ROOM VIII, Building E
Palais des Nations, Geneva
10-12 May 2016

UNITED NATIONS UNCTAD
The Commonwealth
IOI International Ocean Institute

Oceans economy and trade:
Sustainable fisheries, transport and tourism

Climate change adaptation for coastal infrastructure: Ecosystem-based Approach

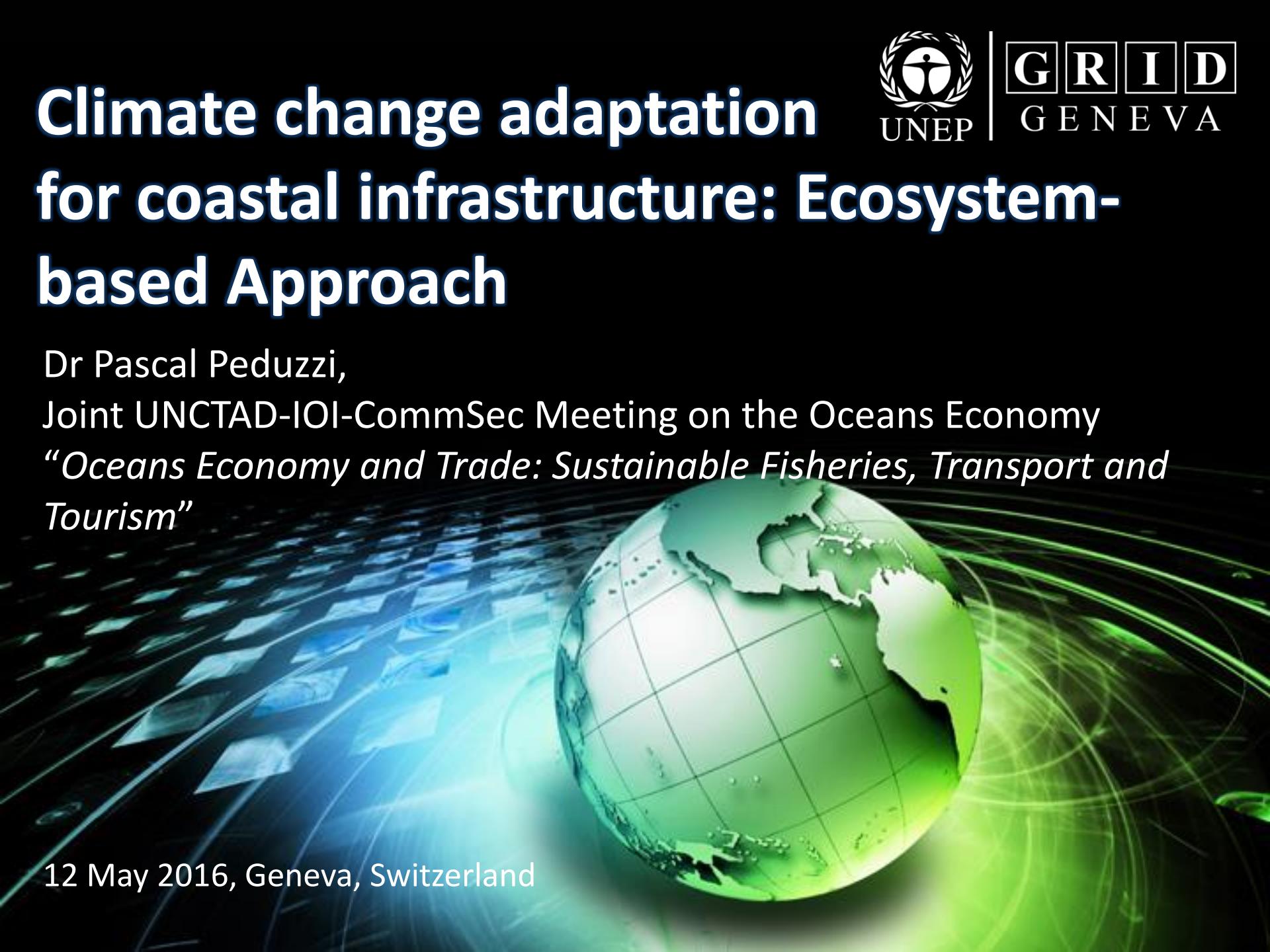
Mr. Pascal Peduzzi
Director of Science, UNEP-GRID

Climate change adaptation for coastal infrastructure: Ecosystem-based Approach

Dr Pascal Peduzzi,

Joint UNCTAD-IOI-CommSec Meeting on the Oceans Economy

"*Oceans Economy and Trade: Sustainable Fisheries, Transport and Tourism*"



12 May 2016, Geneva, Switzerland

Panama canal

- In 2009, nearly 300 million tons of shipping.

- **Every lock going downward requests more than 100,000 m^3 of water to operate.**
- **Water management is a critical issue, both floods and droughts need to be controlled.**

Airport & sea level rise: Barbados

Sea level rise & airport: Solomon islands

Sea level rise & airports: Honk Kong (China)

Sea level rise & airports: Kingston (Jamaica)

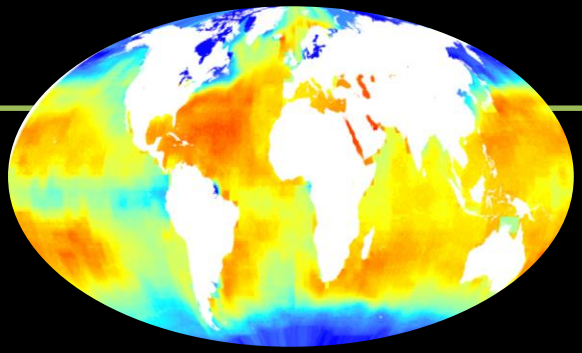
Impacts on harbours and coastal airports: concerns for SIDS connectivity.

Sea level rise & coastal erosion: roads

Landslides and deforestation

Protecting forest cover and reforestation may reduce landslides susceptibility.

Wall for stabilizing slopes?



1 Threats to SIDS (review)

Main threats to SIDS

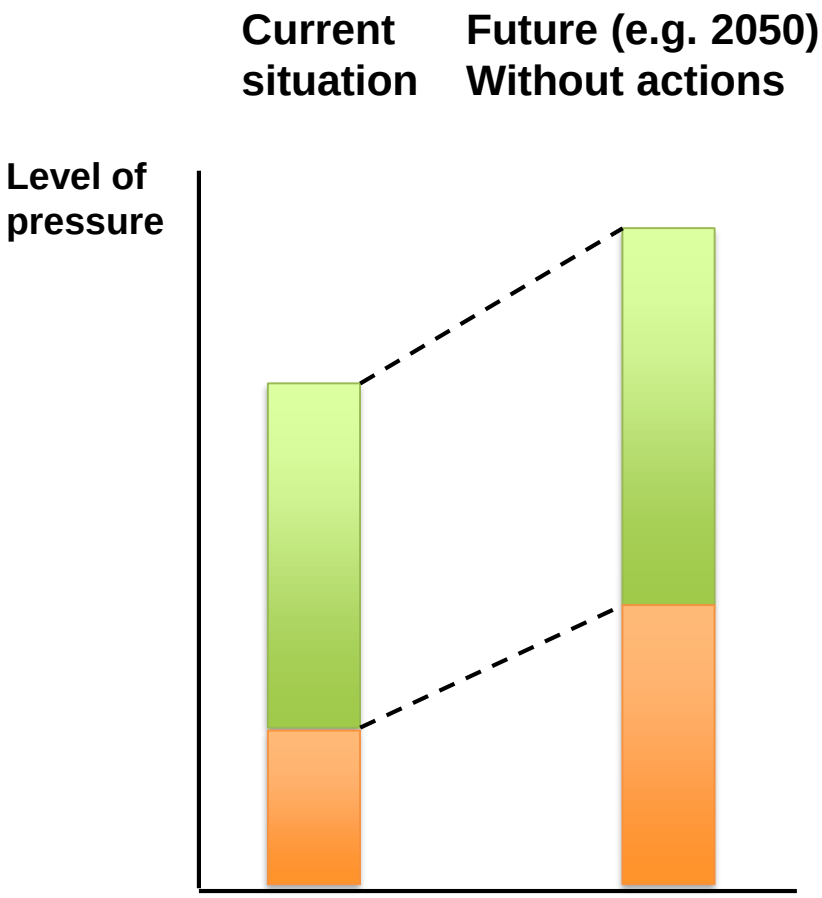
Climate Change (global threats)

- Storm and tropical cyclones (rain, wind, storm surges, wave energy, soil erosion, landslides, floods)
- Droughts & Wild fires
- Heatwaves
- Sea level rise (coastal erosion, salinization of coastal acquifers)
- Increase in sea surface temperature (coral bleaching)
- Ocean Acidification (impacts on coral and fisheries)

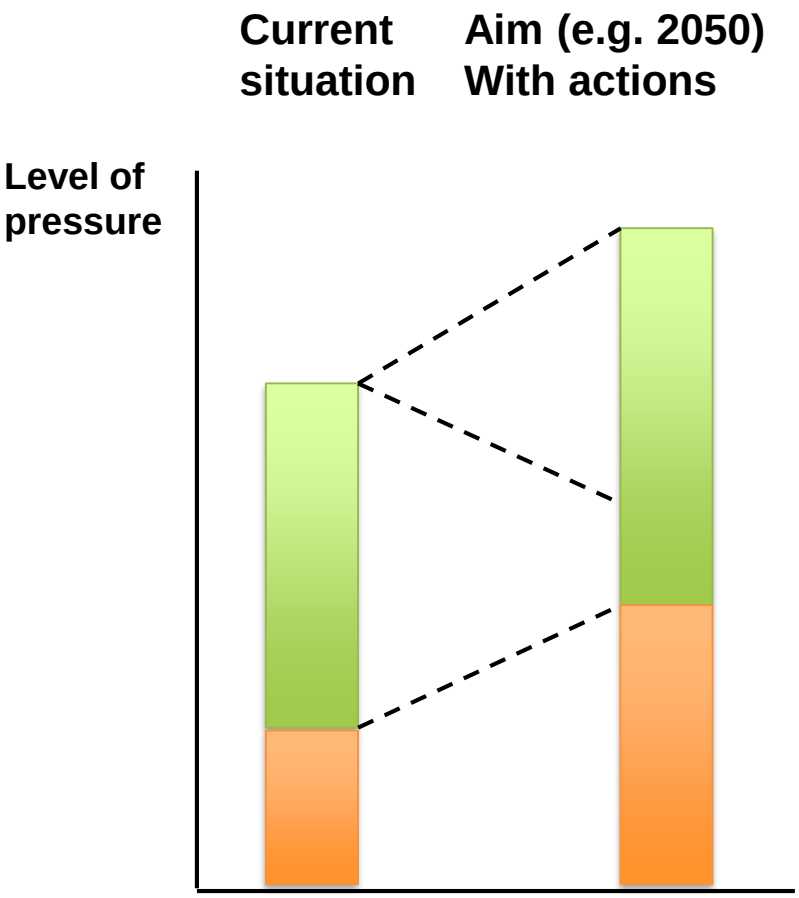
Environmental changes (local threats)

- Pollution (sewage, waste, transport, accidents)
- Deforestation
- Infrastructures for tourism
- Overfishing
- Sand mining
- Decline of ecosystems (biodiversity)

Reduce local pressures



Reduce local pressures



2 Extreme events

Disasters are seen as fast events…





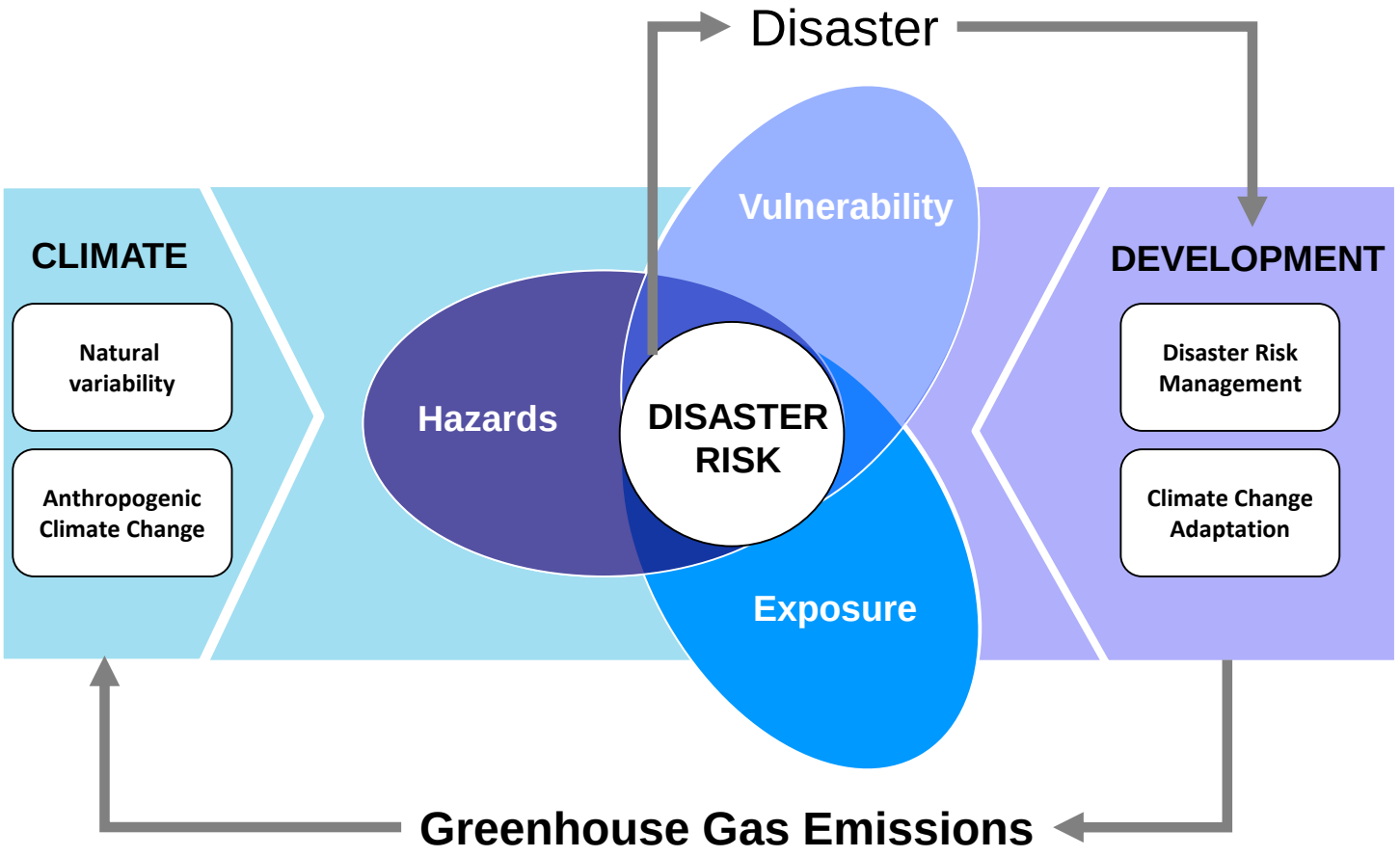




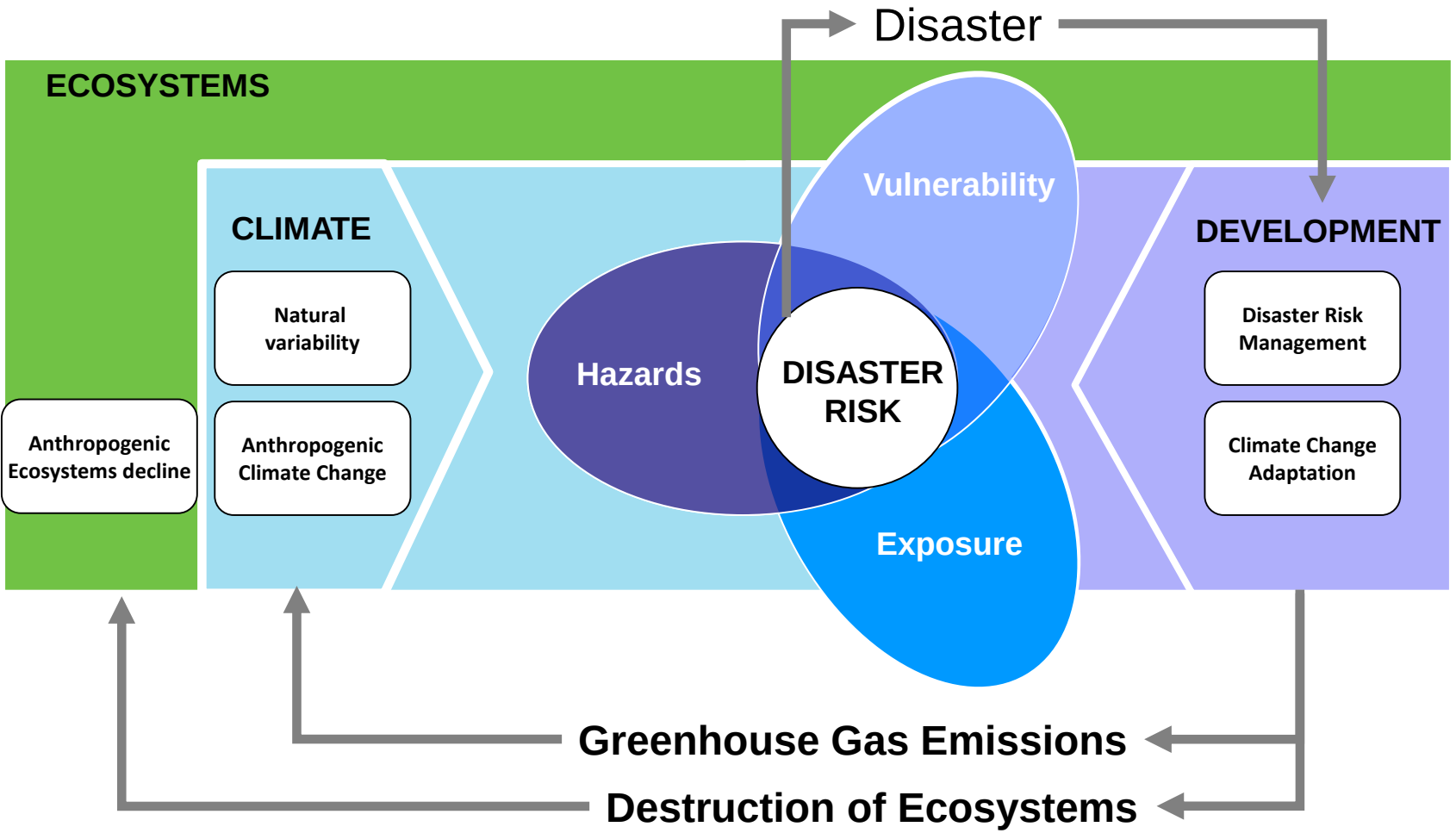
…but disasters are slowly built

They are the consequences of slow / continuous processes resulting from inappropriate (or lack of) choices

IPCC schematic description of disaster risk

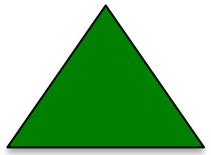


Ecosystems are also part of the equation



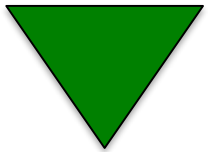
Ecosystems, Hazards and Resilience

$$\text{RISK} = \text{HAZARD} \times \frac{\text{EXPOSURE} \times \text{VULNERABILITY}}{\text{RESILIENCE}}$$



Ecosystems can increase the resilience of population
by providing services such as clean water, food supply (fish, fruits, crops)

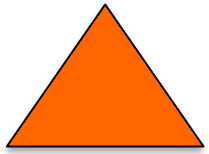
Ecosystems, Hazards and Resilience



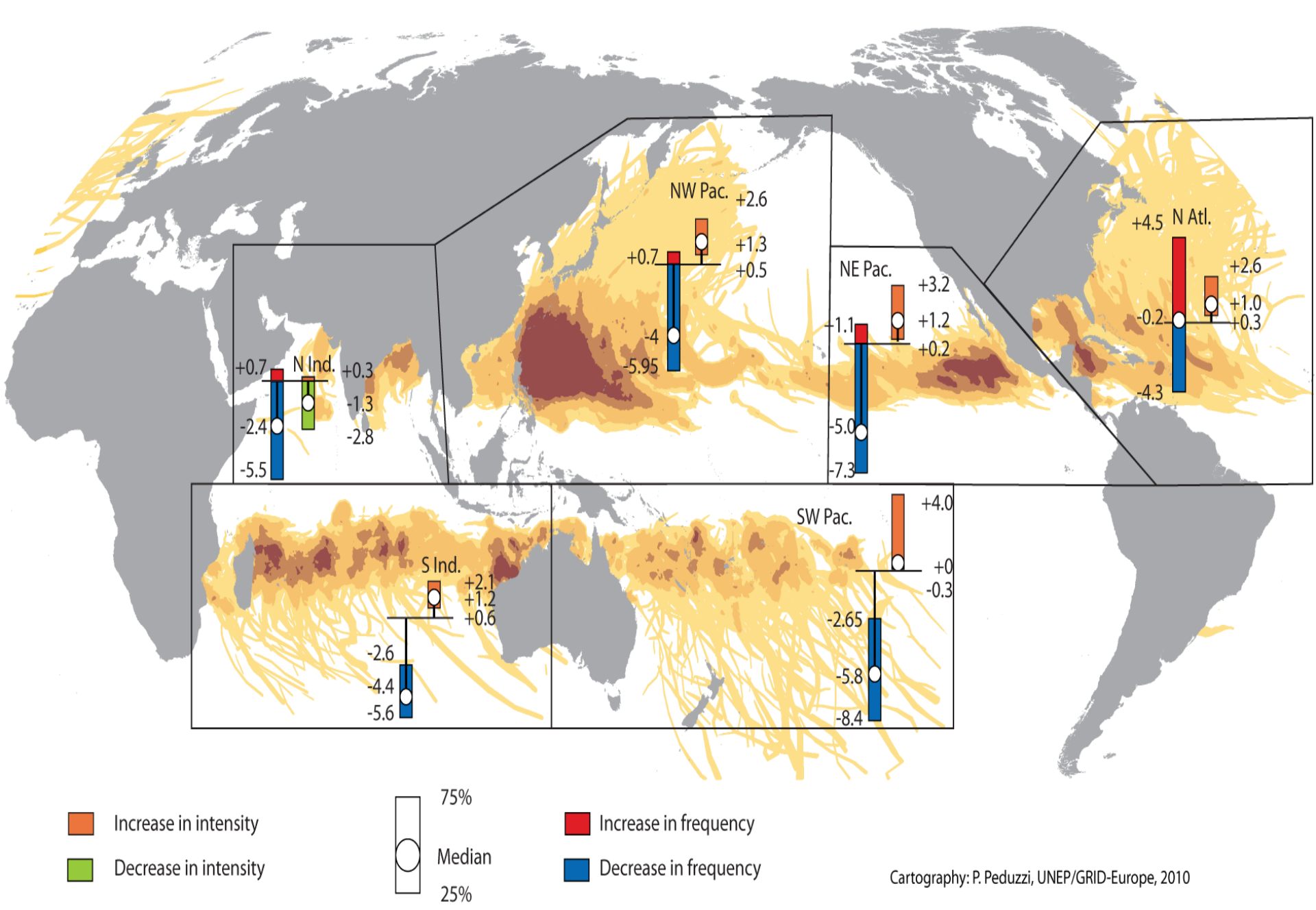
Ecosystems: Can reduce frequency or / and intensity
Slope stabilization, buffering wave energy,
water infiltration,…

RISK = HAZARD x EXPOSURE x VULNERABILITY

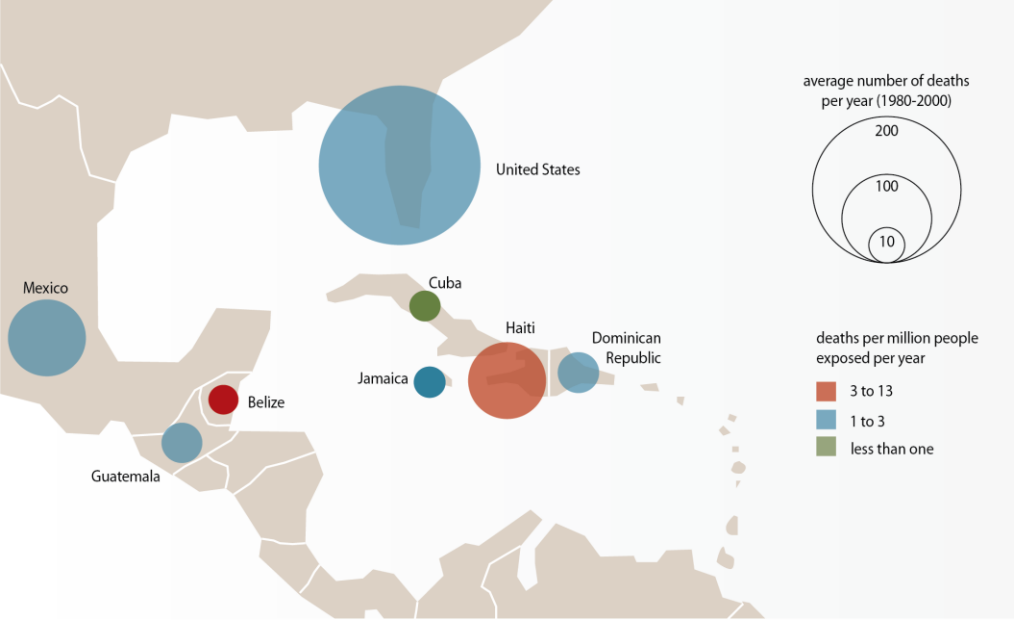
RESILIENCE

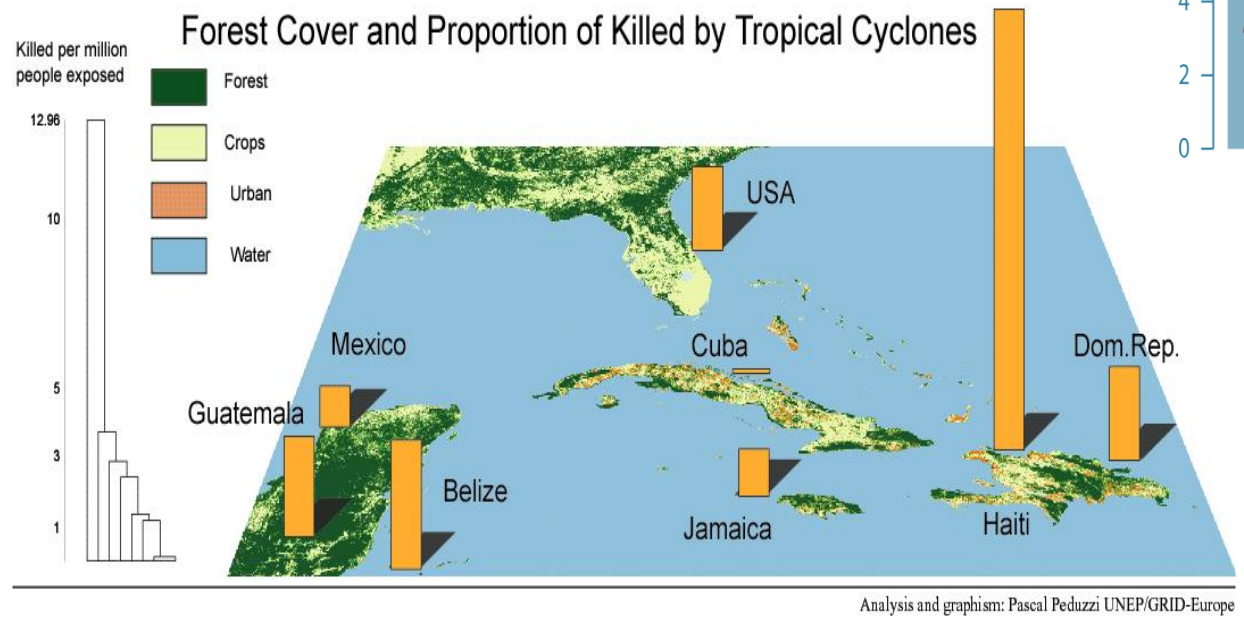


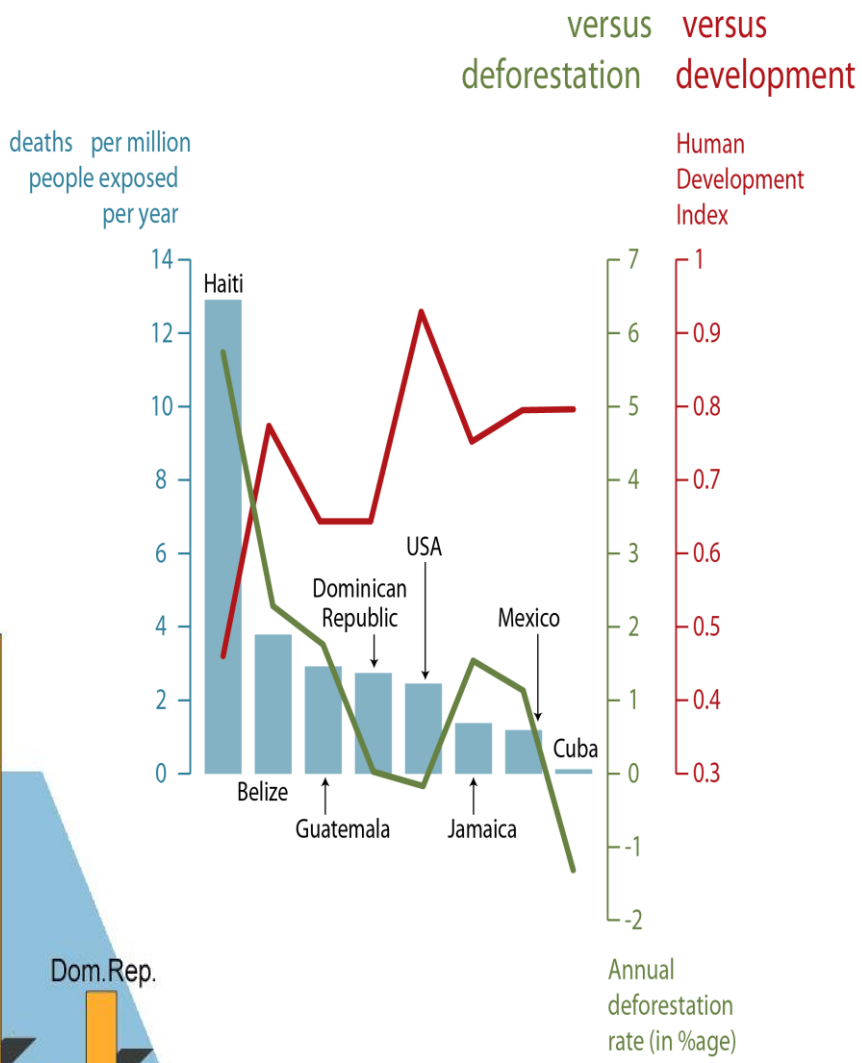
Ecosystems destruction
e.g. deforestation on slopes→ landslides susceptibility
coral destruction→ higher storm surge
Removal of vegetated areas in cities→ bigger heatwaves and urban flooding



Peduzzi, P., Chatenoux, B., Dao, H., De Bono, A., Herold, C., Kossin, J., Mouton, F., Nordbeck, O., Global Trends Tropical Cyclones Risk, *Nature Climate Change*, **2**(4), 289–294, 2012.

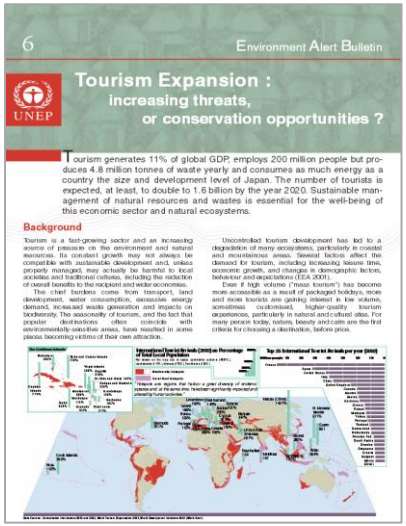

average number of deaths per year (1980-2000)
200
100
10
United States
Mexico
Cuba
Haiti
Dominican Republic
Jamaica
Belize
Guatemala
deaths per million people exposed per year
3 to 13
1 to 3
less than one


Forest Cover and Proportion of Killed by Tropical Cyclones
Killed per million people exposed
12.96
10
5
3
1
Forest
Crops
Urban
Water
USA
Mexico
Cuba
Dom.Rep.
Guatemala
Belize
Jamaica
Haiti
Analysis and graphism: Pascal Peduzzi UNEP/GRID-Europe


versus deforestation
versus development
deaths per million people exposed per year
Human Development Index
14
12
10
8
6
4
2
0
7
6
5
4
3
2
1
0
-1
-2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Haiti
Belize
Guatemala
Dominican Republic
USA
Jamaica
Mexico
Cuba
Annual deforestation rate (in %age)

Tourism pressure

Tourism in the Caribbean


6 Environment Alert Bulletin

Tourism Expansion : increasing threats, or conservation opportunities ?

Tourism generates 11% of global GDP, employs 200 million people but produces 4.8 million tonnes of waste yearly and consumes as much energy as a country the size and development level of Japan. The number of tourists is expected, at least, to double to 1.6 billion by the year 2020. Sustainable management of natural resources and wastes is essential for the well-being of this economic sector and natural ecosystems.

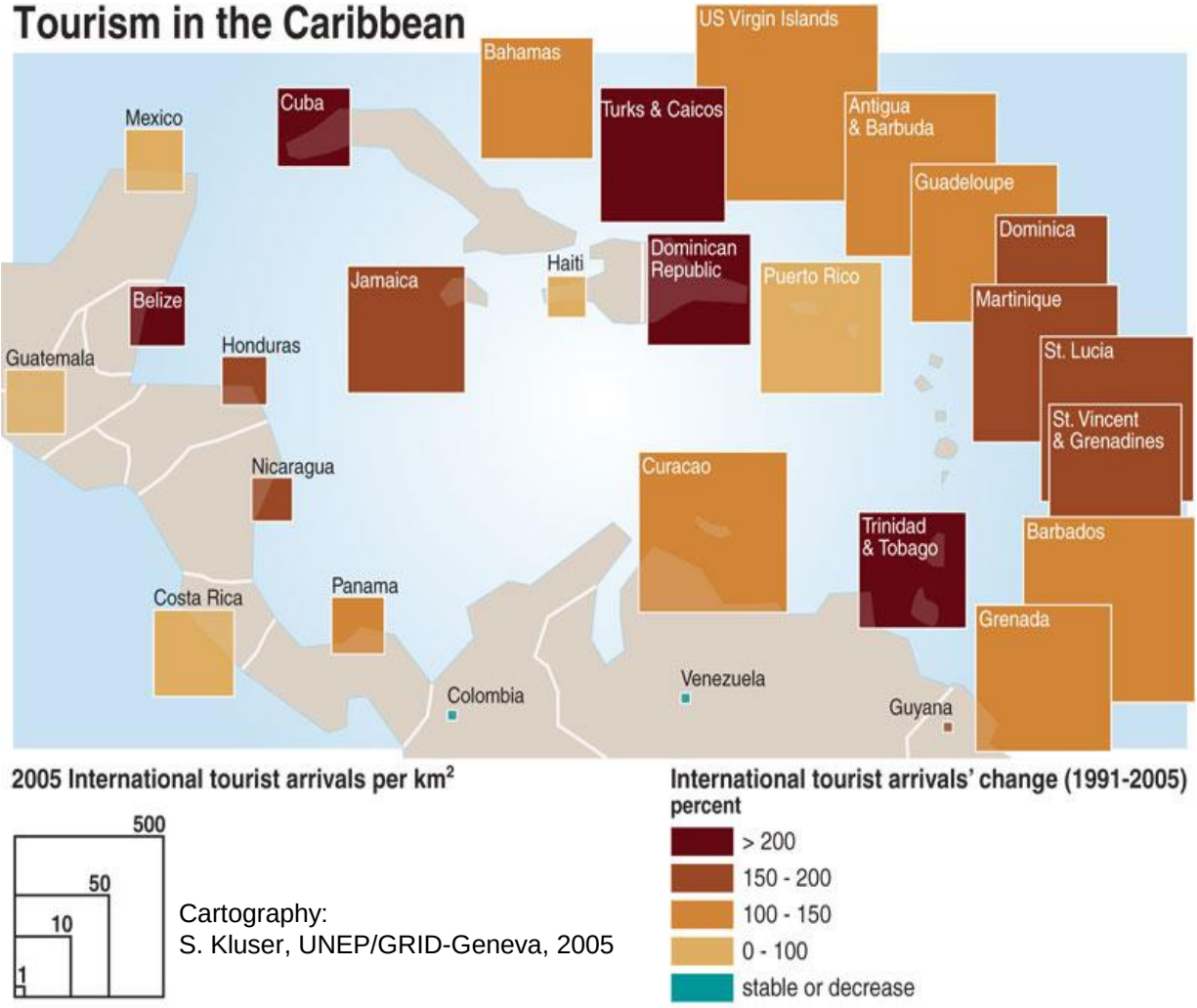
Background

Tourism is a fast-growing sector and an increasing source of pressure on the environment and natural resources. Its constant growth may not always be compatible with sustainable development and, unless properly managed, may actually be harmful to local societies and traditional cultures, including the reduction of overall benefits to the recipient and sector economies.

The chief burdens come from transport, land development, water consumption, excessive energy demand, increased waste generation and impacts on biodiversity. The seasonality of tourism, and the fact that popular destinations often coincide with environmentally sensitive areas, have resulted in some places becoming victims of their own attraction.

Uncontrolled tourism development has led to a degradation of many ecosystems, particularly in coastal and mountainous areas. Several factors affect the demand for tourism, including increasing leisure time, economic growth, and changes in demographic factors, behaviour and expectations (EEA 2001).

Even if high volume ("mass tourism") has become more accessible as a result of packaged holidays, more and more tourists are gaining interest in low volume, sometimes customised, higher-quality tourism experiences, particularly in natural and cultural sites. For many persons today, nature, beauty and calm are the first criteria for choosing a destination, before price.



Cartography:
S. Kluser, UNEP/GRID-Geneva, 2005

Sources: De Bono, A, Kluser, S., Giuliani, G., Peduzzi, P. (2005) Tourism Expansion : Increasing Threats, or Conservation Opportunities? *Environment Alert Bulletin*, **6**: 1-4, UNEP/GRID-Geneva

Significant developments on coastal areas, pressure ecosystems, reduces their services, increases sedimentation and pollutants e.g. from sewages

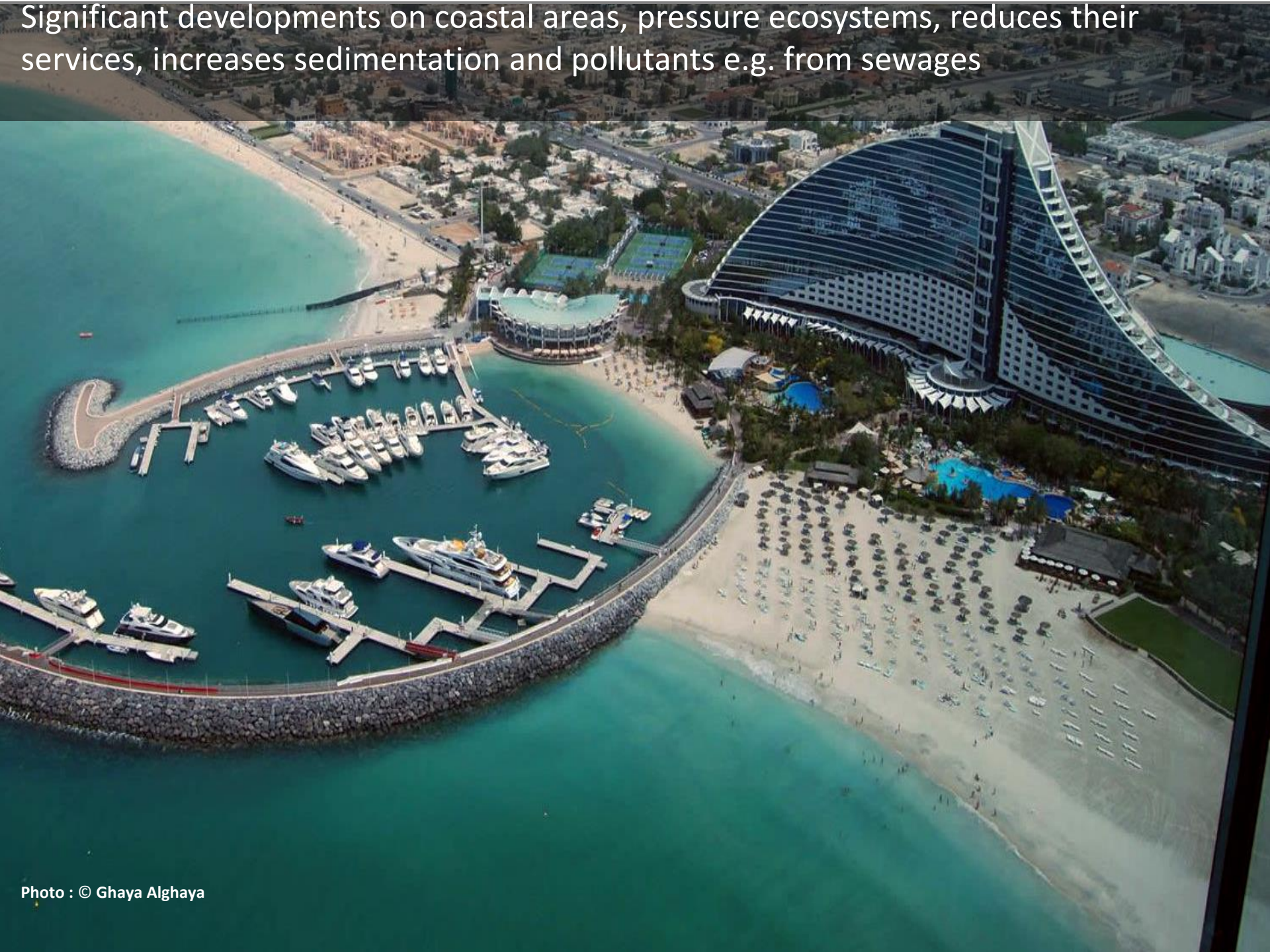


Photo : © Ghaya Alghaya

Digging access for cruise ships

Photos: © Corporate Cruise Consultants

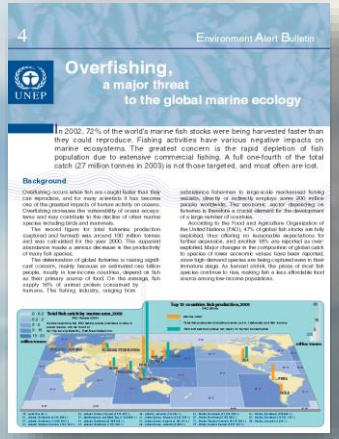
Pollution from “inappropriate” sewage treatments (or absence of)

Photo: © Peduzzi, 2010

Photos: © Ken Tam

Fisheries, agriculture & sand mining

Unsustainable fishing practices


4 Environment Alert Bulletin

UNEP

Overfishing, a major threat to the global marine ecology

In 2002, 72% of the world's marine fish stocks were being harvested faster than they could reproduce. Fishing activities have various negative impacts on marine ecosystems. The greatest concern is the rapid depletion of fish population due to extensive commercial fishing. A full one-fourth of the total catch (27 million tonnes in 2003) is not those targeted, and most often are lost.

Background

Overfishing occurs when fish are caught faster than they can reproduce, and for many scientists it has become one of the greatest impacts of human activity on oceans. Overfishing increases the vulnerability of ocean ecosystems to other impacts, and has a negative effect on other marine species including birds and mammals.

The record figure for total fisheries production (captured and farmed) was around 100 million tonnes and was calculated for the year 2000. This apparent abundance masks a serious decrease in the productivity of many fish species.

The deterioration of global fisheries is raising significant concern, mainly because an estimated one billion people, mostly in low income countries, depend on fish as their primary source of food. On the average, fish supply 16% of animal protein consumed by humans. The fishing industry, ranging from subsistence fishermen to large-scale mechanised fishing vessels, directly or indirectly employs some 200 million people worldwide. The economic sector depending on fisheries is therefore a crucial element for the development of many developing countries.

According to the Food and Agriculture Organization of the United Nations (FAO), 47% of global fish stocks are fully exploited, thus offering no reasonable expectations for further expansion, and another 18% are reported as overexploited. Major changes in the composition of global catch to species of lower economic values have been reported, since high-demand species are being captured more in their immature stage. As harvest shrink, the prices of most fish species continue to rise, making fish a less affordable food source among low income populations.

Photo: courtesy WWF

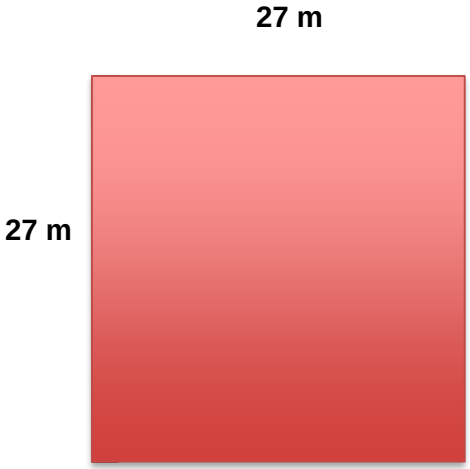
Remote Sensing

E.g. Updating hotspots of environmental changes

Photo : © Tommy Trenchard/IRIN

The global use of sand is about 30 billion tons /year

In one year:
this would be enough to build a wall of 27 x 27 m around the globe



Sand mining: Singapore

UNEP | GRID Geneva

UNEP Global Environmental Alert Service (GEAS)

Taking the pulse of the planet; connecting science with policy

Website: www.unep.org/geas E-mail: geas@unep.org

March 2014 | Home | Subscribe | Archive | Contact

Thematic focus Ecosystem management, Environmental governance, Resource efficiency

Sand, rarer than one thinks

Sand and gravel are mined worldwide and account for the largest volume of solid material extracted globally. Formed by erosive processes over thousands of years (John, 2009), they are now being extracted at a rate far greater than their renewal. Furthermore, the volume being extracted is having a major impact on rivers, deltas and coastal and marine ecosystems (Figure 1), results in loss of land through river or coastal erosion, lowering of the water table and decreases in the amount of sediment supply. Despite the colossal quantities of sand and gravel being used, our increasing dependence on them and the significant impact that their extraction has on the environment, this issue has been mostly ignored by policy makers and remains largely unknown by the general public.

Buh Snatt/Flickr/CC BY NC SA

Why is this issue important?

Globally, between 47 and 59 billion tonnes of material is mined every year (Steinberger et al., 2010), of which sand and gravel, hereafter known as aggregates, account for both the largest share (from 68% to 85%) and the fastest extraction increase (Krausmann et al., 2009). Surprisingly, although more sand and gravel are mined than any other material, reliable data on their extraction in certain developed countries are available only for recent years (Krausmann et al., 2009). The absence of global data on aggregates mining makes environmental assessment very difficult and has contributed to the lack of awareness about this issue.

One way to estimate the global use of aggregates indirectly is through the production of cement for concrete (concrete is made with cement, water, sand and gravel). The production of cement is reported by 150 countries and reached 3.7 billion tonnes in 2012 (USGS, 2013a). For each tonne of cement, the building industry needs about six to seven times more tonnes of sand and gravel (USGS, 2013b). Thus, the world's use of aggregates for concrete can be estimated at 25.9 billion to 29.6 billion tonnes a year for 2012 alone. This represents enough concrete to build a wall 27 metres high by 27 metres wide around the equator.

1

nap of Singapore shows its area increasing from 1973 to 2013. Remote sensing
lysis: UNEP/GRID-Geneva.

Having imported a reported 517 million tonnes of sand in the last 20 years, Singapore is by far the largest importer of sand world-wide (UN Comtrade, 2014; Aquaknow, 2014) and the world's highest per capita consumer of sand at 5.4 tonnes per inhabitant.

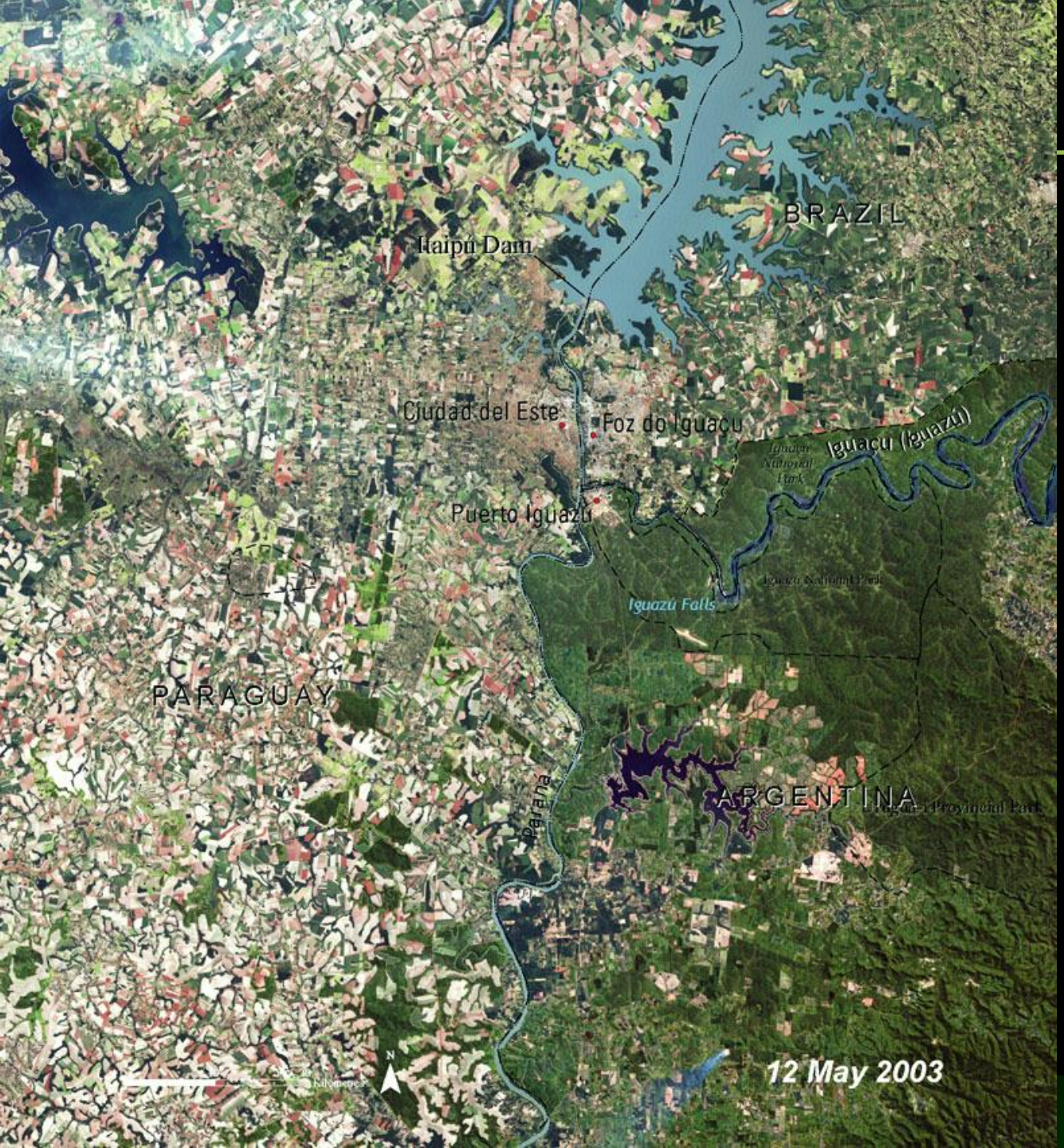
Sand is typically imported mostly from Indonesia, but also from the other neighbouring countries of Malaysia, Thailand and Cambodia. Export of sand to Singapore was reported to be responsible for the disappearance of some 24 Indonesian sand islands. It is reported that this triggered political tensions regarding maritime borders between the two countries (New York Times, 2010; Guerin, 2003).

The reported sand exported from Indonesia to Singapore declined sharply since a temporary ban declared in February 2002 (Guerin, 2003). Other ts to Singapore. Overall, the reported total amount of d the sum of sand exports to Singapore from its four natch (see graph left), showing an underestimation of statistics do not include illegal imports and highlight ed illegal sand trade (Global Witness, 2010). As the local mafias (Global Witness, 2010; Milton 2010; Singapore was US $3 per tonne from 1995 to 2001, 2005 (UN Comtrade, 2014).

2013
09
39
73
er countries
ater
rom Landsat 1
3), Landsat 5 TM
eb. 2009) and
June 2013)
10
20 km

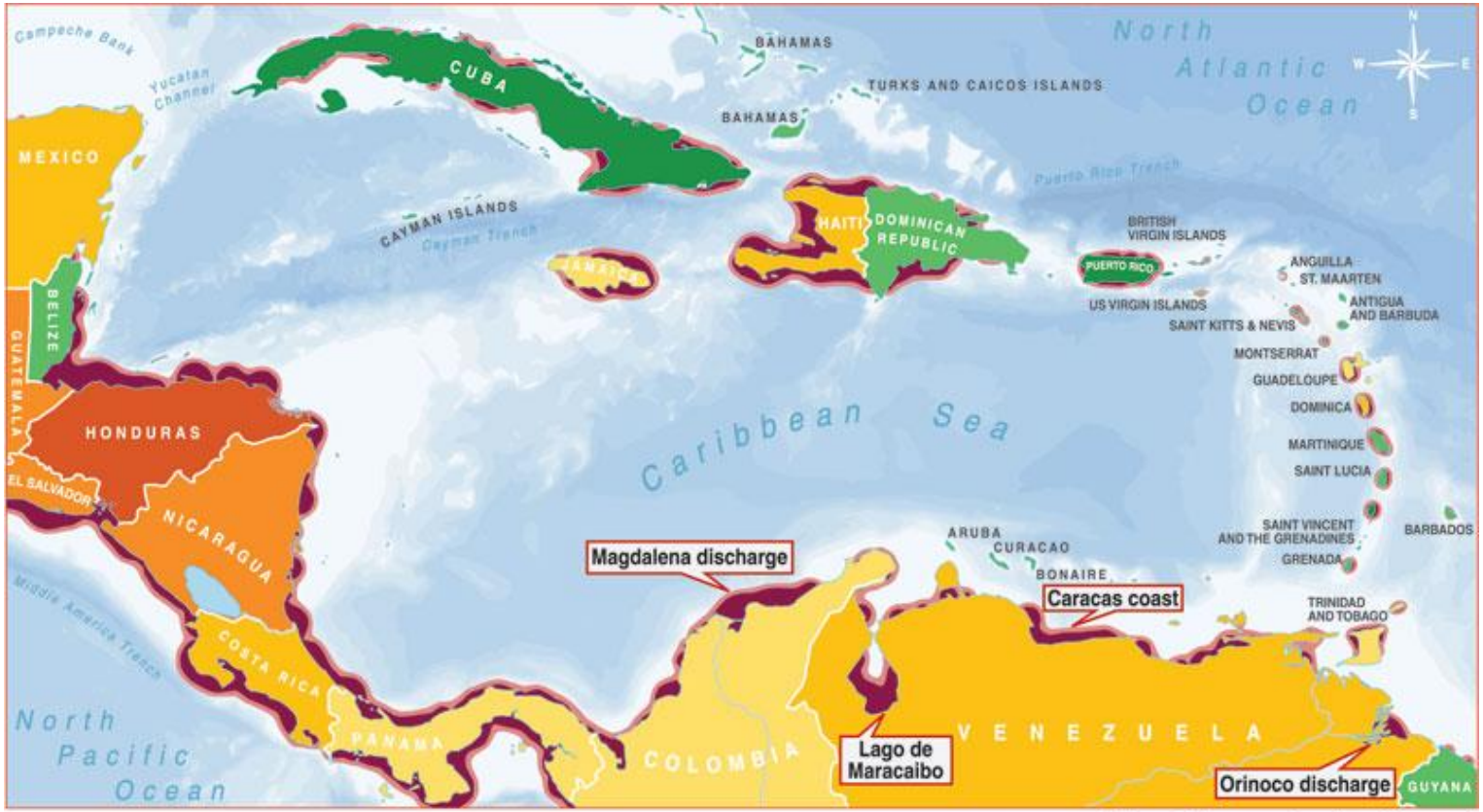
Forest ecosystems

Deforestation
13 million ha / year
globally



Deforestation
13 million ha / year
globally

Monitoring deforestation (Bolivia)



Reefs at risk and deforestation

This map shows that in general, risk related to sedimentation is either linked with land clearing and deforestation leading to high runoff rates, or discharges from major water systems.

1990-2005 forest change
percent+

- > 25% loss
- 15 - 25% loss
- 5 - 15% loss
- 1 - 5% loss
- no change
- reforestation

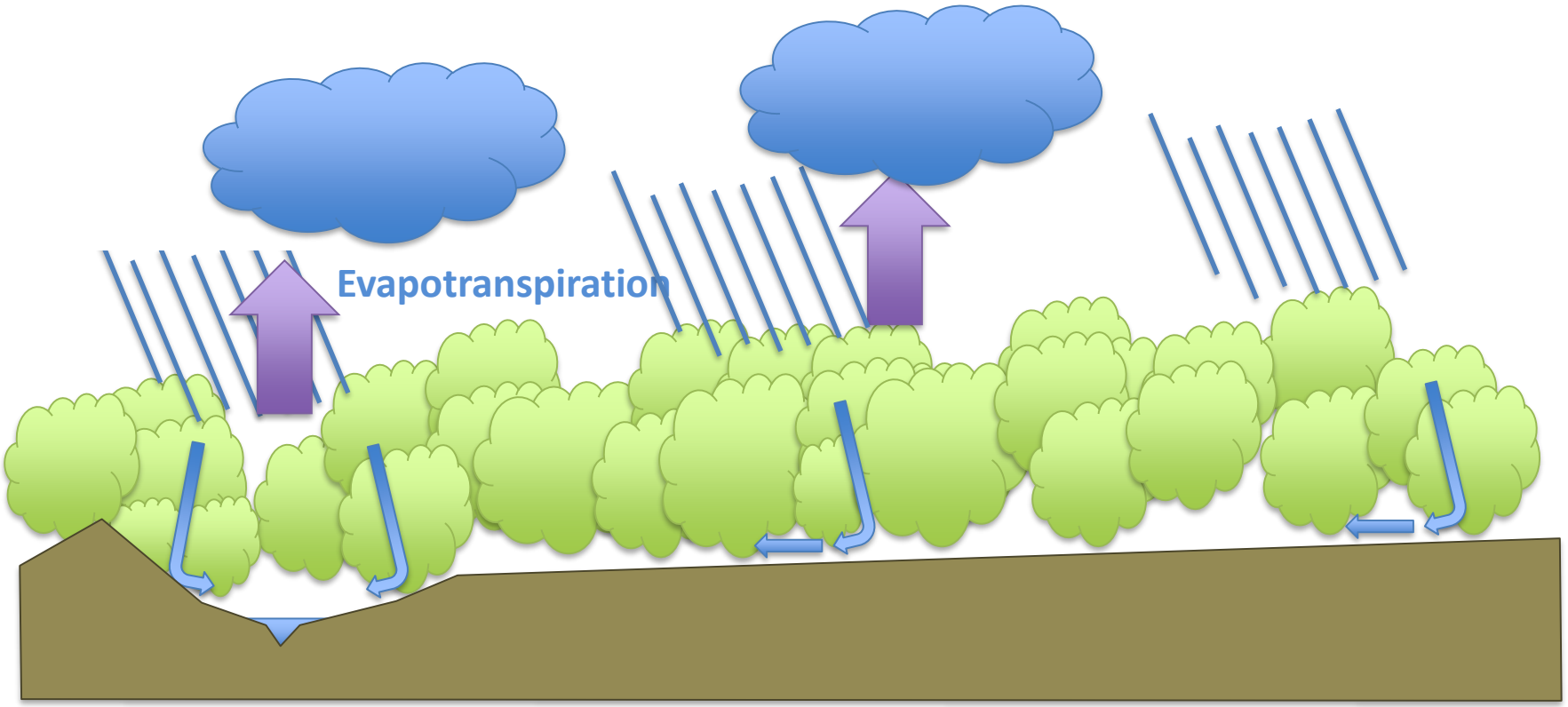
Threat from watershed-based sources of sedimentation and pollution*

- medium
- high

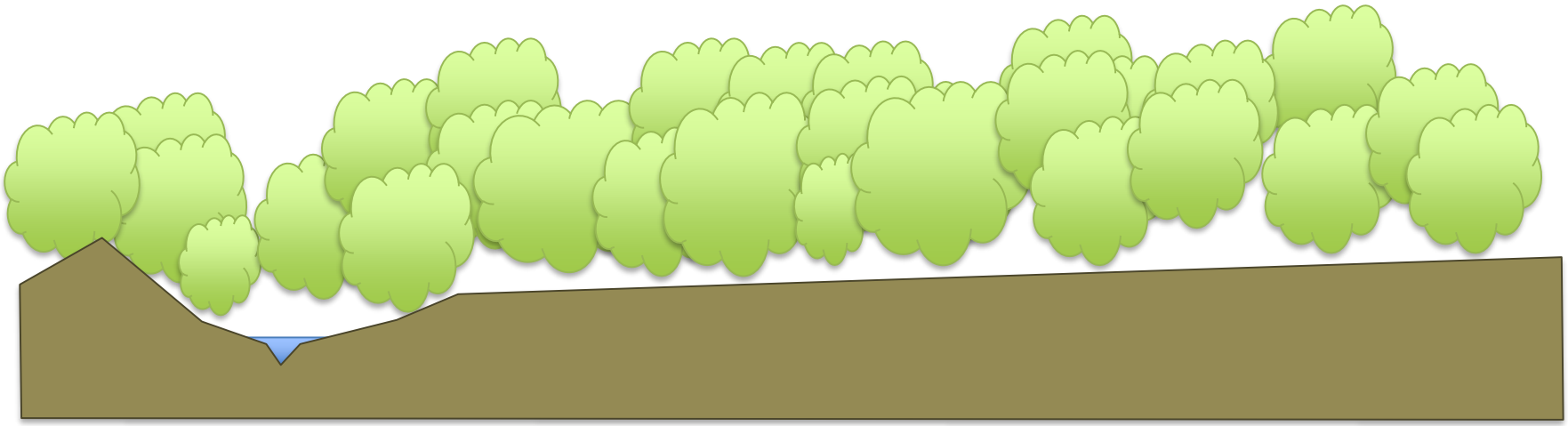
0 100 200 400 600
Kilometres

Sources: Poussart, J-N, Kluser, S., Peduzzi, P. (2008) Coastal degradation leaves the Caribbean in troubled waters, Environment Alert Bulletin, UNEP/GRID-Geneva

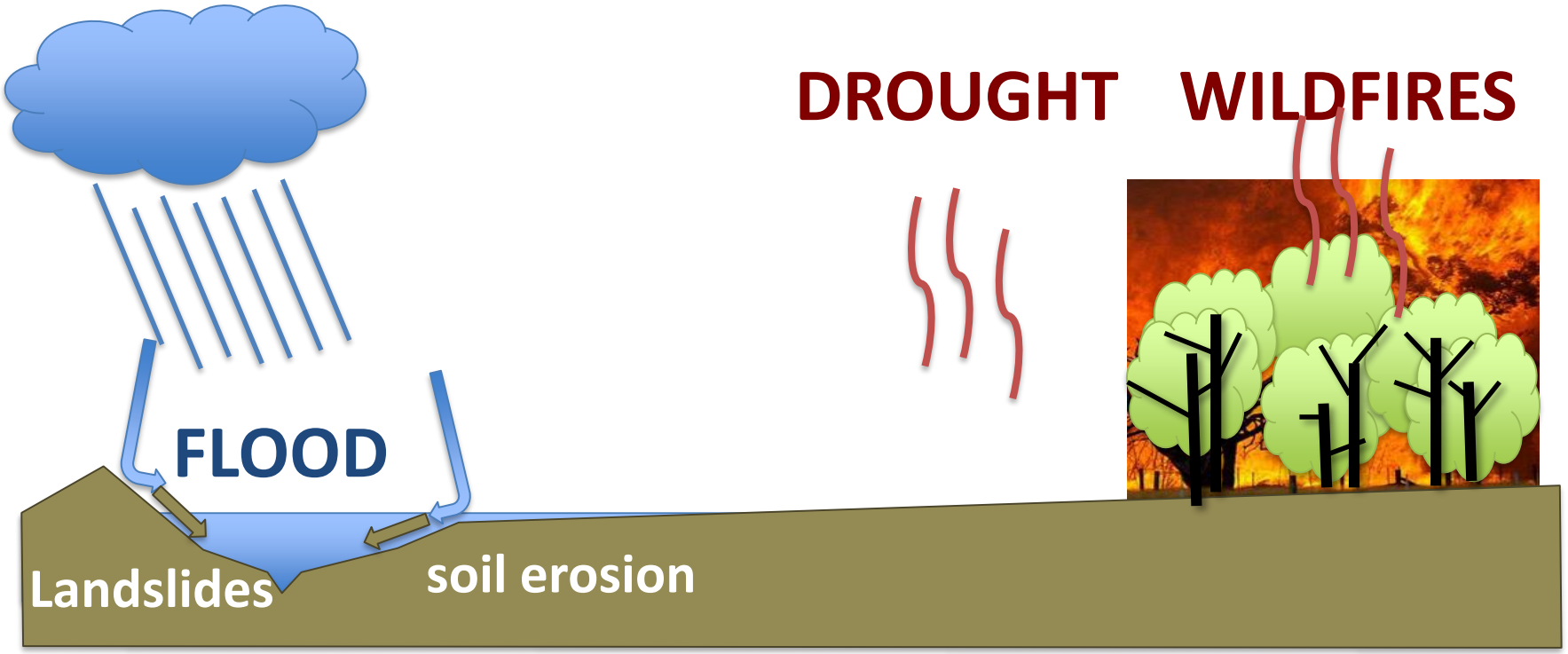
Forest helps the rain to go further inland,…



… but with deforestation,…

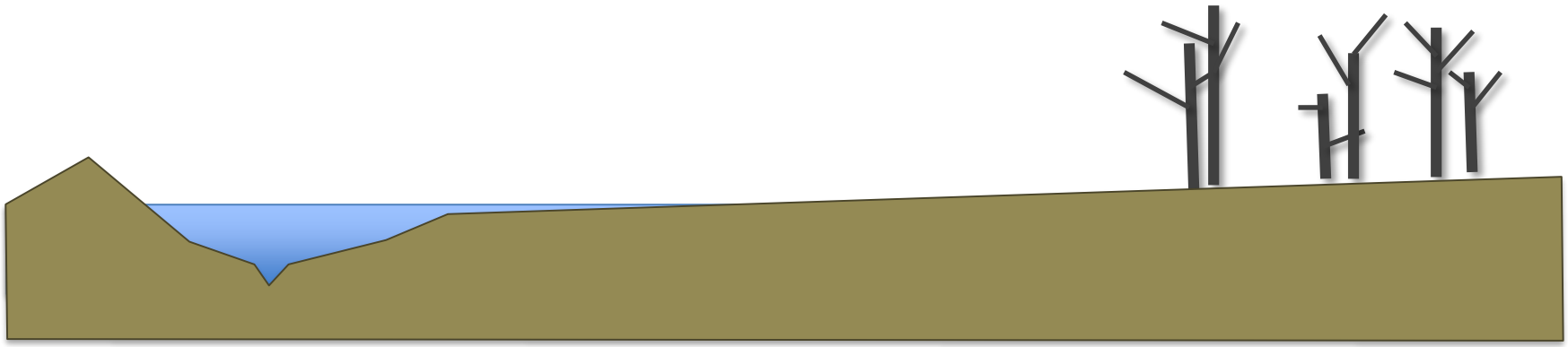


… extremes events are more frequent & intense



this process enters a loop, expending it further

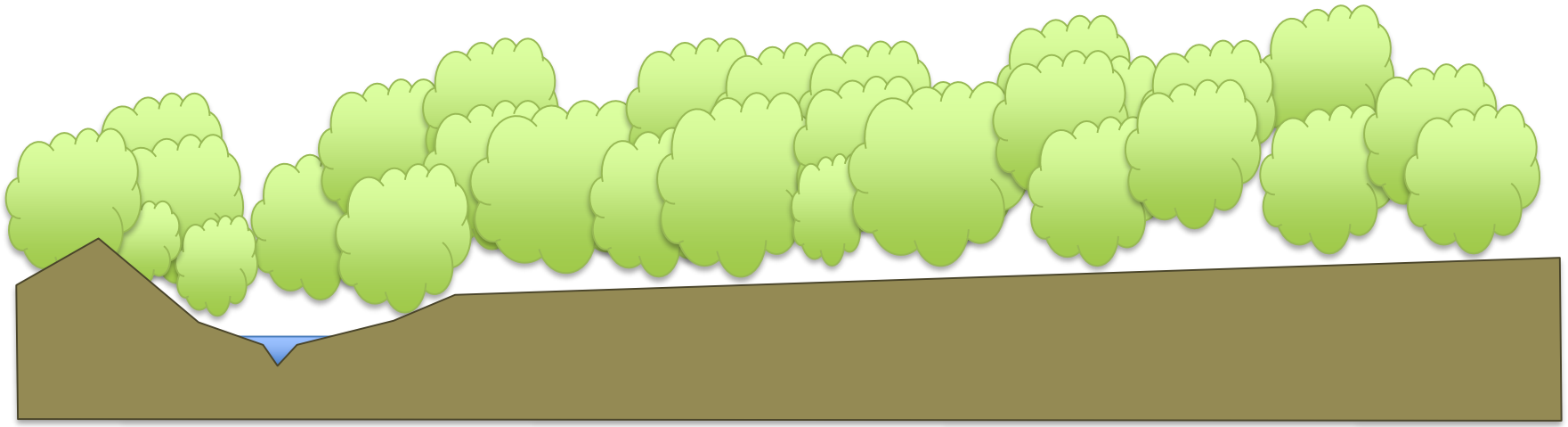
More Deforestation



Drought can be a factor contributing to human-ignited forest fires, which can lead to widespread deforestation and carbon emissions (p.252)

Deforestation

Reforestation can solve this problem



RiVAMP : Identifying and quantifying the role of ecosystems

UNEP

Negril

Erosion rate between 1968-2006 : 0.5 and 1 m/yr
(large temporal and spatial variability; Smith Warner International, 2007)

Observation 2006-2008, shows that beach erosion continues (UNEP, 2010)

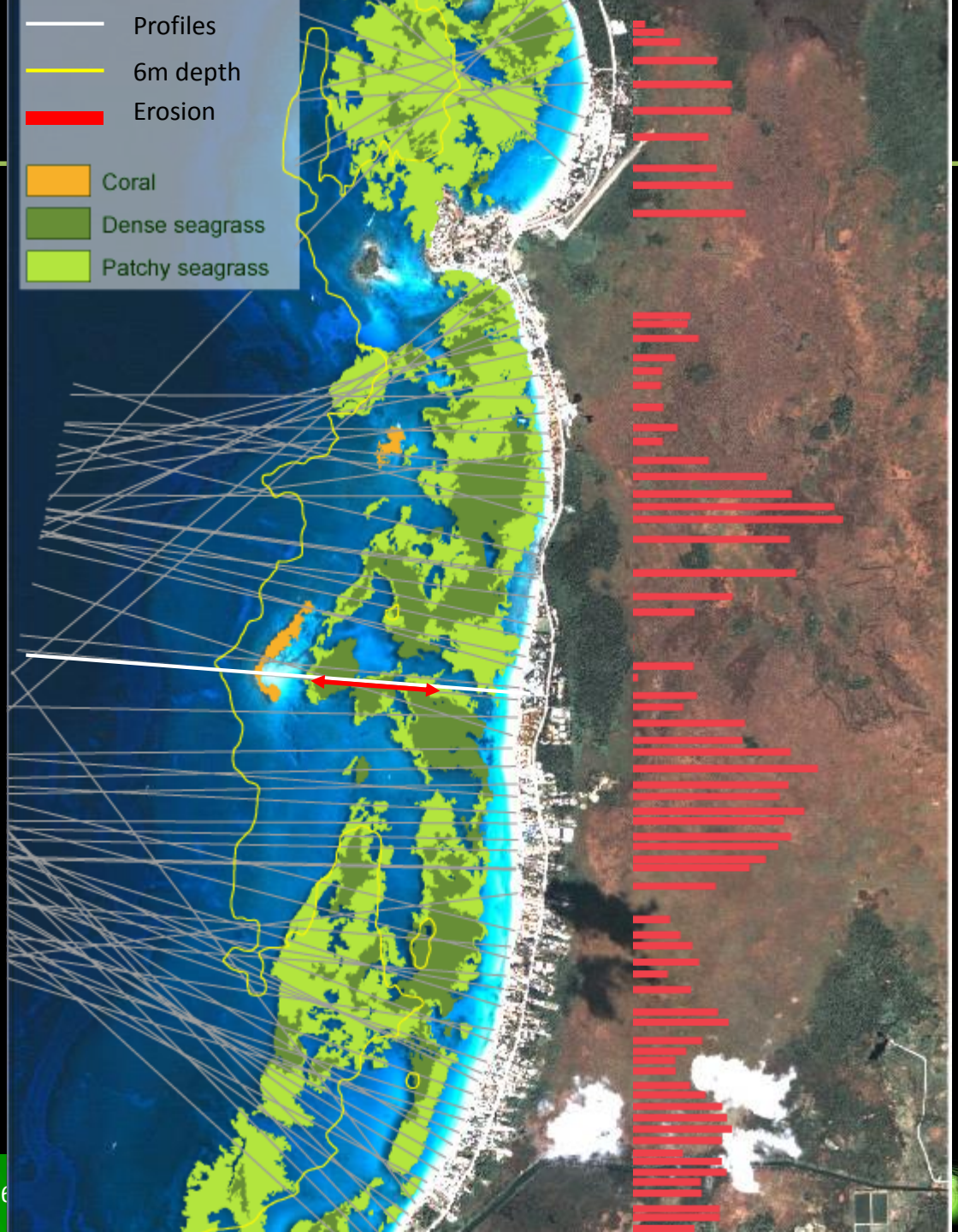
Data extraction

Satellite imagery

To classify marine ecosystems

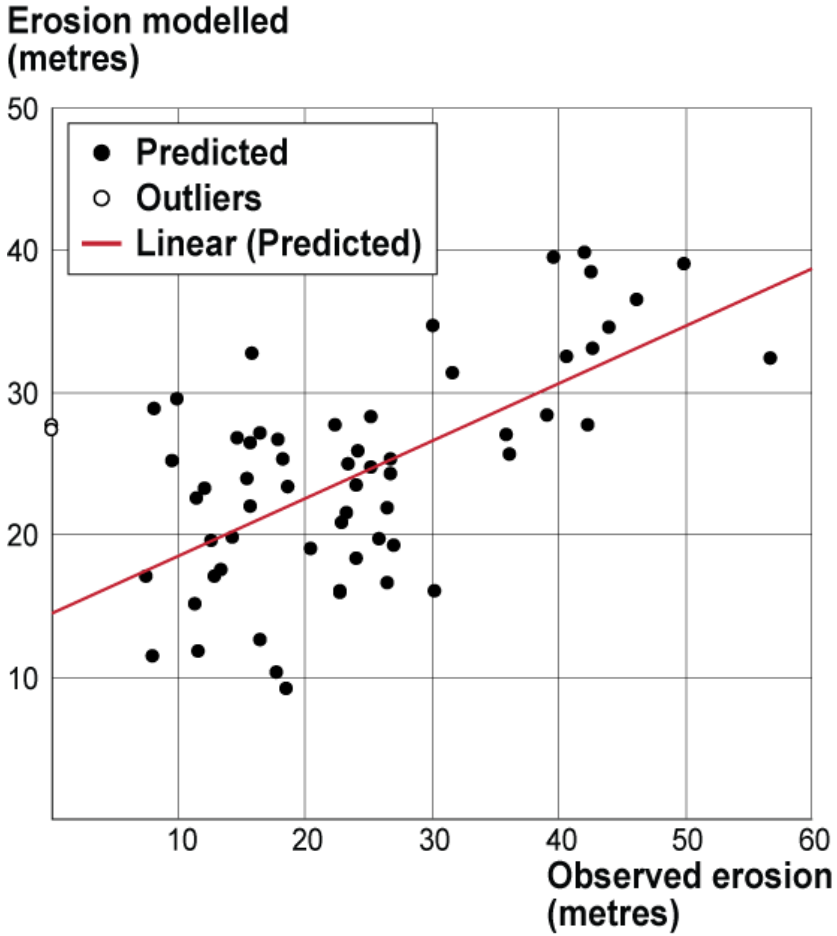
GIS analysis

Data retrieval and remote sensing to identify erosion rate



Multiple regression analysis

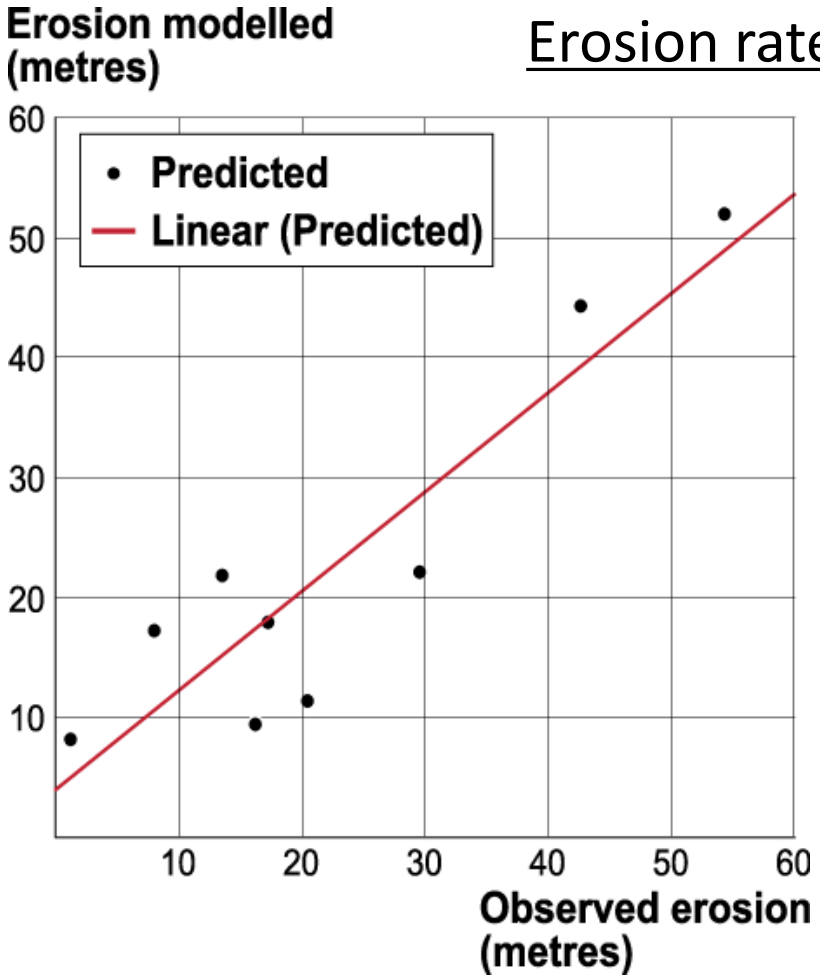
Erosion rate behind sea grass



The model explains 41% of the erosion (correlation r=0.64).

Sea grass, slopes and waves were selected as significant parameters in the model. **Sea grass plays the main role (47%)**: the wider the sea grass the less the erosion.

Multiple regression analysis



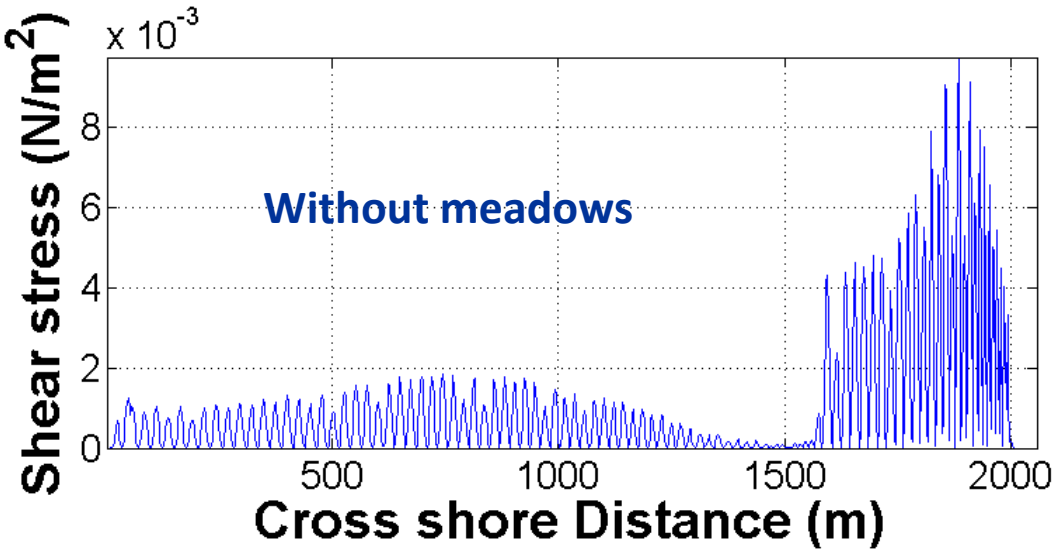
Erosion rate behind coral

The model explains 83% of the erosion (correlation r=0.91).

Coral width and slopes were selected as significant parameters in the model. **Width of coral plays the main role (59%)**: the wider the coral the less the erosion.

Coral is 23.5 times more efficient than sea grass at mitigating beach erosion.

Coastal ecosystem importance: beach protection by seagrass meadows



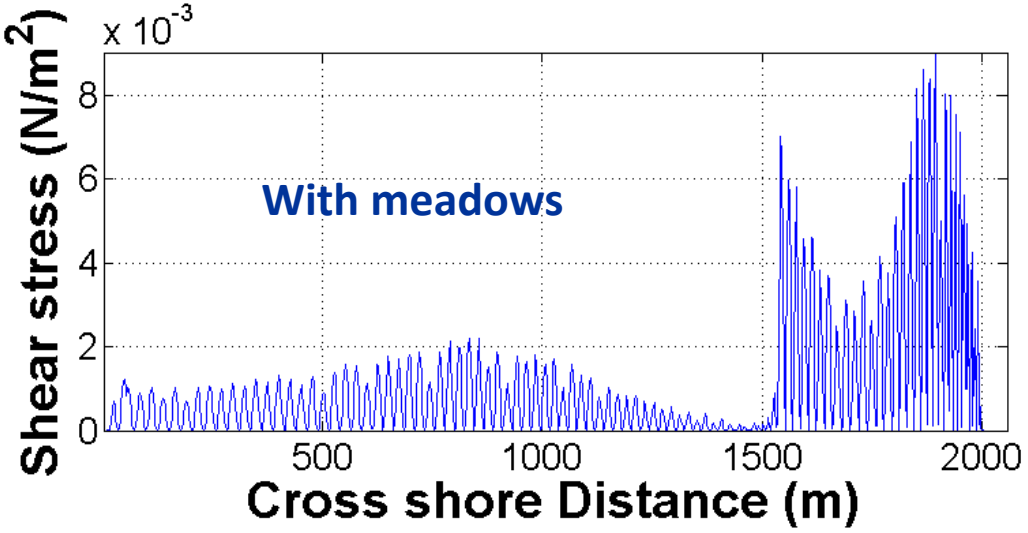


Fig. 11. Modelled bed shear stress (force per unit area) (SBEACH mode (wave height 1 m, period 6s) in the Negril coastal zone

The seagrass meadows spread the wave force on wider area and dissipate wave energy

Coastal ecosystem importance: beach protection by coral reefs

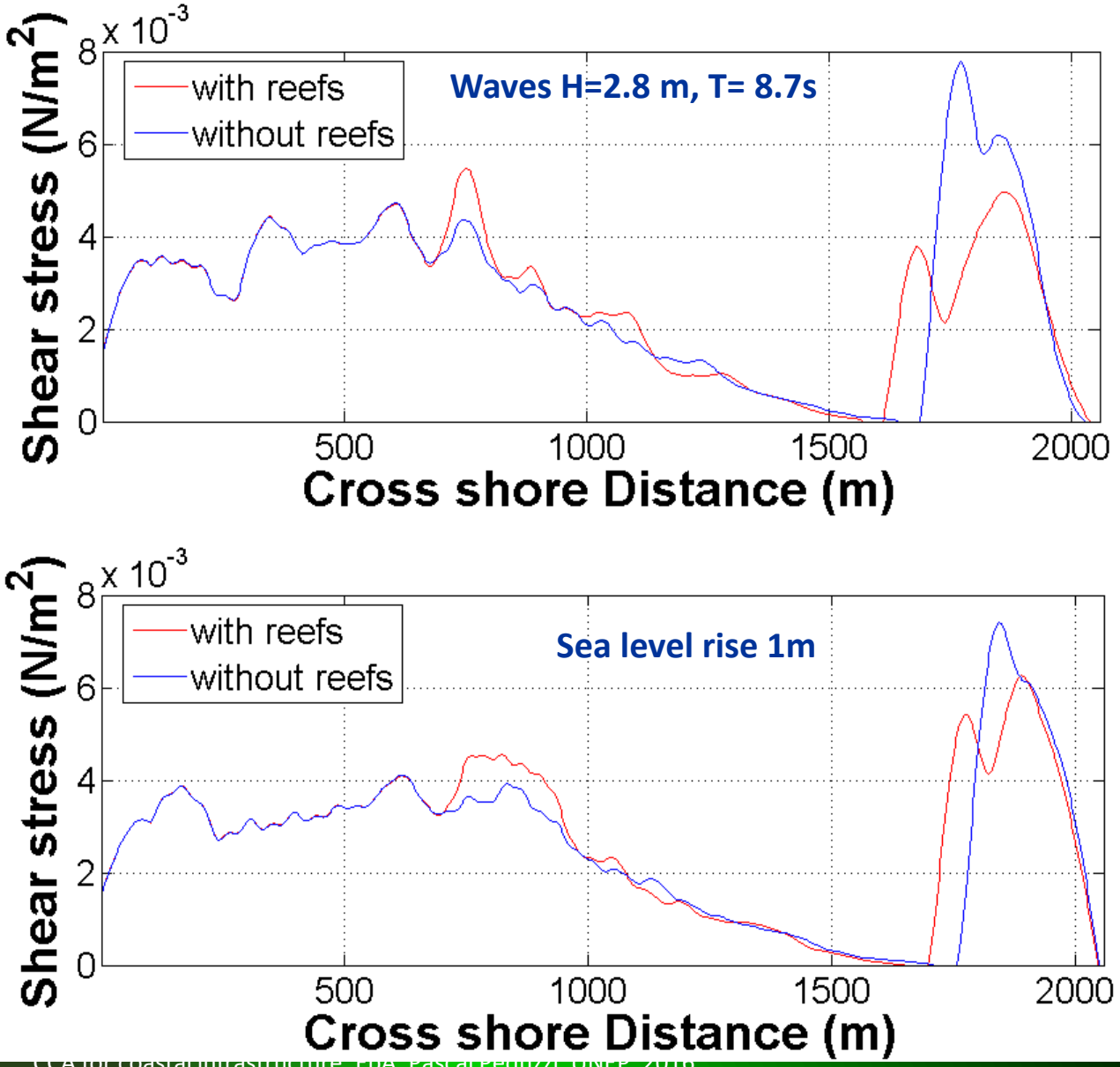
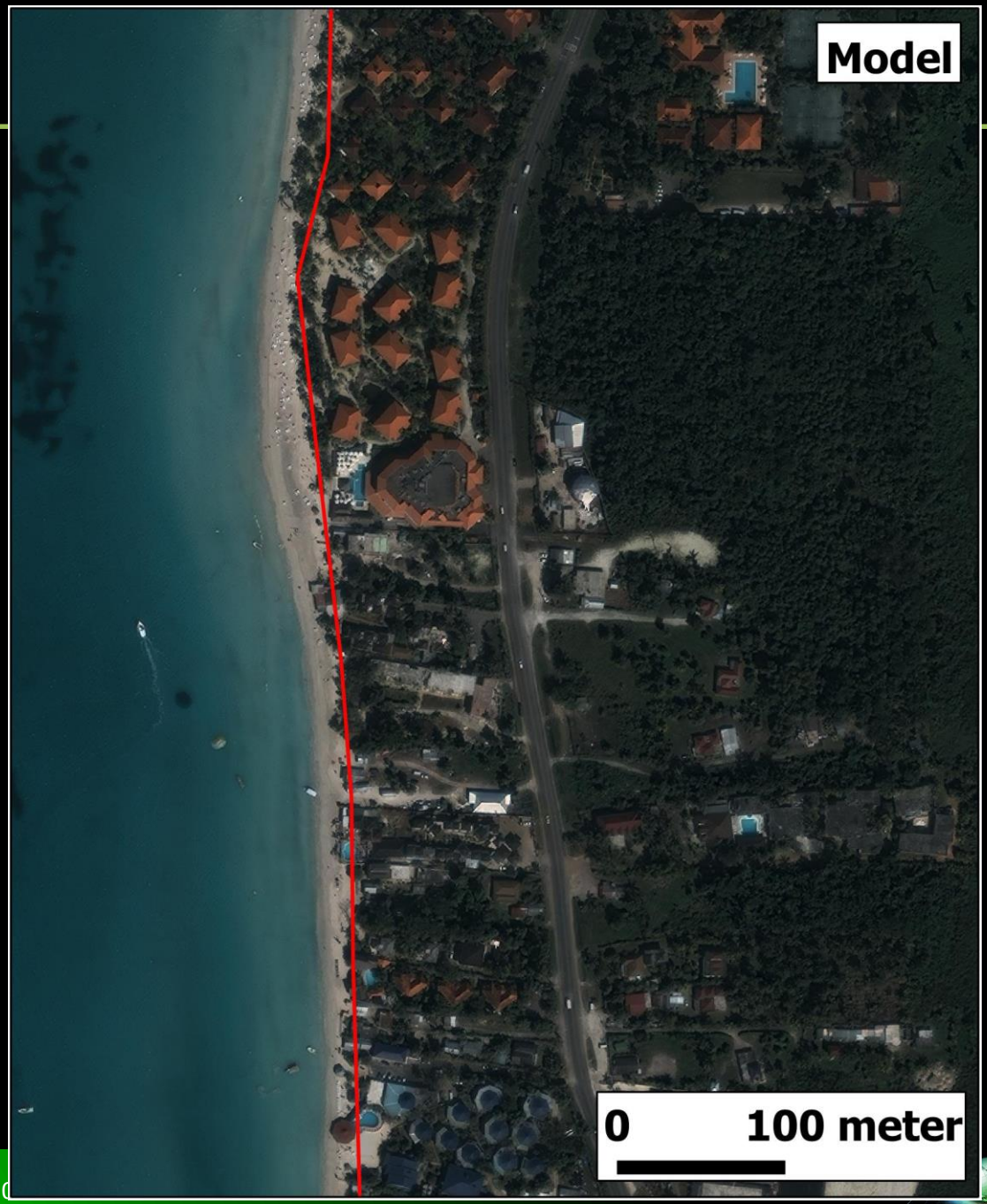


Fig. 9b. Modelled bed shear stress (force per unit area) (SBEACH model) induced by waves in the Negril coastal zone, showing the protection effects of inshore coral reefs

Results from RiVAMP

- Climate change “only” account for 9 %
- Destruction coral (lack of sewage, sediments,…)
- Daily removal of seagrass
- Conversion of the Morass to crop land


Model
0
100 meter

Coastal ecosystems: the security belts

UNEP | GRID Geneva

Jamaica

Coastal and marine ecosystems provide natural protection against wave energy, reduces storm surges and mitigate beach and soil erosion…

Seagrass

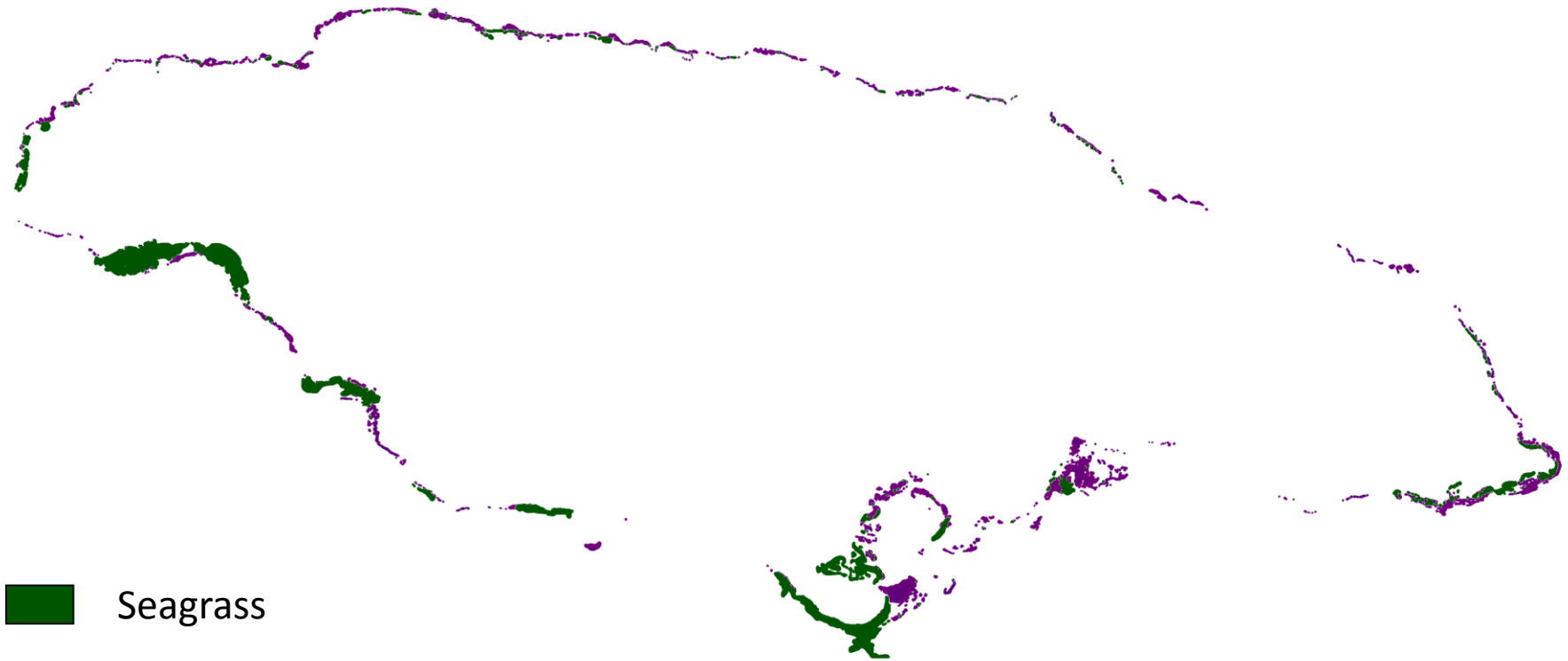
Coral

… they also offer other services such as storing carbon, have aesthetic values, are home of biodiversity, recreational activities, production of sand, support fisheries, water filtration.

Coastal ecosystems: the security belts

Coastal and marine ecosystems provide natural protection against wave energy, reduces storm surges and mitigate beach and soil erosion…

Jamaica



Seagrass

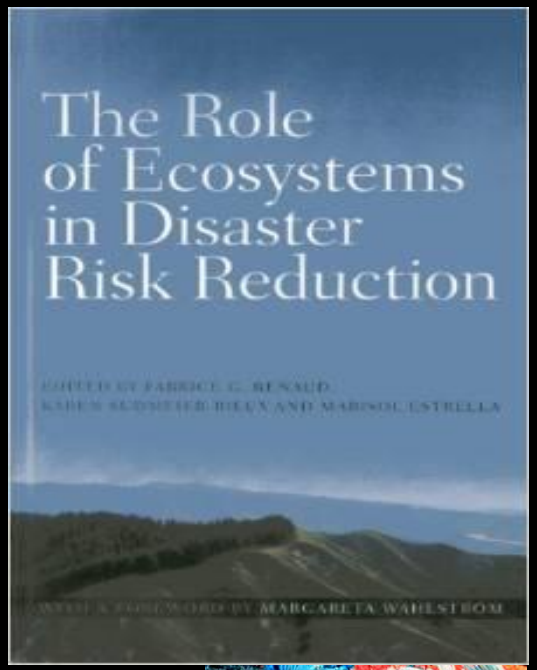
Coral

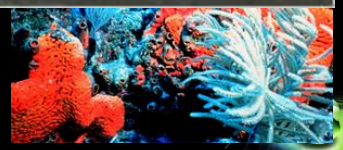
… they also offer other services such as storing carbon, have aesthetic values, are home of biodiversity, recreational activities, production of sand, support fisheries, water filtration.

Conclusions

Ecosystems: the "no regret option"

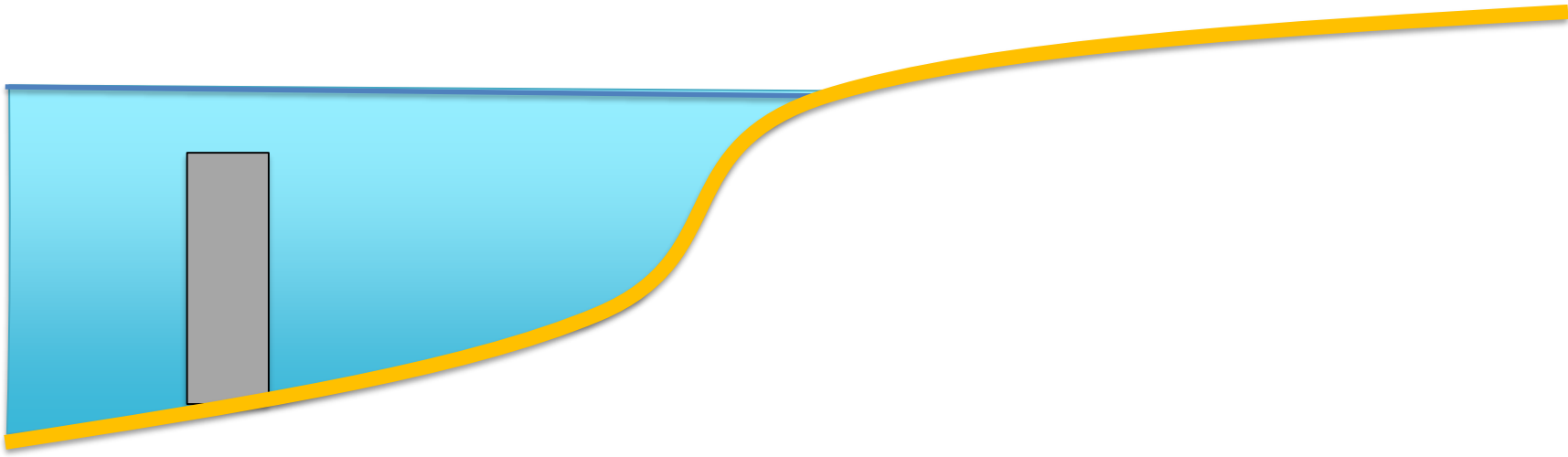
- ✓ Natural and environmental friendly
- ✓ Cost effective
- ✓ Easy, can be done with local population
- ✓ Low (if any) maintenance
- ✓ Esthetical value
- ✓ Carbon storage
- ✓ Support biodiversity
- ✓ Multiple services





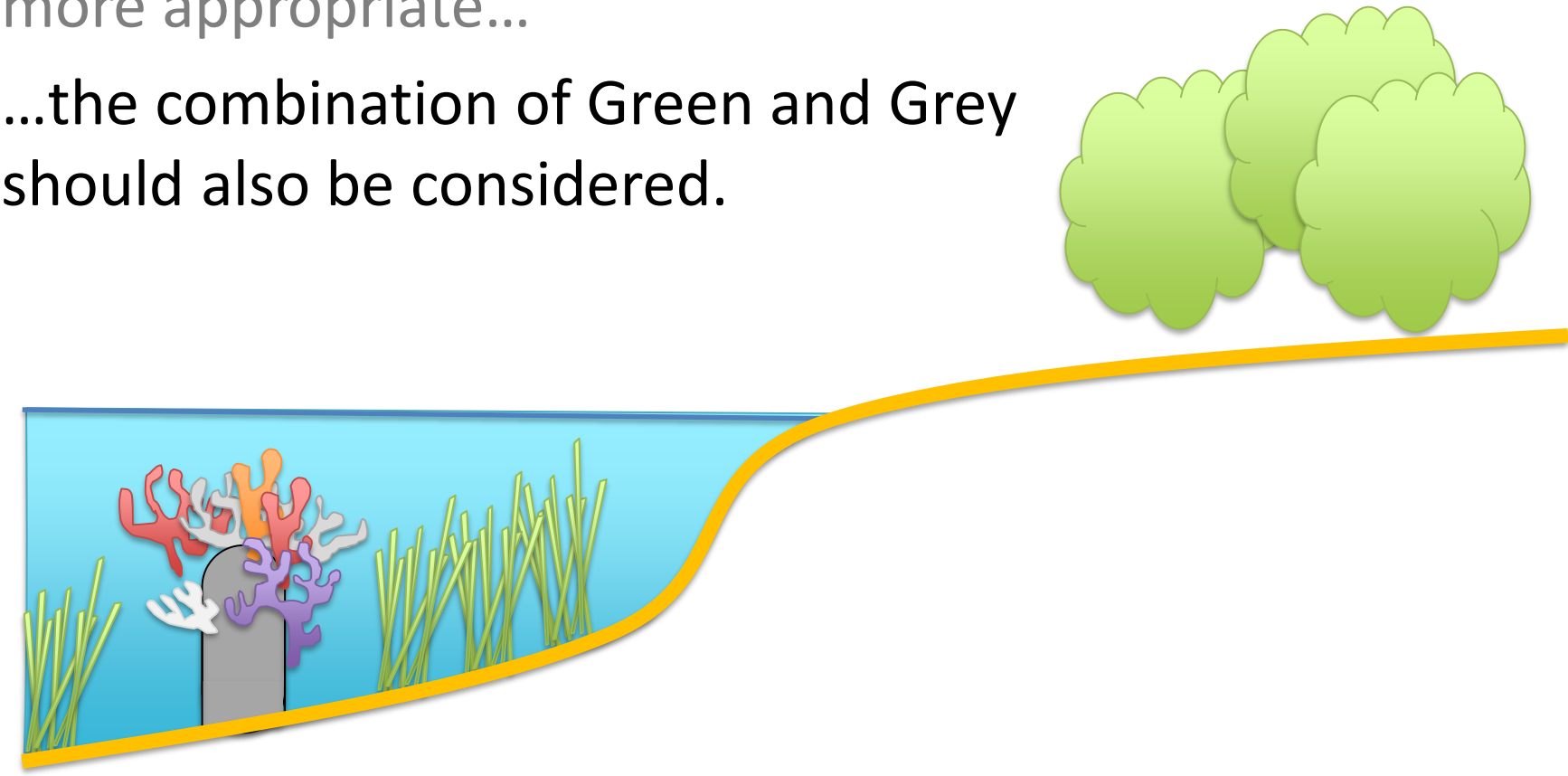
Combining Green & Grey

- Grey infrastructures are sometimes more appropriate,…



Combining Green & Grey

- Grey infrastructures are sometimes more appropriate…
- …the combination of Green and Grey should also be considered.



IPCC conclusions on anthropogenic climate change

- TAR, 2001 → *Likely* (>66%)
- AR4, 2007 → *Very Likely* (> 90%)
- AR5, 2013 → *Extremely likely* (>95%)

We do not need to wait until this is virtually certain (99%) to take actions!

The “no regret” option: