



Coastal Infrastructure Development and Environmental Impacts

Module 3: Coastal and Marine Tourism

Duration: 1 Hour

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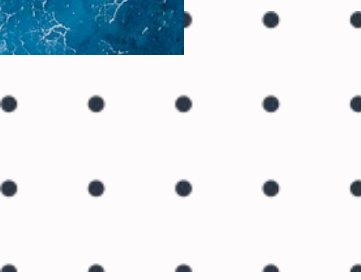
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Introduction to Infrastructure Development and Impact

Infrastructure is the main actor that supports the economic activity in the areas with good services to tourists. Providing facilities and services for consumers, in terms of infrastructure in coastal areas is plays a significant role in attracting tourists.

The development of infrastructure in coastal areas is important to create a great experience for tourists; however, with the rapid growth of infrastructure also brought environmental impact such as erosion and flooding.



Types of Infrastructure

- The infrastructure in a coastal area serves a critical function for the economy to utilize and protect the coastal environment.

Commercial Infrastructure

- Accommodation, road, ports, and marinas.

A building that is used for business activities (Cambridge Dictionary).
Necessity for the tourism economy in coastal areas to function.

Gray and Green Infrastructure

- Seawalls, breakwaters, and mangrove restoration.

Infrastructure design to protect the richness of coastal environment.



Source: Narayan et al. (2016), Conservation International



Types of Infrastructure

- Infrastructure Development is a crucial matter since the expansion of the tourism economy results in many sectors having to construct more Infrastructure and advancing technologies to meet the demand.

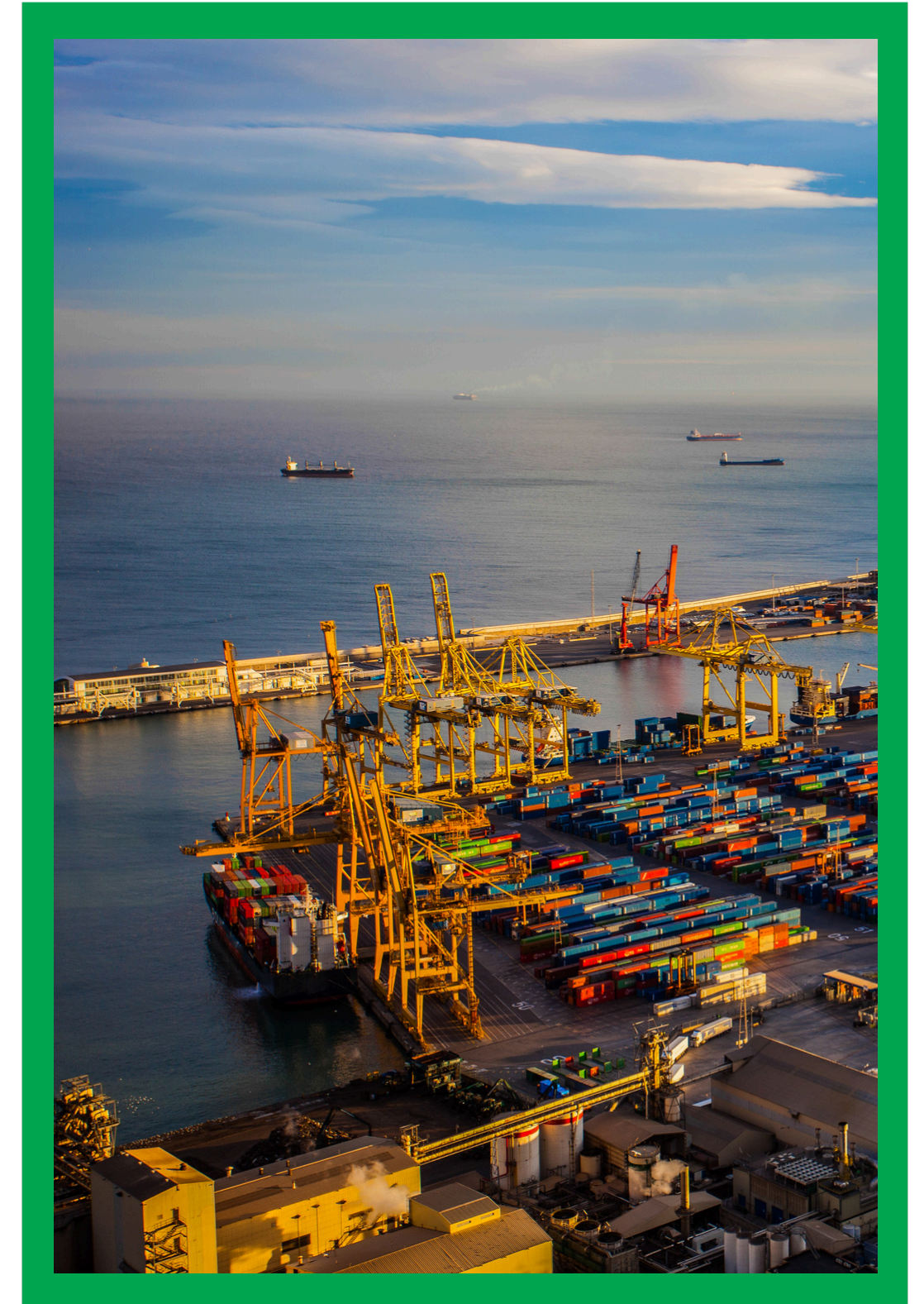
Source: Apriyanti, Sumaryoto, & Meirinaldi (2024)

Ports, marinas:

Increase the number of boats and ships docking due to a higher number of tourists and transportation (supply chain).

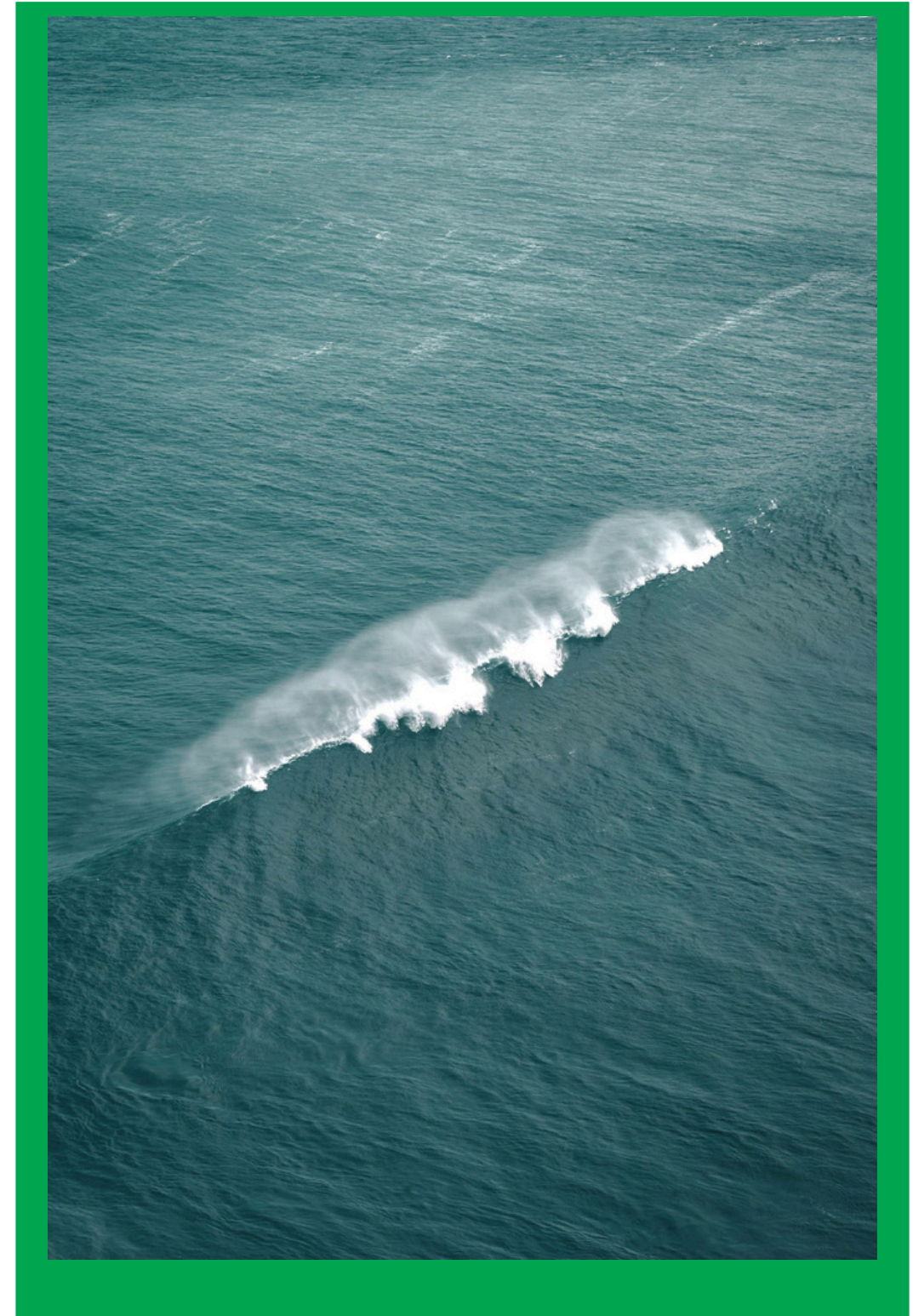
Accommodation, road:

Facilitate tourist activities and experiences, to develop the tourist industry, and generate jobs (human resources).



Common Environmental Impacts

- With the rapid increase of infrastructure contributing to common environmental issues and long-term problems.
 - ➔ Habitat fragmentation
 - ➔ Altered hydrology and sedimentation
 - ➔ Coastal erosion and pollution.



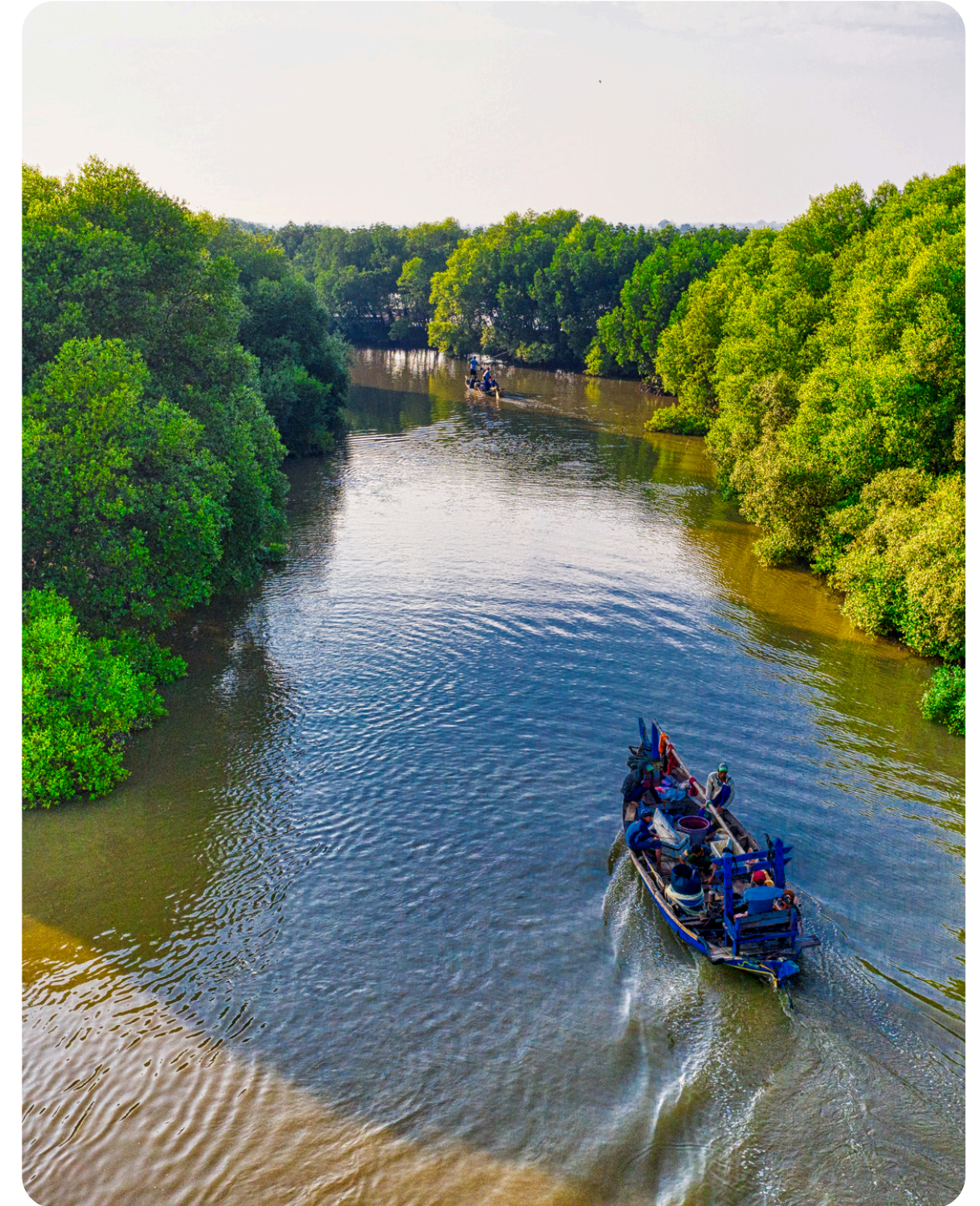
Common Environmental Impacts

Habitat fragmentation

Infrastructure that is involved in the flow of seawater will contribute to disrupting natural sediment fluxes, reducing marine and ecological connectivity due to changes in the volume of seawater flow.

Mangrove loss: requires a high amount of water flow to exchange and transfer nutrients, sediment to survive.

- **Chain effect of Mangrove loss:** Impact on vital areas of ecological relationships.
 - Nursery Habitat
 - Food Source
 - Breeding Grounds
 - Biodiversity Hotspot



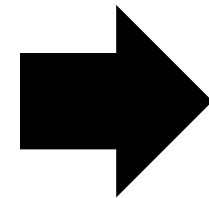
Common Environmental Impacts

- Dynamics of mangrove: Seasonality and Tidal Influence are the main factors of microorganisms and wildlife to function in the mangrove areas.

Seasonality: The temperature between seasons affects the behavior of microorganisms and the demand for nutrient supply.

- During high temperature season: Microbes are more active, increased **denitrification** rate, and the demand for **nitrate nitrogen (NO₃-N)** to keep up with the denitrification rate.

If the supply of **(NO₃-N)** won't reach the demand will impact the survivability of microbes.



A low number of microbes affects the Decomposition rate of dead biomass (plants and seaweed) and **NO₃-N** builds up
Result in Oxygen drops.

Nitrate nitrogen (NO₃-N): a type of nitrogen found in water necessary for plants to grow.
(circulating through water flow)

Denitrification: a process in microbes remove **nitrate** from water and turn it into gas



Common Environmental Impacts

- During low temperature season: Microbes are less active; therefore, **most of $\text{NH}_4\text{-N}$ (ammonium nitrogen)** is being exported through water flow rather than used by microbes.

Low volume of water results in **$\text{NH}_4\text{-N}$** to stack up and not transfer, which allows algae to overgrow and dead biomass to accumulate and ruined the ecosystem

Ammonium nitrogen ($\text{NH}_4\text{-N}$): a type of nitrogen from animal waste or sewage in which necessary for plants to grow. (circulating through water flow)

Tidal Influence: The main mechanism for mangrove to cycle the nutrients and organic matter, with infrastructure that is relevant to water flow, will impact the cycle mechanism.

- Embankments
- Seawalls
- Dams
- Weirs



Common Environmental Impacts

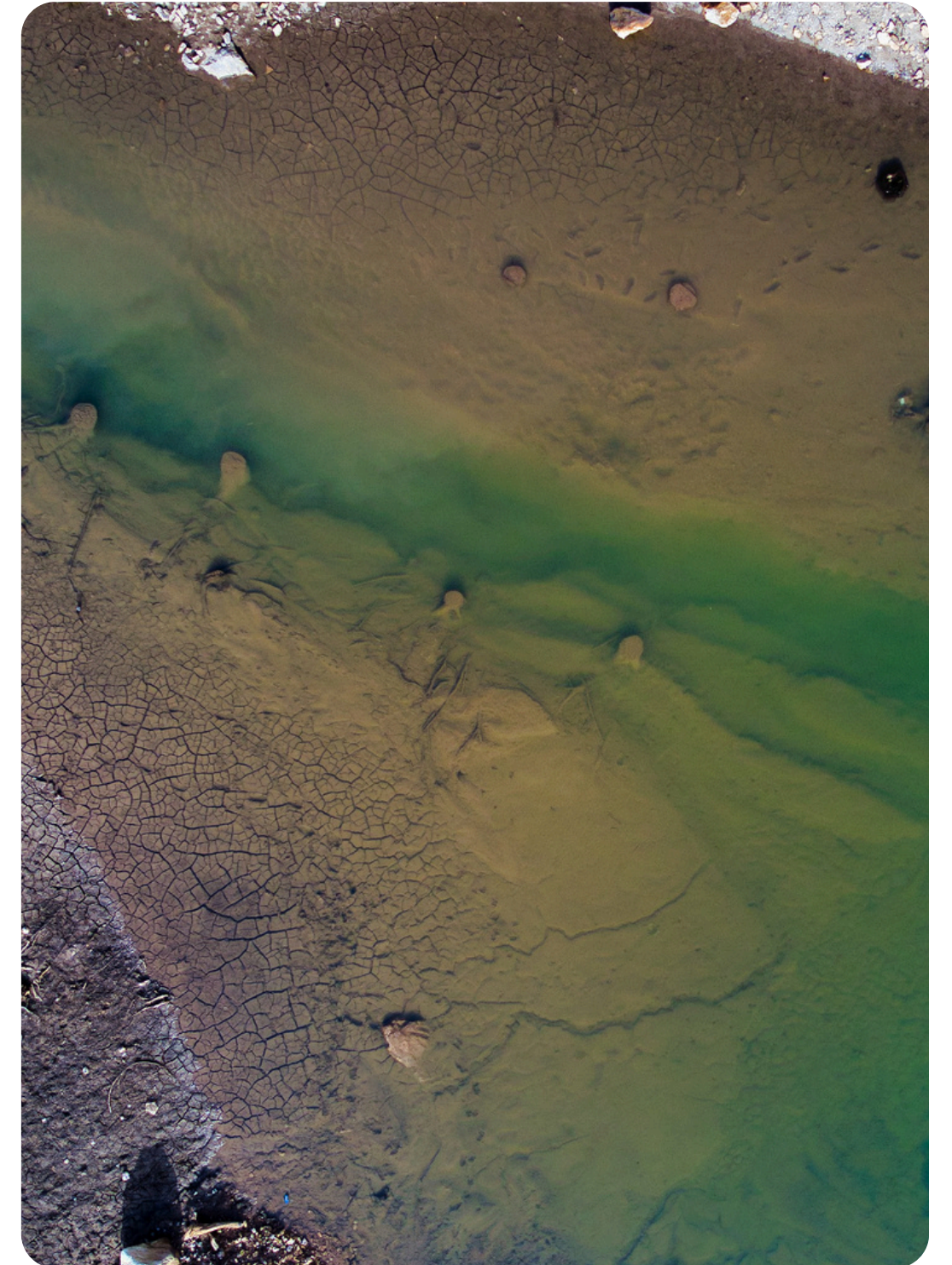
Altered hydrology and sedimentation:

Land reclamation is one of the factors contributing to sedimentation as a method to extend the coastal areas to build more infrastructure and overcome the limited areas used in coastal areas.

Sedimentation:

The development of infrastructure introduces significant amounts of dust and chemical pollutants into the marine environment, which impact coral reef ecosystems.

- Smothering corals
- Sediment clouds



Common Environmental Impacts

Coastal erosion and pollution:

Catchment infrastructure (such as dams and weirs) can lead to decreased fluvial sediment transfer to coastal areas, resulting in sand-starved beaches and accelerated coastal erosion.

Sand-starved beaches:

The coastal areas that won't receive enough sand supply (mainly filled by longshore drift) to maintain their natural beach range and profile.

- beach erosion
- loss of nature buffer zone
- **Accommodation activity:** groundwater extraction leads to saltwater intrusion, and sewage management in some accommodations won't reach the standard can contribute to pollution.



Source: Willis & Griggs (2003)



Mitigation Measures

- Environmental Impact Assessments (EIAs): A process used to evaluate the potential environmental consequences of proposed infrastructure.
 - ➡ Aim to achieve long-term development and sustainability.
 - ➡ Ensure environmental security from the development of infrastructure. (Provide guidelines, design, and plan for infrastructure)



Mitigation Measures

- Regulatory Frameworks EIA: Often legislated and part of the development approval process in most Pacific island countries.
- Engage stakeholders in public consultation: discuss and find a solution for every sector involved.

Local community

resource owners

vulnerable groups

Industry associations
(example: tourism industry)

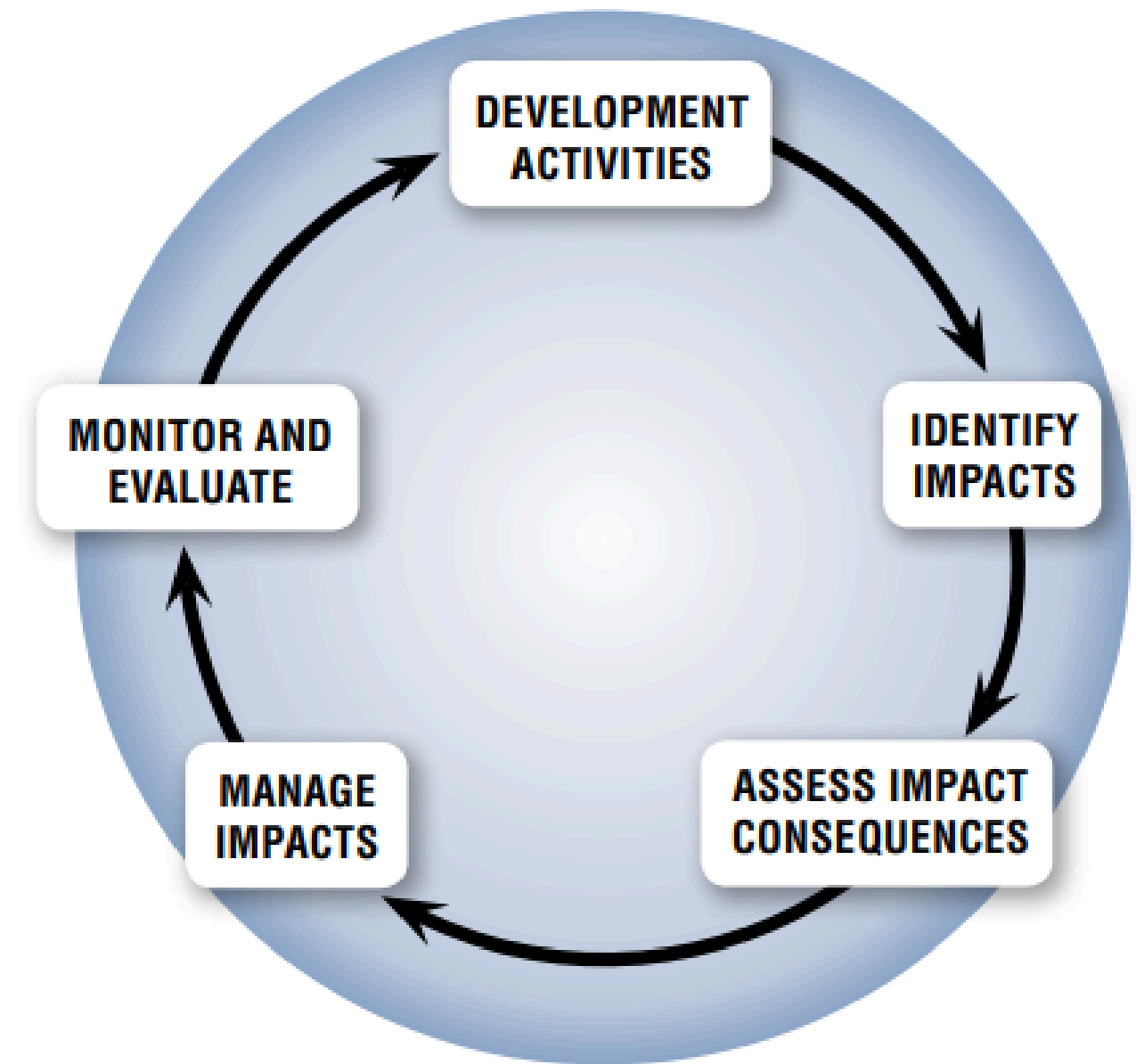


FIGURE 1: EIA is embedded in the project management cycle for tourism development

Mitigation Measures

- Planning and certification by environmental impact assessment have a significant role in minimizing the infrastructure development impact.

Green Infrastructure: EIAs can encourage the construction of Green infrastructure as a mitigation measure to enable relevant sectors to reduce their impacts.

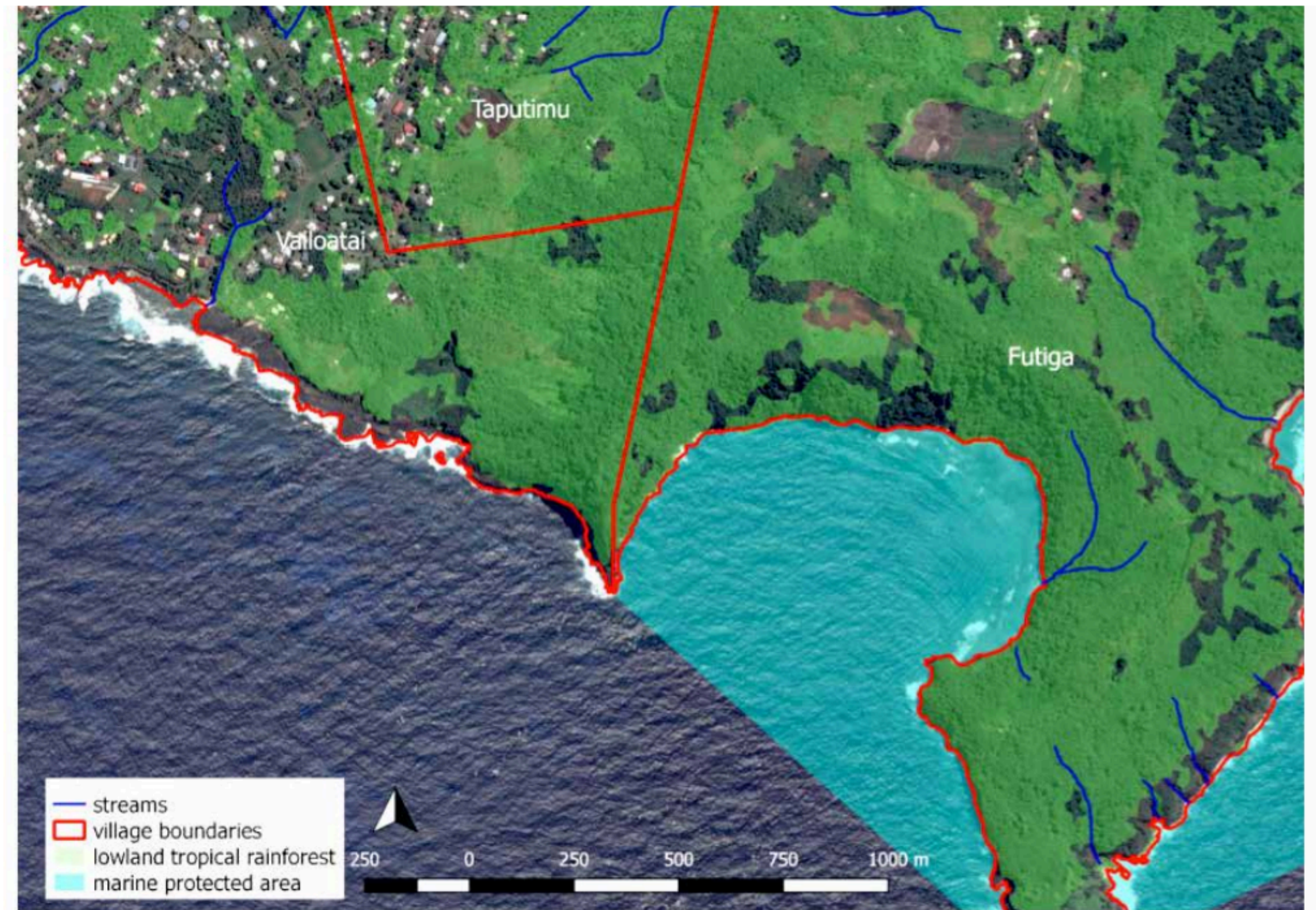
Permeable pavements: Surfaces designed to trap stormwater and sediment prevent pollution from flowing down to coastal areas.

Solar power: Renewable energy by the conversion of sunlight into electricity, reducing the reliance a unrenewable energy such as electricity by combustion of coal.



- The Geographic Information Systems (GIS): analyse and interpret data that potentially impacts in future and impose setbacks and buffer zones to affirm the security of areas.
- The computer system of EIAs compresses with information of environmental data, social and economic data to calculate and predict potential issues in the long term.

Mitigation Measures



An example map of how GIS can be used to show surrounding land/resource uses and ecosystem features e.g. forestry, fresh water stream, MPA and villages to give context to a proposed coastal tourism development



Activity: Coastal Impact Evaluation

- Select a real coastal development (past or proposed).
- Evaluate ecological and social impacts.
- Propose 2 mitigation strategies.
- Post a short summary in the discussion forum.



Summary

- The development of infrastructure is essential due to the growth of the tourism industry, but requires a lot of attention to proceed with environmental concerns.
- Since the unprepared development plan will lead to vital damage to the ecosystem (mangrove forest).
- Environmental Impact Assessments (EIAs) play a significant role in all sectors to find a solution for sustainable development.



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THANK YOU

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