e.g. (Albert et al., 2018); Gilbertese resettled in the Solomon Islands; (Weber, 2016; Tabe, 2019))		New livelihood opportunities	Loss of cultural heritage, impacts on receiving communities

				the conditions offered at relocation site, including concerns about livelihood opportunities, as reported in the Philippines (Jamero et al., 2017)				
	EbA measures (15.5.4)	Medium agreement, medium evidence	Increasingly experienced; includes artificial reefs, e.g. in the Maldives (Fabian et al., 2013) and in Mauritius (Duvat et al., 2020a), beach nourishment in Tuvalu (Onaka et al., 2017) and Mauritius (Onaka et al., 2015)	Environmental/physical conditions: potential effectiveness varies with site configuration and boundary conditions (Temmerman et al., 2013); Social and cultural; Technological; Major role of cooperation agencies/external support for implementation, e.g. JICA in Tuvalu (Onaka et al., 2017)and in Mauritius (Onaka et al., 2015) and of NGOs (in the Caribbean region (Mercer et al., 2012)); IKLK (e.g. Pacific, Nalau, 2018 #91}; Haiti, (Mercer et al., 2012)); Financial Nalau, 2018 #91}; Climate awareness raising increases success (McNamara et al., 2020); Inclusion in national adaptation policies increases the acceptance/implementation of EbA measures:	Limited evidence to date		Biodiversity strengthening; Increased food supply; Increased human health and well-being	

				e.g. considered as a complement to hard protection in Tuvalu; vegetation restoration seen as a key priority to combat erosion in Vanuatu (Hills et al., 2013)				
Key Risk 6. Health degradation	**Increase public awareness of health risks** associated with climate change; **provide training to health sector staff** on health impacts of climate change; **Improve reliability and safety of water storage practices** at household and community level (15.6.2)	Limited evidence	e.g. Dominica (Schnitter et al., 2019)	Financial and human resources to implement options, public uptake and buy in	Primarily reduces vulnerability	Building early warning and response systems for climate sensitive health risks, developing emergency plans, integrating climate services into health decision-making systems, strengthening emergency response and surge capacity, improving climate change and health data collection systems (Schnitter et al., 2019)	Increased water security	
Key Risk 7. Economic decline and	**Circular migration (15.5.3)**	Limited evidence with	Circular migration to Funafuti and	Labour and education opportunities in Funafuti and overseas	Yes on Namumea Atoll (Marino and Lazrus, 2015)	Investment in technology and education	Job and education for migrants	

livelihood failure		regard to climate change adaptation (mostly a response to economic or social factors)	locations overseas from Nanumea Atoll in Tuvalu reduces pressure on limited freshwater availability, thus reducing exposure to drought (Marino and Lazrus, 2015).	(Marino and Lazrus, 2015)		(Blair and Momtaz, 2018), local and indigeneous knowledge (Blair and Momtaz, 2018; Karlsson and McLean, 2020), financing farm inputs (Guido et al., 2018)	(Marino and Lazrus, 2015)	
	Diversifying livelihoods (15.5.6)	Limited to medium evidence, low agreement	Changing fishing grounds and considering weather insurance in Antigua, Domican Republic, and Efate (Vanuatu) (Blair and Momtaz, 2018; Karlsson and McLean, 2020) (Lemahieu et al., 2018; Turner et al., 2020)	Use of Indigeneous knowledge and local knowledge and changing fishing areas (Blair and Momtaz, 2018)	Yes in both Antiqua and Vanuatu (Blair and Momtaz, 2018). New fishing areas in Vanuatu (Blair and Momtaz, 2018) and fishermen go further off-shore in Madacascar (Lemahieu et al., 2018) and Domican Republic (Karlsson and McLean, 2020)		Diversification allows fishermen to fish in new areas and reduces pressure on previous fishing areas (benefits for biodiversity)	New technologies and moving to new areas allows greater catch which puts pressure on the fish stock
	Improved technology & equipment/training (15.5.6)	Limited evidence, medium agreement	In Antigua, adaptation strategies have included investments in	Investments in improved technologies and equipment and education (Popke et al.,	Yes in Antiqua and Vanuatu (Blair and Momtaz, 2018) and Jamaica (Popke et al., 2016) and in Pacific Island Countries on the whole (McLeod et al., 2018).		New technologies and education strengthenin	

			improved technologies and equipment, changing fishing grounds and seeking better training and education (Blair and Momtaz, 2018); in Jamaica they involved irrigation technologies due to increased drought and infrequent rainfall (Popke et al., 2016); experimenting with growing salt-tolerant (taro) crops, and relocating crop cultivation inland (McLeod et al., 2018)	2016; Blair and Momtaz, 2018)			g (Blair and Momtaz, 2018) (Popke et al., 2016)	
	Livestock husbandry (15.5.6)	Limited evidence	Limited, e.g. mall-scale livestock husbandry in Jamaica (Guido et al., 2018)	Varying expenditure on farm inputs and investments (Guido et al., 2018)	No evidence to date. Limited examples of successful livestock husbandry only in Jamaica (Guido et al., 2018)		Investments in farm inputs (Guido et al., 2018)	

	Adaptive finance/education (15.5.6)	Limited evidence, medium agreement	Limited, e.g. in Pueto Rico, women engage in new commercial enterprises (e.g. coffee shops, and food products) that do not rely on traditional coffee supply chains or government assistance (Borges-Méndez and Caron, 2019).	Tourism income provides adaptation finance, investing in education and capacity building, and working with nature rather than against it (Loehr, 2019). Public-private partnerships (Khan and Amelie, 2015]. Ecosystem-based Adaptation initiatives in the Carribean {Mycoo, 2018; Loehr, 2019)	Reduces risk and avoids negative knock-on effects (Loehr, 2019).		Generates opportunities, e.g. for for wetland tourism (Khan and Amelie, 2015)	
	Product/Market diversification (15.5.6)	Medium evidence, high agreement	Widespread, e.g. in Vanuatu and Fiji, households and communities diversify crops within gardens, garden in different areas within their customary lands & store and preserve certain foodstuffs (Campbell, 2014; McMillen et al., 2014;	Availability of different crops and land (Campbell, 2014; McMillen et al., 2014; Guido et al., 2018; Le Dé et al., 2018) and new markets (Borges-Méndez and Caron, 2019)	Reduces vulnerability to tropical cyclones in Fiji and Vanuatu (Campbell, 2014; McMillen et al., 2014; Le Dé et al., 2018) as adaptation strategy in Jamaica (Guido et al., 2018), and new markets in Puerto Rico (Borges-Méndez and Caron, 2019)		Food security and nutrition (Le Dé et al., 2018) and income security (Borges-Méndez and Caron, 2019)	

			Guido et al., 2018; Le Dé et al., 2018). In Jamaica, there is diversifying cropping patterns and expanding or prioritising other cash crops (e.g. fruits and vegetables) (Popke et al., 2016).					
	Adaptation in tourism policies (15.5.6)	Limited evidence, high agreement	Limited, e.g. in the British Virgin Islands, policies like adaptation taxes and levies imposed on tourism can provide funding for adaptation measures (Smith, 2017; Mycoo, 2018a).	Implementation of tourism regulations and policies that mainstream climate change adaptations (van der Veeken et al., 2016; Mycoo, 2018a; Becken et al., 2020; Thomas and Benjamin, 2020); taxes and levies imposed on tourism (for example British Virgin Islands' The Environmental Protection and Tourism Improvement Fund Act, 2017 (Smith, 2017; Mycoo, 2018a).	Limited evidence in reducing vulnerability (Smith, 2017; Mycoo, 2018a).			
Key Risk 8. Loss of cultural resources and heritage	**Integrating Indigenous Knowledge and Local Knowledge (IKLK) with western science to provide integrated approaches to climate change (15.6.5)**	Medium evidence, high agreement	Reported in the Pacific, including in Niue, Tonga, Vanuatu and the Solomon Islands (Chand et al.,	Use of IKLK across islands in preparing for disasters and understanding environmental change (Chand et al., 2014; Johnston, 2015; Janif et al., 2016;	Yes, can reduce vulnerability when IKLK supports robust adaptation; No, can increase vulnerability if IKLK no longer provides accurate information	Supporting and integrating IKLK (Blair and Momtaz, 2018; Karlsson and	Can increase climate change information and its understanding in communities	Reports from Vanuatu indicates that IKLK are at times inaccurate (eg seasonal calendars,

			2014; Chambers et al., 2017; Chambers et al., 2019); and in the Caribbean, e.g. suggested Caribbean Local and Traditional Knowledge Network to share information (Beckford, 2018)	Granderson, 2017; Kelman et al., 2017); social networks in sharing information and helping others Turner, 2020 #1217}; ecotheology increasing people's awareness of the environment (Rubow and Bird, 2016)		McLean, 2020)	, and increase culturally appropriate climate adaptation	biophysical weather indicators) due to climate change (Granderson, 2017)
	Hard Protection (15.5.1)	Limited evidence, low agreement	Widespread in protecting cultural sites and villages e.g. Samoa (Crichton and Esteban, 2018)		Reduces exposure in some places but not in others; increases vulnerability (Nunn et al., 2021)			

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