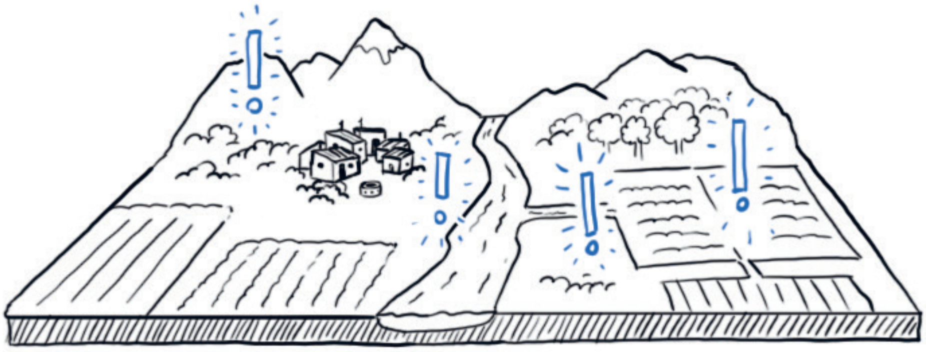
Competence Centre for Climate Change



Climate Change Impact Chains in Coastal Areas (ICCA)

Final study report

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

CIFOR

AdaptationCommunity.net

The study **"Climate Change Impact Chains in Coastal Areas"**, produced by the Center for International Forestry Research, CIFOR, was commissioned by the Inventory of Methods for Adaptation to Climate Change (IMACC) project, a global project by the Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and funded through the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The project aims at user-driven application and advancement of existing tools and methods for adaptation, developing capacities for adaptation action and supporting South-to-South exchange, particularly among its seven partner countries: Grenada, India, Indonesia, Mexico, Philippines, Tunisia and South Africa. IMACC operates the platform **AdaptationCommunity.net** that provides introduction to key topics of adaptation, examples of adaptation experiences and serves as an exchange and webinar platform.

CONTENT

1.

INTRODUCTION

1.1 Objectives of the study

The following report describes the outcomes of the study "Climate Change Impact Chains in Coastal Areas (ICCA)" conducted by CIFOR for the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) as part of the "Inventory of Methods for Adaptation to Climate Change (IMACC)" project.

The objective of the ICCA study is to understand, delineate and communicate climate change impact chains, as well as potential ecosystem-based adaptation practices, in coastal areas with a special focus on Indonesia and the Philippines. The study was conducted in two components: (i) Global literature review covering coastal areas and especially mangrove and coral socio-ecological systems; (ii) Country document review and expert interviews for Indonesia and the Philippines.

The global literature review was conducted following a pre-defined methodology (Annex 1) and aimed to achieve the following objectives:

1. Understand and delineate the current and potential impacts and related feedback loops (impact chains) from climate variability, extremes and change in mangrove and coral socio-ecological systems based on existing peer-reviewed evidence.

2. Understand and delineate the compound impacts resulting from the interaction of climate and non-climate stressors (e. g. deforestation) in mangrove and coral socio-ecological systems based on existing peer-reviewed evidence.

3. Identify potential ecosystem-based adaptation strategies for mangrove and coral socio-ecological systems from peer-reviewed literature.

The second component focusing on Indonesia and the Philippines aimed to achieve the following objectives:

1. Examine current adaptation practices in coastal areas based on national and sub-national project documents.

2. Identify and analyse the adaptation practices with activities focusing on, or related to, mangrove and coral ecosystem services for the adaptation of people.

3. Analyse national and sub-national policy and its current and potential impact on the uptake of ecosystem-based adaptation practices in mangrove and coral socio-ecological systems.

4. Conduct expert interviews with decision-makers, project implementers and researchers in both countries.

For the Indonesia country case, project, program and policy documents published in English and Bahasa Indonesia were included. For the Philippines country case, documents published in English were included. The search terms, methodology used and list of documents reviewed are outlined in Annex 3. Semi-structured interviews were conducted by telephone or email with stakeholders from both countries. The semi-structured interview guides and list of stakeholders interviewed are outlined in Annex 4.

1.2 Rationale for the study

Tropical coastal areas

Tropical coastal areas are characterised by dynamic seascapes which encompass interconnected ecosystems such as mangroves, seagrass beds and corals. These ecosystems provide a wealth of ecosystem services, are highly productive and harbour unique aquatic and terrestrial biodiversity. The ecosystem services of coastal seascapes are vital for the income, subsistence and protection of coastal communities, as well as for the functioning of economic sectors such as tourism and fisheries.

Mangrove forests protect coastal zones from tropical storms, floods and erosion, process waste and nutrient pollution, provide nursery grounds for fish and crustaceans, are important sources of energy and nutrients to coral reefs, sequester and store carbon, and provide an array of wood and non-wood products. Coral reefs protect mangroves and seagrass beds from wave energy, and they supply nutrients and organic material to the entire ocean food web. Fish caught from reefs constitute an important livelihood and protein source for coastal communities worldwide and support the fisheries sector in many countries, especially in small island states. Reefs are also important for tourism in many coastal areas, where frequently other livelihood opportunities are scarce.

It is evident that coastal ecosystems are important for the adaptation of people and sectors to climate change. However, these ecosystems are themselves sensitive to a range of climate-induced pressures such as sea-surface and land temperature shifts, sea-level rise, droughts, floods and changes in seasonality. Climate pressures often occur in combination with human-induced pressures such as unsustainable harvesting and land-use conversion, rendering the broader socio-ecological systems progressively more vulnerable.

Impacts from anthropogenic and environmental pressures in any of these ecosystems are felt throughout the seascape. Mangroves, seagrass beds and coral reefs are in constant exchange with each other, which preserves the balance and diversity in the coastal environment and maintains the flow of important ecosystem services (Figure 1). Coastal seascapes are also influenced by what happens in adjacent ecosystems outside of the coastal area, such as upland watersheds. Sediment carried in runoff resulting from upland deforestation can severely affect mangrove and coral reef structures. Even fresh water alone can be a stressor for both mangroves and coral reefs, and runoff levels can significantly affect species distribution and reproductive success. The transportation of pollutants from upland ecosystems as soluble products or via the surfaces of sediment particles can aggravate these effects further.

The impact chain concept

There is currently little understanding of the present and potential future impacts of climate change in coastal seascapes. For example, preliminary scientific evidence suggests that reductions in direct and catchment rainfall may contribute to the conversion of mangrove systems into salt marshes but a more holistic appreciation of the related socio-economic and ecological impacts, and their direct and indirect effects within and beyond the system, is lacking. Knowledge relevant to climate change impacts in coastal seascapes may exist, but is scattered across disciplines and levels and is not consolidated in a way that is useful for understanding the chain of impacts and for decision-making at the seascape level.

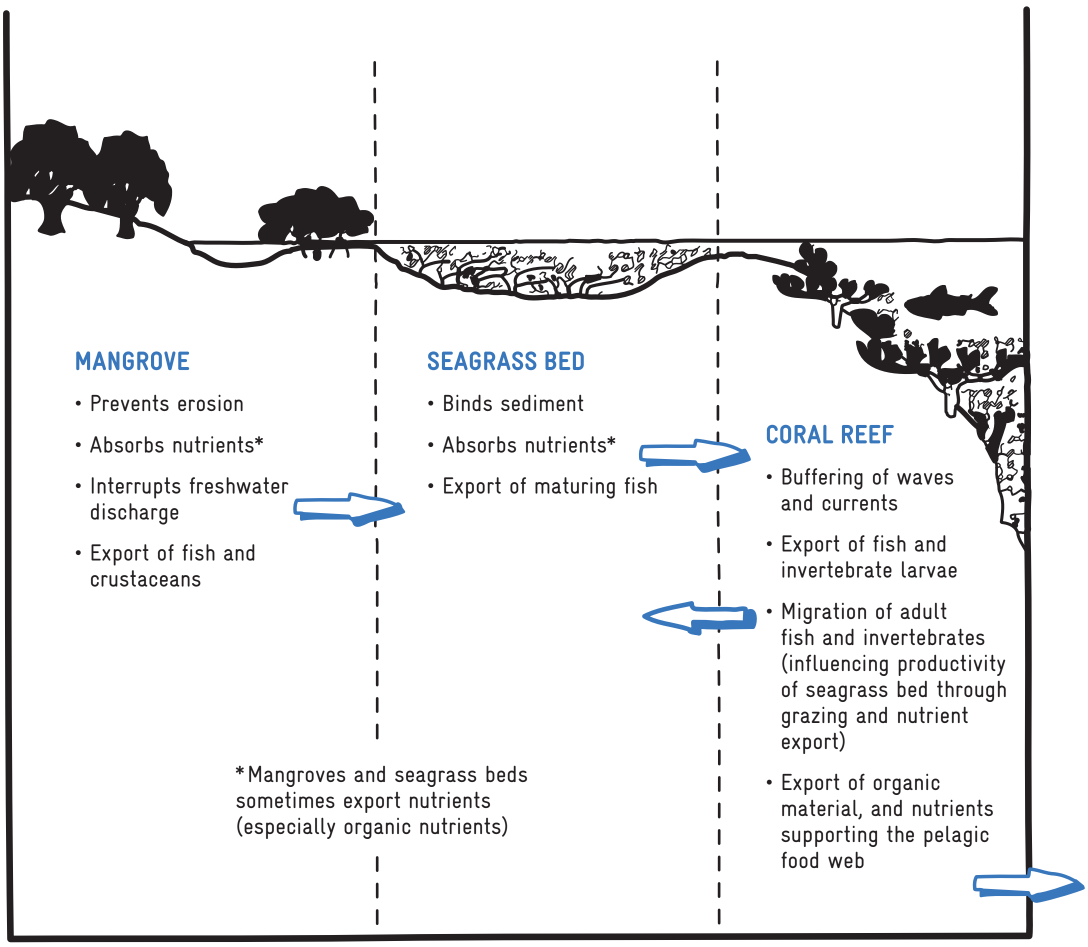


Figure 1: Interactions in the tropical seascape, showing the connections between mangroves, seagrass beds and coral reefs. Source: Moberg and Folke (1999).

Impact risks related to climate change pressures are frequently examined for each system component in isolation, for example through single sector or ecosystem impact studies. This can be a useful way to plan and prioritise adaptation action. However, it can also lead to situations where potential impacts, mal-adaptation risks and feedback loops in dependent sectors or system components are overlooked.

Impact chain maps are one way of illustrating the potential impacts of climate change pressures in a more holistic and system-oriented way. As defined in ci:grasp[1], *"a climate impact chain (in short: impact chain) is a general representation of how a given climate stimulus propagates through a system of interest via the direct and indirect impacts it entails"*. An impact chain is generally illustrated as in Figure 2, where the climate stimulus marks the beginning of the chain.

All impact chains presented in this report can be found on ci:grasp under the following links:

- Ocean acidification
- Ocean warming
- Changes in precipitation
- Sea-level rise
- Tropical storms

This report as well as its annex can be downloaded from AdaptationCommunity.net.

1.3 ICCA impact chains

The impact chain concept was used to illustrate the current and projected impacts that are, or can be, triggered by the different climate-related hazards or stimuli in coastal socio-ecological systems. The impact chain maps were elaborated with the mind mapping software DropMind[2].

The different direct and indirect impacts were conceptualised based on the findings from the global literature review. It is thus important to note that the impact chain maps presented in this report are not exhaustive and a number of other, additional direct and indirect impacts that did not surface as evident from the literature review, can potentially occur. The same is true for the different relationships that are illustrated between the impacts on the maps.

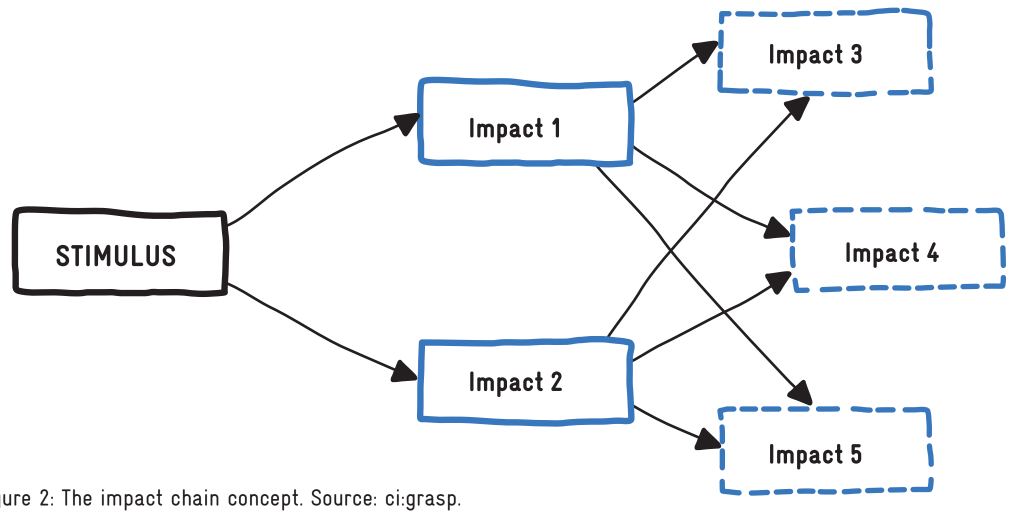


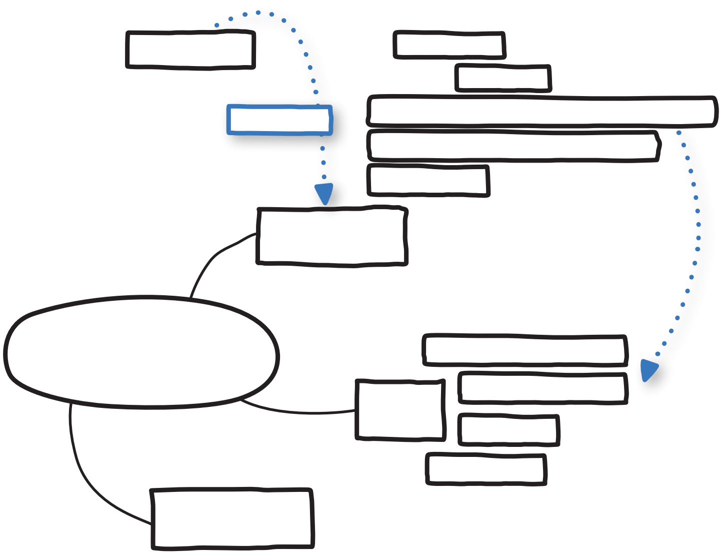
Figure 2: The impact chain concept. Source: ci:grasp.

1 http://www.cigrasp.org

2 http://www.dropmind.com

2.

CLIMATE CHANGE IMPACT CHAINS IN COASTAL AREAS



Impact chain maps were elaborated for the following climate stimuli that were depicted as important for coastal areas in the literature reviewed:

i. Ocean acidification;
ii. Ocean and sea-surface temperature (SST) warming;
iii. Precipitation change;
iv. Sea-level rise;
v. Tropical storms (including cyclones, hurricanes, typhoons etc.).

The evidence in the literature retrieved for other climate stimuli such as land surface temperature rise and heat waves was not found to be substantiated or detailed enough for the elaboration of impact maps that specifically relate to coastal areas. Furthermore, the impacts of rising land and air temperatures on components of socio-ecological systems such as annual crops (e. g. rice, maize etc.) that are common across different areas have been extensively documented in other studies.

2.1 Ocean acidification

Ocean acidification refers to the decrease in the pH of the earth's oceans which is caused by the uptake of carbon dioxide (CO_2) from the atmosphere and its dissolution in water. It primarily impacts coral reefs and marine organisms, with subsequent effects along the trophic chain *(Kleypas and Yates 2009)*.

Ocean acidification can cause several direct and indirect impacts to coral reefs. Acidification leads to changes in marine carbonate chemistry, for example in the aragonite saturation state (Omega(arag)), that directly cause a decline in coral reef calcification and growth. Net reef community calcification rate in the Great Barrier Reef (GBR) is thus projected to decline by 55% of its preindustrial value by the end of the century *(Shaw et al. 2012)*. Coral growth rates have generally declined over the past 30 years in the western Pacific, Indian and North Atlantic Oceans *(Manzello 2010)*.

The substantial decrease in the number of carbonate ions available in the seawater will have serious implications for coral calcification rates and skeletal formation *(Guinotte and Fabry 2008)*. Erosional processes will start occurring at rates that are faster than coral growth, altering reef stability and coral competitiveness for space and light.

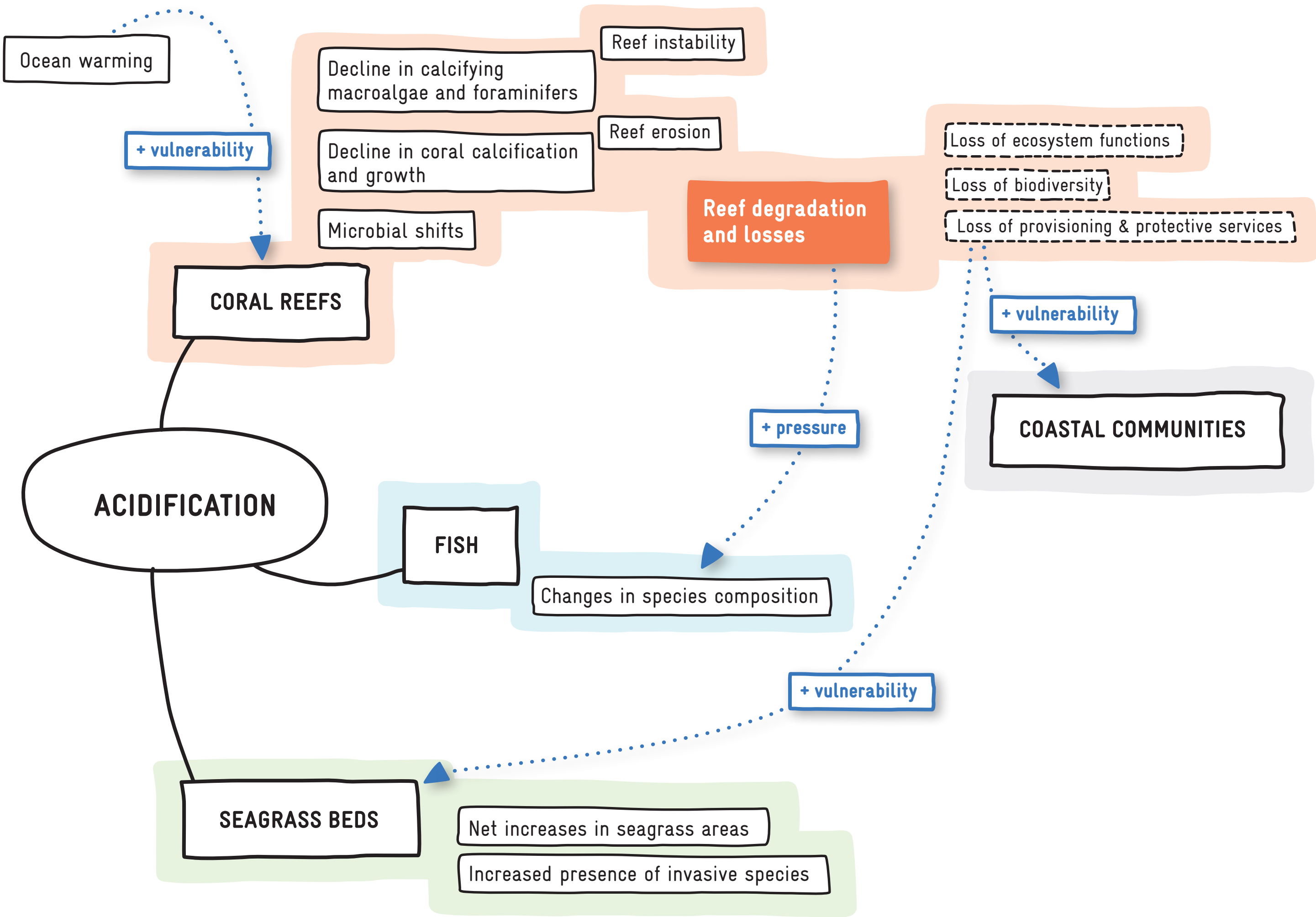
Reef stability is also influenced by calcifying macroalgae and foraminifers; these are negatively impacted by acidification in a similar manner to coral reefs (*Koch et al. 2013; Price et al. 2011; Uthicke et al. 2012)*.

Species of the common coral reef macroalgal genera Halimeda, for example, produce a large proportion of the sand in the tropics and are a major contributor to framework development on reefs because of their rapid calcium carbonate production and high turnover rates *(Price et al. 2011)*. They are highly susceptible to reduced pH and aragonite saturation state, which lower net calcification rates as in all calcifiers (including corals as mentioned above). The decline of calcifying macroalgae and foraminifers due to acidification can lead to the dominance of fleshy and non-calcifying algae (*Guinotte and Fabry 2008; Koch et al. 2013)*. Experiments exposing crustose coralline algae to elevated pCO_2 (twice the present amount) indicate up to a 40% reduction in growth rates, 78% decrease in recruitment, 92% reduction in total area covered by coralline algae, and a 52% increase in non-calcifying algae *(Guinotte and Fabry 2008)*.

Reef instability and erosion occurring from the abovementioned effects will lead to reef degradation and losses. Losses will be amplified in vulnerable reefs that are already in a condition of stress due to anthropogenic or other climatic influences. Ocean warming, for example, increases coral reef vulnerability to acidification *(Guinotte and Fabry; Koch et al. 2013)*. Reef degradation and coral mortality will not only result in biodiversity loss and shifts in ecosystem functions, but also in losses of provisioning and protective (or regulating) ecosystem services *(Kleypas and Yates 2009)*.

Coral reefs provide breakwater benefits that protect shorelines and create quiet habitats for other ecosystems, such as mangroves and seagrass beds (protective services). They are also an important habitat for reef fish. The loss of these ecosystem services will increase the overall vulnerability of people who live on the coasts or depend on these services for their livelihoods (either directly or indirectly). For example, it is estimated that substantial job losses and indirect economic costs will occur in the USA due to ocean acidification and its effects on marine habitats, marine resource availability, and marine and coastal ecosystem services *(Cooley and Doney 2009)*. The direct and indirect socio-economic impacts will be even more dramatic in the less-developed tropical regions.

OCEAN ACIDIFICATION IMPACT CHAIN MAP



Fish communities will not only be disrupted due to the degradation and losses of coral reefs but also as a direct effect of acidification. Increased dissolution of CO_2 in the ocean waters will influence predator-prey relationships in reef fish *(Ferrari et al. 2011)*. Evidence suggests that elevated CO_2 affects brain function in larval fishes and both olfactory and auditory senses in larval and adult fishes. It also induces marked changes in fish behaviour such as alterations in foraging preferences of predators and changes in the anti-predator responses of prey. In general, small juveniles of all species sustain greater mortality at high CO_2 levels. Elevated CO_2 produces long-term effects on metabolic functions, growth and reproduction of fish, all of which could be harmful at population and species levels *(Guinotte and Fabry 2008)*.

One of the few ecosystems that stand to benefit from increasing levels of CO_2 in the seawater are seagrass beds, as they use CO_2 for their photosynthesis *(Guinotte and Fabry 2008)*. An increase in total seagrass area could potentially lead to more favourable habitat and conditions for associated invertebrate and fish species but there is also a danger that invasive species which grow faster under decreased pH will take over *(Koch et al. 2013)*.

The only way to protect coastal and marine ecosystems from ocean acidification is limiting anthropogenic CO_2 emissions. However, several actions are proposed and recommended in the literature reviewed to minimise or delay degradation by informing ecosystem management and related policy with relevant data and research. Cooley and Doney *(2009)* suggest that the design of new policies should begin with comprehensive research targeted towards regional needs and based on time series studies of coastal and open ocean seawater chemistry. Comprehensive studies are also needed at the species and ecosystem levels to better understand responses to decreased pH and elevated CO_2. These should be complemented by economic and social science studies on markets, prices and community responses to declining fishery harvests and how best to mitigate potential socio-economic impacts.

Similarly, Koch et al. *(2013)* and Guinotte and Fabry *(2008)* suggest that bio-geographical surveys of species and in situ experiments should be ongoing to document range shifts of economically and ecologically critical species and the general biological responses of marine taxa. Field experiments that harness the naturally varying carbonate chemistry across coral reefs to study long-term responses across different conditions are essential *(Price et al. 2011)*.

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2.2 Ocean and sea-surface temperature (SST) warming

Ocean warming (including of sea-surface temperatures) is again primarily of concern for coral reefs, fish and other marine organisms. Steadily rising SSTs are already driving dramatic changes in the growth of an important reef-building coral, Diploastrea heliopora, in the central Red Sea *(Cantin et al. 2010)*. Bleaching is another serious impact which occurs when corals' ability to sustain zooxanthellae (symbiotic algae residing in corals) with nutrients for photosynthesis is compromised due to increased temperatures.

During and after the 1998 ENSO events, the bleaching and subsequent mortality of many coral communities was analysed and documented, providing substantial evidence that links bleaching events to increased water temperatures *(Glynn et al. 2001; Fong and Glynn 2001; Wilkinson et al. 1999)*. Massive mortality occurred on the reefs of Sri Lanka, Maldives, India, Kenya, Tanzania and Seychelles, with mortalities of up to 90% in the shallow areas *(Wilkinson et al. 1999)*.

Numerous delayed effects of coral bleaching were also observed including predator concentration, increased bio-erosion, susceptibility to disease by parasites and pathogens, and a decreased capacity for wound healing *(Glynn et al. 2001)*. Bleaching has direct socio-economic effects as well, such as decreases in diving tourism *(Zeppel 2012)*, declines in reef fish stocks *(Munday et al. 2008)* and general losses of coral ecosystem services (e.g. regulating) due to the declines in coral cover.

Coral-dependent fish suffer the most rapid population declines as coral is lost *(Munday et al. 2008)*. The socio-economic effects of coral bleaching for coastal communities of the Indian Ocean were apparent in the aftermath of the 1998 ENSO event. Decreases in reef fish stocks and changes in reef fish populations affected the livelihoods and food security of many fishermen communities *(Wilkinson et al. 1999)*. A decrease in tourism income was also noted as reef fish are one of the main attractions for divers. Furthermore, coral bleaching can lead to erosion, particularly in the Maldives and Seychelles, due to the loss of the protective barrier function of the reefs *(Wilkinson et al. 1999)*.

Apart from declines in coral cover due to bleaching and subsequent losses of habit, increasing water temperatures impact fish directly as well. Fish assemblages where sea-surface temperatures are extreme (range: 12–35°C annually) have been shown to hold significantly lower abundance, richness and biomass, with significantly higher abundances of smaller sized individuals as compared to sites where conditions are moderate (range: 22–31°C annually) *(Feary et al. 2010)*.

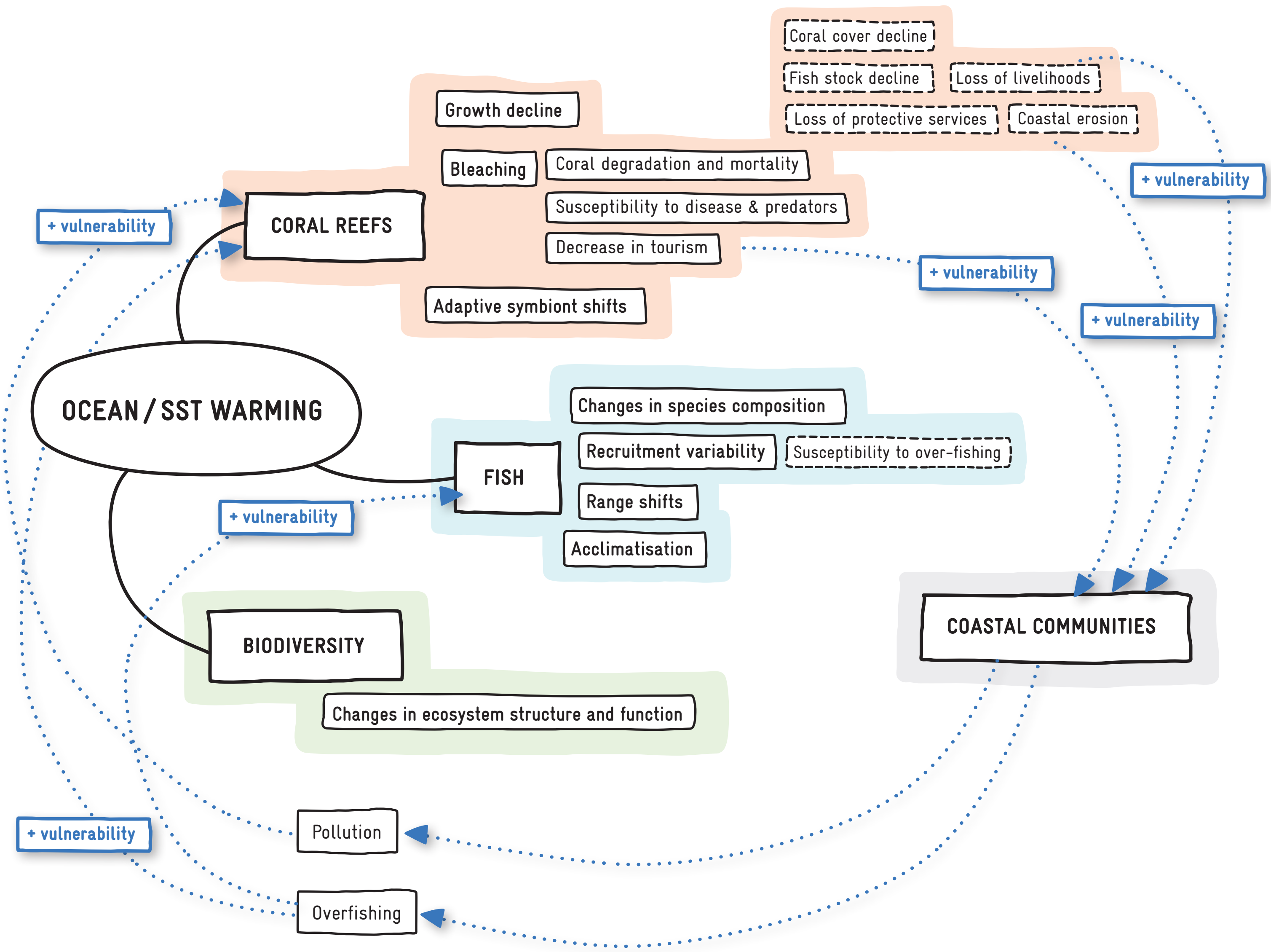
Increased ocean temperatures will affect the physiological performance and behaviour of coral reef fish, especially during their early life history. Small increases might generally favour larval development but adult reproduction could be negatively affected, influencing already variable recruitment. This will make optimal harvest strategies for coral reef fisheries more difficult to determine and populations more susceptible to overfishing *(Munday et al. 2008)*. A substantial number of species could exhibit range shifts; this will mostly affect sub-tropical and temperate species *(Lloyd et al. 2012; Parker and Dixon 1998)*.

Some good news is that tropical fish can acclimate over multiple generations, especially when both parents and offspring are reared throughout their lives at elevated temperatures *(Donelson et al. 2011)*. Fish can thus potentially adapt but only if their capability to do so is not compromised by other pressures such as over-fishing. Coral reefs also have the potential to adapt, through shifts in algal symbionts (algae living in symbiosis with corals). Corals containing unusual algal symbionts that are thermally tolerant and commonly associated with high-temperature environments were found to be much more abundant on reefs previously affected by warming events such as El Niño *(Baker et al. 2004)*. However, many corals do not have the ability to adjust to climate warming by acquiring and maintaining exogenous, more stress-tolerant symbionts *(Coffroth et al. 2010)*.

Even though many corals and fish possess an innate capability to adapt to rising ocean temperatures, their adaptive capacity under the threat of multiple stressors (both climatic and anthropogenic) remains uncertain. Anthropogenic pressures such as nutrient enrichment and over-fishing, for example, can greatly affect coral tolerance to and recovery from thermal stress *(McClanahan 2008; Wooldridge et al. 2012)*.

Some degree of change in ecosystem structure and function should generally be expected under rising ocean temperatures. Increased temperatures will lead to a decline in phytoplankton biomass, for example, which will limit the nutrient supply in coastal and marine ecosystems, affecting population and commu-

OCEAN AND SEA-SURFACE TEMPERATURE (SST) WARMING IMPACT CHAIN MAP



nity dynamics, and ultimately ecosystem structure and function *(Moser et al. 2012)*. This is likely to change the quality and quantity of the resources that people living in tropical coastal areas depend on *(Hoegh-Guldberg 2011)*, as well as the flow of important regulating services such as coastal erosion control.

In order to increase the resilience of ecosystems to thermal stress, almost all authors advocate sustainable management and minimisation of anthropogenic stressors such as pollution and over-fishing *(Obura 2005; Wilkinson et al. 1999)*. Stressors will not act independently. Ecosystems will be exposed to multiple stressors concurrently, including anthropogenic stressors which can significantly increase their vulnerability *(Przeslawski et al. 2008)*. Coastal management should better account for the cumulative, synergistic and mounting stresses arising from climate change and concurrent human activities *(Moser et al. 2012)*. Prioritising conservation in areas that have the ecological capacity to resist and tolerate climatic changes is also recommended *(Ateweberhan and McClanahan 2010)*.

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2.3 Precipitation change

Changes in precipitation will affect coastal areas through either the decrease or the increase of rainfall and associated extreme events (drought, flooding etc.). Decreases in rainfall and drought are expected to significantly impact mangrove ecosystems and coastal agrarian communities.

Drought can have a profound effect on carbon assimilation and leaf photosynthesis of different mangrove species, which can lead to growth decline *(Sobrado 1999)*. Furthermore, decreased rainfall and increased evaporation will increase salinity, which results in growth decline, altered competition between species and the conversion of upper tidal zones to hypersaline flats in the most extreme scenarios *(Gilman et al. 2008)*.

Crop losses will be significant when drought strikes coastal communities due to the lack of fresh water for irrigation, especially in small islands. Climate change is already affecting food systems in South Pacific islands, including the supply of food from agriculture and fisheries, the ability of countries to import food, systems for the distribution of food, and the ability of households to purchase and utilise food *(Barnett 2011)*.

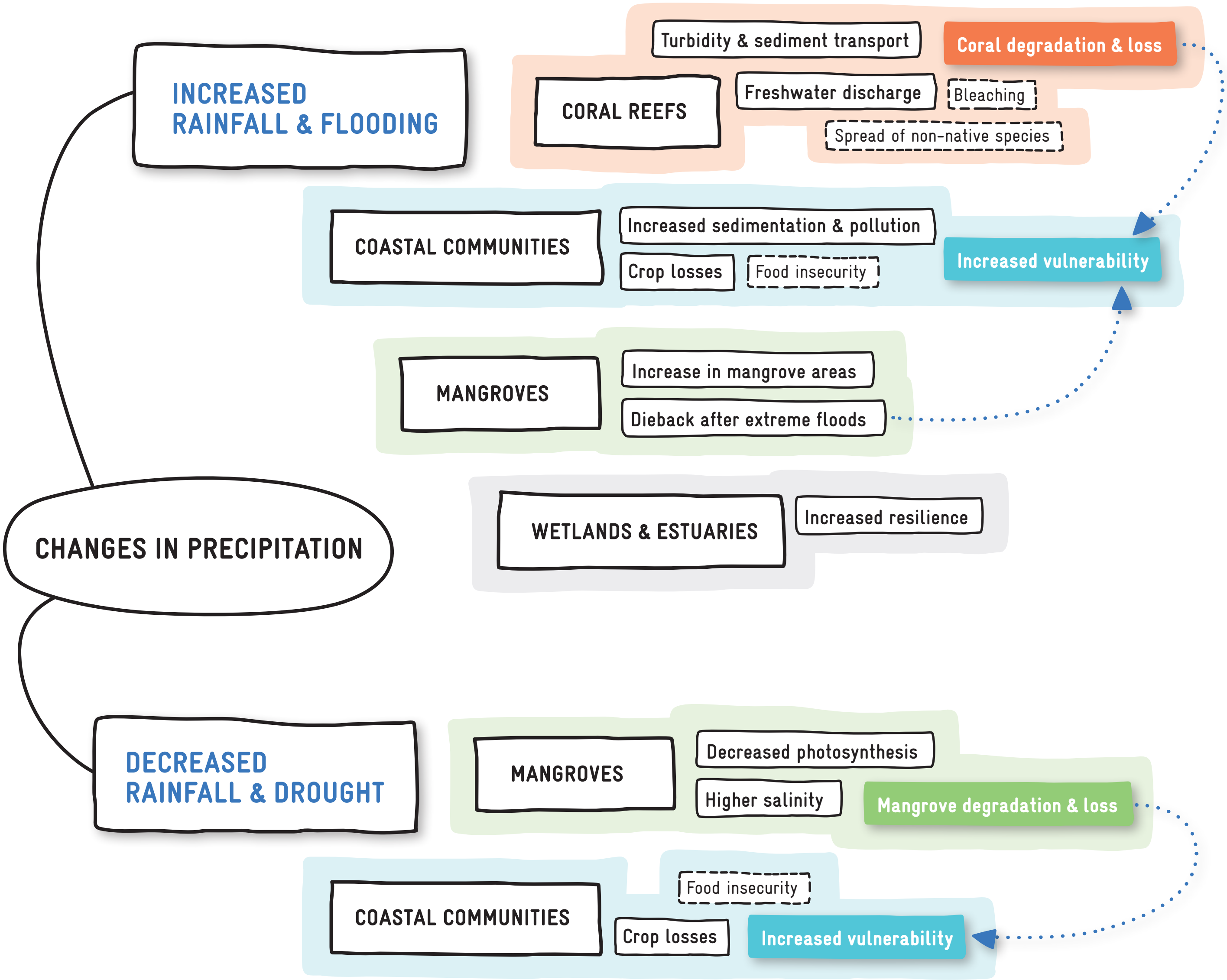
Increased rainfall and flooding on the other hand, will also impact coral reefs in addition to mangroves, coastal communities and wetlands and estuaries. Inland flooding leading to sediment discharge into coral reefs can be detrimental to their health as demonstrated by studies in Mozambique *(Pereira and Gonçalves 2004)*. Apart from sediment discharge, freshwater input from prolonged rainfall and flooding can also cause problems. Freshwater-induced bleaching can occur, especially in reefs located further away from the open ocean (e. g. in lagoons) *(Perry 2003)*. The original faunal composition of the reefs can also change, something which can influence the regeneration and renewed recruitment of corals after the disturbance.

Inland and riverine flooding can directly impact downstream coastal communities, in addition to localised coastal flooding. The transportation of nutrients, sediments, organic matter and pollutants increase under intense precipitation and flooding events *(Martínez Arroyo et al. 2011)*, affecting land and agriculture, and rendering coastal communities more vulnerable to the spread of human diseases. The severe flooding in Fiji in 2004, for example, resulted in the loss of 50%–70% of all crops and caused significant food insecurity *(Barnett 2011)*.

Increased rainfall can, however, be beneficial to mangroves and wetlands. Increased rainfall will result in increased growth rates and biodiversity, and an increase in mangrove areas with the colonisation of previously unvegetated landward fringes in tidal wetland zones *(Gilman et al. 2008)*. It must be noted, though, that extreme floods will directly damage mangroves due to the physical impact and also influence regeneration processes post-disaster *(Erftemeijer and Hamerlynck 2005)*. Higher fresh water input can increase the resilience of other wetland ecosystems and estuaries as it reduces salinity and encourages the input of mineral sediments and nutrients on which organisms depend *(Day et al. 2008)*.

As with discussions regarding other climate stressors, key recommendations include limiting non-climate pressures (e. g. conversion for aquaculture and pollution in mangroves) in order to augment overall ecosystem health and resilience. Ensuring representation, replication and refugia through a system of protected area networks is additionally advised to enhance the adaptability of ecosystems such as mangroves *(Gilman et al. 2008)*. Consistent monitoring is essential too, especially since precipitation variability can induce slow-onset changes in biodiversity and ecosystem structures. Implementing, coordinating, and / or strengthening permanent monitoring networks of oceanographic, environmental and biological variables is needed to allow the measurement of deviations to the general patterns in coastal and marine environments *(Martínez Arroyo et al. 2011)*. Sediment, freshwater and nutrient supplies need to be monitored and subsequently managed at the regional or landscape / seascape level *(Day et al. 2008)*.

PRECIPITATION CHANGE IMPACT CHAIN MAP



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2.4 Sea-level rise

Sea-level rise (SLR) is one of the most certain outcomes of climate change that will adversely impact mangroves, coral reefs, coastal biodiversity and coastal communities and economic sectors. Relative SLR[3] is a substantial cause of recent and predicted future reductions in the area and health of mangroves (*Gilman et al., 2008*), mainly through sediment erosion, inundation stress and increased salinity in landward zones. When the rate of mangrove sediment accretion and elevation is exceeded by the rate of relative SLR, the duration, frequency and depth of inundation goes beyond mangrove tolerance levels *(Gilman et al. 2008)*. Salinity problems are also observed.

Various surface and subsurface processes control the rate of mangrove sediment surface elevation. For example, erosion in high islands can constitute an important source of sediment for mangroves *(Krauss et al. 2010)*. Different hydrogeomorphic settings (including rivers) further influence surface elevation change, suggesting that tropical mangrove ecosystems have differential vulnerabilities to SLR.

As new areas become flooded due to SLR, and inundation in seaward fringes becomes intolerable, mangroves are forced to migrate landwards, as has been observed in Mexico *(López-Medellín et al. 2011)*. Even if mangroves have the possibility of inland / landward expansion (i.e. no barriers are present) this does not ease conservation concerns, as it is the seaward fringes, and not the inland margins, that provide the most valuable ecosystem services for fisheries and coastal protection. Any degradation and losses of mangroves will also lead to substantial carbon emissions as mangroves store vast amounts of carbon both above and below ground.

Accelerating SLR will impact coral reefs through increases in energy and sediment re-suspension, and drowning. Sedimentation is known to increase coral stress and bleaching as particles that settle on coral surfaces interfere with photosynthesis and feeding, and turbidity induced by suspended sediment reduces incident light levels *(Ogston and Field 2010)*. The adverse effects of drowning relate to reduction in photosynthesis as corals that are accustomed to more shallow waters receive less access to light *(Hoegh-Guldberg 2011; Spencer 1995)*.

As discussed in the previous sections, any degradation and losses of coral reefs will have detrimental effects on reef fish, and subsequently on the coastal communities that depend on them for their livelihoods. The forced migration of different fish species due to the inundation of coastal areas and drowning of reefs is to be expected *(Munday et al. 2008)*. Mangrove ecosystems also provide important habitats for fish and crustaceans and any losses in their extent will lead to additional vulnerability for coastal communities.

Losses in mangroves will also reduce the protective services that they provide to coastal communities against the negative impacts of SLR and tropical storms. Coastal ecosystems can act as a shield for the shoreline against climatic hazards, but as sea level rises the protective functions tend to decrease. The SLR impacts of inundation and shoreline erosion have been exacerbated on many coasts in the Pacific by the clearance of coastal vegetation, particularly mangroves, the mining of sand and the construction of artificial structures without a clear understanding of coastal dynamics *(Nunn and Mimura 1997)*.

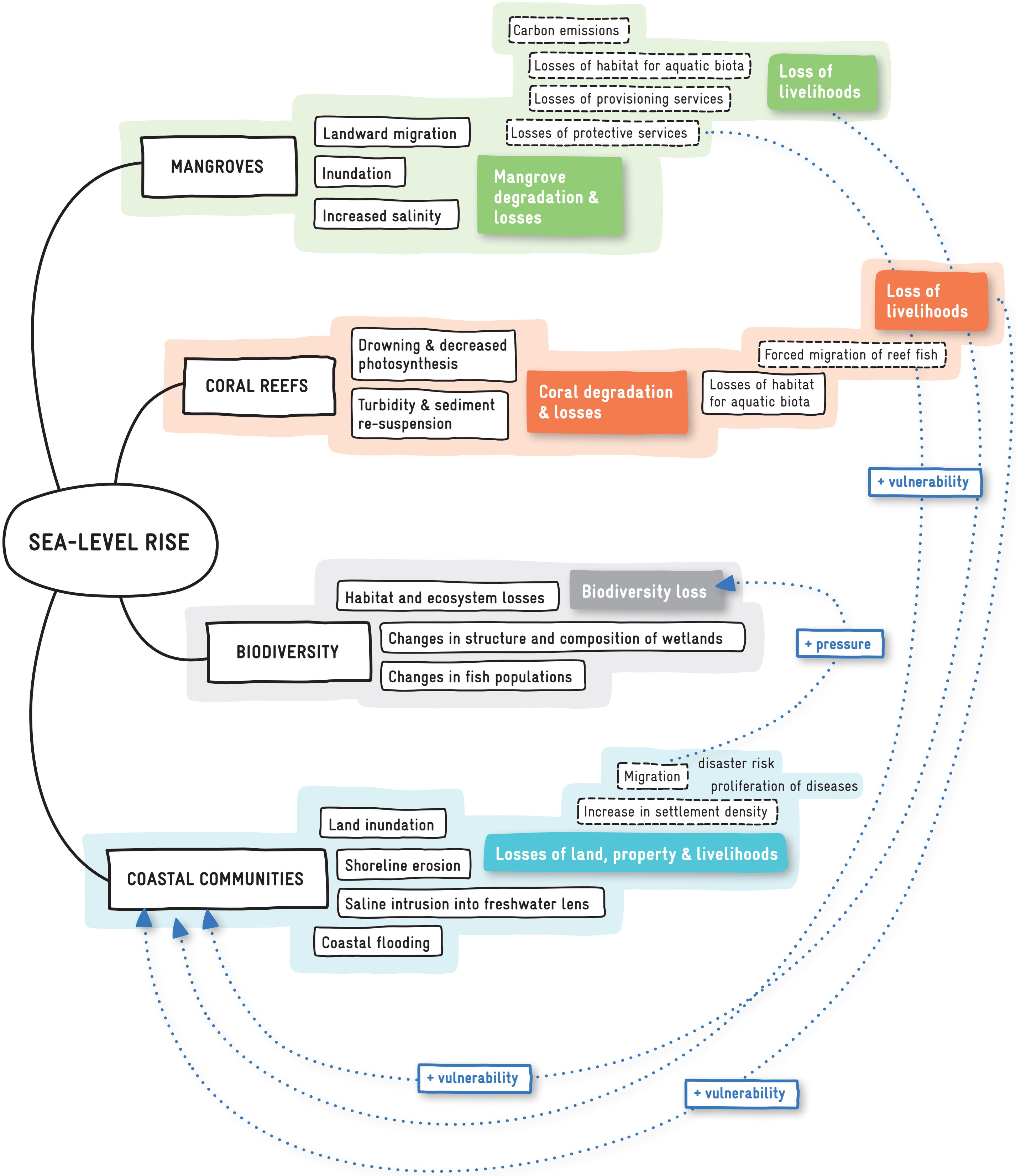
Beyond corals and mangroves, SLR can have a profound effect on ecosystems and biodiversity more broadly. Land inundation, flooding and salinity intrusion due to SLR will lead to changes in the structure and composition of coastal wetlands as the environment will become more saline *(Traill et al. 2011)*. In Mozambique, low relief marshes are expected to be overwashed or completely inundated by SLR *(Chemane et al. 1997)*.

Alterations in tidal patterns and increased turbidity and salinity will lead to a modification in fish habitats and in turn to changes in the distribution of many fish species, especially estuary species, which are less tolerant to salinity changes *(Martínez Arroyo et al. 2011)*. Beach losses due to inundation will further decrease the available habitats for species such as turtles *(Hansen et al. 2010)*.

Beach erosion due to SLR will move shorelines in coastal areas, shifting the beach profile closer inland *(Ng and Mendelsohn 2006)*. The delta front in the Sundarbans coastal area has already undergone a net erosion of 170 km² of coastal land between 1973 and 2010 due to changes in the sea level *(Rahman et al. 2011)*. In the Orinoco delta of Venezuela, a one-metre rise in sea level could translate into the loss of nearly 6,000 km² of land if no measures are taken *(Volonté and Arismendi 1995)*.

3 Relative SLR is the observed change in water level at a particular point, relative to the level of the nearby land.

SEA-LEVEL RISE IMPACT CHAIN MAP



Erosion and land inundation due to SLR will have direct effects on livelihoods and economic sectors, but also on the general way of life and culture, in coastal areas and islands. At a sea-level rise of 50 cm, one fourth of Martinique's coastline is projected to be affected by erosion and one fifth of the island's surface will be at risk of flooding *(Schleupner 2007)*. Beach tourism, the main economic activity in Martinique, will be greatly affected. The same rise in sea levels is expected to result in the loss of 1,570 ha of coastal agriculture, mangroves and aquaculture in the low-lying area of Vellar-Coleroon estuarine, India, and this number rises to 2,407 ha for 1 m SLR *(Saleem Khan et al. 2012)*. In Manila bay, Philippines, 19 municipalities will be affected under the 1 m scenario *(Perez et al. 1999)*.

In Vellar-Coleroon, India, salinity intrusion due to SLR will decrease agricultural production by limiting fresh water supplies and inducing soil degradation. Salt water intrusion coupled with rising temperatures will threaten many aquaculture farming species such as finfish and shellfish *(Saleem Khan et al. 2012)*. Sea-level rise will also significantly increase the risk of coastal flooding, as projected for low-lying countries such as Bangladesh *(Rawlani and Sovacool 2011)*.

It is evident that coastal communities will be impacted by SLR both directly and indirectly. Indirect impacts will result from the loss of ecosystem services due to the inundation and degradation of ecosystems. Direct impacts will occur due to inundation and erosion of land, saline water intrusion and coastal flooding as mentioned above. The losses of land, livelihoods and property will be significant and is expected to force the migration of many coastal communities. In the 1,200 islands studied by Wetzel et al. *(2012)* in Southeast Asia and the Pacific, approximately 8 – 52 million people are projected to migrate due to SLR depending on the scenario considered (1, 3 and 6 m sea elevation) *(Wetzel et al. 2012)*. Urban and intensive agricultural areas will be relocated due to migration leading to even more habitat and species loss and thus consequences to biodiversity. Some species will be more vulnerable to these secondary effects of SLR than the primary effects *(Wetzel et al. 2012)*.

Sea levels will continue to rise even under the most strict mitigation scenarios and measures for the protection of coastal communities and ecosystems should be undertaken. Sustainable ecosystem management, conservation and restoration, and limiting anthropogenic stressors are again proposed as no-regret measures to increase the resilience of both people and ecosystems. The use of hard engineering technology including seawalls, revetments and bulkheads is likely to result in increased vulnerability *(Gilman et al. 2007)*.

Ecosystem management should however be done at the landscape / seascape level to manage sediment and other inputs that can induce further stress on coastal ecosystems, especially coral reefs *(Ogston and Field 2010)*. Activities within the mangrove catchment can be conducted to minimise long-term reductions in sediment or enhance elevation, such as limiting the development of impervious surfaces, managing rates and locations of groundwater extraction, and limiting human activities such as deforestation that reduce mangrove soil organic matter *(Gilman et al. 2008)*. Integrated coastal zone management to address both short- and long-term problems, with the involvement of communities in the area, is key *(Chemane et al. 1997; Perez et al. 1999)*.

Conserving ecosystems such as mangroves, or allowing coastal wetlands to migrate landwards, could be an effective way to reduce the negative impacts of coastal erosion due to SLR *(Jallow et al. 1999; Ng and Mendelsohn 2006; Schleupner 2007)*. In the Sundarbans, the land-gain areas along the coastlines can be targeted for afforestation with appropriate salt-tolerant mangrove species to enhance the delivery of ecosystem services, and the land-loss areas can be targeted for selective dike building (with careful consideration of down-current erosion) to prevent further land loss *(Rahman et al. 2011)*.

However, some ecosystems need to be conserved with priority, such as mangroves at seaward fringes *(Krauss et al. 2010; López-Medellín et al. 2011)*. A better understanding of the balance between mangrove loss and mangrove expansion will foster more effective conservation activities *(López-Medellín et al. 2011)*.

Improved monitoring with standardised techniques to cover the full range of ecosystem structures and environmental settings is needed *(Spencer 1995)*. Both primary and secondary SLR effects on people and ecosystems and biodiversity need to be monitored and incorporated into ecological risk assessment, conservation and regional planning *(Wetzel et al. 2012)*. A new generation of conservation decision support tools needs to be developed, so that managers are better equipped for balancing numerous competing objectives in the context of dynamic and complex systems *(Traill et al. 2011)*.

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2.5 Tropical storms

Tropical storms, which include cyclones, hurricanes and typhoons, are low pressure systems that form over warm tropical waters and are accompanied by violent winds and rains near the centre of origin *(Lugo-Fernandez and Gravois 2010)*. They can impact both ecosystems and people directly and result in a number of cascading effects.

The physical force of storms can cause direct degradation and mortality to mangroves. Following Hurricane Mitch in Honduras *(1998)*, for example, the trunks of adult red mangroves were broken, while adult black mangrove trunks were uprooted on the islands of Guanaja and Roatan. Continued severe impact in Mangrove Bight was indicated by a complete lack of recovery (i.e. no regrowth) within the high impact area in 2001, 27 months after the storm *(Cahoon et al. 2003)*. Mass tree mortality causes rapid elevation loss and the collapse of underlying peat which influences recovery processes and future resilience to climate hazards. By changing the space available to different species, hurricanes can also play a role in resetting succession and altering composition *(Piou et al. 2006)*. This could lead to either positive or negative impacts, depending on the site and species that dominated before the disturbance event.

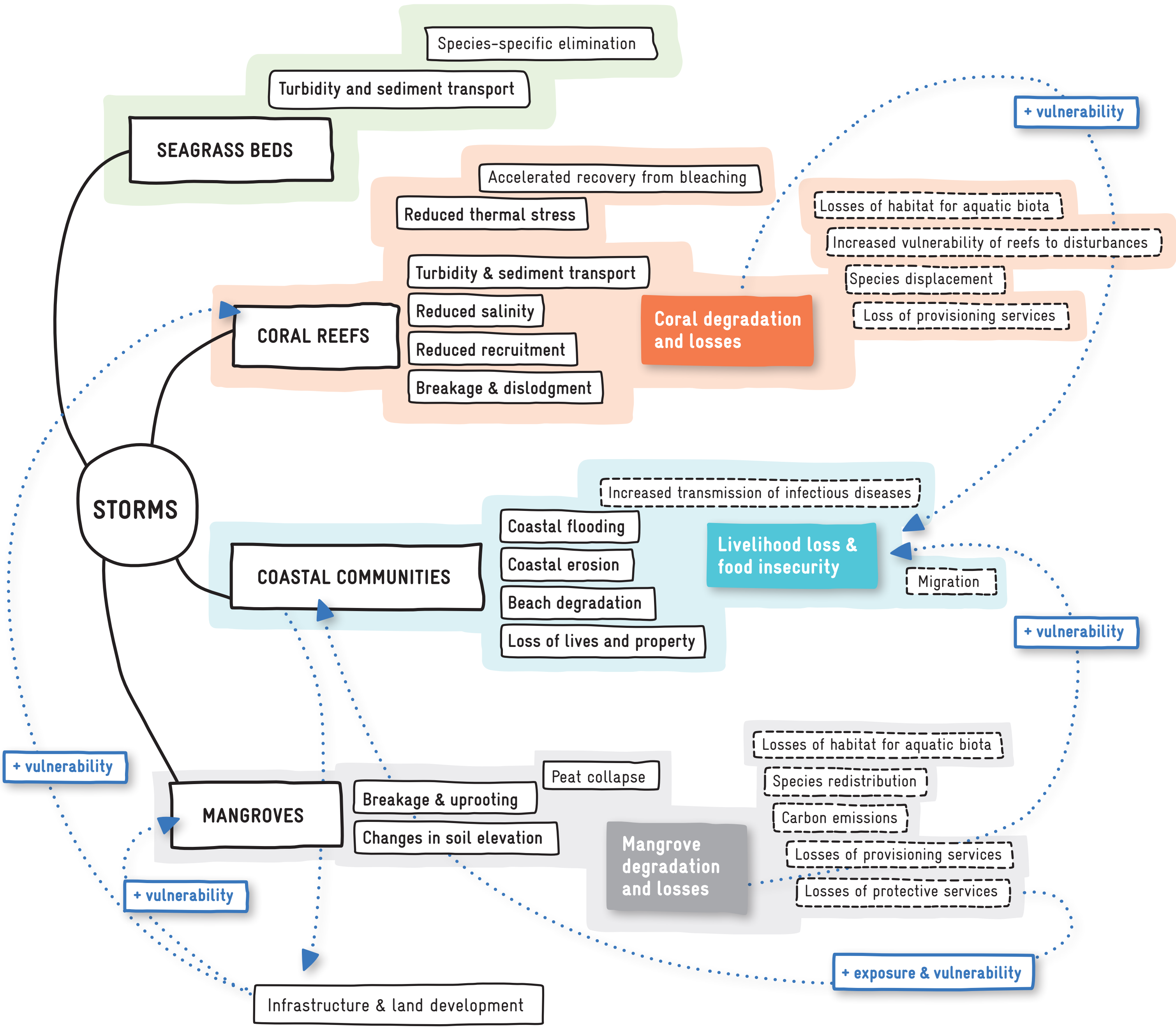
Storms alter mangrove sediment elevation through soil erosion, soil deposition, peat collapse and soil compression *(Gilman et al. 2008)*. When soil elevation is increased, the impact for mangrove ecosystems can be positive as soil elevation is important for counter-balancing the effects of relative sea-level rise *(Whelan et al. 2009)*. Sediment deposition or smothering on the other hand has negative consequences both in the short and longer term. Changes in mangrove area in the eastern Exmouth Gulf of Australia, documented over six years (1999–2004) following Cyclone Vance, indicated that close to half of the mangroves were converted either to bare sediment or to live saltmarshes due to sediment deposition or smothering *(Paling et al. 2008)*.

Positive impacts can occur for coral reefs as well. At broad spatial scales, tropical cyclones can induce cooling of the upper ocean which can persist for weeks, reducing thermal stress and accelerating the recovery of bleached corals *(Carrigan and Puotinen 2011; Lugo-Fernandez and Gravois 2010)*. Moderate storms can transfer sediment particles through wave-current flows that uplift reef layers without breaking the corals *(Lugo-Fernandez and Gravois 2010)*. Tropical storms also aid larvae dispersal from and onto reefs.

But certain storms can be damaging to corals. Strong storms induce physical damage through breakage and dislodgement, especially in branching and tabular coral colonies *(Foster et al. 2011; Jordan-Dahlgren and Rodriguez-Martinez 1998)*. Reef damage surveys at 33 sites in the Netherlands Antilles following Hurricane Lenny *(1999)* documented occurrences of toppling, fragmentation, tissue damage, bleaching and smothering due to the storm *(Bries et al. 2004)*. In the Great Barrier Reef, offshore reefs showed the deepest depth of damage while inshore reefs had the greatest rates of coral breakage and dislodgement following the severe tropical cyclone of 2005, cyclone Ingrid *(Fabricius et al. 2008)*. Storms can also limit coral recruitment *(Mallela and Crabbe 2009)* and reduce salinity levels below 27 ppt, a condition which can be lethal for corals *(Van Woesik 1994)*.

Large sediment blow-outs during storms have led to the destruction of seagrass meadows as well, as evidenced in Puerto Rico *(Rodriguez et al. 1997)*. The effects of sediment blow-outs can be long-lasting and can influence recovery processes. Seagrass beds, impacted by hurricane Georges in the USA, that had little to moderate sediment deposition recovered from the storm within one year, while areas buried by 50 cm of sediment or those that experienced substantial erosion showed very little recovery in the following three years after the storm *(Fourqurean and Rutten 2004)*. The clearing of seagrass beds due to sediment disturbances could enable invasion of rapid colonisers of seagrass and macroalgae *(Van Tussenbroek 2008)*.

TROPICAL STORMS IMPACT CHAIN MAP



As mentioned in the previous sections, any degradation and losses in ecosystems due to climatic and / or anthropogenic disturbances has an impact on coastal communities through the loss of ecosystem services. Apart from habitat loss *(Wantiez et al. 2006)* and species displacement *(López-Victoria and Zea 2004)* which result in the decrease or migration of economically-important reef fish, the loss of storm protection services renders communities progressively more vulnerable to climate stressors.

A number of studies have demonstrated the storm protection services of mangroves. Villages protected by the Bhitarkanika mangrove ecosystem suffered significantly less damages than the unprotected villages during the super cyclone that struck the state of Orissa in India *(Badola and Hussain 2005)*. Villages with wider mangroves between them and the coast experienced significantly fewer deaths than ones with narrower or no mangroves *(Das and Vincent 2009)*. In the Gulf Coast of the United States it was found that mangrove wetlands reduced water level height by as much as 9.4 cm/km inland during hurricane strikes *(Krauss et al. 1999)*. The 6-to-30 km wide mangrove forest along the Gulf Coast of South Florida effectively attenuated storm surges from hurricane Wilma by reducing both the amplitude and extent of overland flooding and protecting the freshwater marsh behind the mangrove zones from surge inundation *(Zhang et al. 2012)*. The surge amplitude decreases at a rate of 40 – 50 cm/km across the mangrove forest and at a rate of 20 cm/km across the areas with a mixture of mangrove islands with open water.

With climate change, tropical storms are predicted to become more intense and frequent in the future. Impacts such as coastal flooding, erosion and beach degradation *(Rodriguez et al. 1994)*, and the loss of life, property and livelihoods *(Adger 1999; Barnett 2011; Badola and Hussain 2005; Das and Vincent 2009; Haque et al. 2012)*, recorded in the aftermath of previous storm events, will become even more severe if coastal protection is not implemented.

The conservation of ecosystems such as mangroves is a no-regret option for coastal protection that is economically justified as it also provides numerous other ecosystem services of importance for coastal communities *(Das and Vincent 2009)*. However, additional actions need to be implemented to minimise disaster risk. These include constructing or modernising early warning systems, developing shelters and evacuation plans, constructing coastal embankments, raising awareness at the community level, mapping the high-risk areas, and establishing and enforcing appropriate building codes *(Haque et al. 2012)*.

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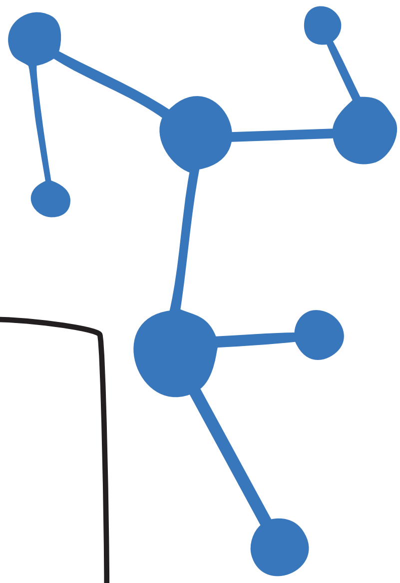
Zhang, K., Liu, H., Li, Y., Xu, H., Shen, J., Rhome, J., Smith, T.J., 2012. The role of mangroves in attenuating storm surges. Estuarine, Coastal and Shelf Science.



3.

CONCLUSION

The impact chain concept can facilitate a better understanding of the direct and indirect effects that can be triggered by a climate stimulus or stressor at different levels in a socio-ecological system. Although impact chain maps can illustrate possible impact scenarios, a number of different socio-economic (e.g. disaster preparedness, availability of assets, ecosystem governance) and biophysical or ecological (geomorphology, hydrogeomorphic settings, ecosystem connectivity) factors will influence the degree of impacts in different contexts.

Furthermore, multiple stressors (climatic, anthropogenic, other environmental) usually interact in generating vulnerability and / or impacts. Although impact chains might strive to capture more than one stressor, decision-making should be based on context-specific assessments and projections.

Impact chains, however, also make it apparent that the resilience of the different system components is interconnected: resilient ecosystems will support the resilience and adaptation of people that depend on them, but people need to manage ecosystems appropriately to ensure their resilience and the delivery of important ecosystem services. On the other hand, the degradation of ecosystems due to climatic or anthropogenic stressors inevitably leads to diminished flows of ecosystem services, which in turn renders society more vulnerable, but also influences the capacity of ecosystems to withstand future disturbances.

Ecosystem-based adaptation, defined as the use of biodiversity and ecosystem services to help people to adapt to climate change, could be one way forward if planned and implemented appropriately and according to local conditions. However, it should be supplemented by additional measures such as early warning systems and capacity building which are essential for tropical coastal areas.

Gaps remain in studies and knowledge of the interlinkages between ecosystem health, services and social vulnerability under climate change in coastal areas. Although the biophysical knowledge is quite advanced (e.g. impact of ocean warming on corals), the socio-economic impacts are not well understood. Both primary and secondary effects of climate stimuli on people and ecosystems need to be monitored and incorporated into ecological and social risk assessment and planning at the landscape / seascape level.

The potential and challenges associated with planning and implementing ecosystem-based adaptation, and ecosystem interventions in general, are explored in the component 2 case-study countries Indonesia and the Philippines.

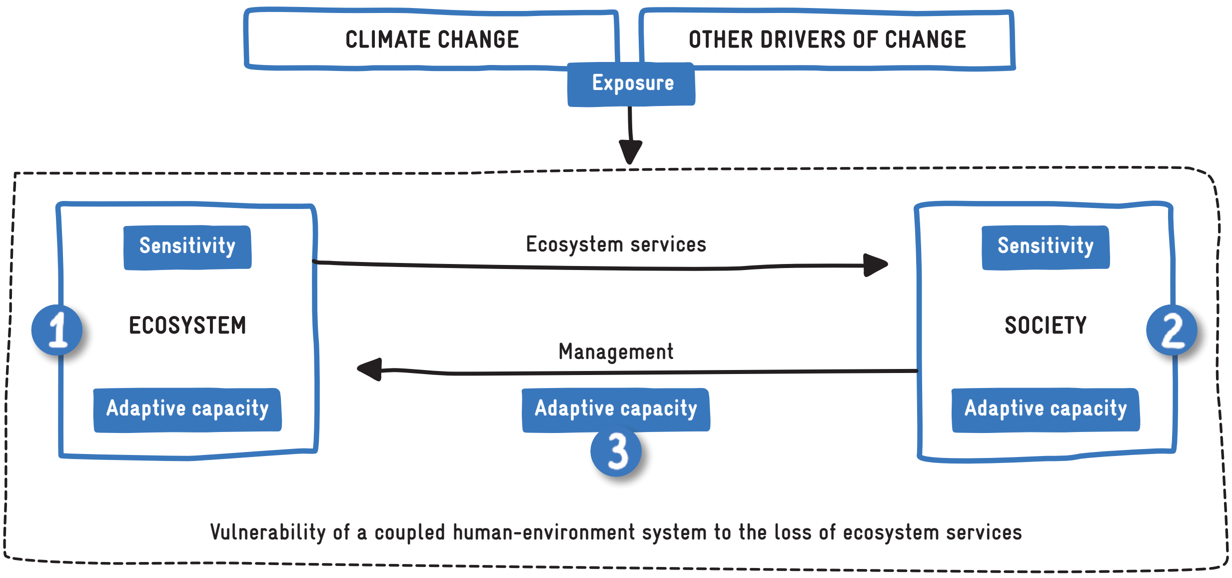
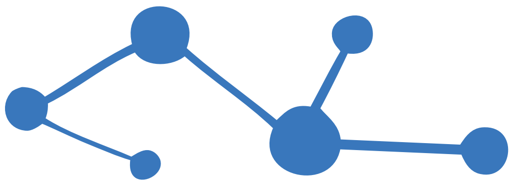


Figure 3: Climate change and the coupled human-environment system. Source: Locatelli 2008

4.

LIST OF ALL REFERENCES RELATED TO THE IMPACT CHAIN MAPS



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5.

COUNTRY DOCUMENT REVIEW AND EXPERT INTERVIEWS: INDONESIA & THE PHILIPPINES

5.1 Summary of main findings

The country document review demonstrated that national adaptation planning has been elaborated in both countries, with different adaptation and ecosystem management initiatives underway in coastal areas at the local level. In the Philippines, a legal framework is also created at the national level that mainstreams the consideration of climate resilience into government mandates across sectors (Philippines Climate Change Act), including coastal areas.

In Indonesia, legal frameworks concerned with coastal zones mostly relate to governing ecosystem management and use, with a special emphasis on preventing (and punishing) illegal extraction of resources. Incentive systems for rewarding best practice ecosystem management or restoration seem to be missing. A number of ecosystem-related interventions are planned or implemented in coastal areas of Indonesia. They are, for example, interventions related to increasing awareness of the conservation or sustainable use of resources, improving ecosystem management capacities, enhancing community development through resource use and management, enhancing social and ecological adaptive capacity, establishing regulations and reducing disaster risks. Many of these interventions are not planned with adaptation as the main goal but they could bring adaptation benefits for both people and ecosystems.

Despite these interventions, plans and regulations, there are still difficulties in implementing sustainable and integrated coastal ecosystem and resource management in Indonesia, which is a prerequisite for effective EBA. Unclear, multiple and conflicting jurisdictions involving various government institutions and lack of coordination for integrated coastal zone management seem to be a major underlying reason.

Nevertheless, a number of vulnerability and climate change impact assessments have been conducted in the coastal areas of the country. It must be noted though that most adaptation planning initiatives, including projections of future climate change impacts, are based on results from global models. Local or regional observational climate data is used where available, but in few instances and without regional or downscaled modelling for elaborating future projections.

The availability of good quality and locally-relevant climate data seems to be an issue in the Philippines as well. Although some experience exists with regional climate modelling, and PAGASA (Philippine Atmospheric, Geophysical & Astronomical Services Administration) hosts an extensive set of observational data, much is left to be desired, particularly in channelling relevant climate information to the local level in a user-friendly manner. This is especially important since the devolution of adaptation planning responsibilities to the local level is well advanced in the Philippines, where local governments are mandated to integrate adaptation and mitigation into development, disaster risk reduction, resource management and land-use plans according to their set priorities, in addition to developing Local Climate Change Action Plans (LCCAPs). Local governments have expressed the need for more training, capacity-building and resources to be able to go forward with climate change planning and implementation (as concluded from the expert interviews in section 5.5).

With regard to ecosystem-based interventions in coastal areas, both countries put an emphasis on mangrove restoration and conservation, fisheries management and the establishment of protected areas. The integrated coastal management approach (ICM) seems to be more prominent in the Philippines, while in Indonesia planning and implementation seem to be more focused on single-sector and project-based interventions, as well as on regulations. This is perhaps due to the institutional complexity, conflicting jurisdictions and the issue of coordination between levels when it comes to integrated coastal zone management in the country. As mentioned earlier, adaptation and other local-level initiatives with an emphasis on awareness-raising and capacity-building are underway.

Concerning ecosystem-based adaptation (EBA) specifically, interventions are not really conceptualised as such in both countries, although many of the planned and implemented activities have resulted, or could result, in EBA-related benefits. Policies and national frameworks in the Philippines approach EBA more directly. For example, the Philippines Strategy on Climate Change Adaptation 2010–2022 mandates interventions for "reducing climate change risks and vulnerability of human and natural ecosystems through ecosystem-based management approaches and appropriate technologies" (page 8). Two inter-related intervention themes are promoted: (i) adopting ecosystem-based approaches to reduce climate change risks and impacts by adequately managing ecosystems; and (ii) enhancing institutional and community knowledge and capacities on the topic of climate change and adaptation technologies.

The design and implementation of EBA strategies is not without challenges, as was mentioned by many of stakeholders interviewed. Although ecosystem management and climate change impacts on important resources are main issues in many of the policies, projects and programmes reviewed, there is a need for improving coordination across levels and enhancing the capacities of different stakeholder groups. Data and knowledge gaps also need to be filled, especially with regard to the impact of climate change on ecosystems and biodiversity, and on their ability to provide services.

The experts and stakeholders interviewed demonstrated high awareness of the impacts of the different climate hazards in coastal areas of Indonesia and the Philippines. Stakeholders in Indonesia recognised the compound effects as well (e. g. how non-climate pressures such as uncontrolled waste discharge augment the impacts from the climate pressures), while stakeholders in the Philippines discussed the chain of impacts from direct to indirect effects (e. g. pressures on ecosystems which lead to diminished supply of ecosystem services that affect livelihoods and the vulnerability of communities).

The strategies most frequently employed in the coastal areas of Indonesia to address climate and other challenges and problems, as perceived by the stakeholders interviewed, include integrated coastal management, coastal rehabilitation (e. g. restoring mangrove and coral), enhancing traditional practices and knowledge, developing alternative livelihood strategies, building infrastructures (e. g. wave breakers), providing climate information (e. g. to fishermen) and increasing community awareness with regard to climate change impacts. Integrated coastal zone management however did not surface as an important strategy (or was not mentioned as such) in the documents reviewed.

Stakeholders judged that current local and autonomous efforts are insufficient to tackle the many climate challenges and persistent vulnerability in Indonesian coastal areas. According to the majority of the respondents, coastal ecosystems are also degrading in many areas due to unsustainable development activities, gaps in knowledge (e. g. on ecosystem services and their benefits), project-based activities that are either abandoned or replicated in unsuitable areas, and the development and implementation of policies in a non-collaborative, non-integrated manner.

Similar challenges relate to the mainstreaming of EBA. Respondents mentioned that it is difficult to convince stakeholders at the local level to engage with EBA as many are mostly accustomed to extractive ecosystem management practices. Furthermore, data on the status of Indonesian coastal areas (e. g. maps) is not available or is very scarce and there have been significant funding and coordination constraints. Climate change, adaptation and the intangible benefits that ecosystems provide are also poorly understood by stakeholders at all levels.

Different advantages, disadvantages and enabling conditions were pointed out by the stakeholders when asked to compare ecosystem-based strategies with infrastructure development for adaptation. Among the comparative advantages of ecosystem-based strategies, the interviewees mentioned lower implementation and maintenance costs, biodiversity benefits, lower risk of mal-adaptation (e. g. no danger of waves bouncing back), improvement of soil and water quality, habitat provision of other species, carbon sequestration and livelihood benefits to communities (e. g. silvofishery, harvesting of crustaceans, eco-tourism). On the other hand, ecosystem-based strategies take more time to materialise and to produce benefits (disadvantage in comparison to infrastructure solutions which have proven effectiveness and function from the beginning).

The majority of the respondents in Indonesia agree that the policy and intra-institutional cooperation frameworks in the country are inadequate for promoting EBA strategies. For improving policy frameworks and cooperation between institutions some suggestions are proposed such as awareness-raising at all levels with regard to the multiple benefits of EBA, improving communication and coordination among institutions at the national level (e. g. by developing common guidelines on coastal ecosystem restoration, vulnerability assessments etc.), altering the narrow sectoral focus of government agencies, and improving the relevant policies. Setting up effective monitoring and evaluation networks for ecosystem-based strategies in coastal areas, and communicating the subsequent results to all stakeholders involved, will be another step in fostering a wider implementation of EBA in the future. Continuing with impact and vulnerability assessments in coastal areas and setting up ecosystem and resource inventories will contribute towards addressing the data and information gaps.

Stakeholders in the Philippines believe that good frameworks and conditions exist for the implementation of EBA in coastal areas of the Philippines. For example, emphasis is given to integrated coastal zone management, disaster risk reduction and sound environmental management. Interviewees mentioned that local networks of marine and coastal protected areas strive to integrate human uses of the ecosystems in sustainable ways so as to not exclude people from livelihood opportunities. Coastal strategies are also aligned with local legal, political and institutional requirements. However, similar challenges to the ones mentioned in Indonesia were stressed with regard to awareness of EBA benefits, capacity-building and cooperation across levels.

Apart from the low awareness but also knowledge of the different costs and benefits of EBA, respondents in the Philippines also noted that EBA benefits take a longer time to manifest and are not as straight-forward as the benefits associated with infrastructure strategies. Furthermore, the implementation of EBA goes beyond the political term of local government leaders. More often than not, leaders change at the beginning of each term, which also leads to re-shifting of priorities. This issue was also commented on by stakeholders in Indonesia.

In addition, more time and effort are needed when implementing capacity-building activities associated with EBA. Considerable social mobilisation and development of institutions is usually required, as well as setting up good governance processes, systems and standards. Ecosystem-based adaptation is a relatively new approach and significant efforts need to be made with new awareness and education campaigns, including those targeted at policy-makers and executives.

Another challenge that was mentioned relates to the gaps in biodiversity data and ecological knowledge. The data that is available is inadequate to better understand the state of biodiversity in coastal and marine ecosystems in the Philippines. Some research efforts are made to address this gap but the utilisation of research output is considered low. Interviewees also noted that not all local governments demonstrate sustained support of marine protected area (MPA) management strategies and planning, and consequently for the uptake and utilisation of biodiversity data. Similar challenges prevail in Indonesia as well.

Local Government Units (LGUs) have considerable control in matters related to environmental protection but many lack technical and financial capabilities, expertise and logistics to carry out sustainable coastal resources management and adaptation projects. Interviewees called again for increased capacity-building and resources channelled to the local level. Fragmentation is another major systemic hindrance to more effective coastal zone management, as mentioned by several stakeholders. There is an urgent need for sectoral integration and coordination, and especially concerning cooperation between different LGUs when managing shared ecosystems at the landscape or seascape level, and monitoring and evaluation of coastal and marine protected area networks.

And finally, for the success of any EBA implementation, it was widely recognised that both short-term and long-term objectives should be planned and monitored, as well as immediate (e. g. livelihoods) and more long-term benefits (e. g. enhancement of ecosystem services).

5.2 Document review: Indonesia

Main issues addressed

In total, 70 documents related to projects, programmes and policies and 21 legislation documents were reviewed. The main focus of the projects, programmes and policies is on adaptation (9 documents), development (4), disaster risk reduction (9), ecosystem and resource management (19), and a combination of two or more of the aforementioned issues (27). The distribution of projects, programmes and policies affecting coastal areas in Indonesia by type is depicted in the chart below.

The documents mainly address challenges and issues related to climate change and its impacts (e.g. sea-level rise, temperature increase, rainfall change), disaster risk, unsustainable or unregulated resource use, community livelihoods, lack of awareness of different issues (e.g. importance of conserving ecosystems) and lack of climate information.

In relation to the 21 legislations, 18 refer to the national level and 3 to the sub-national or local level. The main focus is on ecosystem and resource management (12 regulations), development (3), disaster risk reduction (1), other relevant issues such as capacity building and ecosystem restoration (2), or on two or more of the aforementioned (3). The problems addressed mainly relate to unregulated resource use, pollution and unsustainable development, and lack of capacity.

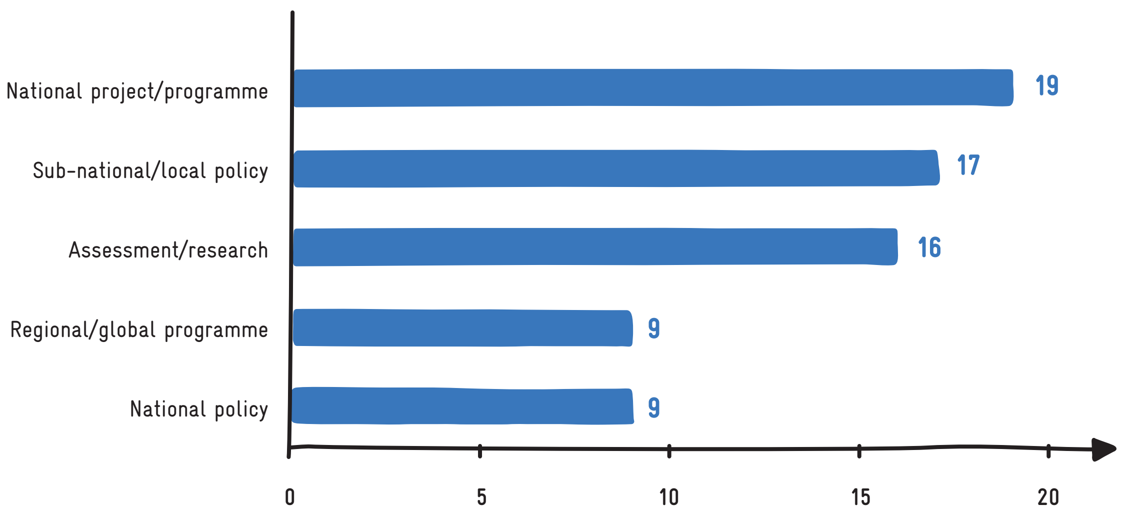

Figure 1: Documents reviewed by type

Main interventions proposed / implemented

The adaptation and coastal management initiatives reviewed in the country mainly encompass interventions and activities such as:

- Developing legislation (21)[4], for example, Law 27 2007 on Coastal areas and small islands management;
- Improving human capacity and wellbeing (13), for example, Green Coast Project;
- Developing guidelines or plans for sustainable resource management under climate change (12), for example, "National action plan addressing climate change" and "Indonesia Climate Change Sectoral Roadmap";
- Improving coastal ecosystem and resource management (9), for example, "Proyek Pesisir / Coastal Project" and "Pengelolaan berbasis ekosistem di Bentang Laut Kepala Burung Indonesia / ecosystem based management of Bird-head seascape Indonesia";
- Planning and implementing research activities (9), for example, "Pusat Penelitian perubahan iklim dan kebijakan, Kemenhut, rencana strategis 2010 – 2014 / Climate Change and Policy Research Centre, Ministry of Forestry, Strategic Plan 2010 – 2014" and "Mangrove management: integrated research plan 2010 – 2014 of the Forest Research and Development Agency".

In addition to the above, other interventions include mapping and assessing vulnerability (6), consolidating climate information and developing forecast tools and infrastructure (e.g. DATACLIM) (5), assessing potential climate change impacts (e.g. on resources such as water) (5), developing training and exchange programmes and manuals (e.g. on fishery management) (4), awareness raising (3), analysis of past and existing adaptation activities and needs (2), disaster risk reduction (1), and analysis of community perceptions (1) e.g. on marine resources and their use and conservation.

For predicting climate change impacts and planning interventions, information is mostly derived from observation data, modelling results and literature review. For example, data on historic or potential future sea-level rise projections is derived from:

- Global observation data (e.g. the data used for the Indonesia Climate Change Sectoral Roadmap is from the University of Hawai'i Sea Level Centre based on altimeter and satellite observations);
- Modelling results, e.g. Global Circulation Models (MRI 32, CCCMA CGCM, Miroc 32, NASA GISS ER); Ocean Models (Hybrid Coordinate Ocean Model / HYCOM; Finite Volume Coastal Ocean Model / FVCOM; Simple Ocean Data Assimilation / SODA; Regional Ocean Modelling Systems / ROMS); and results from linear regressions;
- Literature review, e.g. from *IPCC AR4; Hoegh-Guldberg et al. 2009; ADB; Bakosurtanal 2002.*

With regard to air temperature, historical data and future projections are obtained from:

- Observation data where available (e.g. the vulnerability assessment for North Sumatra and South Sulawesi Provinces used data from the Meteorology, Climatology and Geophysics Agency – Indonesia and five weather stations respectively. The climate change risk and adaptation studies in Tarakan, South Sumatra and Malang Raya used data from the University of Delaware and global climate data).
- Modelling results, e.g. composite assembly model and Global Circulation Models, e.g. GFDL-CM20. No regional circulation models were identified in the documents reviewed.
- Literature review, e.g. from *IPCC 2007; Bakosuranal 2002; Firdaus 2010.*

Data on historic or projected sea surface temperature is sourced from:

- Literature review, e.g. from *IPCC; Sofian 2010; Levitus et al 2000; Aldrin 2008; Sofian 2009; Hoegh-Guldberg et al. 2009.*

4 Number of documents reviewed encompassing related activity.

The analysis of historic and projected rainfall changes is mostly based on:

- Observation data where available (e.g. the vulnerability assessments for North Sumatra and South Sulawesi Provinces were based on data from the Meteorology, Climatology and Geophysics Agency as well as 37 rainfall stations in South Sulawesi respectively, while the Assessment of Impacts and Adaptation to Climate Change Project used data from from 9 rainfall stations in Bukittinggi, Kendari, Jogyakarta, Semarang, Bandung, Jakarta, Kupang, Meulaboh and Ambon).

- Modelling results, e.g. from climate models of CCSR, CSIRO, ECHAM4, CGCM1, HadCM3, GFDL-CM20, Global Circulation Models and some statistical downscaling. The use of regional models has not been observed.

- Literature review, e.g. from *IPCC 2007; AIACC 2006; MOE 2007; Sofian 2010; Firdaus 2010; Santoso and Herawati 2010; Faqih 2004.*

Finally, climate analysis related to extremes (e.g. ENSO events) is mostly based on:

- Observation data such as the effects of past El Niño events (e.g. on coral ecosystems as used by the Ministry of Environment 2007 National action plan addressing climate change);

- Modelling results, e.g. using GCMs for El Niño and La Niña, and NINO3 MRI_cgcm3.2 for El Niño frequencies;

- Literature review (e.g. from *IPCC 2007* on tropical cyclone intensity increase).

Incentives and potential for employing ecosystem-based adaptation

Many interventions related to coastal ecosystem and resources use and management, improving human wellbeing and anticipating climate change have been developed and implemented in coastal areas across Indonesia. Many of these interventions could lead to an improvement of the overall ecological conditions in the given areas, and subsequently to an enhanced delivery of ecosystem services. Examples of such interventions include the promotion of sustainable development and resource use as in Proyek Pesisir *(Bengen 2003)*, the conservation of ecosystems as in the Marine Resources and Fishery Decree No. 17 2008 and ecosystem restoration as in the Mangrove Action Project Indonesia *(Mangrove Action Project Indonesia 2006)* and the Green Coast Project *(Wetlands International Indonesia)*.

Interventions that address capacity-building and human well-being as in the Marginal Fishing Community Development Program *(Hasan 2004)* and disaster risk reduction and preparedness as in Safer Communities through Disaster Risk Reduction (SC-DRR) Project *(Hillman and Sagala 2011)* can contribute to a reduction of social vulnerability. Although most of these interventions are not developed for anticipating climate change, they can deliver adaptation benefits. For example if social, economic and environmental resources and conditions are enhanced, adaptive capacity to deal with climate hazards will also be improved. Several vulnerability and impact assessments have also been conducted across the country which can support adaptation planning.

The regulations and legislations that target or promote conservation (e.g. protected areas), sustainable ecosystem and resource management (e.g. fisheries, mangroves), human well-being improvement and climate change adaptation can further contribute to meeting the twin goal of reducing social vulnerability and enhancing ecosystem resilience. However, these regulations rarely encompass both goals in an integrated way through the concept of ecosystem services. Some exceptions can be found in the law on coastal areas and small islands management (*No. 27 2007)*, the fisheries law *(No. 31 2004 and No. 45 2009)* and the Long-term National Development Plan 2005–2025: they emphasise conservation and sustainable resource use but also integrated, decentralised, participatory and equitable development in coastal areas.

The potential is present for employing EBA in coastal areas of Indonesia by building on existing policies and programmes. Nevertheless, there are significant constraints to the effective implementation of EBA such as a lack of observational data in many areas and limited experience with regional or downscaled climate models. Furthermore, coastal ecosystem and resource management currently falls under the jurisdiction of various government institutions *(Purwaka and Sunoto 2011)* from the local (e.g. Districts Governments and their agencies) to the central / national level (e.g. different ministries such as Ministry of Forestry, Ministry of Marine Resources and Fishery, Ministry of Environment, Ministry of National Planning and Development etc.).

Although local government institutions are the implementing agencies at local level, their mandates and authorities in relation to coastal ecosystem and resource use and management are still unclear. Confusion and conflict can easily occur as each institution has its own priorities and these might clash with the priorities of another institution or stakeholder group. For example, in using and managing mangrove areas, the central government often is more interested in sustainability and conservation while local governments are often more interested in increasing revenues from the conversion of mangroves into fish and shrimp ponds or housing areas.

Moreover, there is a lack of coordination and collaboration among government institutions *(Purwaka and Sunoto 2011)* for implementing sustainable and integrated coastal resources and ecosystem management, while many stakeholders in coastal areas actively support economic development without the consideration of sustainability. Most coastal plans are also elaborated and implemented without broad stakeholder participation or consultation.

With regard to the regulations and legislations, although many promote conservation or sustainable management, few of them have been effective in practice. A possible reason for this could be that regulations tend to focus on single issues, e.g. on mangrove conservation, fisheries management, coral reef protection, or spatial planning, without addressing coastal zone management in an integrated and holistic manner. The legislations also tend to be more focused on punishing unwanted behaviour than on establishing incentive systems to encourage good practice, even though law enforcement systems are lacking *(Purwaka and Sunoto 2011)*. In the related documents, it is pointed out that communities, including businesses, lack awareness of the different legislations related to coastal management (e.g. regulations for issuing permits for building settlements, hotels, and fish and shrimp ponds). And, lastly, customary and traditional laws have not been consulted and integrated into government legislations; this increases conflict potential in coastal areas *(Purwaka and Sunoto 2011)*.

Conclusions and recommendations

A number of ecosystem-related interventions are planned or implemented in coastal areas of Indonesia. They are, for example, interventions related to increasing awareness of the conservation or sustainable use of resources, improving ecosystem management capacities, enhancing community development through resource use and management, enhancing social and ecological adaptive capacity, establishing regulations and reducing disaster risks. As noted earlier, many of these interventions are not planned with adaptation as the main goal but they could bring adaptation benefits for both people and ecosystems.

Despite these interventions, plans and regulations, there are still difficulties in implementing sustainable and integrated coastal ecosystem and resource management, which is a prerequisite for effective EBA. Unclear, multiple and conflicting jurisdictions involving various government institutions and lack of coordination for integrated coastal zone management seem to be a major underlying reason.

For improving coastal zone and ecosystem management, and incentivising ecosystem-based interventions, Indonesia needs to establish regulations that address integrated coastal zone and marine resources management in a holistic manner and that provide related incentive systems beyond the punishment of unwanted behaviour *(Purwaka and Sunoto 2011)*. More inclusive stakeholder participation is needed in both planning and implementation, from community to cross-sectoral participation, and the jurisdictions and responsibilities of local governments need to made more clear *(Purwaka and Sunoto 2011; Wiranto 2004)*. Apart from improving the stakeholder consultation process when drafting or updating regulations and legislations (e.g. taking into account customary laws), communities and other stakeholders at the district and province level need to be informed about any related changes.

Clear policies and related funding to foster the development of climate data infrastructure and data sharing up to the community level are needed as well *(DNPI 2011)*. Several activities that enhance the availability of climate-relevant information, such as vulnerability, impact and adaptation assessments, have already been carried out in some coastal districts and islands. These activities should be scaled-up and implemented in other coastal areas *(Kementerian Lingkungan Hidup 2012)*.

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5.3 Document review: the Philippines

Main issues addressed

The main issues tackled by projects and policies (listed in Annex) targeting coastal areas in the Philippines are deterioration of the environment and biodiversity loss, lack of marine and coastal management, and climate change. Ecosystem degradation and lack of marine and coastal management are however strongly linked to the other issues and challenges such as food insecurity, poverty, erosion, floods, overfishing and watershed degradation. Climate change is considered with regard to changes in temperatures, increases or decreases of precipitation, tropical storms, and alterations in planting and harvesting periods.

Climate change is the top issue in policies targeting coastal areas. This is perhaps because the country has a long history, in comparison to other countries in the region, of recognising general environmental problems and elaborating policies to address them. In other words, environmental policies are in place and it is now time to address the climate challenge.

On the other hand, the main focus of projects and programmes is environmental degradation and loss of biodiversity, though the majority of the projects and programmes recognise that climate change aggravates these problems. They are locally and / or regionally oriented, and although they have the main aim of addressing environmental degradation, they each concentrate on specific aspects such as overfishing or erosion.

MAIN ISSUES/PROBLEMS ADDRESSED

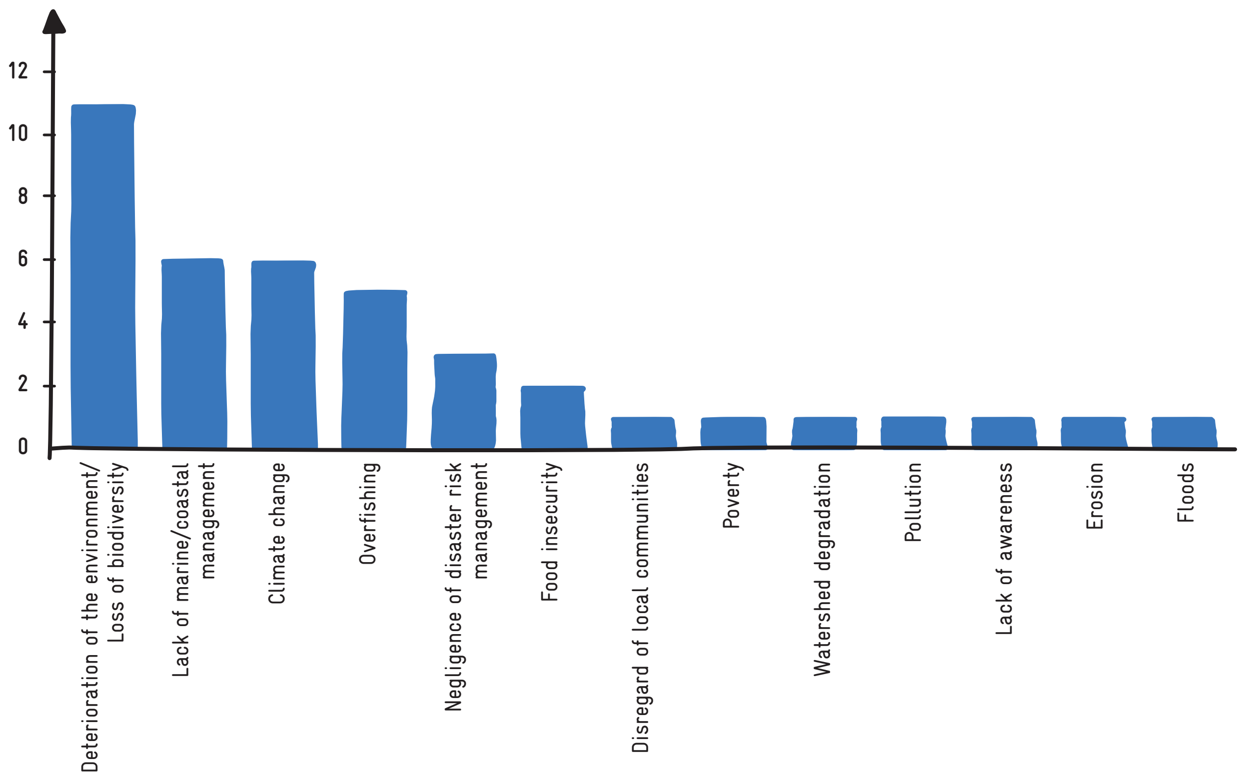

Figure 1: Main issues/problems addressed by projects and policies in the Philippines

Main interventions proposed / implemented

The interventions that are most frequently proposed in project, programme and policy documents in the Philippines are related to “soft” measures that focus on knowledge, information and empowerment (as opposed to “hard” measures that are based on technologies and actions that involve capital goods).

Out of the 36 documents reviewed, half include education and awareness-raising as a main component. Facilitating access to information is a critical activity included in 7 projects and programmes such as the Philippines Integrated Coastal Resource Management project. Climate change impacts in coastal regions are often not well understood by the people directly concerned and decision-makers *(Perez, 2002)*. Therefore promoting awareness about climatic effects could be a way to reduce negative consequences.

Community empowerment coupled with the promotion of gender equality emerges as the second most mentioned intervention. These are generally considered as “no-regret” interventions that add benefits well beyond the period of project implementation and under different future conditions. Furthermore, it is considered critical to involve local communities in the decision-making processes that directly affect their lives and livelihoods.

Another important intervention focus is marine and coastal management which includes measures such as the capacity-building of fishermen, establishing best-practice recommendations, promoting sustainable aquaculture, addressing overfishing etc. Together with the establishment of marine protected areas (MPAs), this constitutes the most frequently proposed group of interventions.

As is stated in the PEMSEA 2009 report, the long-term protection and management of coastal and marine resources needs to go beyond the mere establishment of MPAs, as in many cases local communities and their needs are not taken into consideration when MPAs are established, rendering it difficult to sustain ecosystem stewardship into the future. Specifically with regard to climate change, vulnerability assessments have also been conducted but to a limited extent.

INTERVENTIONS PROPOSED

RANK	INTERVENTION	N. OF DOCUMENTS PROPOSING INTERVENTION	EXAMPLES OF DOCUMENTS
1	Education/Awareness raising	18	“The Integrated Population and Coastal Resource Management (IPOPCORM) – Fishing for families: Reproductive health and Integrated coastal management in the Philippines” (PATH Foundation)
2	Marine Management	14	“Enhancing coastal and marine management through effective information management” (Programme on Partnerships in Environmental management for the Seas of East Asia (PEMSEA/GEF/UNDP))
3	Social Empowerment	11	“Western Mindanao Community Initiatives Project (WMCIP)” (Department of Agrarian Reform)
4	Assessment of climate change impacts	9	“National Framework Strategy on Climate Change 2010–2022” (Office of the President of the Philippines, Climate Change Commission)
5	Facilitating local/national partnerships	7	“Centre for empowerment and resource development” (UNDP)
5	Local capacity building	7	“Transforming the management of marine and coastal resources in the Coral Triangle – A region-wide program to safeguard marine biological resources for future generations” (WWF)
6	Institutional strengthening/ Knowledge transfer	6	“Promoting sustainable mariculture” (Coral Reef Targeted Research and Capacity Building for Management)
6	Establishment of protected areas	6	“The rising tide of community-led conservation: Strengthening local fisheries management in the Coral Triangle” (RARE)

7	Reforestation/Afforestation/ Rehabilitation Programmes	5	"Trowell Development Foundation" (Equator Initiative)
7	Monitoring and Evaluation	5	"Integrated Coastal Management (ICM): Revitalising the coasts and oceans program in the Philippines" (Programme on Partnerships in Environmental management for the Seas of East Asia (PEMSEA))
8	Access to information	4	"Republic Act No.9729: An act mainstreaming climate change into government policy formulations, establishing the framework strategy and program on climate change, and creating for this purpose the climate change commission, and for other purposes" (The Senate and House of Representatives of the Philippines in Congress)
9	Gender equality	3	"Centre for empowerment and resource development" (UNDP)
9	Development of plan, processes and policies	3	"Republic Act No.101211: An act strengthening the Philippine disaster risk reduction and management system, providing for the national disaster risk reduction and management framework and institutionalising the national risk reduction and management plan, appropriate funds therefor and for other purposes" (The Senate and House of Representatives of the Philippines in Congress)
9	Improvement of waste management	3	"Integrated Coastal Management (ICM): Revitalising the coasts and oceans program in the Philippines" (Programme on Partnerships in Environmental management for the Seas of East Asia (PEMSEA))
10	Recommendation of adaptation solutions for governments	2	"Responding to sea-level-rise: a study of options to combat coastal erosion in the Philippines" (Economy and Environment Programme for Southeast Asia (EEPSEA))
10	Mainstreaming climate change	2	"Republic Act No.9729: An act mainstreaming climate change into government policy formulations, establishing the framework strategy and program on climate change, and creating for this purpose the climate change commission, and for other purposes." (The Senate and House of Representatives of the Philippines in Congress)
10	Mitigation and adaptation development plans	2	"The National Disaster Risk Reduction and Management Plan 2011–2028" (The Philippines Office of Civil Defense)
10	Coordinate different plans at national level	2	"Transforming the management of marine and coastal resources in the Coral Triangle – A region-wide program to safeguard marine biological resources for future generations" (WWF)
11	Development of infrastructure	1	"PH – Climate change adaptation project" (World Bank and Government of the Philippines)
11	Implementation of biodiversity corridors	1	"The Republic of the Philippines: Integrated Coastal Resource Management project" (Asian Development Bank)
11	Development of sustainable financing	1	"The Philippines Strategy on Climate Change Adaptation 2010–2022" (Philippines Department of Environment and Natural Resources)
11	Eco-tourism	1	"Integrated Coastal Resource Management in the Philippines" (World Vision)

For assessing potential climate change impacts and planning interventions, climate information is mostly derived from observation data, modelling results and literature reviews. Data is mainly retrieved from PAGASA (Philippines Atmospheric, Geophysical, and Astronomical Services Administration). PAGASA has expertise and capacity to engage with climate modelling and seasonal climate forecasting, hazard mapping, vulnerability and adaptation assessments, and flood and drought early warning systems. The institution also hosts the most extensive record of observational climate data.

For climate predictions with regard to changes in temperatures and precipitation, sea-level rise, tropical storms and other natural disasters, modelling is the main tool used, as well as scenario analysis in some cases, with data from PAGASA. Both global models (GCM) and regional downscaled models are used (although the latter to a lesser extent). This is the case for projects such as "Climate change vulnerability assessment of the Verde Island Passage", and "Joint programme on strengthening the Philippines institutional capacity to adapt to climate change 2008–2010". In the "Philippines Climate Change Adaptation" programme (2010) data provided by the Manila Observatory is also used.

Incentives and potential for employing ecosystem-based adaptation

Ecosystem-based adaptation is gaining ground as an effective and cost-efficient approach for the reduction of vulnerability of both people and ecosystems though it is not specifically referred to as such in most of the project and programme documents reviewed. The importance of ecosystem services for human well-being is, however, mentioned in the majority of the documents.

Policies and national frameworks approach the EBA topic more directly. For example, the Philippines Strategy on Climate Change Adaptation 2010–2022 mandates interventions for "reducing climate change risks and vulnerability of human and natural ecosystems through ecosystem-based management approaches and appropriate technologies" (page 8). Two inter-related intervention themes are thus promoted: (i) adopting ecosystem-based approaches to reduce climate change risks and impacts by adequately managing ecosystems; and (ii) enhancing institutional and community knowledge and capacities on the topic of climate change and adaptation technologies. Specifically with regard to coastal ecosystems, the National Framework Strategy on Climate Change 2010–2022 states that there is a "need to acknowledge the interrelations across the country's coastal ecosystems in order to take advantage of all ecosystem services that can be available" (page 28).

However, the design and implementation of EBA strategies is not straight-forward, as was also mentioned by many of the experts and involved stakeholders interviewed (see chapter on expert interviews). None of the project and programme documents specifically mention the strategy of ecosystem-based adaptation as such, though some of the activities and interventions could bring EBA benefits. Ecosystem-based management or the ecosystem approach, a central component of EBA, is considered in several projects, for example, in the project "Promoting Sustainable Mariculture" conducted under the Coral Reef Targeted Research and Capacity Building for Management programme. The project focuses on developing aquaculture through the ecosystem approach, where the resilience of the whole ecosystem is considered rather than focusing on individual zones only.

Marine protected areas could serve as a foundation for integrating ecosystem-based adaptation measures targeted to the needs and priorities of local communities. For example, several of the interventions under marine and coastal management include activities such as coastal reforestation and afforestation which could be implemented through community management that targets livelihood and coastal protection benefits.

Furthermore, integrated coastal management (ICM – including integrated coastal zone management and integrated coastal resources management), which is a strategy that is widely pursued in the Philippines, could also effectively facilitate the implementation of EBA. ICM is a dynamic multi-stakeholder iterative process that encompasses adaptive management at the ecosystem or coastal seascape scale (linking terrestrial, coastal and marine sub-systems) and that also seeks to balance environmental, economic, social, cultural and recreational objectives over the long term within the limits set by natural processes and dynamics. The consideration of ecosystem services thus becomes an essential component of ICM as it reconciles social and environmental objectives.

Of the documents analysed, four mention the ICM approach. For example, the World Vision project "Integrated Coastal Resource Management in the Philippines" (2009) implemented in Lamon Bay and Tabogon targeted the restoration of mangroves for coastal protection, erosion and flood control, water purification and support of feeding grounds and nurseries for fish. Sales *(2009)* states that the most appropriate strategy to increase the resilience of coupled socio-ecological systems in the coastal areas of the Philippines is to mainstream climate change issues into ICM, as ICM promotes both the natural and human aspects. Consequently, ICM is a good avenue for mainstreaming and implementing EBA as well.

Managing ecosystems across jurisdictions and levels can present several difficulties. As pointed out in the vulnerability assessment of the Verde Island Passage *(Conservation International, 2011)*, much complexity and disagreement can arise at the local scale, especially when local resources are not managed at the same level (such as municipal lands and municipal waters). Local governments have thus claimed that they have a very low adaptive capacity to climate change as they do not have the mandate to carry out adaptation and mitigation plans in foreshore areas *(Conservation International, 2011)*.

Conclusions and recommendations

Although ecosystem management, and especially ICM, is a main consideration in policies, projects and programmes in the Philippines, and there is good potential for mainstreaming and implementing EBA, there is a need to improve coordination across levels and enhance the capacities of different stakeholder groups as stressed in many of the documents reviewed. Government agencies for example should create partnerships at different levels. Municipal and provincial levels need help from "higher up" to understand better how local activities can fit in the "bigger picture" and how they can plan and implement them accordingly *(Boquiren et al., 2010)*. Similarly, stakeholders from the national level need to be connected to the local scale to be aware of the issues and challenges that coastal communities face.

A specific need to conduct more capacity building and training at the local level (e.g. with farmers, communities, fisherfolk, local NGOs etc.) with regard to climate change adaptation also emerged *(NACA, 2009)*. A review of the successes and failures in mangrove rehabilitation in the Philippines revealed for example that both forestry technicians and local NGO staff need comprehensive forestry training for both the ecological and the management issues *(Primavera et al., 2008)*.

Data and knowledge gaps also need to be filled, especially with regard to the impact of climate change on ecosystems and biodiversity and their ability to provide services *(Regional Climate Change Adaptation Knowledge Platform for Asia, 2012)*. This is critical for the successful implementation of any EBA or broader adaptation strategies in coastal areas. Local-level stakeholders and communities should have access to this data as well, delivered in a format that is tailored to their needs. This would contribute to local empowerment (as mentioned above) especially with regard to adaptive ecosystem management.

Furthermore, coastal and marine management and disaster risk reduction and management should be planned and implemented in a more integrated manner, as they are directly linked. The Philippines is prone to natural hazards and disasters such as hurricanes, cyclones, coastal storms and tsunamis, many of which have their point of origin at sea. Integrating the two strategies and approaches would not only lead to a more effective and efficient use of resources but would also foster coordination between different levels and government departments and consolidation of plans *(PEMSEA, 2006)*.

Lastly, there is a clear need for monitoring and evaluation systems in all projects, policies and plans implemented in the Philippines and globally, as this is essential for adaptive management and for evaluating what works and what not *(Boquiren et al., 2010)*. Outcomes and impacts need to be monitored and assessed in the long-term, and not only in the short term, as adaptation materialises in different time frames.

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5.4 Expert interviews: Indonesia

Stakeholders interviewed

Although 15 stakeholders were contacted to arrange a potential discussion over telephone or Skype, interviews were scheduled and conducted with a total of ten experts (listed in Annex). The stakeholders interviewed are representatives of different expert groups such as adaptation and disaster risk reduction decision-makers and planners, planners and practitioners from natural resource / environmental agencies focusing on coastal areas, planners and practitioners from development agencies focusing on coastal areas, and stakeholders from research organisations.

Perceptions on most important hazards and impacts

Stakeholders mentioned that all climate-related hazards affect Indonesian coasts including extreme climate events (e. g. El Niño, strong winds, hurricanes and storms, high waves, strong sea currents), changes in climate variability and seasonality and increased unpredictability of events (e. g. changes in rainfall and wind patterns), air and sea temperature increase, heavy precipitation events and sea-level rise. The majority of coastal communities are affected, especially traditional and small-scale farmers and fishermen, and communities that live in peri-urban coastal areas. Impacts in coastal areas are severe, as climate hazards increase water turbidity and coastal siltation, destroy settlements, induce coastal flooding and alter fish migration patterns. Climate-related hazards also lead to coastal inundation and land losses, abrasion, salt water intrusion, losses of livelihoods (e. g. due to destruction of fish ponds, salt intrusion into rice production etc.) and also lives. Biodiversity and coastal biota are impacted as well, and especially mangroves and corals that provide essential habitat and ecosystem services.

Stakeholders stressed the compound effects resulting from the interaction of climate hazards with non-climate challenges that increase vulnerability and / or lead to the aggravation of impacts. Serious problems arise under extreme climate events in densely populated coastal settlements where development is unsustainable and ecosystems are degraded. In these situations extreme events lead to disasters: the loss of lives and property, destruction of settlements and infrastructure and loss of livelihoods. The exacerbation of poverty is an almost certain consequence.

Strategies and interventions

The strategies most frequently employed in the coastal areas of the country to address climate and other challenges and problems, as perceived by the stakeholders interviewed, include integrated coastal management, coastal rehabilitation (e.g. restoring mangrove and coral), enhancing traditional practices and knowledge, developing alternative livelihood strategies, building infrastructures (e.g. wave breakers), providing climate information (e.g. to fishermen) and increasing community awareness with regard to climate change impacts. The strategies are planned at the ministerial level (e.g. Ministry of Environment, Ministry of Marine Resources and Fishery, Ministry of Forestry, Ministry of National Planning and Development, Ministry of Public Works) other national levels (Climate Change National Council, President Unit for Development Monitoring and Control (UKP4), but also at the local level by local government agencies (e.g. Environment Agency) and NGOs.

One respondent mentioned that communities and individuals also often implement strategies on their own initiative to address climate and other problems in coastal areas. Seven experts however consider that all aforementioned strategies are currently not very effective and that communities need more support to address challenges in an adequate manner. This is mainly due to the fact that local knowledge is not enhanced with scientific knowledge, strategic plans for village level development are absent, most interventions are still sporadic and isolated, and the activities are more focused on building physical infrastructures than building human capacity. Information and awareness of climate issues, including climatic data and assessments of coastal vulnerability, are also lacking. The three remaining experts mentioned that the effectiveness of strategies employed is yet to be evaluated and cannot be judged at this stage.

Coastal ecosystem and resource management

In relation to the management of coastal resources and ecosystems in Indonesia, one respondent perceives that policies at the national and local level are improving towards good management, three respondents mentioned that there is an inevitable trade-off between economic development and conservation, and two others believe that coastal resources and ecosystems have not been managed sustainably or according to expectations. According to the majority of the respondents, coastal ecosystems are degrading in several areas due to unsustainable development activities, gaps in knowledge (e.g. on ecosystem services and their benefits), project-based activities that are either abandoned or replicated in unsuitable areas, and the development and implementation of policies in a non-collaborative, non-integrated manner. However, research needs to be carried out on the effects of different management practices on ecosystem conditions. All respondents believe that the unsustainable management of coastal resources and ecosystems will negatively affect communities and biodiversity. Coastal ecosystem degradation will lead to losses of livelihoods, increased ecosystem vulnerability and a decrease in ecosystem carrying capacity.

Adaptation strategies

Most respondents mentioned that adaptation strategies have been implemented to a degree in coastal areas of Indonesia such as the Resilient Coastal Village Program and different strategies for the development of alternative livelihoods. The Climate Change Sectoral Roadmap and the Action Plan for Adapting to Climate Change encompass more examples. Nevertheless, two respondents mentioned that adaptation implementation is still at its very early stages as it is currently in the phase of conceptualising and understanding and figuring out planning processes.

Mangrove-related and community-based strategies were those mentioned as most effective by three respondents. Mangrove planting and afforestation strategies are most successful when communities are provided with income-generating and capacity-building activities until the mangrove trees are mature enough to generate ecosystem services and benefits by themselves. Communities also need support in planning, implementing and monitoring mangrove strategies and in integrating local knowledge and priorities in village development plans.

With regard to the adaptation strategies employed in Indonesia, two respondents perceive that they are generally not effective as they change frequently according to the priorities of every new elected government official. In other words, there is no continuity or sustainability. Three other respondents were unsure whether or not the strategies are effective as adaptation takes a long time to materialise and outcomes need to be monitored.

Almost all interviewees (9) have been involved in the planning or implementation of adaptation activities. Adaptation activities are mostly conducted because climate change is expected to affect food security and development, and increase the vulnerability of ecosystems and conservation areas. Adaptation is also pursued due to mandates for addressing climate change (including mandates from the Ministry of National Planning and Development). The main adaptation actors and decision-makers in the country are at the ministerial level (e. g. Ministry of Agriculture, Ministry of Marine Resources and Fishery, Ministry of Forestry, Ministry of National Planning and Development, Ministry of Public Works, Ministry of Environment, Ministry of Finance), the Climate Change National Council, the President Unit for Development Monitoring and Control (UKP4), the Agency for Meteorology, Climatology and Geo-physics, local government agencies (e. g. Environment), researchers and academia.

Ecosystem-based strategies

Four of the respondents are aware of, and six have been involved in, ecosystem-based strategies in Indonesian coastal areas (including strategies with a climate change adaptation objective). Specific activities include coastal restoration and management (e. g. mangrove planting and management, coral reef rehabilitation and management), development of laws (e. g. Law No. 27 / 2007 on coastal areas and small islands management), development of national strategies on mangroves, development of strategic plans for Balikpapan and East Kalimantan watersheds etc. The aforementioned are mostly implemented with the objective of addressing issues such as coastal abrasion, high waves and tides, storms, coastal flooding and inundation, mangrove and coral ecosystem degradation, climate hazard impacts on livelihoods, poverty and greenhouse gas emissions. These activities generally result in multiple benefits such as improvement in ecological conditions, coastal protection (e. g. from abrasion, strong sea current, weather threats), carbon sequestration, provision of mangrove products (e. g. vegetables, flour), rehabilitation of fish stocks, environmental awareness in communities, and development guidelines (e. g. for buildings and construction) in accordance with ecosystem protection.

However, the implementation of these activities has not been without challenges. One such challenge refers to the lack of interest from communities when strategies begin and the fact that they are mostly accustomed to extractive and unsustainable ecosystem management practices. Furthermore, data on the status of Indonesian coastal areas (e. g. maps) is not available or is very scarce and there have been significant funding and coordination constraints. Climate change, adaptation and the intangible benefits that ecosystems provide are also poorly understood by stakeholders at all levels. The challenges are addressed by demonstrating to communities that preserved ecosystems can bring not only environmental but also economic benefits and by promoting environmentally sound development activities such as eco-tourism. Several data and knowledge activities have also been initiated such as developing coastal area maps and disseminating information on the benefits of establishing conservation areas.

Comparing ecosystem-based strategies with infrastructure

Different advantages, disadvantages and enabling conditions were pointed out by the stakeholders when asked to compare ecosystem-based strategies with infrastructure development for adaptation. Among the comparative advantages of ecosystem-based strategies, the interviewees mentioned lower implementation and maintenance costs, biodiversity benefits, lower risk of mal-adaptation (e. g. no danger of waves bouncing back), improvement of soil and water quality, habitat provision of other species, carbon sequestration and livelihood benefits to communities (e. g. silvofishery, harvesting of crustaceans, eco-tourism). On the other hand, ecosystem-based strategies take more time to materialise and to produce benefits (disadvantage in comparison to infrastructure solutions).

With regard to infrastructure strategies (e. g. sea walls and concrete wave breakers), advantages such as proven effectiveness and function from the beginning, suitability for densely populated coastal areas (e. g. people and activities do not have to be relocated to make space for ecosystem restoration), and protection of adjacent ecosystems were mentioned. Disadvantages include alteration of coastal contour and natural processes, increase in the hazard potential of certain coastal dynamics (e. g. waves bounce back, changes in sea current patterns), higher financial costs for implementation and maintenance, no biodiversity benefits, may exclude communities from accessing sea or land, may cause accidents, and may deteriorate quite quickly.

It terms of enabling factors, several conditions need to be met for both ecosystem-based and infrastructure strategies to materialise effectively. These include bottom-up planning and community participation, capacity building, clear coastal tenure, status and ownership and awareness raising.

Mainstreaming ecosystem-based adaptation: current policy incentives and gaps

The majority of the respondents (6) agree that the policy and intra-institutional cooperation frameworks in Indonesia are inadequate for promoting EBA strategies. One interviewee considers them sufficient, one that EBA for coastal areas is almost never discussed at the national level, while two others believe that mainstreaming EBA depends on other factors. For improving policy frameworks and cooperation between institutions some suggestions are proposed such as awareness-raising at all levels with regard to the multiple benefits of EBA, improving communication and coordination among institutions at the national level (e. g. by developing common guidelines on coastal ecosystem restoration, vulnerability assessments etc.), altering the narrow sectoral focus of government agencies, and improving the relevant policies. Setting up effective monitoring and evaluation networks for ecosystem-based strategies in coastal areas, and communicating the subsequent results to all stakeholders involved, will be another step in fostering a wider implementation of EBA in the future.

Furthermore, a common understanding needs to be developed with regard to EBA across stakeholder groups and capacity building needs to be implemented at all levels, from government officials, extension personnel and NGOs, to local communities. Improvement is also needed with regard to specific data and knowledge related to EBA but also adaptation in general in coastal areas. This includes assessments of climate impacts on both people and ecosystems, evaluation of socio-ecological benefits but also costs that could result from such strategies, most appropriate ecosystem management strategies in different conditions, and knowledge of relevant ecological processes. The immense local knowledge, especially in relation to ecosystem management but also changes occurring due to climate change, should also be valued and recorded more appropriately and systematically.

The knowledge improvement and capacity building activities can be in the form of stock-taking activities (who is doing what), pilot activities and comparative field studies with monitoring and evaluation, workshops and trainings with on-the-ground activities that will be maintained after the workshops finish (e. g. community radio), and shared learning visits among communities. Conducting more vulnerability assessments in coastal areas could be another effective way of addressing the information and knowledge gaps. Sharing climate and vulnerability information with communities in a suitable and user-friendly format is also crucial. This could be done through short message services (SMS), community radio and television among other media.

Conclusions

The stakeholders contacted have a generally high awareness of the severity of climate change impacts that occur or can potentially occur in coastal areas. A number of different ecosystem strategies have been employed across coastal areas in the country but their effectiveness is considered limited. In managing coastal resources and ecosystems it seems that there is a trade-off between economic development and ecosystem conservation in Indonesia. Strong economic development interests and lack of incentives and enthusiasm for conservation are just some of the underlying reasons for coastal ecosystem degradation in Indonesia. Coastal communities are usually the first stakeholder groups to be affected by such degradation, and are also the group most seriously affected.

Some adaptation strategies have also been implemented in coastal areas of the country. Mangrove restoration (essentially an ecosystem-based intervention) and community-based adaptation strategies were pointed out as successful examples. There is some experience with ecosystem-based adaptation interventions but EBA is far from being an important topic of discussion at the national and regional planning level.

Ecosystem-based strategies are employed to address problems such as coastal abrasion, high waves and tides, storms, coastal flooding and inundation, mangrove and coral ecosystem degradation, livelihood vulnerability and poverty, and there advantages and disadvantages related to these strategies as compared with infrastructure strategies. For example, EBA interventions are considered to be less costly and they result in multiple benefits (e. g. biodiversity, livelihoods, mitigation), but it takes longer for the benefits to materialise and it is difficult to define their socio-economic value. On the other hand, infrastructure measures, although more costly to implement and maintain, are associated with a more straight-forward and clear account of functions and benefits across space and time.

Several recommendations were made for both the national and local level to incentivise the uptake of EBA interventions. Apart from awareness and capacity-building on the benefits of EBA at the local level, livelihood-generating activities should be a central component of any EBA strategy, especially in situations where the benefits from ecosystem services take a long time to materialise. At the national and regional level, cooperation between institutions needs to be strengthened and incentivised, and a common understanding of EBA and related common guidelines are needed as a foundation for this. Planners and practitioners at this level need to be more aware of the full range of costs and benefits associated with EBA.

One critical first step towards achieving the aforementioned recommendations concerns data and information gathering, consolidation and communication. There is a tremendous gap in data and knowledge related to climate hazards and impacts on both people and ecosystems in coastal areas, but also with regard to optimal ecosystem management, costs and benefits of EBA and associated ecological processes. Setting up pilot projects and monitoring and evaluation systems, and conducting vulnerability assessments in coastal areas, is one way of addressing the data and information gaps.

5.5 Expert interviews: the Philippines

Stakeholders interviewed

Seventy (70) potential respondents were contacted through email to schedule a potential interview. A total of 34 interviews were conducted as a result (interviewees listed in Annex). Stakeholders responded either through filling out a questionnaire over email or conducting semi-structured discussions over telephone or Skype. The stakeholders interviewed are representatives of different expert groups such as adaptation and disaster risk reduction decision-makers and planners, planners and practitioners from natural resource / environmental agencies focusing on coastal areas, planners and practitioners from development agencies focusing on coastal areas, stakeholders from research and academia, and private sector professionals.

Perceptions on most important hazards and impacts

Stakeholders mentioned a number of different climate-related hazards that impact coastal areas in the Philippines. Sea-level rise is one of the most alarming hazards, as the country encompasses many low-lying coastal towns whose population depends on coastal resources for their livelihoods. Based on the routine monitoring of the Global Sea Level Observing System (GLOSS) in various locations including Manila and Legaspi, there has been a rapid increase in sea level over the years. If this continues, terrestrial areas and small islands located just a little above sea level might submerge.

Variability and extreme events related to precipitation are already impacting coastal areas and their frequency and intensity is expected to increase with climate change. The compound effects of heavy precipitation events, storms and sea-level rise will likely be disastrous for many coastal settlements. Changes in rainfall patterns, longer periods of drought and saltwater intrusion into freshwater reserves will affect the supply of drinking water.

The sudden or gradual inundation of coastal land due to storms or sea-level rise will lead to significant losses of arable land and yields. This will very likely result in the displacement of many coastal or island communities that are already experiencing vulnerability, livelihood challenges and other problems. The migration of coastal communities to the uplands is expected to lead to the clearing of more forested areas. This will have an impact on ecosystems and biodiversity, and on the delivery of important ecosystem services.

Two other hazards related to climate change mentioned by the respondents are ocean acidification and sea temperature increase. Both hazards will result in more coral reef stress, higher coral mortality and lower productivity and fecundity. These impacts will directly affect fish habitats and population dynamics.

Current ecosystem-based strategies

Interviewees emphasised integrated coastal management (ICM) as a national strategy for sustainable development associated with the country's coast and marine environments. It addresses the inter-linkages among watersheds, estuaries and wetlands, and coastal and marine environments, and also the inter-linkages between different stakeholder groups such as national and local agencies, communities, civil society and the private sector. Activities conducted under ICM include vulnerability assessments and hazard mapping, coastal zoning, disaster risk reduction, ecosystem restoration (e.g. mangroves), habitat conservation (e.g. protection of coral reefs and seagrass ecosystems), establishing community conservation areas and livelihood activities (e.g. eco-tourism), solid waste management, and strengthening coastal law enforcement to decrease illegal extraction of resources (e.g. fish). The majority of the aforementioned activities are also related to adaptation (even if they are not planned and implemented with adaptation goals in mind).

Examples of concrete projects include the ICM initiative in Balayan and adjacent bays of Calatagan Peninsula led by WWF and the Batangas provincial government, and the ICM programme in the province of Camiguin. The initiative of Calatagan covers about 261 km of coastline and 226,000 hectares of municipal waters with activities such as establishment of community resource management plans, strengthening of law enforcement within the bay, monitoring of coral cover, fish densities and fish catches, solid waste management, mangrove reforestation and integrated land-use planning and management (including the integration of disaster-risk reduction and adaptation). In the province of Camiguin, the programme includes development of coastal resource management plans for barangays[5] and municipalities, capacity-building for law enforcement teams, establishment of marine protected areas (e.g. Mantigue Island Nature Park, giant clam sanctuary), rehabilitation and protection of mangroves, and development of community enterprises (e.g. eco-tourism).

The country is also a part of the Coral Triangle Initiative (CTI) on Coral Reefs, Fisheries and Food Security in collaboration with Indonesia, Malaysia, Papua New Guinea, Solomon Islands and Timor-Leste. The Philippine National Plan of Action (NPOA) commits to achieving the goals of CTI, which are to address the most urgent threats facing the coastal and marine resources of one of the most biologically diverse and ecologically rich regions on earth. Specific activities include ecosystem-based fisheries management, establishment of marine protected areas, developing climate change adaptation interventions, protecting threatened species and developing capacity across levels.

Disaster-risk reduction planning is a major focus at the local level in coastal areas. It includes increasing the resilience of coastal livelihoods and community groups such as fishermen, mainstreaming disaster risk reduction into local land-use and water plans, and establishing early warning and response systems. Disaster-risk reduction strategies also encompass awareness and capacity-building activities such as establishing, strengthening and capacitating Disaster Risk Reduction and Management Councils (DRRMCs).

Empowerment and capacity-building with communities are also conducted frequently at the local level. The focus is placed on channeling knowledge (including scientific) and tools to communities so that they can become active stewards of coastal ecosystems, manage them sustainably to improve their livelihoods, and restore degraded areas for enhanced delivery of ecosystem services. In several areas this has led to the establishment of community-managed marine protected areas.

5 Lowest administrative level in the Philippines

Current adaptation activities and ecosystem-based adaptation strategies

The stakeholders interviewed mentioned that diverse adaptation strategies are being implemented in the coastal areas of the Philippines, including planned interventions and autonomous actions. Most of these strategies are implemented at the local level, with a special focus on mainstreaming adaptation into the municipal Comprehensive Land Use Plans (CLUPs) and Coastal Resource Management Plans (CRMPs) and developing Local Climate Change Adaptation Plans. Local plans usually encompass activities such as mapping of hazardous areas, creating inventories of natural and man-made assets, mapping the areas, assets and stakeholder groups that will be most affected by climate hazards (based on climate modeling where possible), and identifying specific adaptation actions.

Planned adaptation strategies in coastal areas include interventions such as construction of protection infrastructure (e.g. sea walls), development of coastal resource management plans, development of early adaptation plans and RESTORED strategies for habitat and fishery resilience and coastal integrity, mapping of hazardous areas and of most vulnerable ecosystems and species, developing and implementing coastal setback regulations, local capacity building and beach nourishment. Data and information strategies such as setting up weather forecasting systems and climate databases are also implemented.

Autonomous or spontaneous adaptation strategies implemented by communities include sandbagging, temporary migration, building houses on stilts, seeking alternative livelihood sources, and borrowing money.

Adaptation strategies for addressing specific hazards were mentioned as well. The construction of sea walls and mangrove reforestation were proposed for addressing coastal erosion. Mangrove reforestation was also suggested for limiting the impacts of storm surges, together with the construction of breakwaters and dikes/levees. For coastal flooding, the development of early warning and disaster response systems, integrated drainage and diversification of livelihoods were suggested. River bank rehabilitation and dike construction were mentioned as interventions to limit flooding impacts from overflown rivers. As far as inland flooding is concerned, upland reforestation and information and education campaigns were pointed out.

Many stakeholders demonstrated awareness of ecosystem-based adaptation (EBA) interventions. Coastal EBA interventions are mostly associated with mangrove ecosystem and habitat management, managing fishery resources, identifying and protecting endangered species, establishing marine protected areas, and sustainable management of ecosystems for disaster risk reduction. Mangrove activities include establishment of nurseries and reforestation, and habitat management in priority areas. Fisheries management is mostly associated with the establishment of marine protected areas (MPAs), and related MPA management plans, to increase fish stocks and foster sustainable extraction.

Protected areas are proposed widely to reduce coastal hazard risks but also to increase the resilience of the ecosystems to climate change. The Philippine National Plan of Action (NPOA) under the Coral Triangle Initiative encompasses the development and implementation of a climate change adaptation plan for the coastal communities and small island ecosystems in the region. Reducing human pressure on coastal ecosystems is a major component of these strategies. However, the interviewees hardly mentioned any sustainable ecosystem management activities for the provision of livelihood goods and services to help communities adapt, with the exception of the community adaptation activities proposed in the Verde Island Passage vulnerability assessment (conducted by Conservation International).

Beside vulnerability assessments conducted by GIZ and partners, as well as by NGOs (e.g. Conservation International), other research-oriented activities are implemented in coastal areas by organisations such as World Fish. These include economic assessments of adaptation strategies, and resource and biodiversity inventories.

Challenges related to the implementation of EBA

Respondents mentioned several challenges associated with both promoting and implementing ecosystem-based adaptation strategies in coastal areas of the Philippines. One major challenge relates to the longer time needed for the benefits of EBA strategies to materialise. Infrastructure projects for example result in immediate gains related to protection of coastal areas while the gains of EBA strategies emerge in the longer term. Furthermore, it can be very difficult to protect ecosystems for adaptation benefits if this would mean forgoing economic gains from exploitation or resource extraction in a given region, for example, mining.

In addition, the implementation of EBA goes beyond the political term of local government heads. More often than not, the heads change at the beginning of each term, which also leads to re-shifting of priorities. Consequently, any ecosystem-based initiatives of the previous local government might not be sustained by the new leaders. Sourcing of funds for EBA is another issue. Councils will usually only support ecosystem measures if there is an external budget available to them for this, either from the national government or from a donor institution. Local budgets (own budgets) are usually preferentially spent in other areas.

More time and effort are needed when implementing capacity-building activities associated with EBA. Considerable social mobilisation and development of institutions is usually required, as well as setting up good governance processes, systems and standards. Ecosystem-based adaptation is also a relatively new approach and thus significant efforts need to be made with awareness and education campaigns, including those targeted at policy-makers and executives.

Another challenge that was mentioned relates to the gaps in biodiversity data and ecological knowledge. The data that is available is inadequate to better understand the state of biodiversity in coastal and marine ecosystems. Some research efforts are made to address this gap but the utilisation of research output is considered low. Interviewees also noted that not all local governments demonstrate sustained support of MPA management strategies and planning, and consequently for the uptake and utilisation of biodiversity data.

The lack of livelihood projects is considered to be a critical challenge as well. Without sustainable or alternative livelihood opportunities and related support, it is difficult to limit the extraction of coastal and marine resources and to consequently increase ecosystem resilience.

Institutional arrangements facilitating EBA

Several frameworks, laws and policies exist that can facilitate the promotion and implementation of EBA in coastal areas but there is a need for them to be more effectively and “aggressively” (as mentioned by one interviewee) enforced and implemented. These include but are not limited to the following, as mentioned by respondents in email communication:

1. Republic Act (RA) 7160, known as the Local Government Code of 1991 that gives local government units (LGUs) the primary control over marine and coastal resources.

2. Republic Act (RA) 8550, New Fisheries Code that emphasises food security, prioritisation of local fishermen in sustainable development programmes, enhancing resilience of MPA networks, restoring coastal integrity through living buffers, coastal zoning and SMART proofing, and fostering ecosystem approaches to fisheries management (EAFM).

3. Biodiversity and protected areas acts such as the National Integrated Protected Areas System (7586), and Wildlife Act (9147).

4. Republic Act 8371, Indigenous People’s Rights Act – recognising the rights of indigenous peoples over land and resources.

5. Executive Order No. 578, establishing the National Policy on Biological Diversity, prescribing its implementation throughout the country particularly in the Sulu-Sulawesi Marine Ecosystem (SSME) and the Verde Island Passage Marine Corridor.

6. Presidential Proclamation No. 102, Declaring the entire Sulu and Celebes Seas as an integrated conservation and development zone.

7. Executive Order No. 797, adopting the Coral Triangle Initiative National Plan of Action.

8. Executive Order No. 533, adopting the Integrated Coastal Management (ICM) approach as the national coastal management strategy.

9. Presidential Proclamation 2146 identifying environmentally critical projects related to heavy industries, resource extractive industries, as well as infrastructure projects. The environmentally critical areas (ECAs) were also defined, including all declared protected areas, critical habitats of wildlife, prime agricultural lands, mangrove areas and coral reefs, areas of significant historical, cultural or aesthetic value and areas often hit by natural calamities.

10. Republic Act No. 10121, Disaster Risk Reduction and Management Act.

11. Climate Change Act of 2009 including the National Framework Strategy and Program on Climate Change and the creation of the Climate Change Commission.

12. Formulation of the National Climate Change Action Plan (NCCAP) and guidelines for Local Climate Change Action Plans (LCCAPs).

Additional issues and recommendations

Several respondents mentioned that the country has insufficient facilities to provide reliable predictions of climate change and its impacts on different sectors. Thus there is a need for increased access to downscaled, standardised and quality-controlled climate data to foster coastal zone planning and management.

Local Government Units (LGU)s have considerable control in matters related to environmental protection but many lack technical and financial capabilities, expertise and logistics to carry out sustainable coastal resources management and adaptation projects. Interviewees called again for increased capacity-building and resources channelled to the local level.

The existing institutional set-up is perceived as too complex, confusing, sectoralised and fragmented. Fragmentation is the major systemic hindrance to more effective coastal zone management, as mentioned by several stakeholders. There is an urgent need for sectoral integration and coordination, especially concerning the following:

- Cooperation of LGUs through management of common resources and beyond political boundaries;
- Comprehensive monitoring and evaluation of protected area management and other policies across jurisdictions;
- Integrated and sustainable land and coastal planning that encompasses environmental protection, waste management, alternative livelihood development, housing and infrastructure development;
- Enhanced coordination between donor agencies to address priority needs of key vulnerable sectors in an integrated manner;
- Closer cooperation and integration between the Climate Change Commission (CCC) and the Disaster Risk Management Council.

Stakeholders made several additional recommendations such as:

- Enhancement of existing building codes and zoning ordinance standards to make them adaptive to climate change and extreme events;
- Quantify impacts and risks, and also costs-benefits of adaptation options in different coastal areas to provide a good basis for priority-setting and decision-making;
- Allocate adequate funding to support effective coastal adaptation;
- Adopt a community-based monitoring system and early warning system for disaster preparedness and adaptation;
- Promote participatory monitoring and evaluation of adaptation plans and strategies;
- Replicate success stories and strategies to enable local governments and communities.

Conclusions

It is evident that good frameworks and conditions exist for the implementation of EBA in coastal areas of the Philippines. For example, emphasis is given to integrated coastal zone management, disaster risk reduction and sound environmental management. Interviewees mentioned that local networks of marine and coastal protected areas strive to integrate human uses of the ecosystems in sustainable ways so as to not exclude people from livelihood opportunities. Coastal strategies are also aligned with local legal, political and institutional requirements.

Nonetheless, the implementation of EBA faces challenges. As mentioned above, one challenge relates to evaluating the benefits. The availability of downscaled climate information is another challenge. Respondents also identified several factors that are critical for the success of any coastal and marine resource management strategy, including EBA:

1. Elaboration of ecosystem inventories, clear delineation of boundaries and ecosystem characteristics. Implementation of integrated frameworks (e. g. ICM) across sectors and scales;

2. Stakeholder involvement in both planning and implementation and balancing of different stakeholder objectives;

3. Both short-term and long-term objectives should be planned and monitored, as well as immediate (e. g. livelihoods) and more long-term benefits (e. g. enhancement of ecosystem services);

4. Development and application of appropriate indicators, including sustainability indicators, during planning and monitoring;

5. Recognition of both local and external threats (i. e. climate hazards, industrial hazards, etc.);

6. Establishment and maintenance of ecological network connectivity for increased resilience.

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