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Development of Regional Joint Master Program in Maritime Environmental Protection and Management

- MEP&M -

Know-how transfer to teaching staff related to MEP&M

Environmental management (dev.3.4.4)

Ecosystem services: Valuing Nature for a better protection

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Kotor, Montenegro

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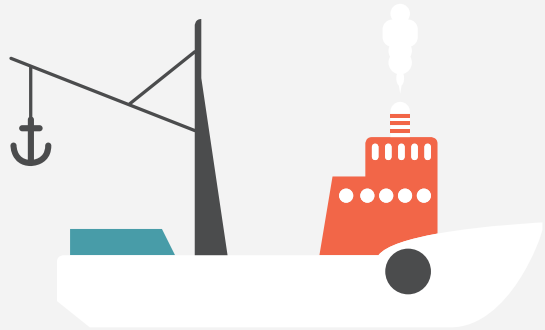
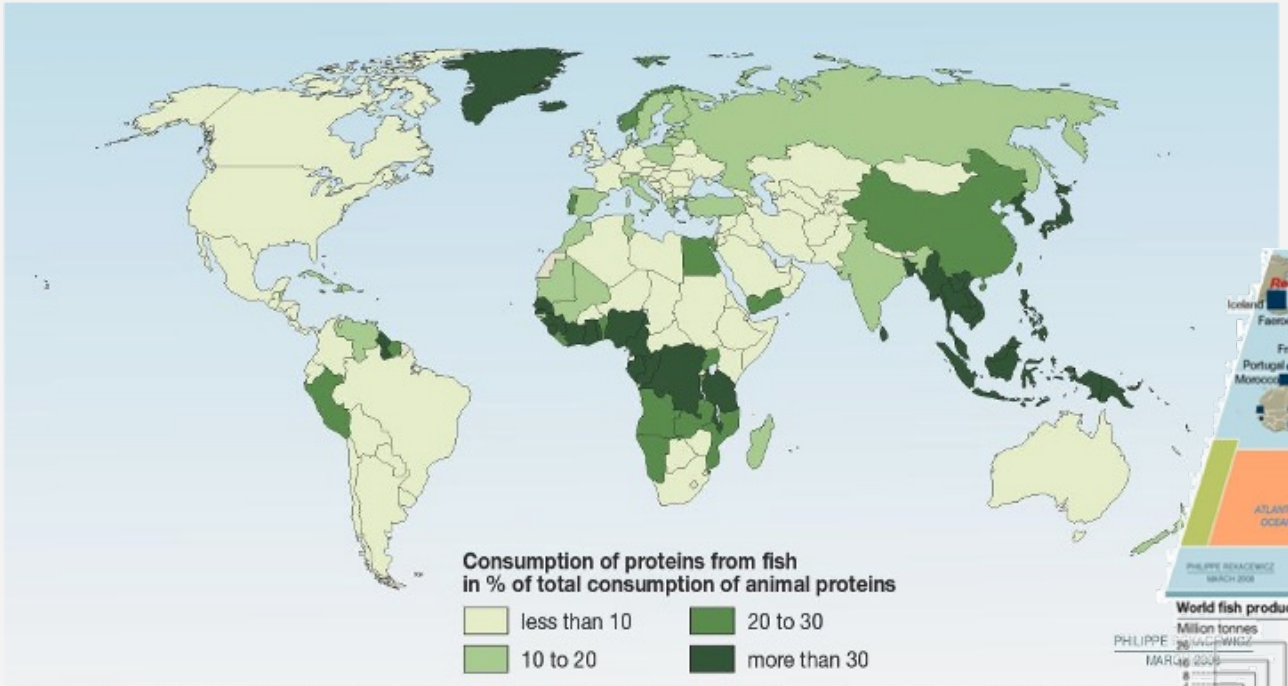
Ecosystem Services

1. Value Nature

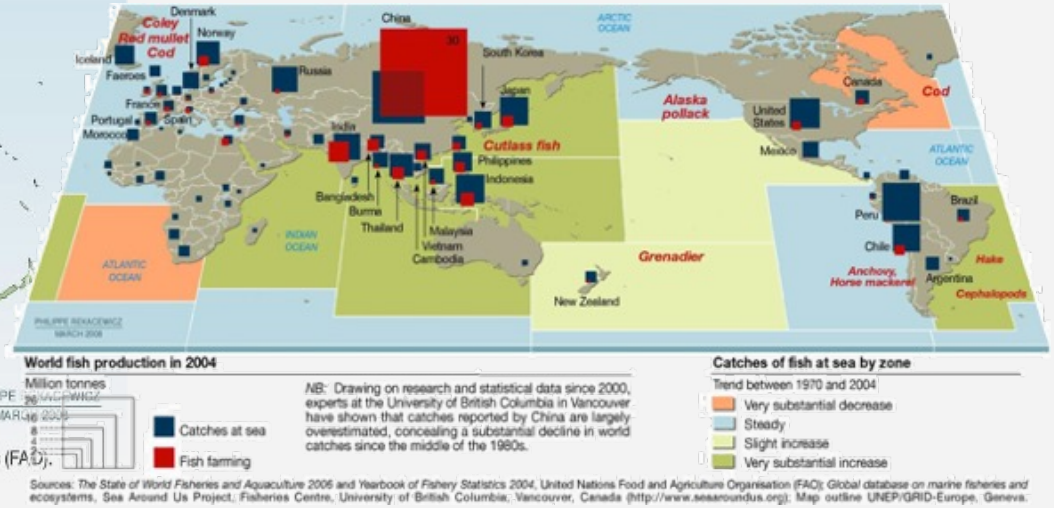
A valuable Environment

- **Fisheries**
  - The Ocean = resource to feed 9 billion peoples
    - the population expected in 2050
    - if fisheries are more well managed





Source: Earthtrend database, World Resources Institute (WRI), Washington ; Faostat, Food and Agriculture Organization of the United Nations (FAO).



Sources: *The State of World Fisheries and Aquaculture 2006* and *Yearbook of Fishery Statistics 2004*, United Nations Food and Agriculture Organisation (FAO); *Global database on marine fisheries and ecosystems*, Sea Around Us Project, Fisheries Centre, University of British Columbia, Vancouver, Canada (http://www.seaaroundus.org); Map outline UNEP/GRID-Europe, Geneva.

A valuable Environment

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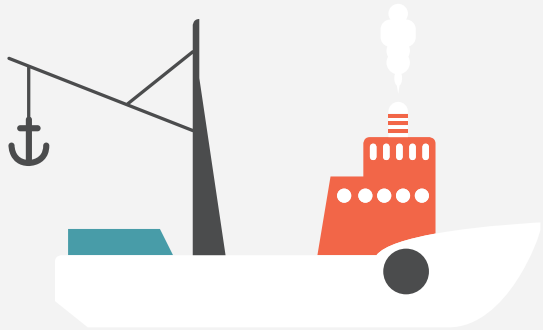

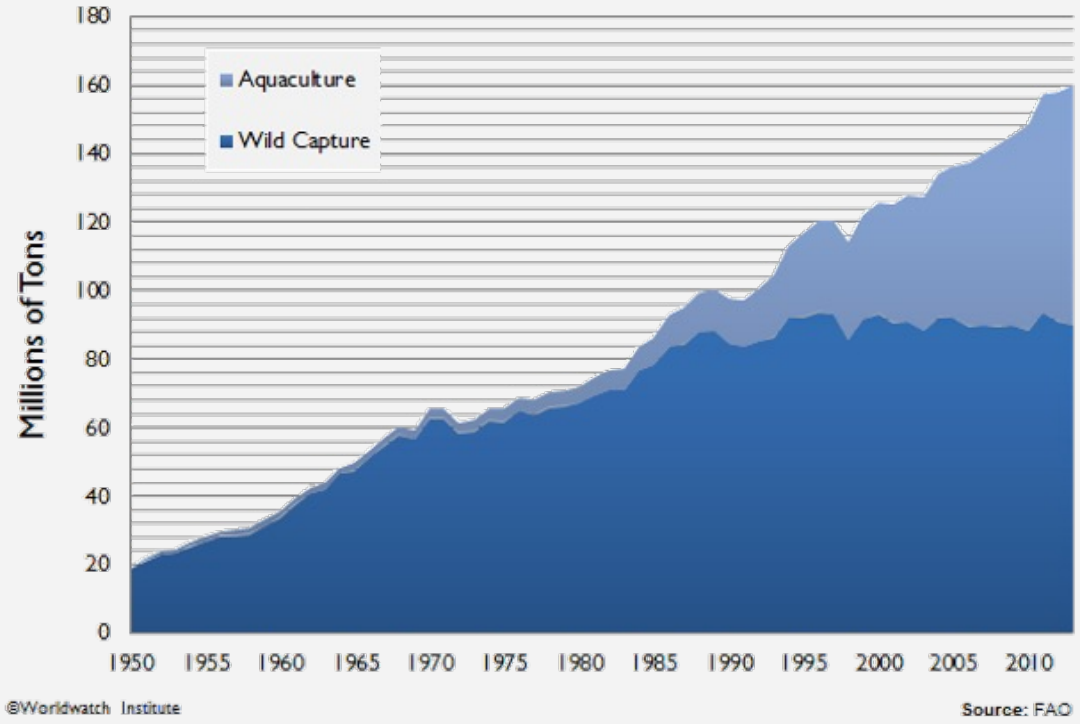

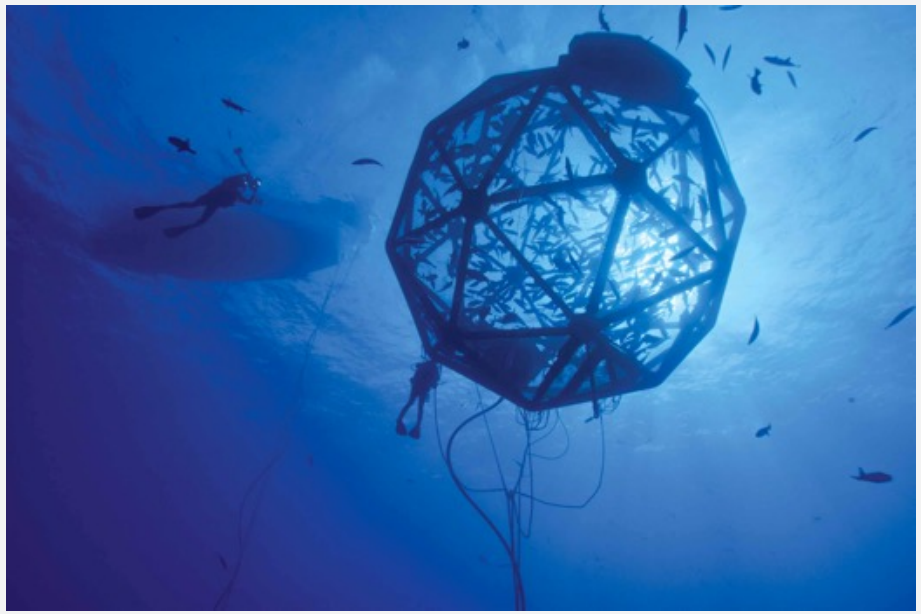

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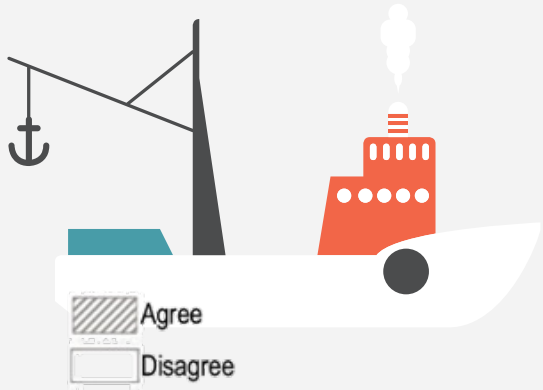
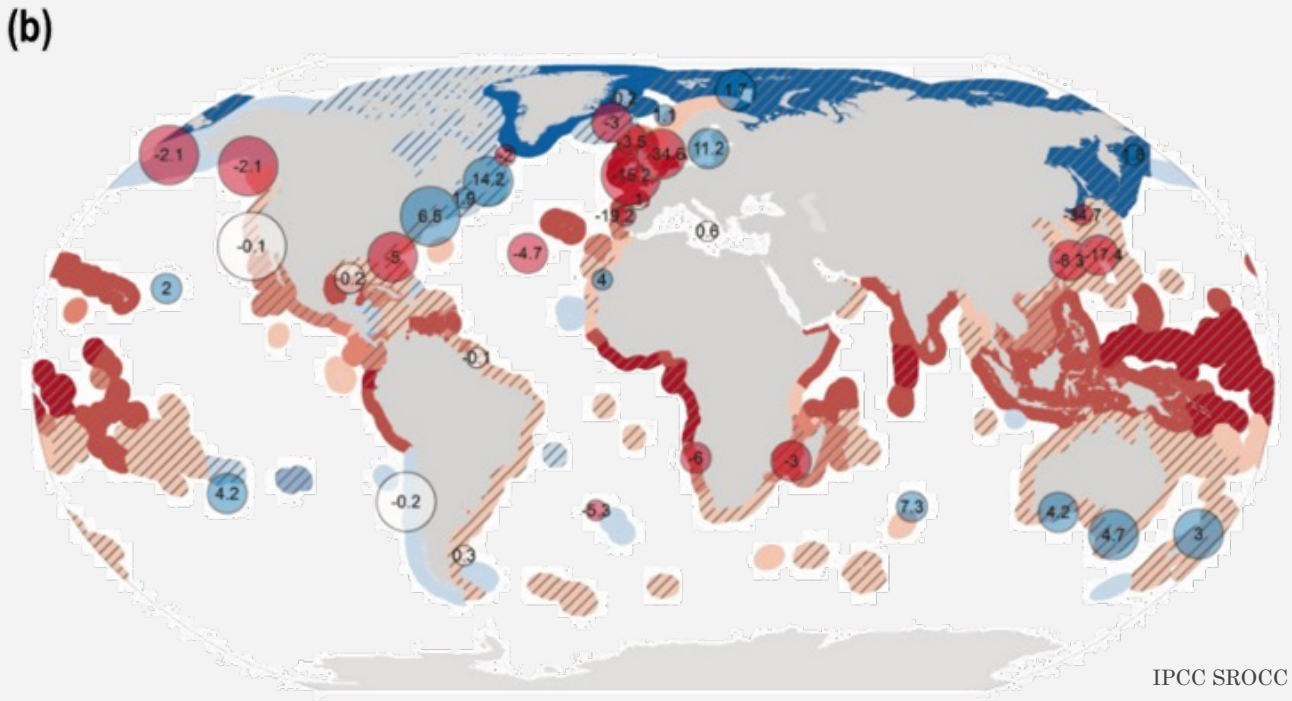


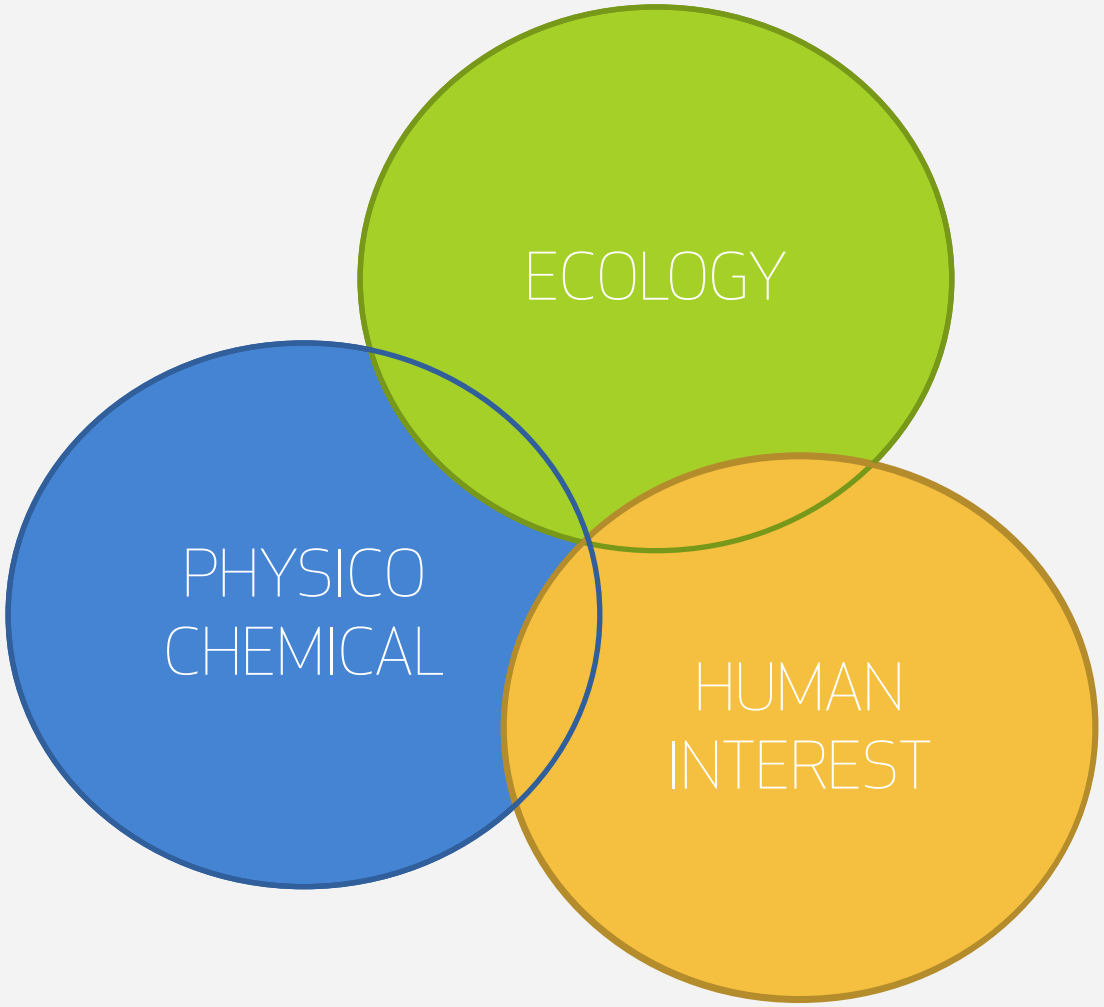


IPCC SROCC

pilot site of Paimpol-Bréhat (France), DCNS and OpenHydro installed in two 16-metres tidal turbines on behalf of EDF

A valuable Environment

- **The 3 aspects of the Environment**



A valuable Environment

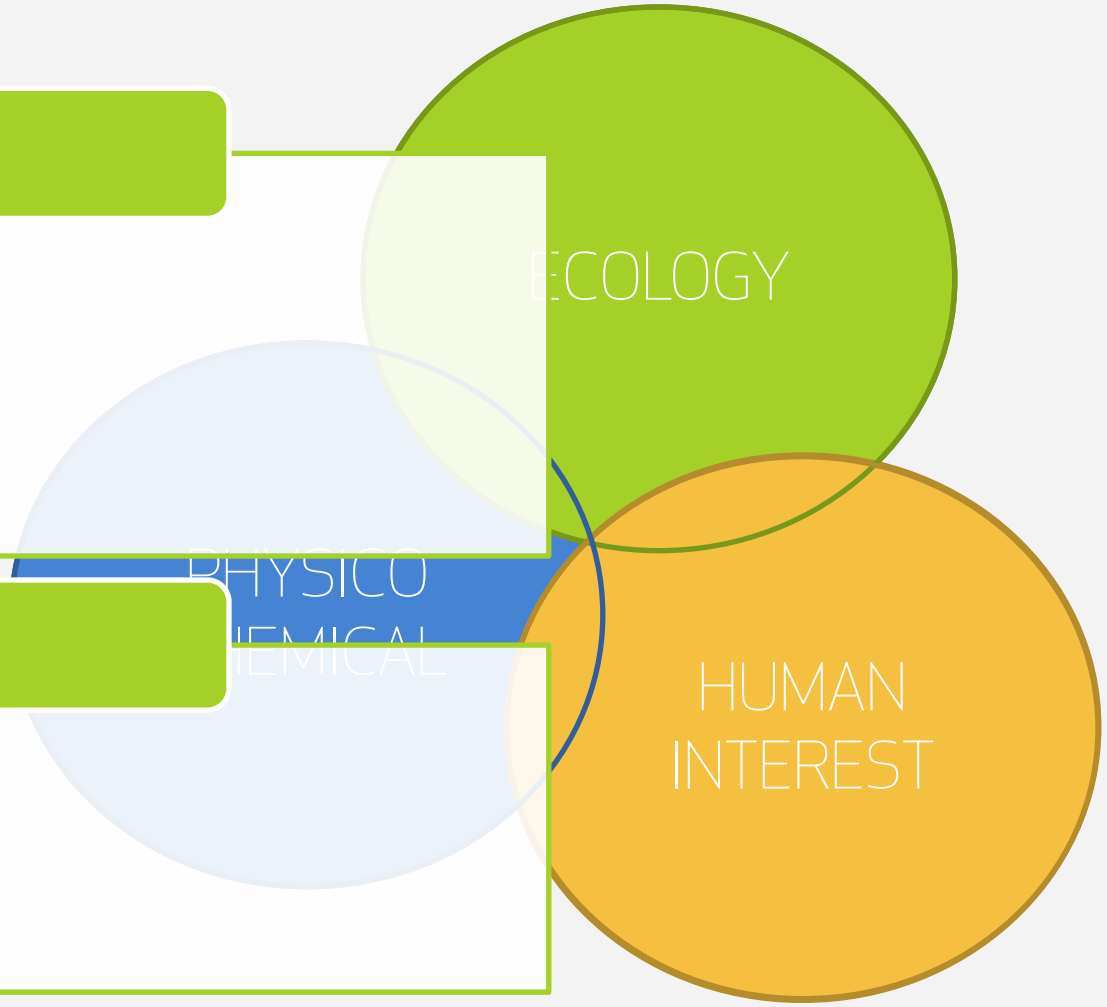
- **The 3 aspects of the Environment**

Aquatic

- Fisheries
- Eutrophication
- Aquatic Weeds
- Species diversity
- Endangered species

Terrestrial

- Forest
- Wildlife
- Species diversity
- Endangered species



A valuable Environment

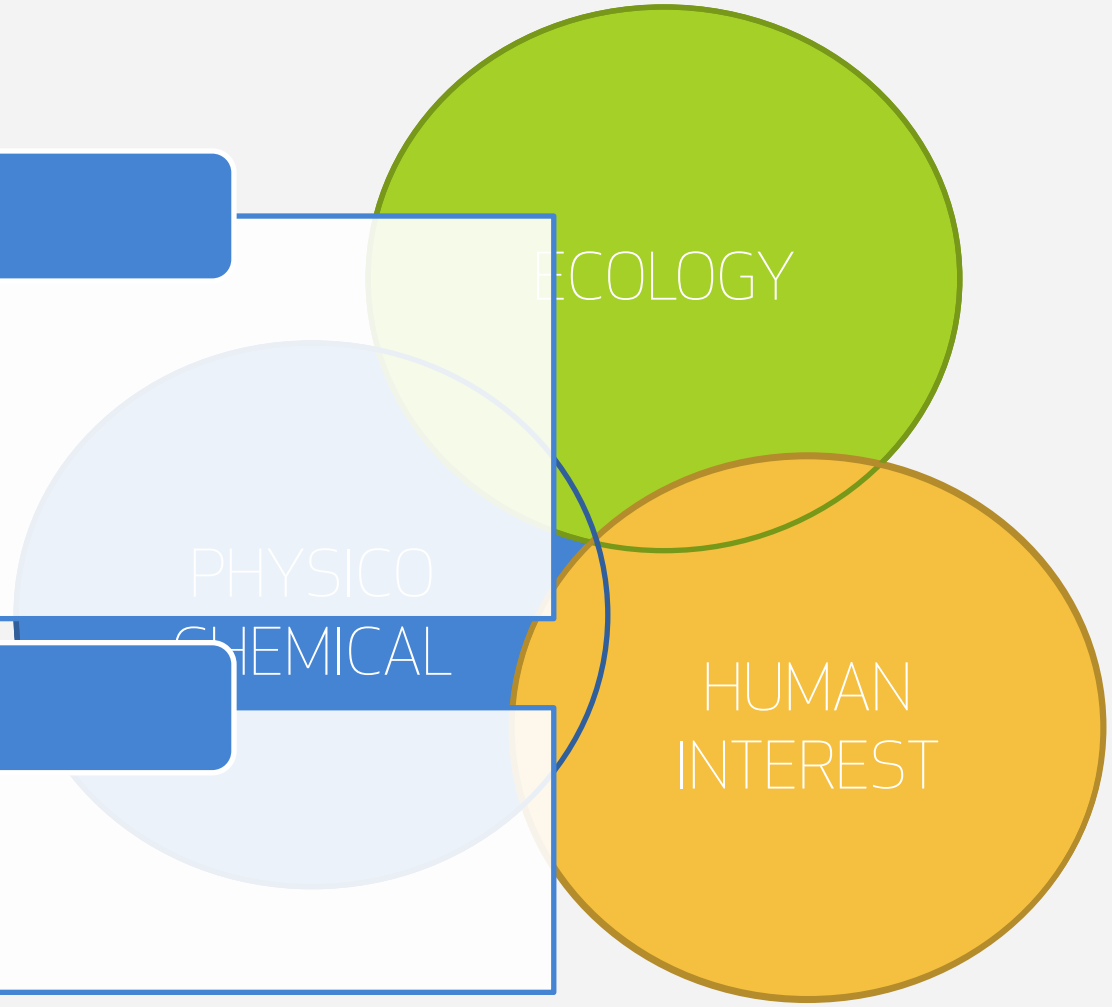
- **The 3 aspects of the Environment**

Land

- Erosion and Siltation
- Backwater Effect
- Bank stability
- Drainage
- Soil characteristics

Surface water

- Regional Hydrology
- Silt Load
- Water Pollution



A valuable Environment

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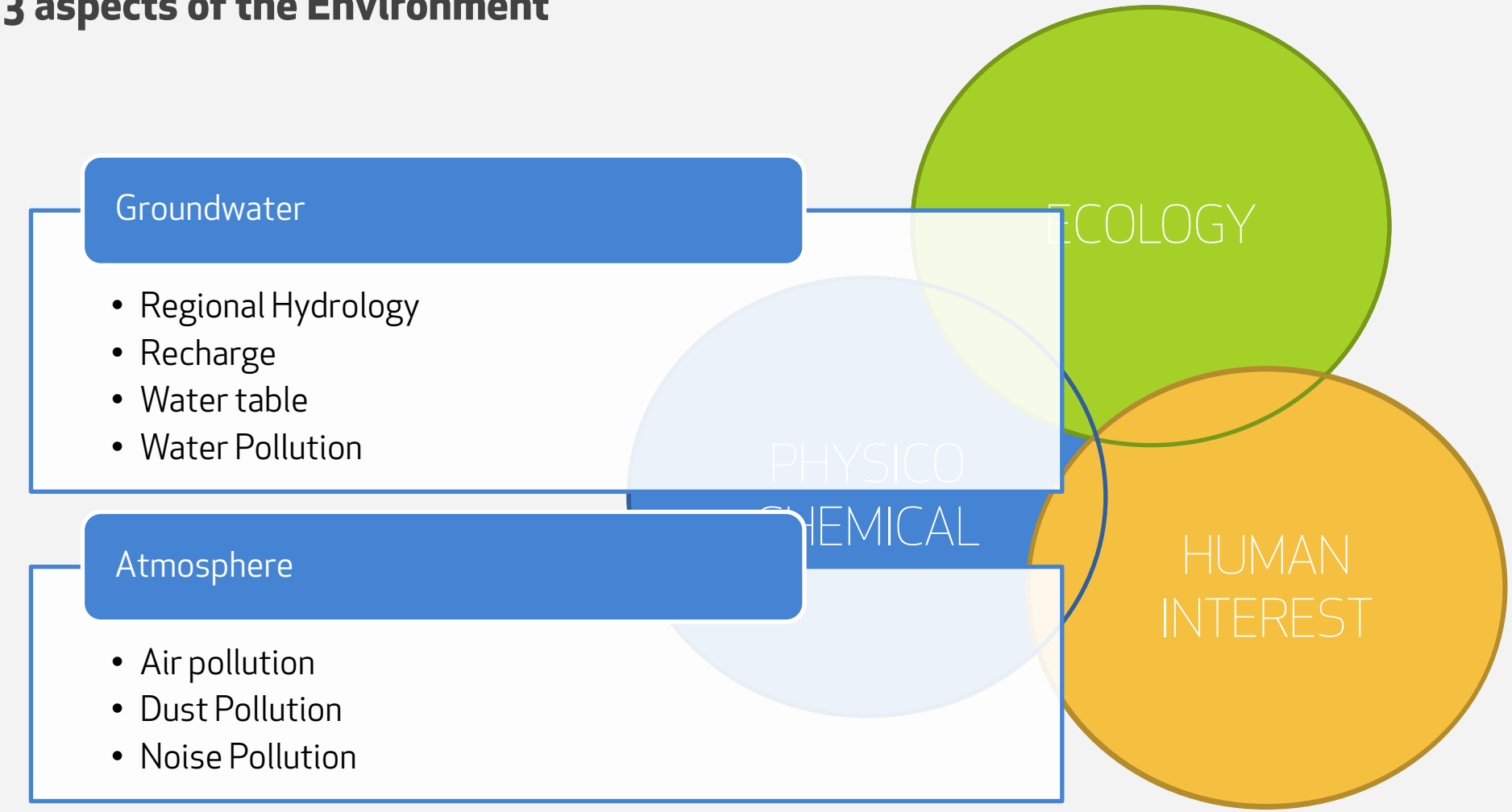


A valuable Environment

- **The 3 aspects of the Environment**

Health

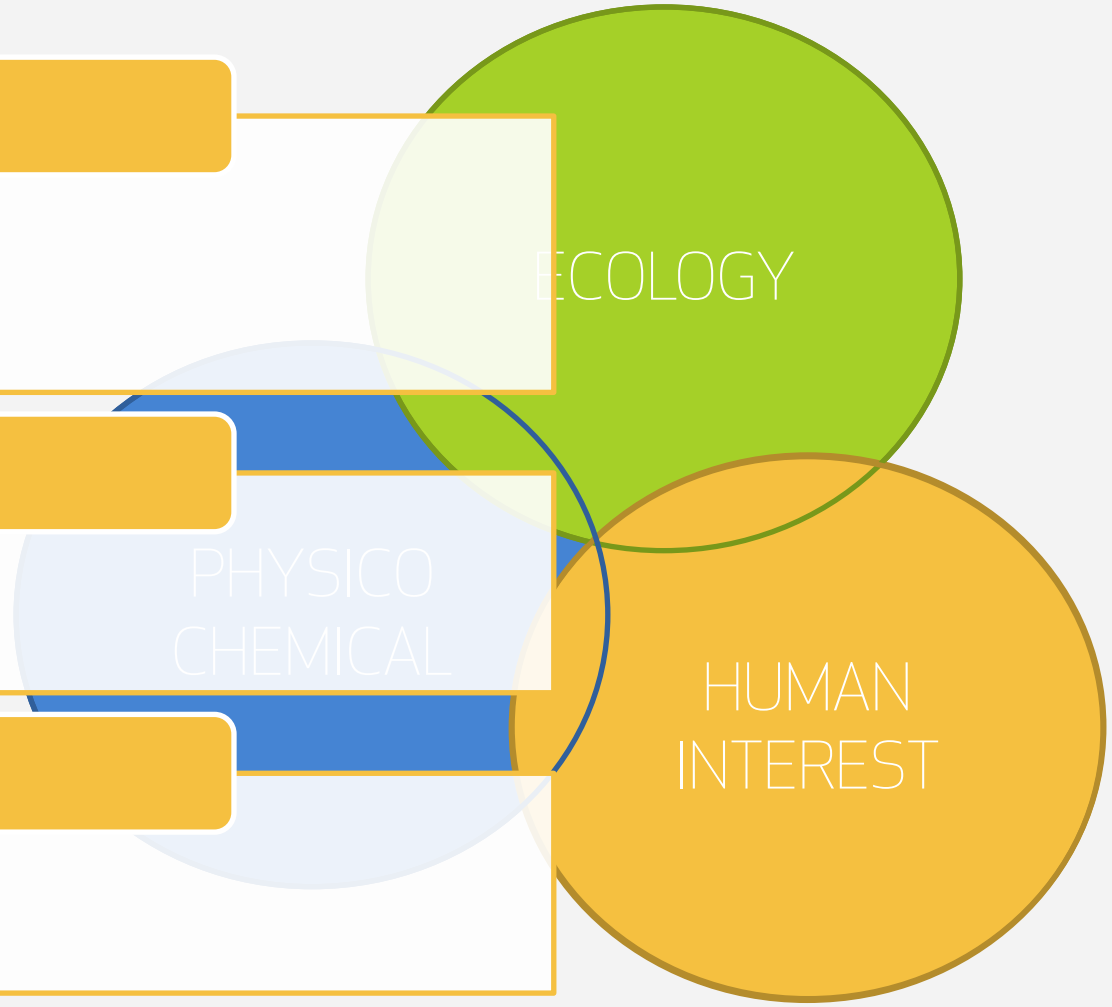
- Diseases
- Sanitation
- Nutrients

Aesthetic

- Landscape
- Recreation

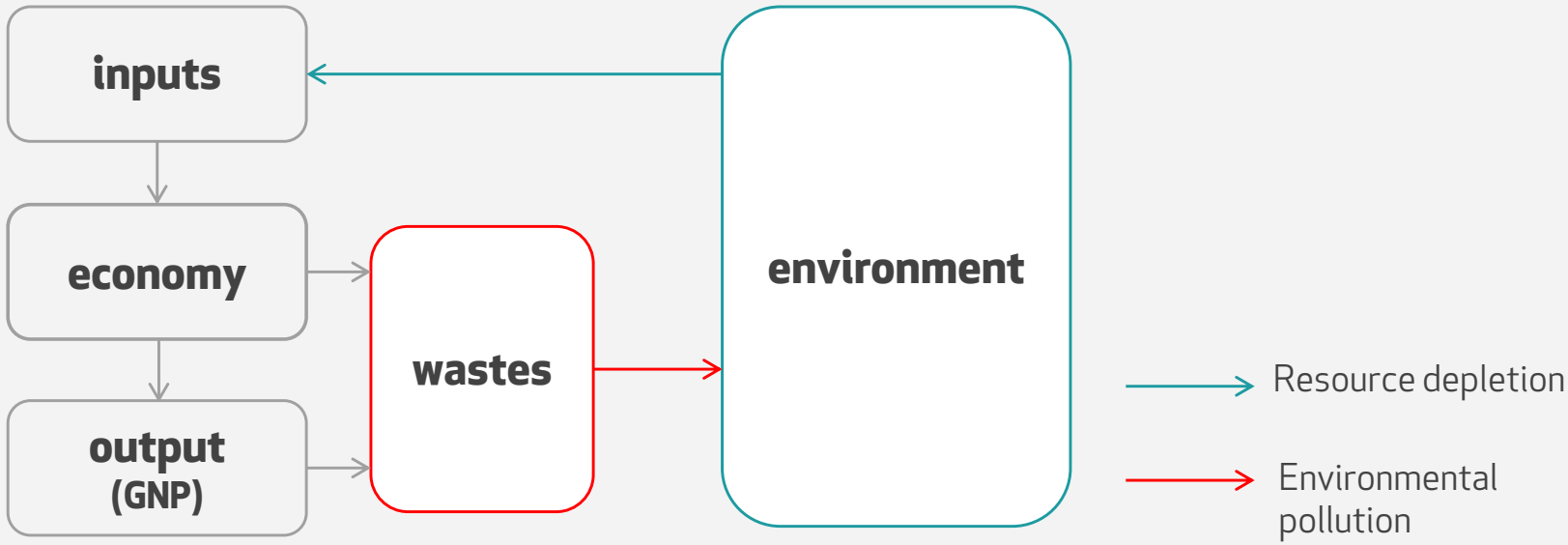
Socio-economics

- Resources, values…
- Employment



A valuable Environment

- **The Environment is a Resource**
  - Economic & Social developments must be placed in their environmental context (Boulding 1966)
    - « Environmental pollution and the depletion of resources are invariably the ancillaries to economic development »



Adapted from Boulding 1966

Pont du Gard, Occitanie, France

Pont de Millau, Occitanie, France

The Old Library at Trinity College, Dublin, Ireland

Chablis, Bourgogne, France

British Columbia, Canada

A valuable Environment

- **The different environmental capitals**

- Man-made capital
  - Road, schools, historic buildings…

- Human capital
  - Knowledge, skills…

- Natural / Environmental capital
  - Clean air, fresh water, rainforests, ozone layer, biological diversity…

Ecosystem Services

2. Monetary Valuation

Monetary valuation

- **Benefits we gain from nature**
  - 4 groups
    - **Supporting services**
    - **Provisioning services**
    - **Regulating services**
    - **Cultural services**
  - Barely impossible to quantify entirely
    - 'The total value of biodiversity is infinite, so having debate about what is the total value of nature is actually pointless because we can't live without it'. (Salles 2011)
    - between US$16–54 trillion per year, with an average of US$33 trillion per year (Constanza et al. 1997, Nature)

Monetary valuation

Monetary valuation

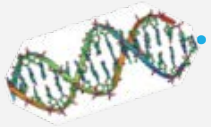
- **Supporting services**
  - necessary for the production of all other ecosystem services
    - Eg: nutrient recycling, primary production and soil formation.
    - Allow ecosystems to provide food supply, flood regulation, water purification…

Monetary valuation

- **Provisioning services**
  - Products directly obtained from ecosystems

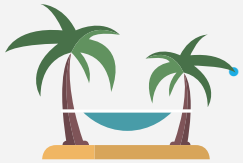
- Food
  - Land and seafood, game, crops, wild foods, and spices

- Raw materials
  - lumber, skins, fuel wood, organic matter, fodder, and fertilizer



- Genetic resources
  - crop improvement genes, health care

- Water



- Minerals
  - Sand, glass…

- Medicinal resources
  - pharmaceuticals, chemical models, test and assay organisms

- Energy
  - hydropower, biomass fuels

Monetary valuation

- **Regulating services**
  - Benefits obtained from the regulation of ecosystem processes

- Carbon sequestration and climate regulation

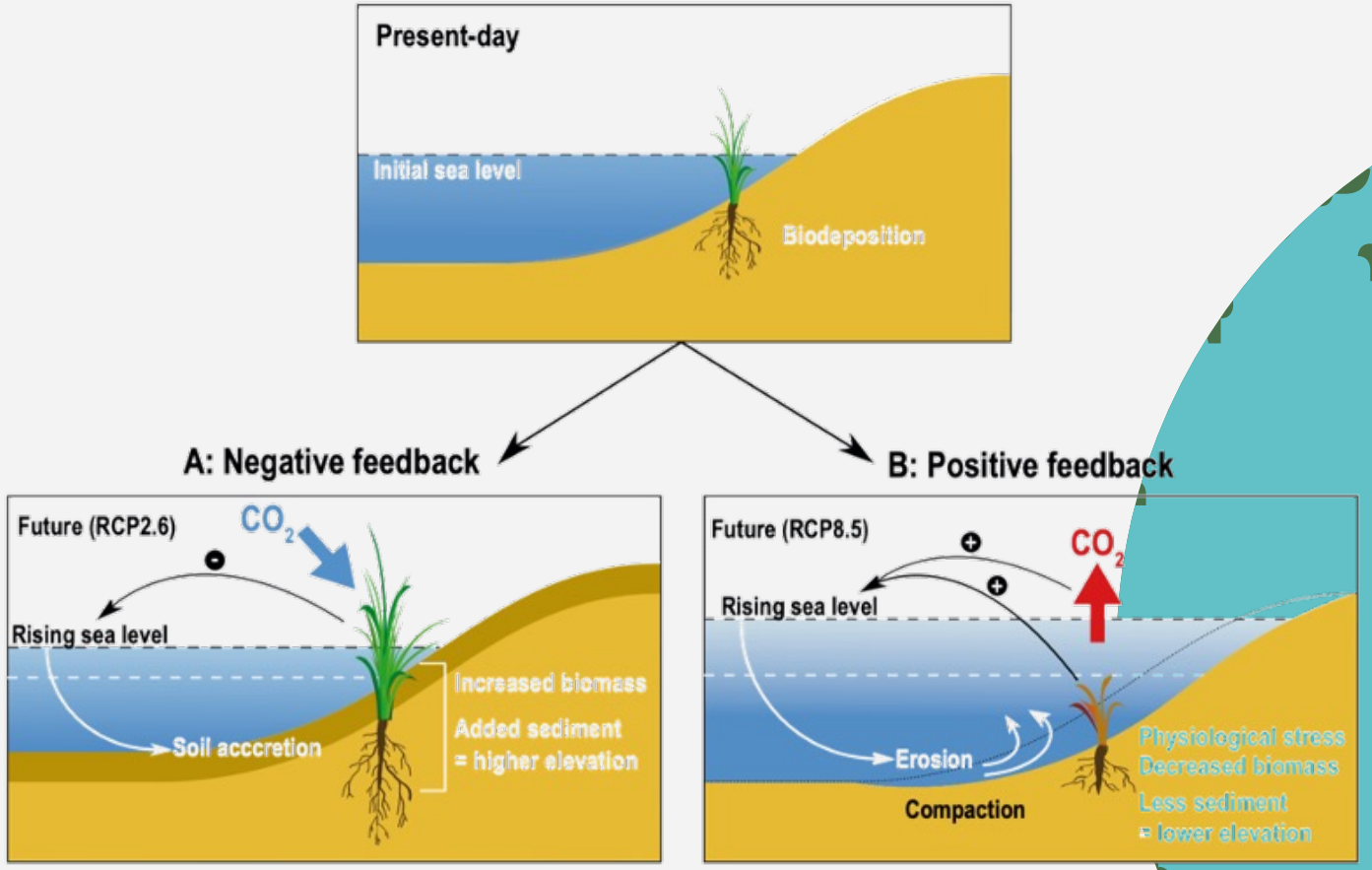
- Waste decomposition and detoxification

- Purification of water and air

- Pest and disease control

Monetary valuation

- **Regulating services**



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Monetary valuation

- **Cultural services**
  - Nonmaterial benefits through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences

  - cultural
    - use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.

  - spiritual and historical
    - use of nature for religious or heritage value or natural

  - recreational experiences
    - ecotourism, outdoor sports, and recreation

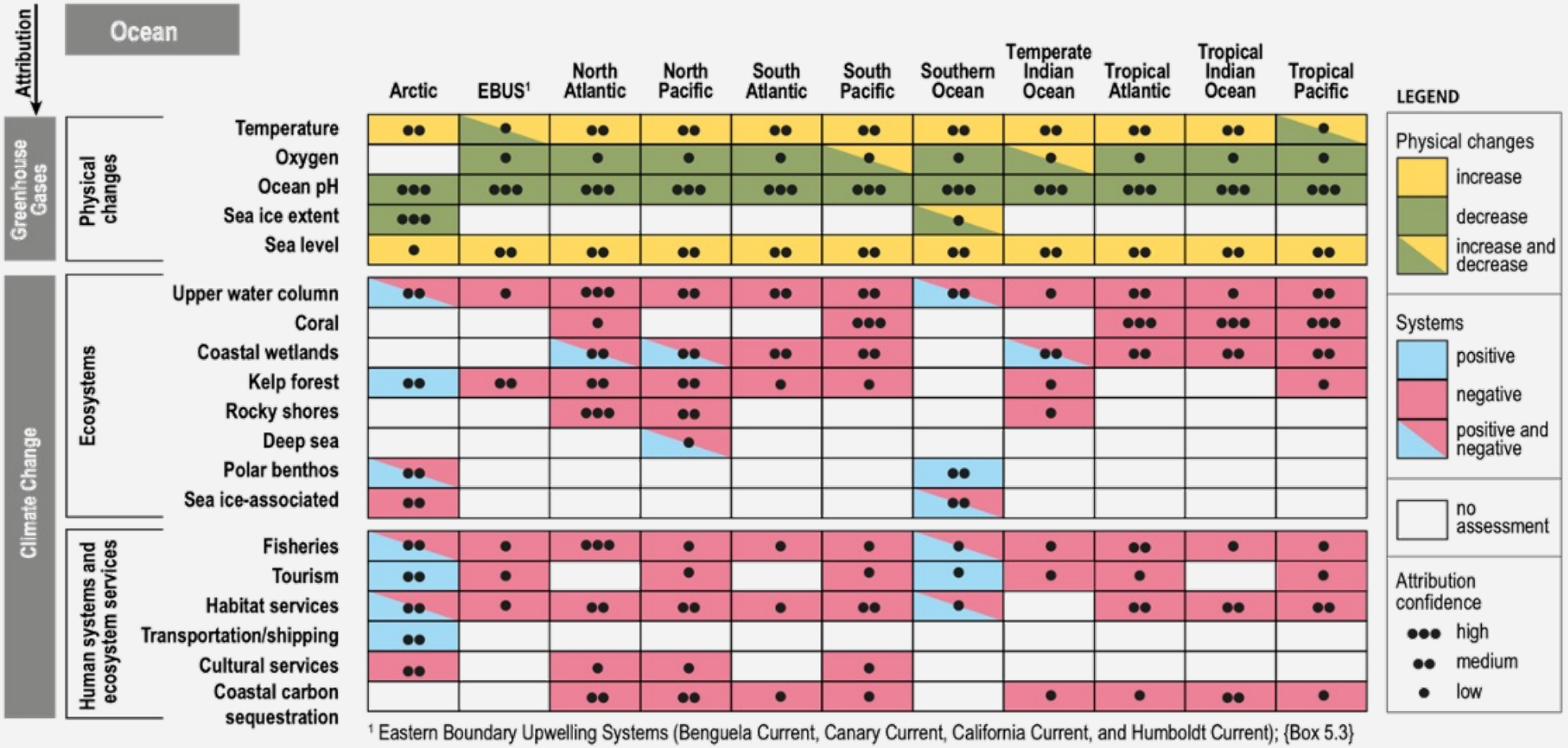
  - science and education
    - use of natural systems for school excursions, and scientific discovery

Monetary valuation

Dimensions	Sections under 5.4.2
Human and environmental health	Water-borne diseases (5.4.2.1.1) Harmful algal blooms (HABs) (Box 5.4) Interactions with contaminants (5.4.2.1.2) Food security (5.4.2.1.3)
Culture and other social dimensions	Cultural and aesthetic values (5.4.2.2.1) Potential conflicts in resource utilisation (5.4.2.2.2)
Monetary and material wealth	Fisheries (5.4.2.3.1) Coastal and marine tourism (5.4.2.3.2) Property values and coastal infrastructure (5.4.2.3.3)

IPCC SROCC

Monetary valuation



[1] Eastern Boundary Upwelling Systems (Benguela Current, Canary Current, California Current, and Humboldt Current); {Box 5.3}

Monetary valuation

- **Points of view**
  - Avoided cost
    - avoid costs that would have been incurred in the absence of those services
  - Replacement cost
    - could be replaced with man-made systems
  - Factor income
    - enhancement of incomes
  - Travel cost
    - may require travel, whose costs can reflect the implied value of the service

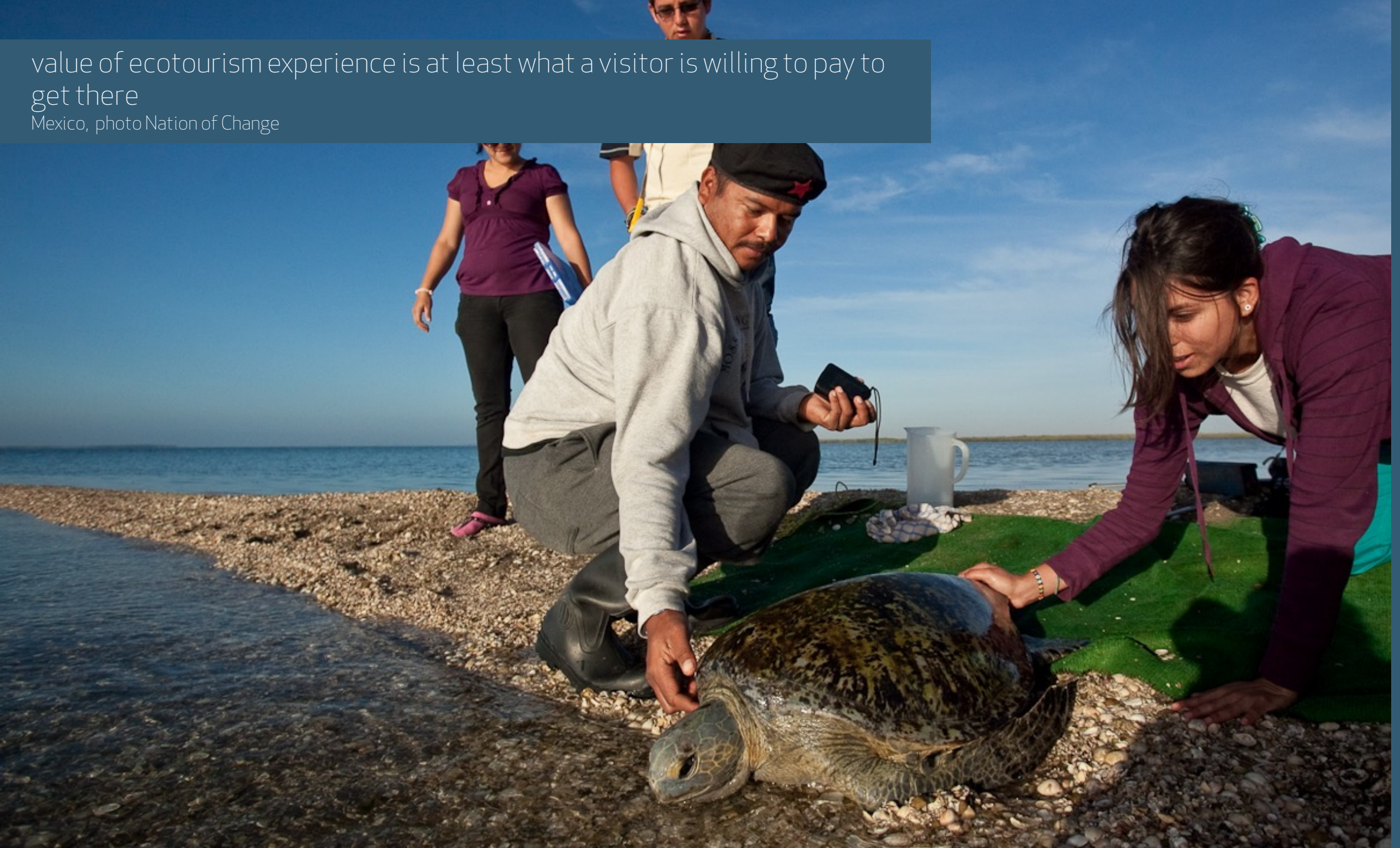
Waste treatment by wetland habitats avoids health costs

Constructed floating treatment wetland (BioHaven®), Florida

restoration of the Catskill Watershed
cost less than the construction of a water purification plant
NY state, USA

improved water quality increases the commercial take of a fishery and improves the income of fishers

Bengladesh, photo WorldFish Center



value of ecotourism experience is at least what a visitor is willing to pay to get there

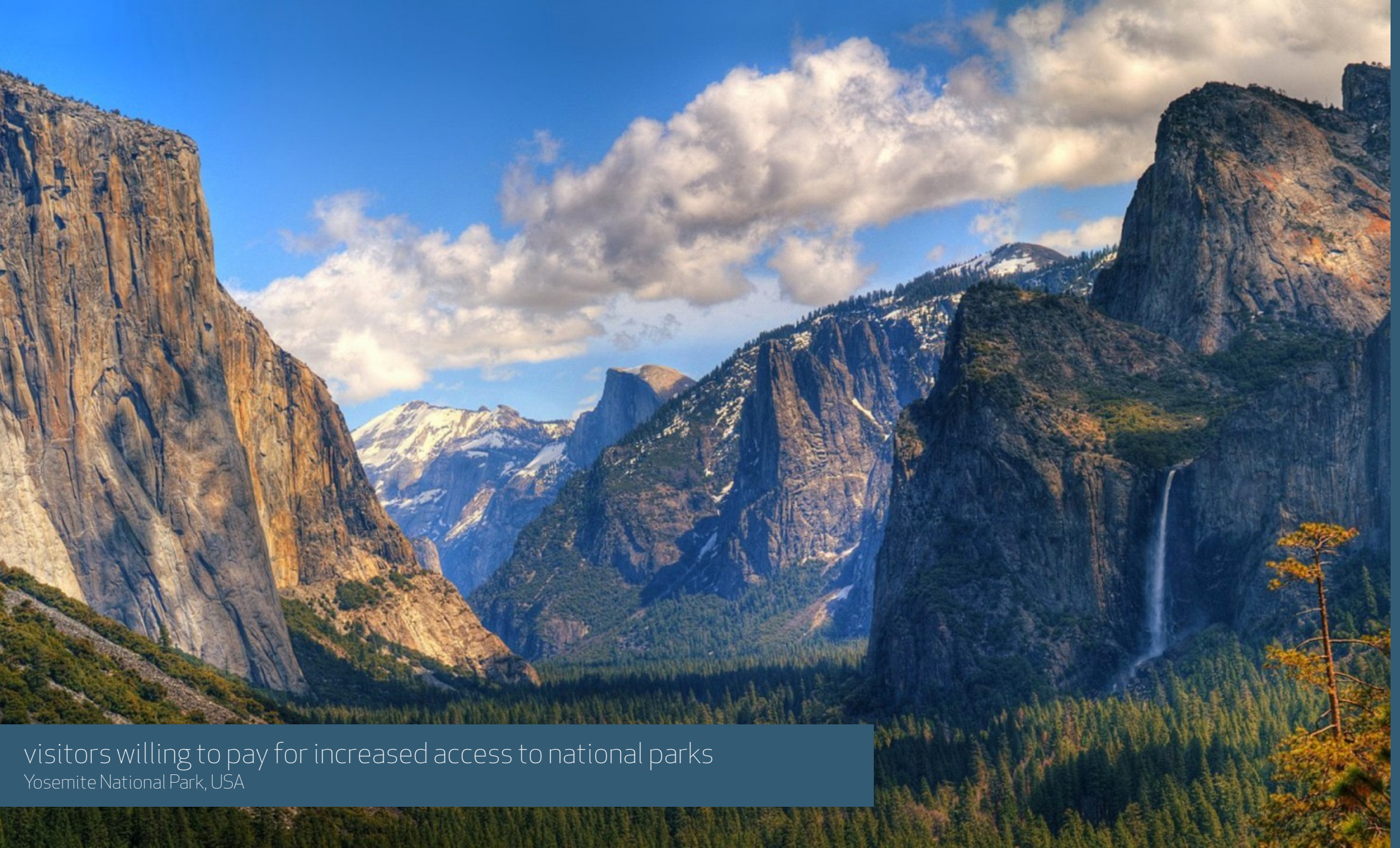
Mexico, photo Nation of Change

Monetary valuation

- **Points of view (2)**
  - Hedonic pricing
    - may be reflected in the prices people will pay for associated goods
  - Contingent valuation
    - may be elicited by posing hypothetical scenarios that involve some valuation of alternatives

coastal housing prices exceed that of inland homes

Saint Jean Cap Ferrat, France



visitors willing to pay for increased access to national parks

Yosemite National Park, USA

Ecosystem Services

3. The coral reef case study

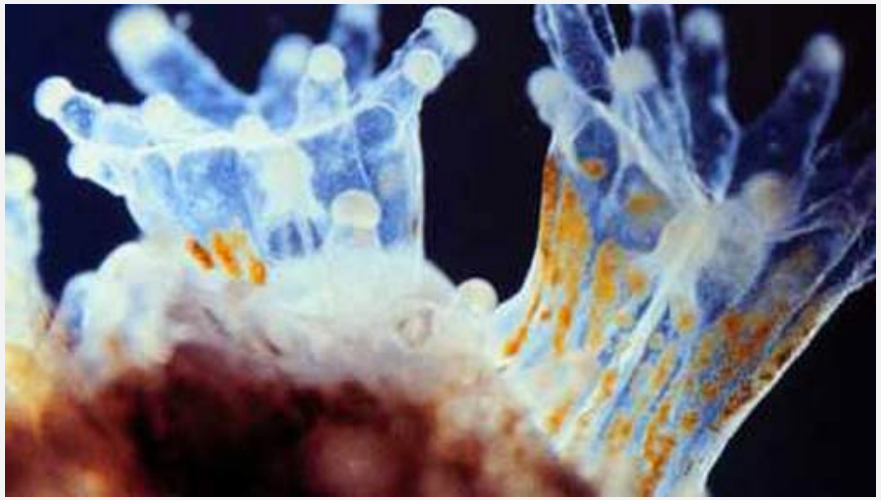
The Coral Reef case study

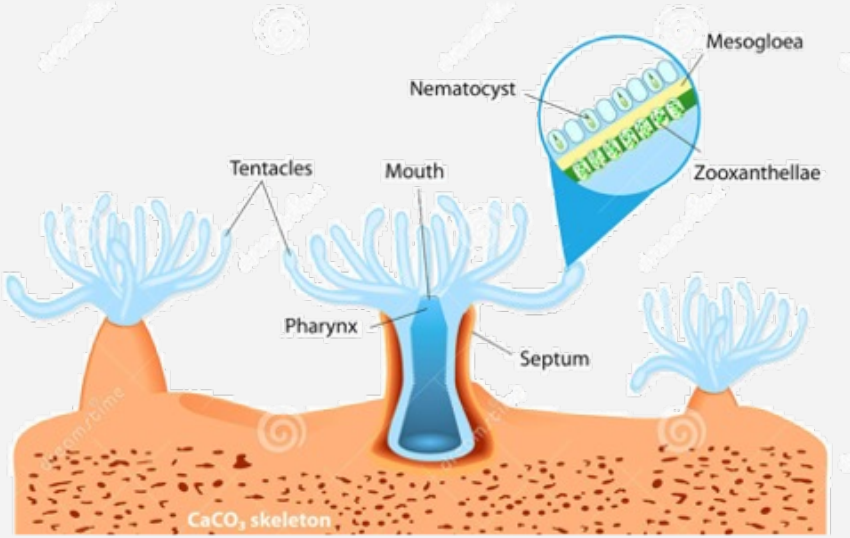
The Coral Reef case study

- **What is Coral?**
  - It's a **living organism**
  - It is an **animal** (invertebrate)
  - 2 different types:
    - Colonial / Reef Building
    - Solitary
  - Cnidarians
    - Coral is cousin to jellyfish and anemones
    - Carnivorous (theoretically)

The Coral Reef case study

- **What is Coral?**
  - Symbiotic association with microalgae
  - Coral provides protection
  - Algae provides food and color





The Coral Reef case study

- **What is Coral?**
  - Require very specific habitats
    - Temperature — relatively warm
    - Salinity — normal levels *(35ppt)*
    - Depth — less than 100-150m *(around 30 feet)*
      - *Light* Algae need light to survive
    - Waves — they like big waves!
      - remove silts + brings more oxygen

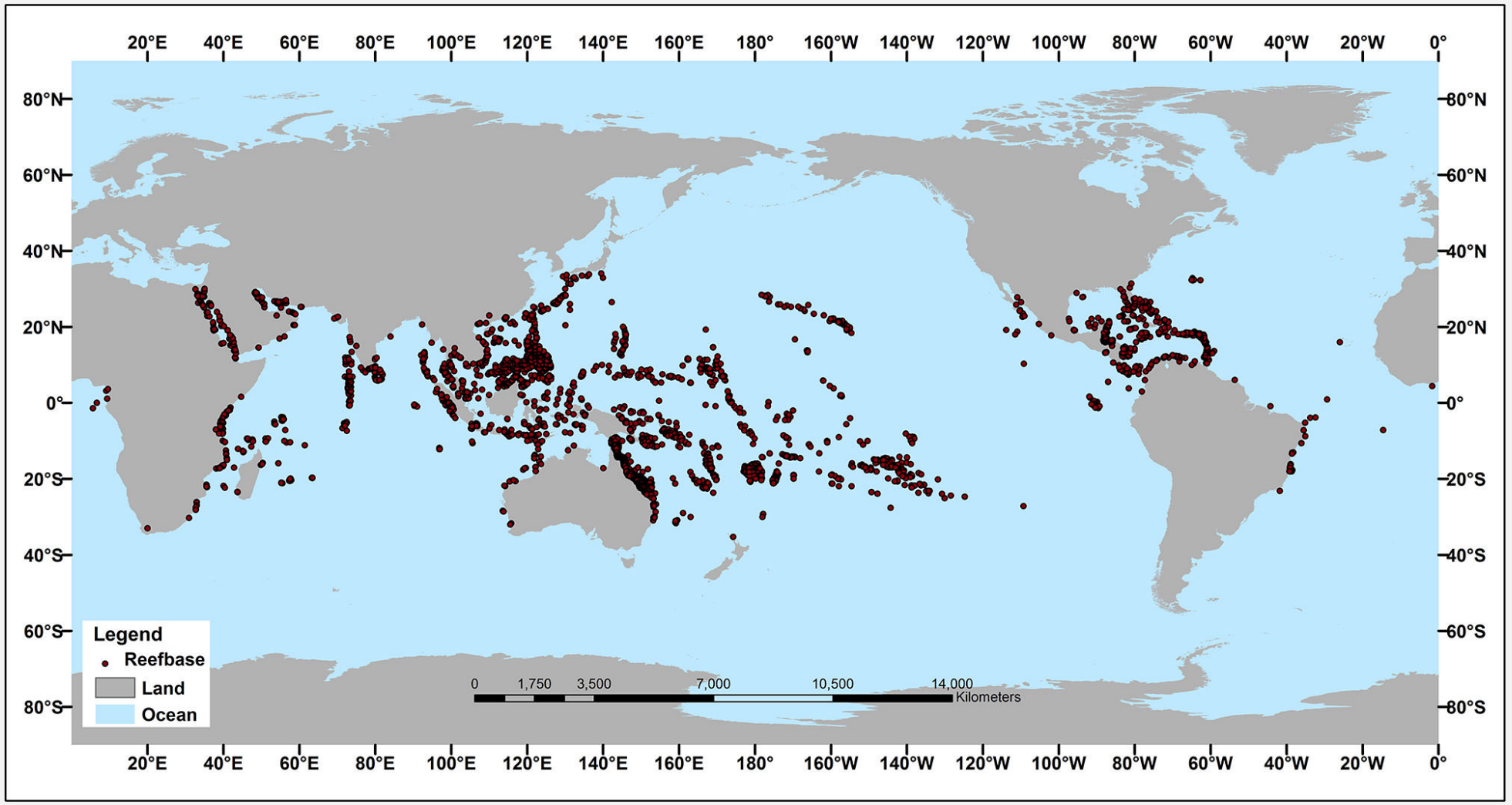
The Coral Reef case study

- **What is Coral?**
  - Two ways to reproduce
    - Asexual
      - also called "budding" *(bourgeonnement)*
      - growing off the adult
      - detach and live on its own
      - Cannot start new colonies, only helps old colonies to grow bigger

The Coral Reef case study

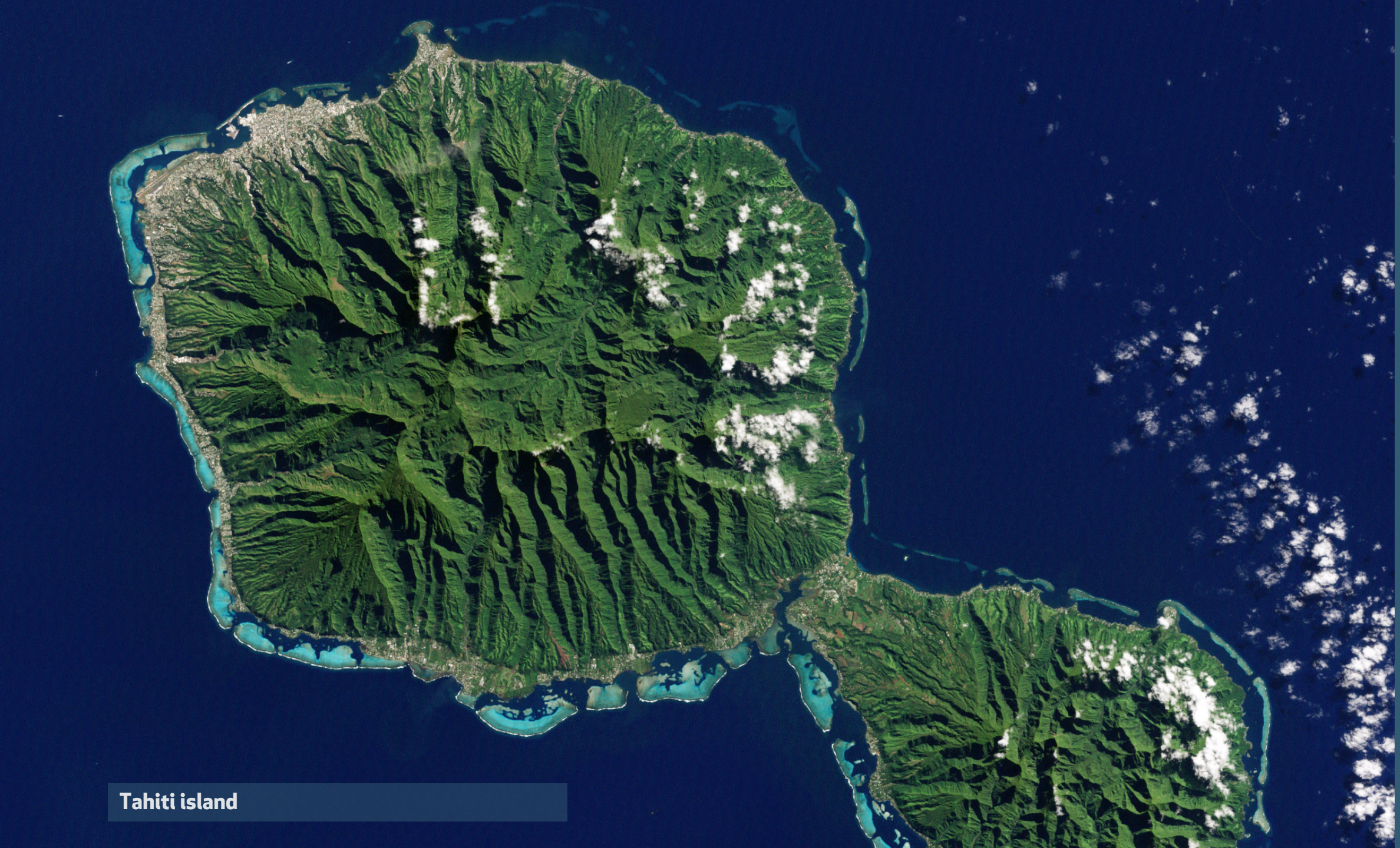
- **What is Coral?**
  - Two ways to reproduce
    - Sexual
      - Sperm and eggs released into the water
      - Fertilized egg becomes a larvae
      - Larvae swims until it finds a good place to live

The Coral Reef case study



The Coral Reef case study

- **How do corals build reefs?**
  - The animal portion of the reef is called a **polyp**
  - The polyp absorbs **calcium carbonate** out of the water
  - The calcium carbonate (limestone *calcaire*) is used to build the reef



Tahiti island

Maupiti island

Mataiava atoll

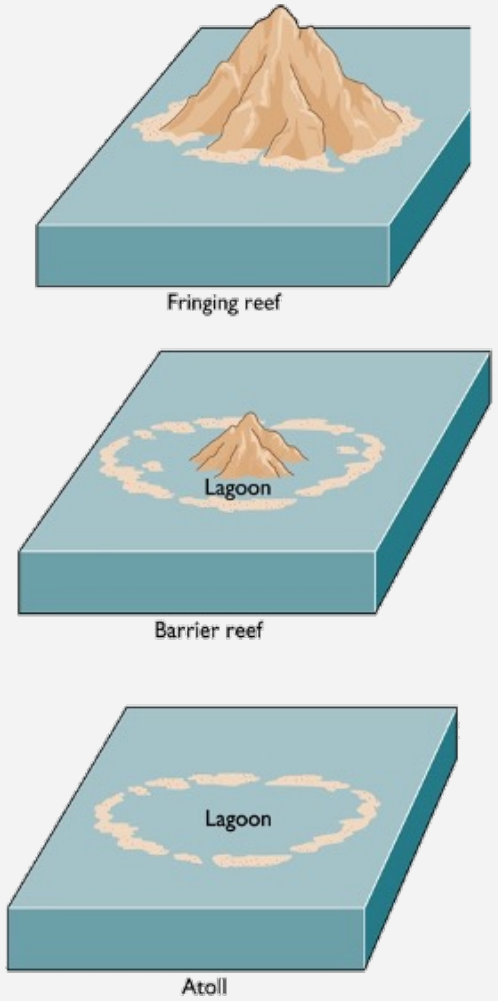
The Coral Reef case study

- **Corals can build three types of reefs**
  - Fringing

    grows close to **shore**
  - Barrier

    also grows close to shore but has a **lagoon** separating it from the shore
  - Atoll

    a ring of coral that surrounds a lagoon, often grows on a **submerged** mountain or volcano



The Coral Reef case study

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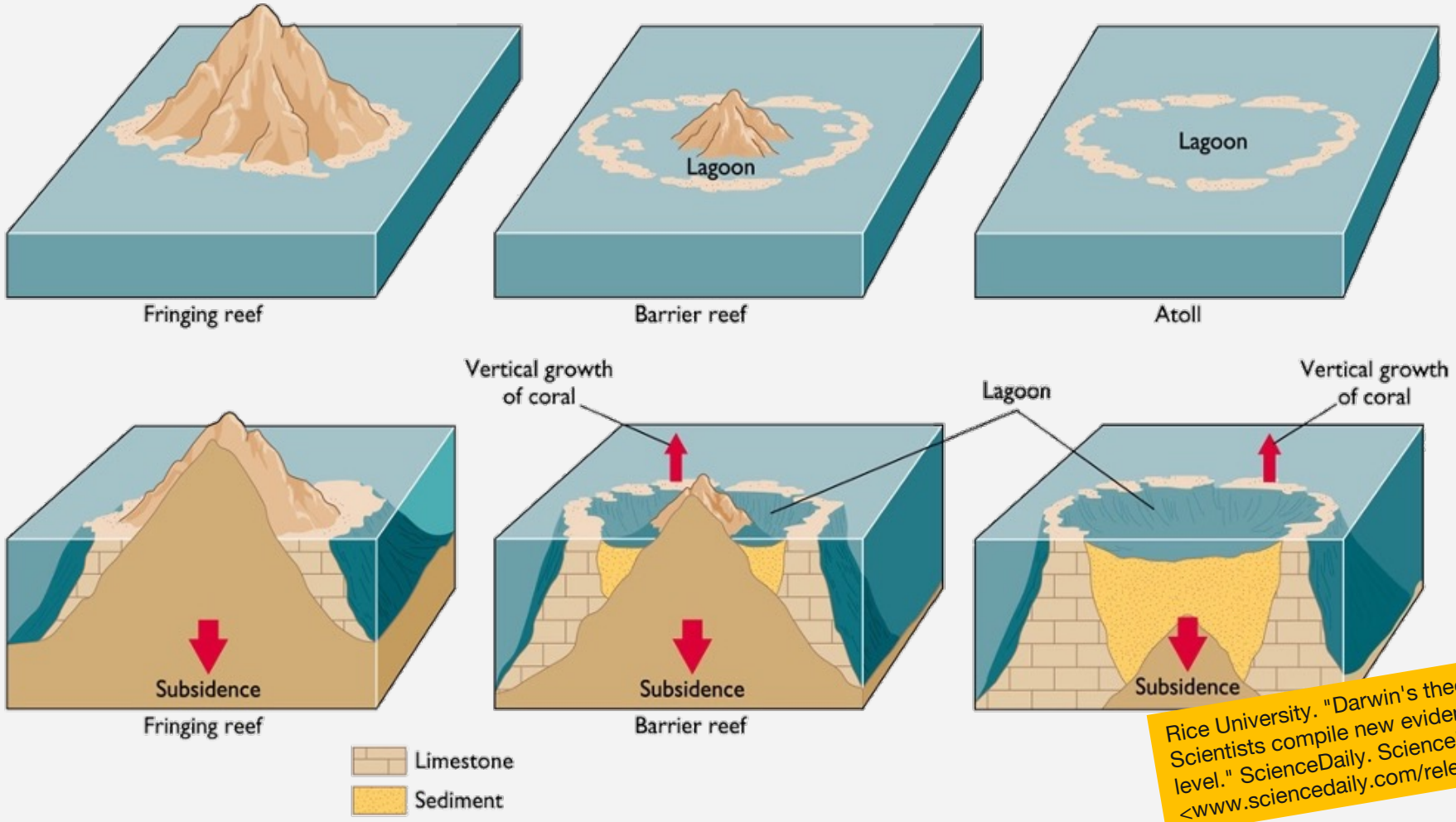
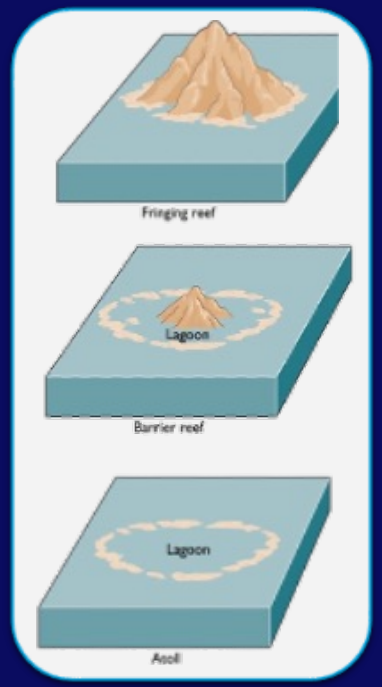
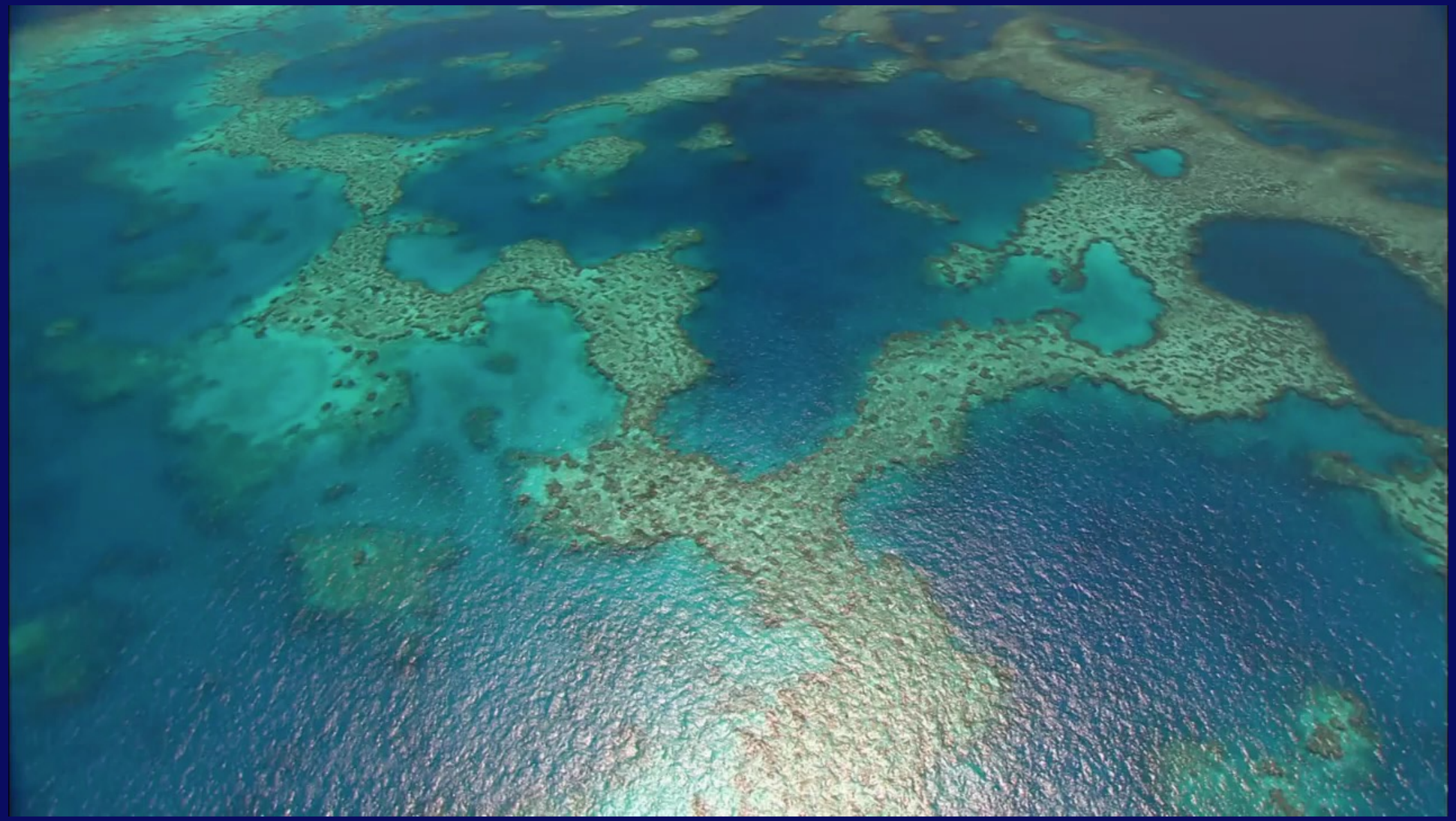


REALLY??

Rice University. "Darwin's theory about coral reef atolls is fatally flawed: Scientists compile new evidence that atolls are formed by cyclic changes in sea level." ScienceDaily. ScienceDaily, 13 October 2020. <www.sciencedaily.com/releases/2020/10/201013105811.htm>.



Tahaa, Raiatea & Bora Bora islands



The Coral Reef case study

500 000 000+ people rely on coral reefs for food, coastal protection, and livelihoods

Wilkinson, C. (ed.) 2004. Status of Coral Reefs of the World: 2004. Volume 1. Australian Institute of Marine Science. Townsville, Queensland, Australia. 301 p.

More than **150,000** km of shoreline in **100** countries and territories receive some protection from

Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011. Reefs at Risk Revisited. Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network,

850 000 000 people live within 100 km of coral reefs.

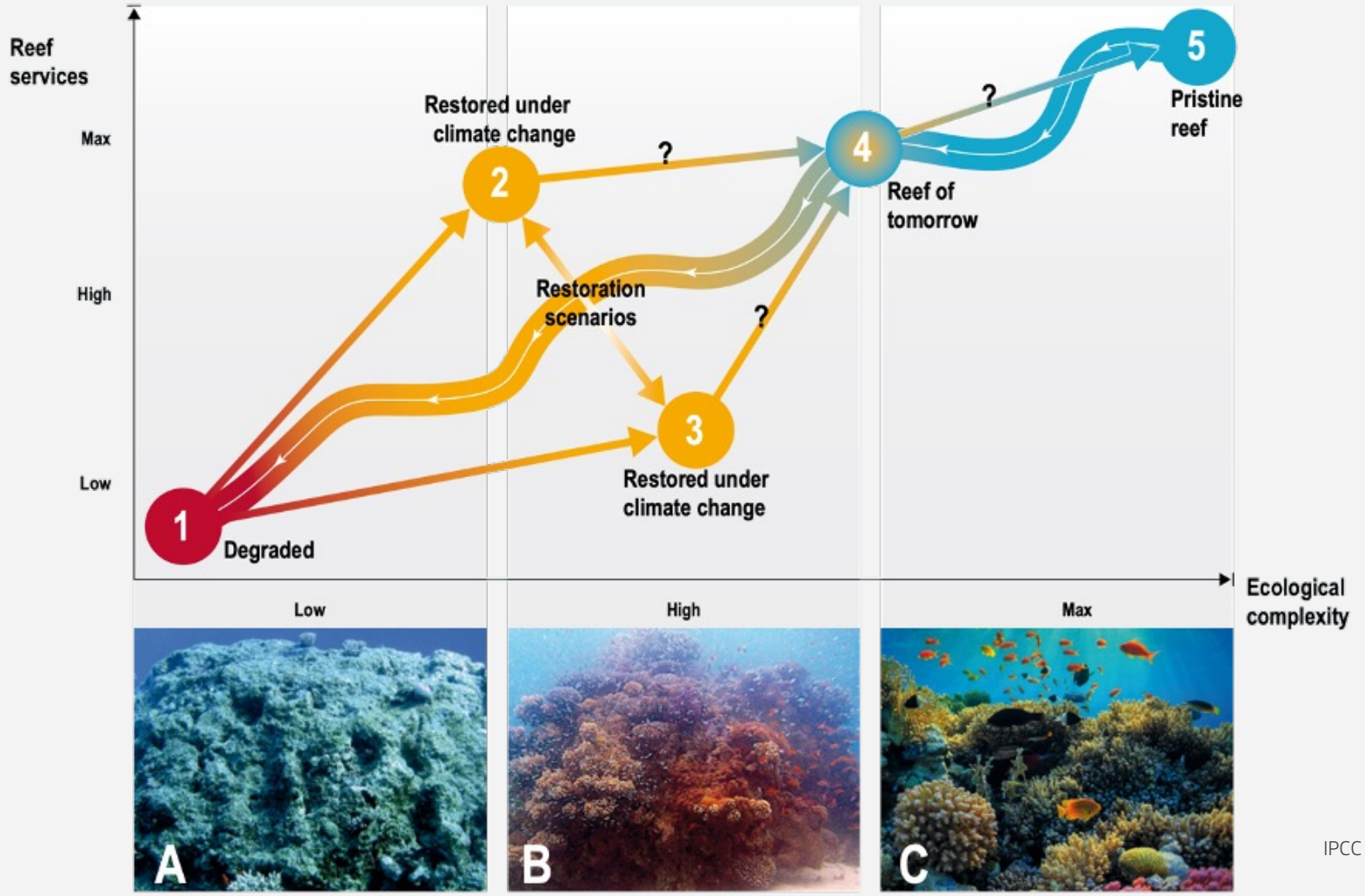
Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011. Reefs at Risk Revisited. Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, WorldFish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network, 114p.

In developing countries, coral reefs contribute about **1/4** of the total fish catch,

providing food to an estimated **1 000 000 000** people in Asia alone

Moore, F. and B. Best. 2001. Coral Reef Crisis: Causes and Consequences. In: Papers Presented at a Symposium held at the 2001 Annual Meeting of the American Association for the Advancement of Science.

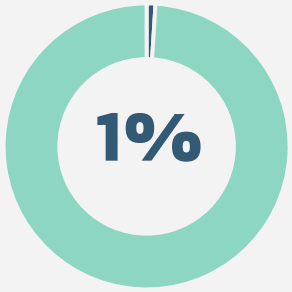
The Coral Reef case study



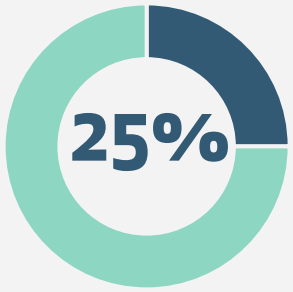
IPCC SROCC

The Coral Reef case study

- **Biodiversity hotspot**



of the ocean is covered by coral reefs



of all marine fish species live in coral reefs

Burke, L., D. Bryant, J. McManus, and M. Spalding. 2008 Reefs at Risk. World Resources Institute (WRI):

The Coral Reef case study

- **Protection to coastline**

- **absorb energy of ocean waves**
- **reduce erosion of shoreline**
- **reduce storm damage**
- **reduce flooding**

The Coral Reef case study

- **Fisheries**

- **Food**
  Industrial, artisanal, subsistence
- **Ornamental**
- **Game**

The Coral Reef case study

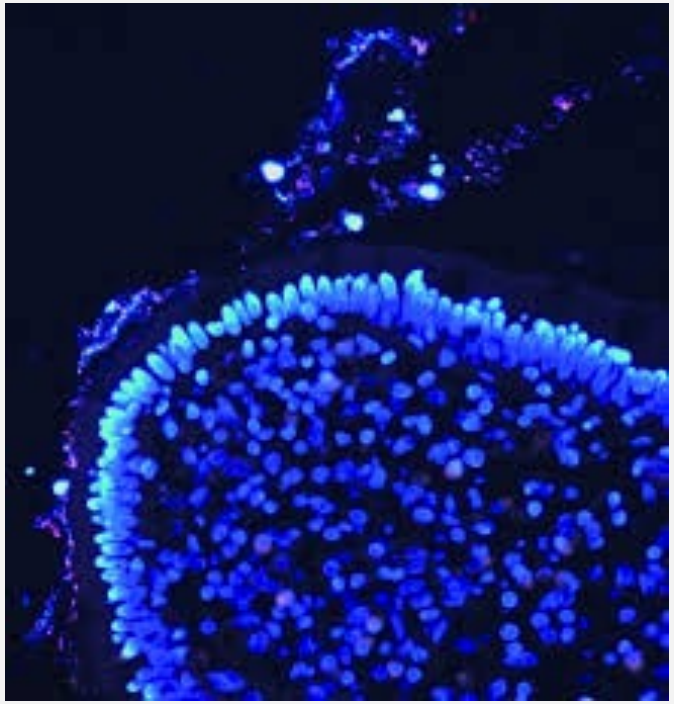
- **Tourism & Recreation**

- **Cultural service**
- **Millions of divers and tourists per year**

The Coral Reef case study

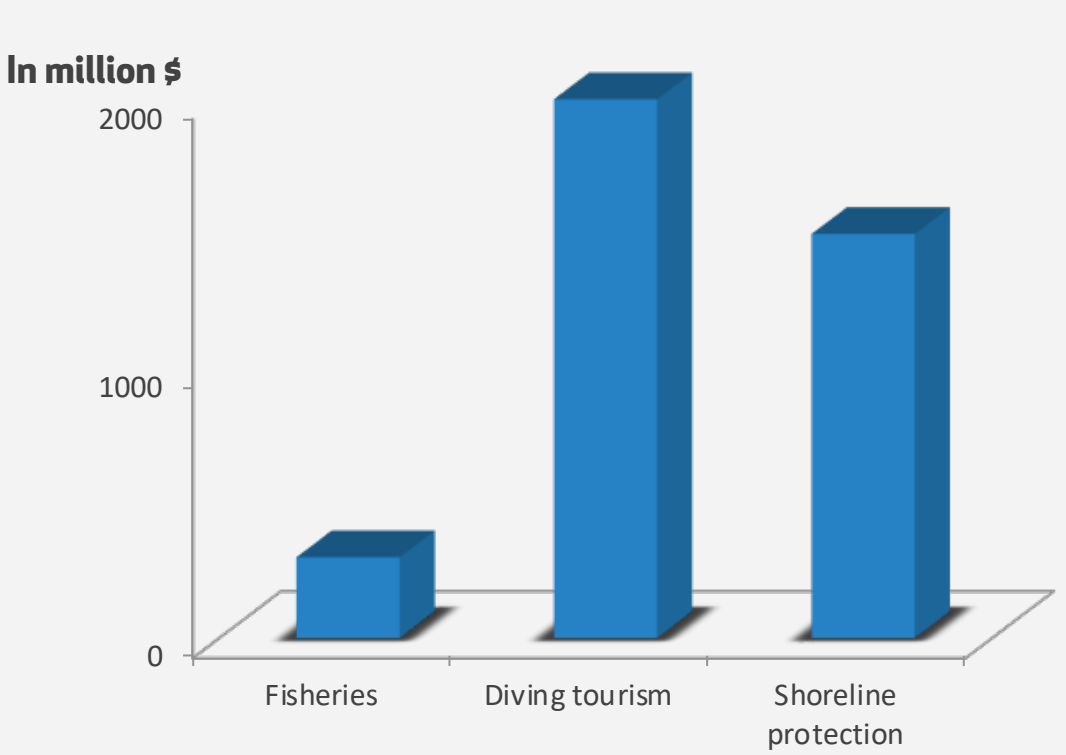
- **Biotechnology**

- **Bioprospecting**
- **Coral reef is the medicine cabinet of the 21th century**



The Coral Reef case study

- **Economic resource**

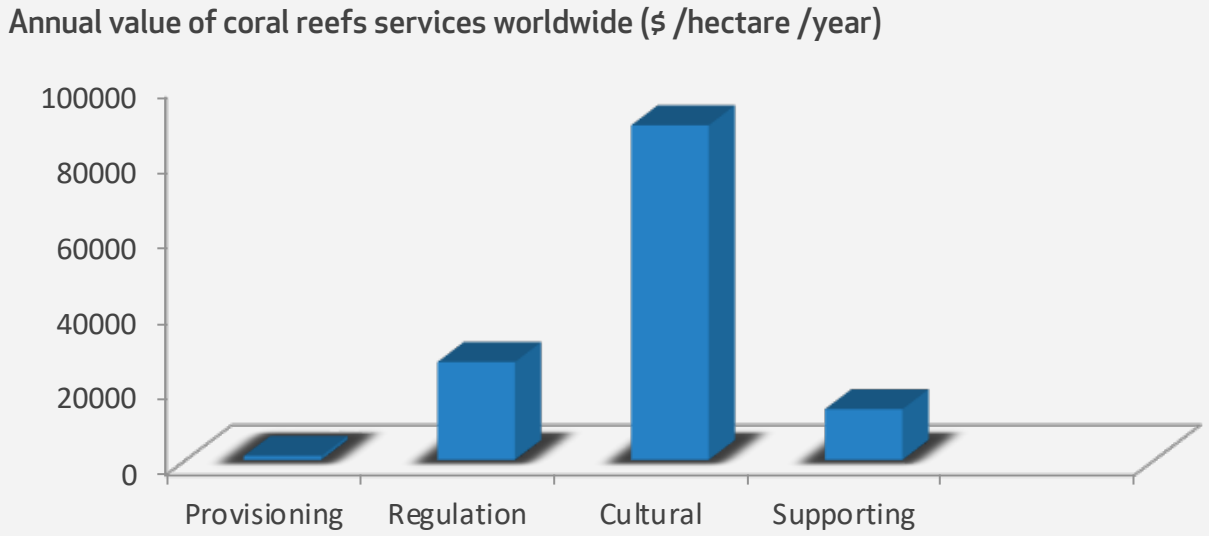


The Coral Reef case study

- **Economic resource**

$ 130,000 per hectare average worldwide (up to $ 1.2 million)

Conservation International. 2008. Economic Values of Coral Reefs, Mangroves, and Seagrasses: A Global Compilation. Center for Applied Biodiversity Science, Conservation International, Arlington, VA, USA



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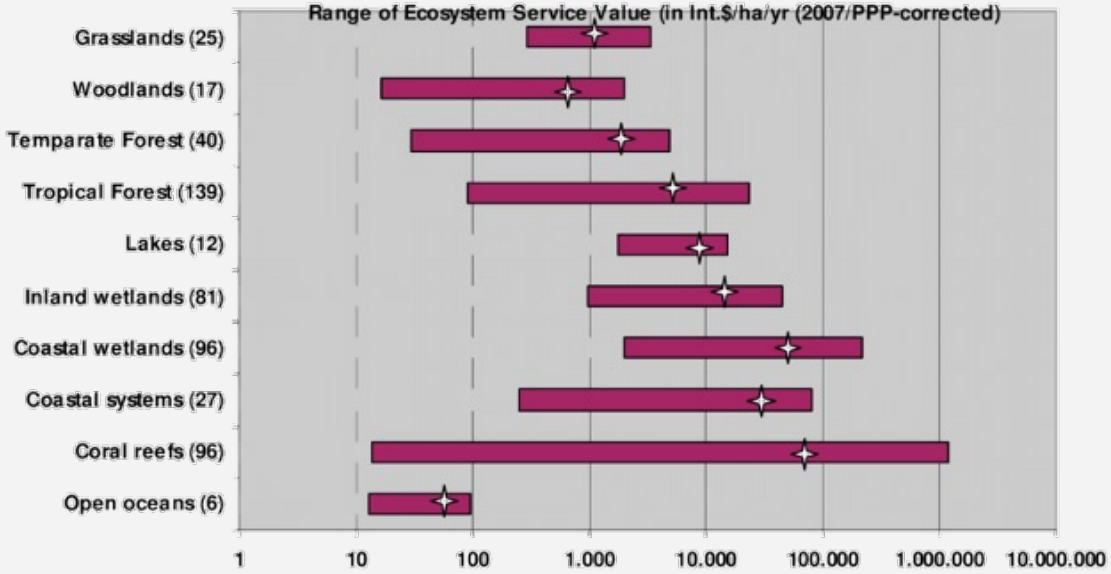
$ 130,000 per hectare average worldwide (up to $ 1.2 million)

Conservation International. 2008. Economic Values of Coral Reefs, Mangroves, and Seagrasses: A Global Compilation. Center for Applied Biodiversity Science, Conservation International, Arlington, VA, USA



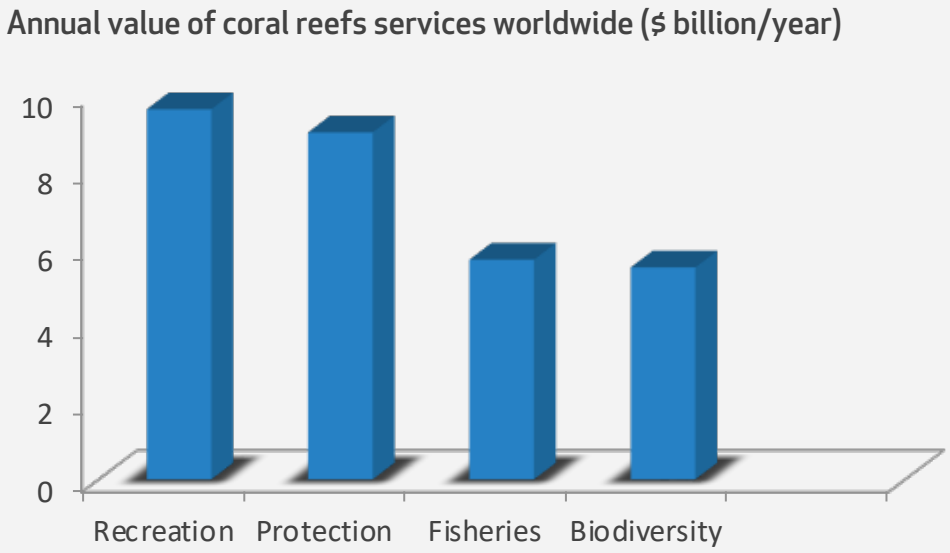
From Ploeg, Sander & Groot, Dolf & Wang, Yafei. (2010). The TEEB Valuation Database: overview of structure, data and results.

The Coral Reef case study

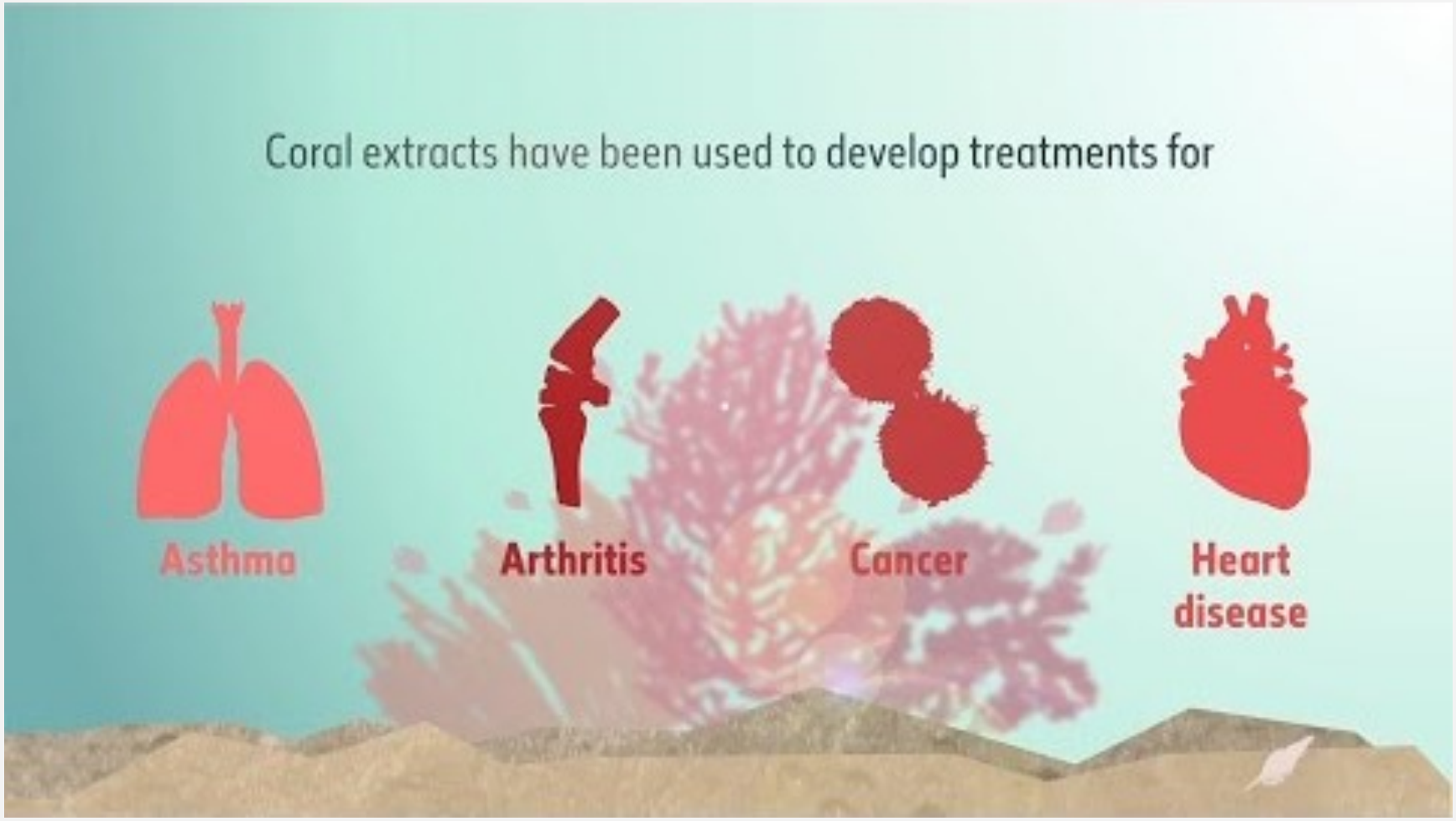
- **Economic resource**

$30 billion per year net benefice worldwide

Diversitas. "What Are Coral Reef Services Worth? $130,000 To $1.2 Million Per Hectare, Per Year." ScienceDaily. ScienceDaily, 28 October 2009



The Coral Reef case study



The Coral Reef case study

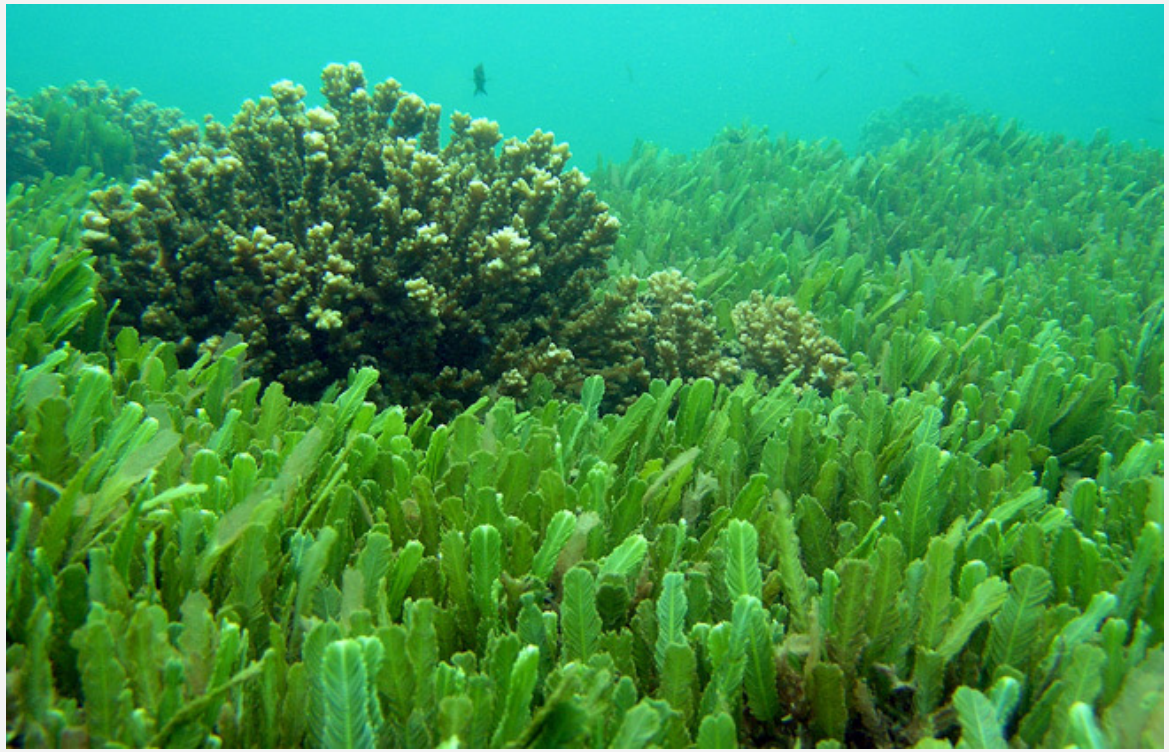
- **Threats > Natural**
  - **Hurricanes, Earthquakes, Tsunamis**
    - Physical damages
    - Smothering (étouffement)
    - Freshwater poisoning

The Coral Reef case study

- **Threats > Natural**
  - **Predators**
    - crown of thorns starfish
    - Snails (escargots)
    - parrotfish (poisson perroquet)
    - butterfly fish

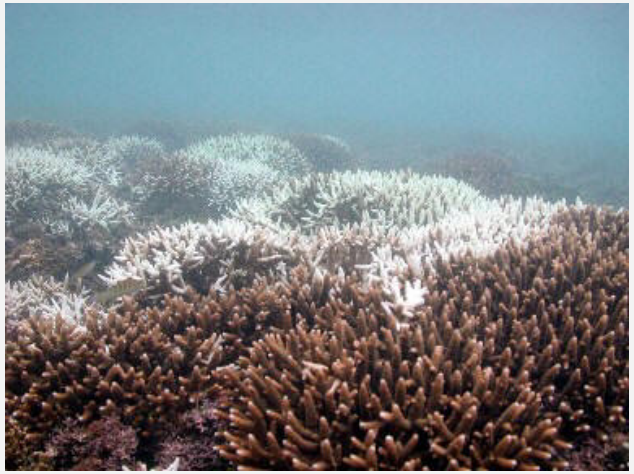
The Coral Reef case study

- **Threats > Natural**
  - **Competitors**
    - Encrusting, turf & macro-algae compete with coral for light and space



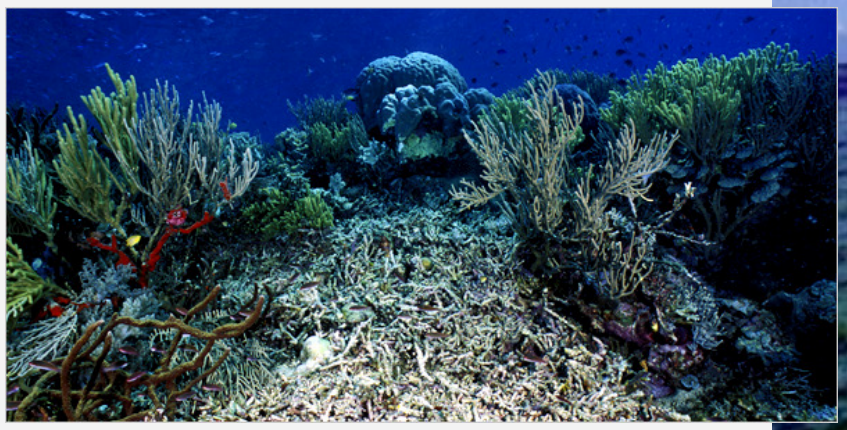
The Coral Reef case study

- **Threats > Natural**
  - **Natural bleaching**
    - Loss of algae
    - may be linked to temperature, salinity or UV



The Coral Reef case study

- **Threats > Human**
  - **Overfishing**
    - destructive practices



The Coral Reef case study

- **Threats > Human**
  - **Overfishing**
    - Ecosystem balance disruption

The Coral Reef case study

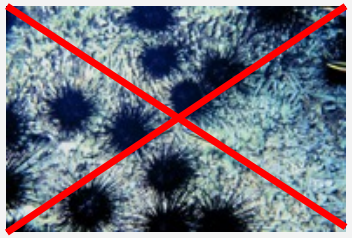
- **Threats > Synergistic effects**

  = **interaction between natural & human causes**

In 1980 and 1988, 2 Hurricanes hit the Caribbean islands, causing heavy physical and chemical damages

- Case study 1: Jamaica

  Overfishing + Hurricanes
  > Diadema and Acropora die-off 1980s




Carysfort Reef 1975

The Coral Reef case study

- **Threats > Synergistic effects**

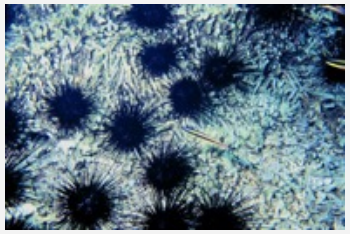
  = **interaction between natural & human causes**

In 1980 and 1988, 2 Hurricanes hit the Caribbean islands, causing heavy physical and chemical damages

- Case study 2: Virgin Islands

Protection since 1961

> no severe damages after the hurricanes



ECOSYSTEM SERVICES

- 4 groups
  - Supporting services
  - Provisioning services
  - Regulating services
  - Cultural services

- Different points of view
  - Avoided cost
  - Replacement cost
  - Factor income
  - Travel cost
  - Hedonist cost
  - Contingent valuation

CORAL REEFS

- Symbiotic association between
  - the animal (polyp)
  - micro algae (zooxanthelles)
- Need particular conditions of
  - Light (clear water)
  - Waves
  - Temperature & salinity
- Great importance
  - local economies
    - Protection, food, jobs, material, tourism, biotechnology…
  - general biodiversity
- In danger
  - overfishing
  - climate change