CONSERVATION INTERNATIONAL

adapting to climate change

Maintaining ecosystem services for human well-being in the Verde Island Passage, Philippines




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This document presents the outcomes of the climate change Vulnerability Assessment of the marine biodiversity and related well-being in the Verde Island Passage completed by Conservational International and its partners in 2009.

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The Verde Island Passage Vulnerability Assessment Project was conducted in partnership with the Provincial Government of Batangas, the Provincial Governments of Occidental and Oriental Mindoro, the Provincial Government of Marinduque, the Provincial Government of Romblon, and all their Municipal Governments, and the Department of Environment and Natural Resources (DENR).

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Conservation International (CI)

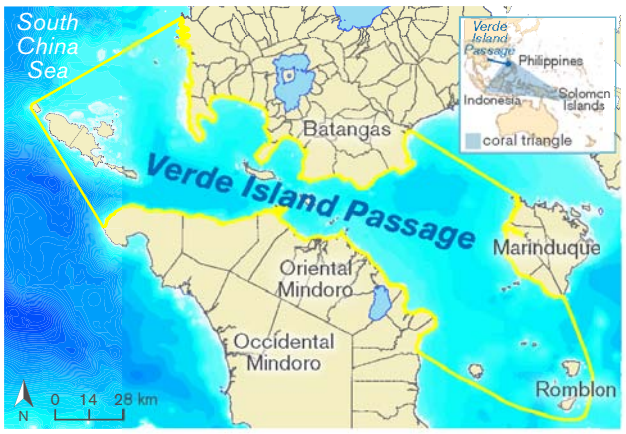
Mission
Building upon a strong foundation of science, partnership and field demonstration, CI empowers societies to responsibly and sustainably care for nature, our global biodiversity, for the well-being of humanity.

Vision
We imagine a healthy prosperous world in which societies are forever committed to caring for and valuing nature, our global biodiversity, for the long-term benefit of people and all life on Earth.

The Verde Island Passage

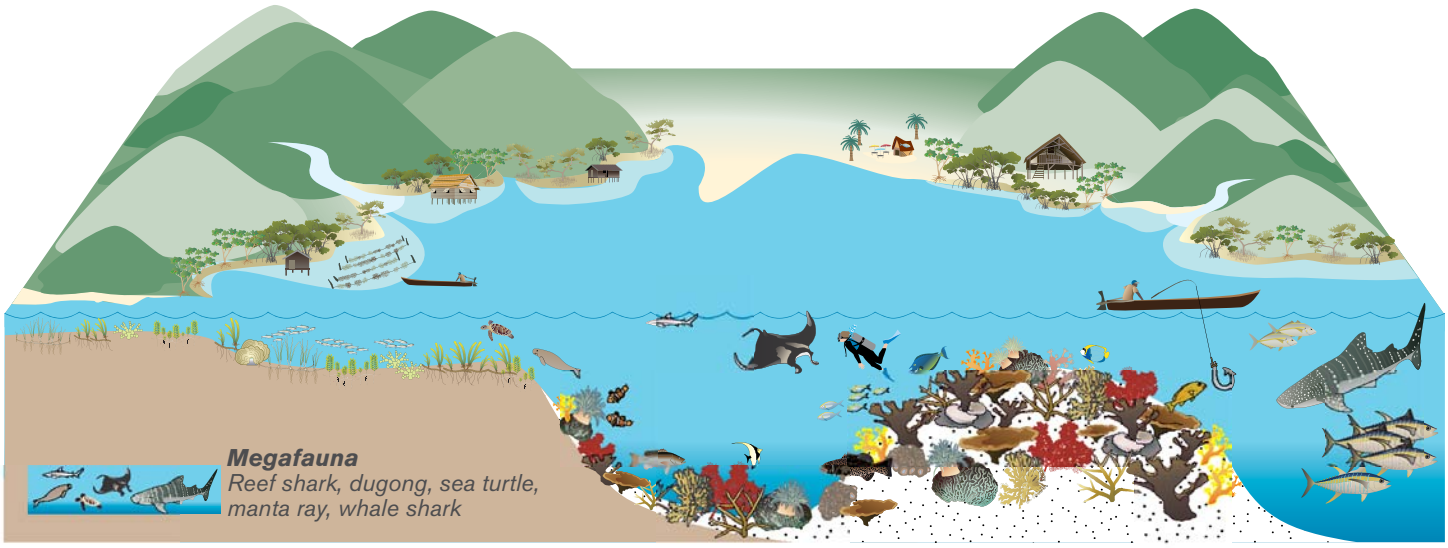
The 100 km long Verde Island Passage in the northern Philippines is located within the globally significant Coral Triangle, an area considered the center of the world's marine biodiversity, and as such, has a wealth of coastal marine resources, including highly diverse coral reefs, mangrove forests, and seagrass meadows.

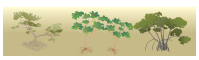
The Verde Island Passage is a conservation corridor managed by five provinces: Batangas, Occidental Mindoro, Oriental Mindoro, Marinduque, and Romblon. The abundant fish and charismatic megafauna support over 7 million people in those provinces, whose livelihoods include fishing, aquaculture, and tourism.



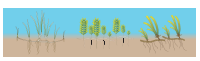
The Pacific Ocean and South China Sea converge within the Verde Island Passage channel, which is surrounded by five provinces (names above).

Human well-being in the Verde Island Passage is supported by rich marine and coastal ecosystems.

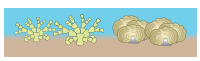




Mangrove
Mangrove forests reduce storm effects and stabilize shorelines.



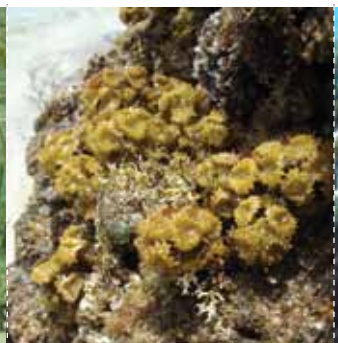
Seagrass
Seagrass meadows reduce erosion and improve water quality.

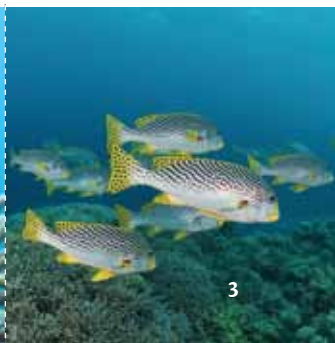


Seaweed
Seaweed communities support a range of invertebrates and are the cement of coral reefs.

Coral
Predominantly fringing coral reefs support abundant and diverse fish communities.

Fish
Abundant fish provide food and livelihood for commercial and municipal fishers.





Multiple impacts threaten the natural

Overfishing

With more than 1,000 fishers of aquarium species, and approximately 10,000 municipal and 2,000 commercial fishers in the Verde Island Passage, there is very high pressure on local fish resources, especially territorial and iconic species such as groupers, snappers, and tuna.

Destructive and illegal fishing practices

Blast fishing (right) results in physical habitat destruction; cyanide fishing for the live fish trade kills corals and juvenile fish; shark fin fishing rapidly depletes populations; unlicensed fishing vessels are common; and, some fishing gear has high by-catch including manta rays, dolphins, and sea turtles.

Unsustainable coastal development

Within the Verde Island Passage, 30-50% of the population lives on the coastline, which continues to grow rapidly. Shipyards and industrial developments contribute nutrients and pollution to coastal waters and increase coastal erosion.

Unsustainable land use practices

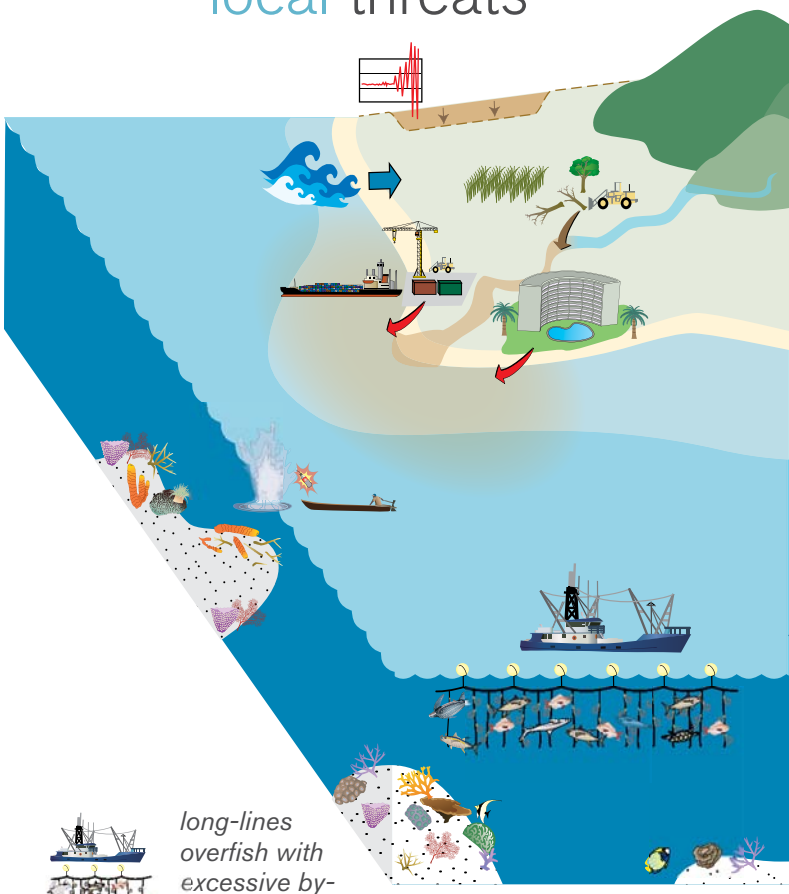
The removal of mangroves for aquaculture ponds (right) and upland forests for sugar cane fields, as well as infrastructure development, increases sediment and nutrient runoff to the sea, leading to the death of corals and seagrasses.

Natural disasters—earthquakes and tsunamis

The Verde Island Passage is located within a tectonically active area where there are numerous active faults and volcanoes, resulting in frequent earthquakes that can lead to subsidence or tsunamis, with associated destruction of coastal marine resources.

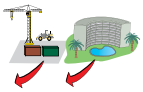
Increasing coastal population leads to multiple local impacts to marine natural resources. Unsustainable fishing and land use practices, as well as natural disasters, also have significant impacts.

local threats



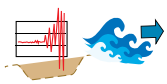
long-lines overfish with excessive by-catch

dynamite fishing kills fish and destroys reef



development runoff sends nutrients to ocean

plantation logging loads streams with sediment



earthquakes and tsunamis cause earth slumping and flooding

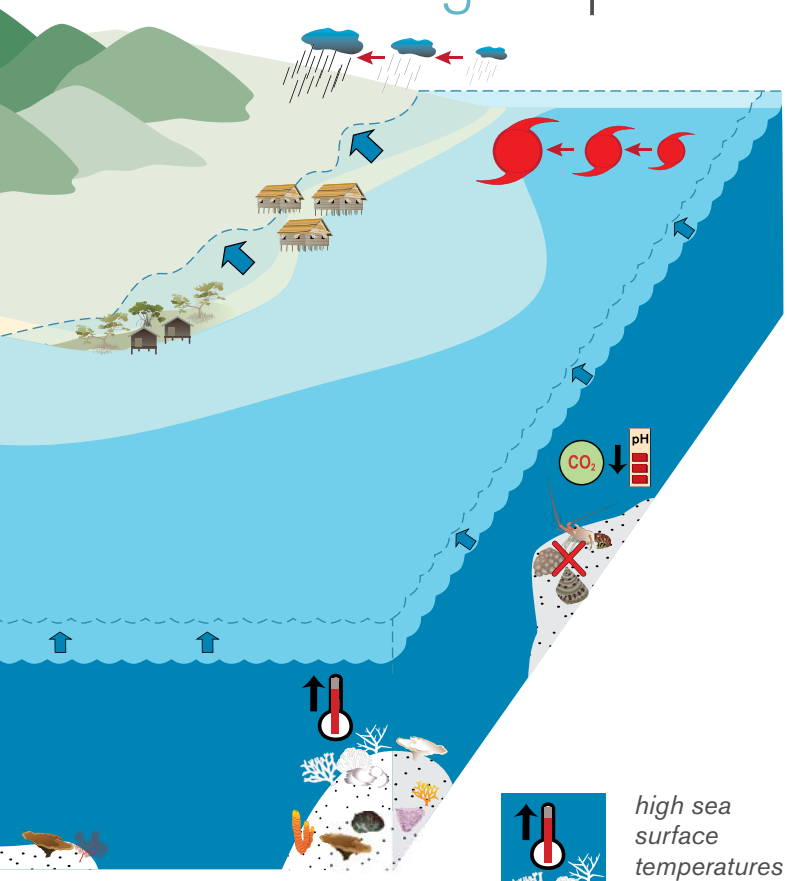
cyanide fishing

coastal development

resources of Verde Island Passage

At a broader scale, climate change will also impact natural coastal resources in areas such as Verde Island Passage, Philippines.

climate change impacts



high sea surface temperatures bleach coral

sea level rise inundates coastal areas

the frequency and intensity of storms increase

increased rainfall causes flooding

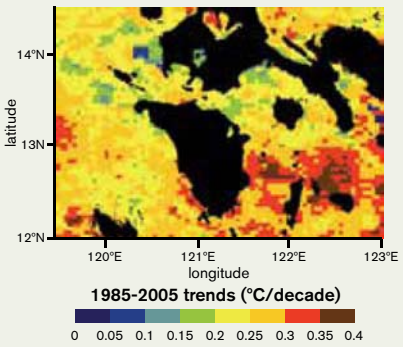
acidic ocean threatens shellfish and corals

bleached coral

storm flooding

Increased sea surface temperature

Sea surface temperature varies among years, but an increase of 0.06 °C/decade over the last 100 years and 0.2 °C/decade for the past 20 years has been observed (right). Increases are most pronounced in bays with low circulation, e.g., Mabini.



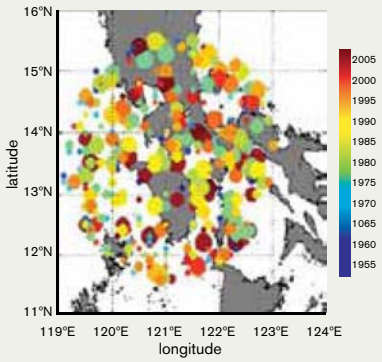
NOAA-Coral Reef Watch

Sea level rise

As sea water temperature increases, it expands, resulting in sea level rise. Over the last five years, sea level surrounding the Verde Island Passage has been increasing at 0.5 to 1.0 mm per year.

Increased storm frequency and intensity

Between 1952 and 2008, 160 typhoons passed within 200 km of the Verde Island Passage (right). With increasing sea surface temperatures, predictions are that the number and intensity of storms are likely to increase.



Japan Meteorology Agency

Increased rainfall

Rainfall shows high variability in the Verde Island Passage, but a general increase has been recorded in the region. Although it is unclear how climate change might affect rainfall patterns, increased rainfall is expected in some Verde Island Passage areas.

Ocean acidification

As the ocean absorbs the excess carbon dioxide (CO_2) from emissions released into the atmosphere, the acidity of the ocean increases.

Ecological vulnerability to climate

Increased sea surface temperature

Physical effects: shallow, limited circulation bays are likely to see the greatest temperature increases, but offshore upwelling of nutrient-rich waters may be disrupted, lowering ocean productivity.

Fish vulnerability: potential 13-20% reduction in production due to impacts on fish larvae development (siganids, groupers, snappers) and disruption to reproduction. Additionally, fish may move offshore to escape high temperatures.

Coral vulnerability: coral bleaching, resulting in loss (3-20%) of live hard coral cover, and subsequent reduction in reef structure.

Mangrove vulnerability: potential for decreased seedling production, survivorship, and regeneration, leading to forest degradation.

Seagrass vulnerability: heat stress can impact growth, reproduction, and induce shifts to more tolerant species.

Seaweed vulnerability: changes to growth and reproduction as well as community structure.

Sea level rise

Physical effects: all areas will be affected, with impacts further exacerbated by coastal development, limiting the opportunity for mangrove, seagrass, and coral communities to migrate onshore.

Fish vulnerability: changes in salinity will cause shifts in fish ranges. Loss of mangrove nursery habitat can affect larval development and availability of refugia.

Coral vulnerability: between 0.4 and 7.0% loss of cover depending on location as well as loss of 0.6-0.8% of coral diversity, with greatest impacts in the deep reefs.

Mangrove vulnerability: as outer forest edges become too deep and coastal development precluding movement onshore, expansion areas will be reduced.

Seagrass vulnerability: shallow, high light-requiring species may be replaced by those tolerant to lower light.

Seaweed vulnerability: species shifts will occur with changes in salinity, mangrove forest, and seagrass meadows.

Climate change in the Verde Island Passage is highly likely to impact key components of marine ecosystems, including fish, coral, mangrove, seagrass, and seaweed communities. However, as these ecosystems are highly connected, the combined effects are likely to be even larger. For example,

climate change impacts

- *increased sea surface temperature*
- *increased storm frequency and intensity*
- *increased rainfall*
- *sea level rise*
- *ocean acidification*

Increased storm frequency and intensity

Physical effects: the Verde Island Passage is well protected from high waves. However, storms that cause flooding, coastal erosion, and destruction of biotic communities will worsen, with consequences for biodiversity and coastal resilience.

Fish vulnerability: lower recruitment, abundance, and diversity due to habitat loss and decreased habitat complexity.

Coral vulnerability: physical destruction of corals and detrimental effects on water quality impacting coral growth.

Mangrove vulnerability: physical destruction of mangrove

change in the Verde Island Passage

the life cycles of grouper and snapper are supported not only by mangrove, seagrass, and coral communities, but also by open ocean and estuaries. Therefore, impacts on all of these ecosystems will combine to result in declines to these regionally important fisheries.

ecological vulnerability

- *moderate vulnerability*
- *increasing vulnerability*
- *extreme vulnerability*
- *mangrove*
- *seagrass*
- *seaweed*
- *coral*
- *fish*

forests, and negative effects on seedlings production.

Seagrass vulnerability: physical removal and species changes to rapid growth, high turnover species.

Seaweed vulnerability: loss of biomass and potential shifts to colonizer species.

Increased rainfall

Physical effects: increased erosion of upland areas will result in increased sediment and nutrient inputs, reducing water quality in shallow coastal areas. Salinity fluctuations may increase.

Fish vulnerability: marine species are likely to shift farther offshore due to salinity fluctuations in shallow coastal areas.

Coral vulnerability: likely species shifts inshore resulting from increased nutrient and sediment inputs.

Mangrove vulnerability: increased sedimentation may potentially create new mangrove habitat, as long as this is not reclaimed for development.

Seagrass vulnerability: increased nutrients and sediment are likely to limit light to seagrass with potential losses of seagrass meadows, as well as shifts to more tolerant species.

Seaweed vulnerability: a low number of abundant, stress tolerant species.

Ocean acidification

Physical effects: as the ocean becomes more acidic, many chemical processes such as the laying down of calcium carbonate by marine organisms (e.g., shells of marine snails and skeletons of corals) may become limited.

Fish vulnerability: loss of diversity and abundance resulting from habitat loss (particularly coral). Also, likely impacts on zooplankton which provide food for commercial fish species.

Coral vulnerability: corals will become more brittle due to inability to lay down calcium carbonate skeleton, making them more susceptible to storm damage.

Mangrove vulnerability: potential effects on shellfish communities such as marine snails and mollusks.

Seagrass vulnerability: causative increase in CO_2 may promote growth, however, predicted to be very minimal effect.

Seaweed vulnerability: may show some increase in growth due to elevated CO_2 concentration.

Human vulnerability to climate change

Natural resources of the Verde Island Passage are essential to the livelihood of the more than 7 million people living in the five surrounding provinces, 30-50% of whom reside

Increased sea surface temperature

Summary effects: coral bleaching, degradation of mangrove, seagrass, and seaweed communities, and movement of fish offshore, will affect fisheries, aquaculture, and tourism-related livelihoods.

Fisheries: high vulnerability of municipal fisheries from loss of coral reef fish and small pelagic species, negatively affecting low income fishers and food availability.

Tourism: loss of livelihood potential through reduced tourism income due to degraded coral habitat, reduced fisheries and fish diversity for species such as whale sharks and sea turtles.

Foreshore development: low vulnerability

Human health: potential impacts to health and freshwater safety as warmer water can induce toxic algal blooms.

Food security: greater effort to obtain fish (farther offshore) and food shortages due to reduced fish production.

Sea level rise

Summary effects: coastal flooding, habitat loss, and salt water intrusion will affect aquaculture, water supply, and coastal infrastructure.

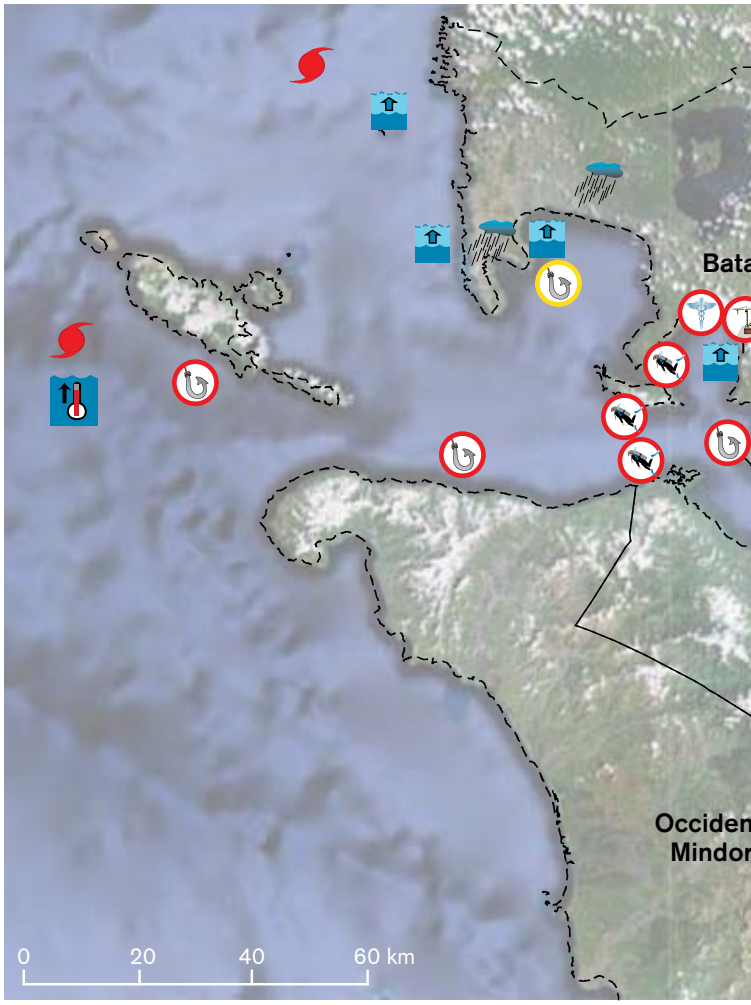
Fisheries: loss of coral habitat impacts aquarium and artisanal fisheries, limiting livelihood options in low-income areas.

Tourism: damage to coastal resorts and reduced tourism potential resulting from degradation of coastal habitats.

Foreshore development: flooding can cause damage to infrastructure, including homes, farms, and entire villages with serious consequences for human safety and the economy of local communities.

Human health: flooding causing increased pollution (from industry) and water contamination (from wastewater), increased water-borne diseases.

Food security: intrusion of saltwater and flooding into agricultural lands and inland aquaculture can affect food prices and freshwater availability.



climate change impacts

- *increased sea surface temperature*
- *increased storm frequency and intensity*
- *increased rainfall*
- *sea level rise*
- *ocean acidification*

Increased storm frequency and intensity

Summary effects: habitat destruction, floods, and coastal erosion will affect infrastructure, food availability, and health.

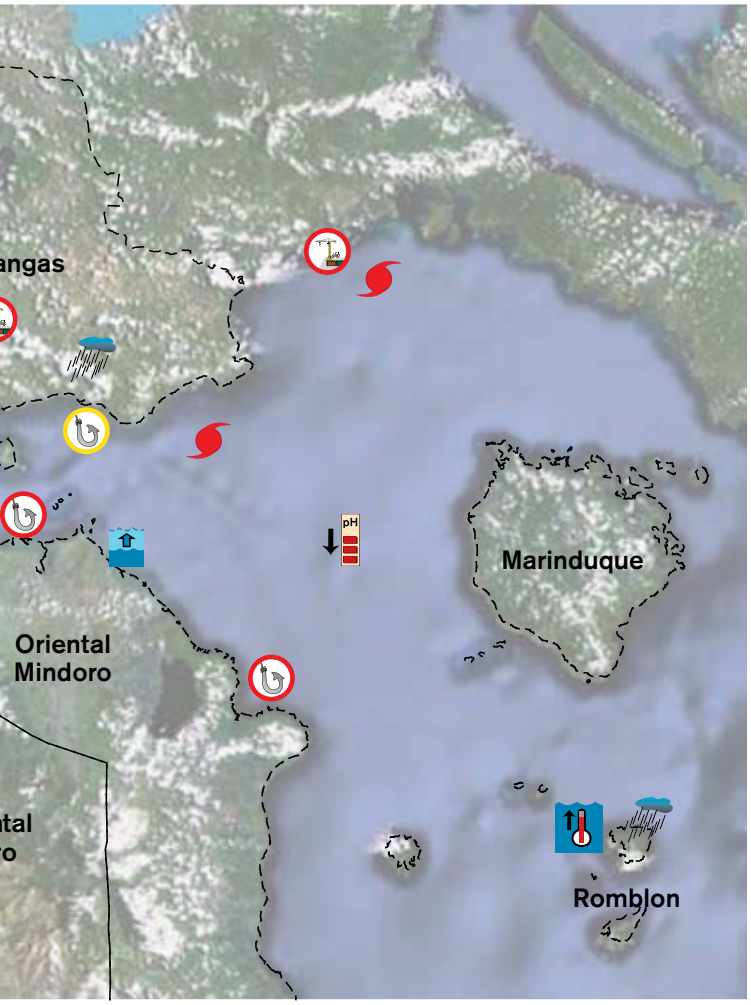
Fisheries: damage to boats, fishing equipment, aquaculture ponds, and seaweed farms, causing increased financial stress to municipal fisheries.

Tourism: damage to coral with loss of biodiversity and charismatic species, resulting in reduced tourism potential. Damage to resorts and tourist infrastructure.

Foreshore development: damage to coastal infrastructure,

in the Verde Island Passage

in coastal communities. The influence of climate change has the potential to impact not only their livelihoods and infrastructure, but also their food and health.



human vulnerability

- *moderate vulnerability*
- *increasing vulnerability*
- *extreme vulnerability*
- *fisheries*
- *tourism*
- *foreshore development*
- *human health and food security*

interruptions to commercial operations, e.g., factory closure.

Human health: illness, injuries, loss of lives or housing due to weather, and damage to health infrastructure such as hospitals.

Food security: damage to agricultural production and stored food spoilage.

Increased rainfall

Summary effects: increased land erosion, and sediment and nutrient loads affects tourism activities and inshore fisheries.
Fisheries: reduced catches and loss of income, caused by degraded marine habitats.
Tourism: poor water quality and loss of coral reefs, reducing tourism revenues. Potential flooding with negative effects on tourist infrastructure and contamination of freshwater.
Foreshore development: erosion and potential flooding which can damage houses and aquaculture plants with consequential loss of properties, incomes, and population displacement, especially in low income areas.
Human health: increased pollution, water contamination, and water-borne diseases.
Food security: negative effects on agriculture and aquaculture. Impacts on seaweed farms will reduce livelihood opportunities for women.

Ocean acidification

Summary effects: degradation of coral and calcifying organisms threatens food security and reduces shellfish fishery revenues.
Fisheries: loss of coral habitat and shellfish species, affecting lobster and bivalve fisheries, and shrimp farming.
Tourism: losses in dive tourism revenues as coral reefs degrade and associated biodiversity is lost.
Foreshore development: low vulnerability
Human health: low vulnerability
Food security: limiting growth of marine snails, bivalves, and lobsters with consequences for local food markets, negatively affecting low income fishers and food availability.

Recommendations for adapting to climate change impacts

Climate change has already altered the balance of the oceans with serious and irreversible consequences for marine ecosystems and the services they provide. The disruption of ecological functions and ecosystem services has severe impacts on the well-being of human communities, especially in coastal areas like the Verde Island Passage, where human dependencies on the oceans are high. Immediate and substantial actions need to be taken to increase the adaptive capacity of coastal marine ecosystems and the people that depend on them. Adapting to climate change is the only solution to ensure ecosystems and human societies can survive and maintain their well-being when exposed to climate change impacts. To decrease vulnerabilities of the Verde Island Passage to climate change, the following recommendations should be implemented.

Implement:

- municipal management strategies that are climate change-smart and efficiently used, and ecosystem monitoring and evaluation that address climate change.
- sustainable aquaculture practices that minimize the impacts to the natural ecosystems (e.g., low density finfish pens and chemical-free shrimp ponds).
- a review of existing local, regional, and national policies and ordinances focused on resource management and reform to include ecosystem-based adaptation, and enable new frameworks where necessary.
- guidelines and best practices for coastal and foreshore development planning that take into account the potential for increased storm activity, salt water intrusion, and other climate change impacts.

Regulate:

- artificial reef development, channel dredging, and seaweed farming through zoning activities.
- the establishment of better enforcement of illegal fishing activities including blast fishing, cyanide fishing, and shark fin fishing.
- use of sustainable fishing gear to minimize bycatch.

Instigate:

- use of newly propagated accretion from eroded uplands for mangroves as a buffer against coastal erosion and large waves.
- the improvement and retrofit of existing infrastructure to make sure they can sustain climate impacts.
- appropriate engineering of ports, quarries, and foreshore development so as to not impact long-shore sediment movement.
- use of best management practices for fishing on coral reefs, seagrass beds, and mangrove forests, and increased enforcement towards illegal and destructive practices (e.g., dynamite fishing and push nets).
- enforcement against deforestation and extensive agriculture in the watersheds that promote high sediment runoff, causing coral reef degradation and the decline of coastal and offshore fisheries.

Establish:

- Marine Protected Areas to reduce current impacts, preserve biodiversity, and sustain fisheries, increasing the resilience and adaptive capacity of marine ecosystems to sustain climate change impacts.
- climate-smart Marine Protected Areas that apply adaptive management approaches to address current and future climate change impacts.
- outreach programs to create awareness and engage communities on climate change and its impacts on marine resources.
- enforcement patrol and communication tools among wardens within the local Marine Protected Area network.

Protect:

- areas of critical life stages of vulnerable fisheries species, e.g., siganids, and critical biological communities, e.g., upwelling areas.
- natural mangrove, seagrass, and coral habitats that act as natural coastal defense mechanisms, reducing erosional processes and buffering storms and other extreme weather events.
- a variety of habitats including seagrass, seaweed, and mangroves as they support various life stages of multiple fisheries species.
- areas (e.g., Mabini, Puerto Galera), species (e.g., whale sharks), and ecosystems (e.g., mangroves, coral reefs) that sustain important tourism activities, providing income for local communities.

Diversify:

- livelihoods for coastal miners (e.g., pebble picking) to reduce coastal erosion and enable revenues to derive from sustainable practices.
- livelihoods, particularly for climate change-vulnerable activities such as aquarium fishing.
- gear use, adaptation, and mechanization within sustainable limits to facilitate fishing as fish move farther offshore.
- opportunities for solid waste and chemical disposal that favor the spread of disease, pollution, and burial of important coastal ecosystems (e.g., seagrass meadows and mangrove seedlings).

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For further reading

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