

Drivers and stressors of coastal zones, research challenges and information needs for coastal management

Claudia G. Simionato



UMI-IFAECI (3351)



Centro de Investigaciones del Mar y la Atmósfera
(CIMA/CONICET-UBA)

Instituto Franco-Argentino para el Estudio del Clima y sus
Impactos (UMI IFAECI/CNRS-CONICET-UBA)

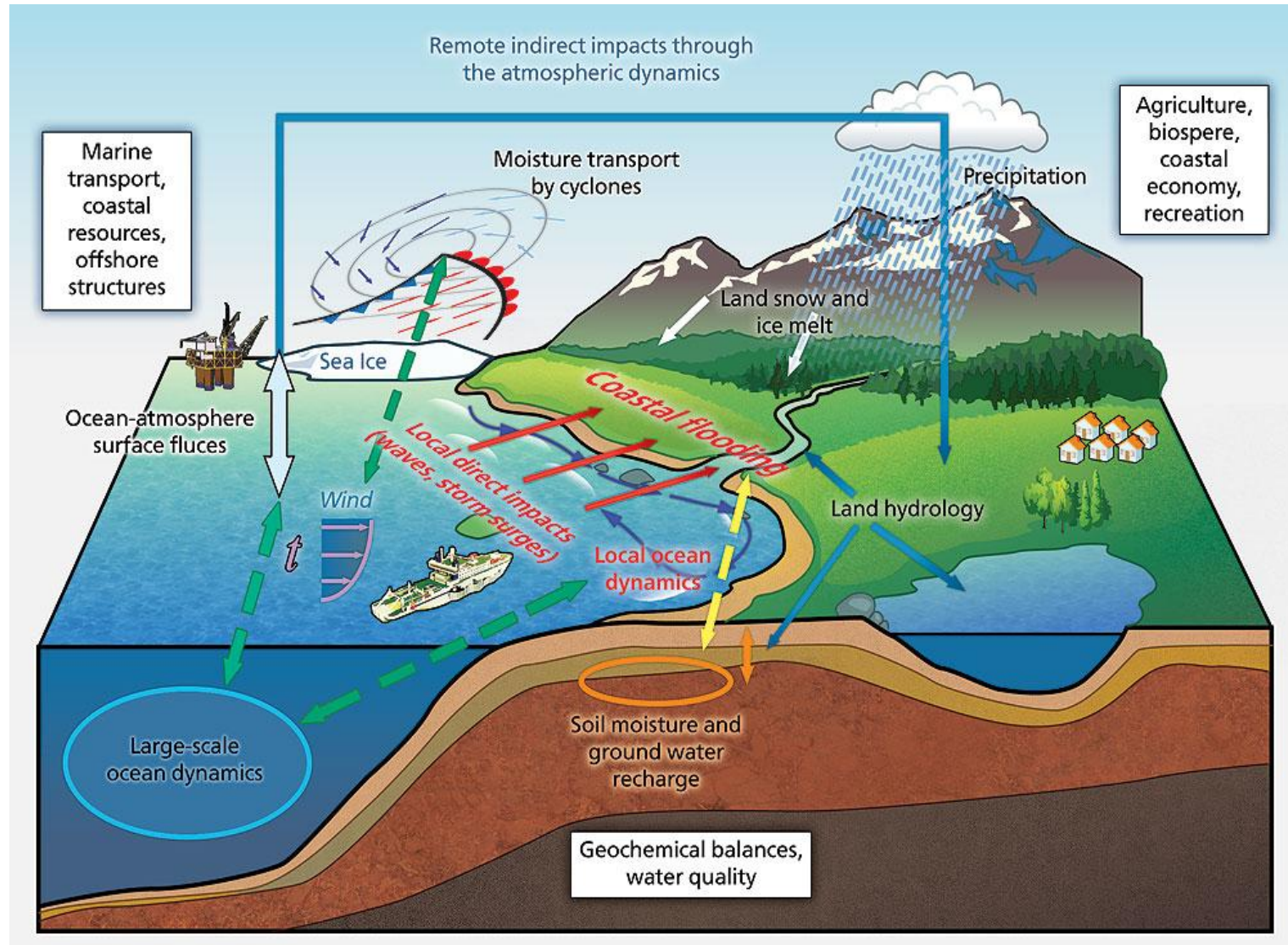
Departamento de Ciencias de la Atmósfera y los Océanos, FCEN,
Universidad de Buenos Aires



WCRP Conference for
Latin America and the Caribbean:
Developing, linking and applying climate knowledge



The coastal zone is one of the most dynamic natural systems



=> Interconnected systems

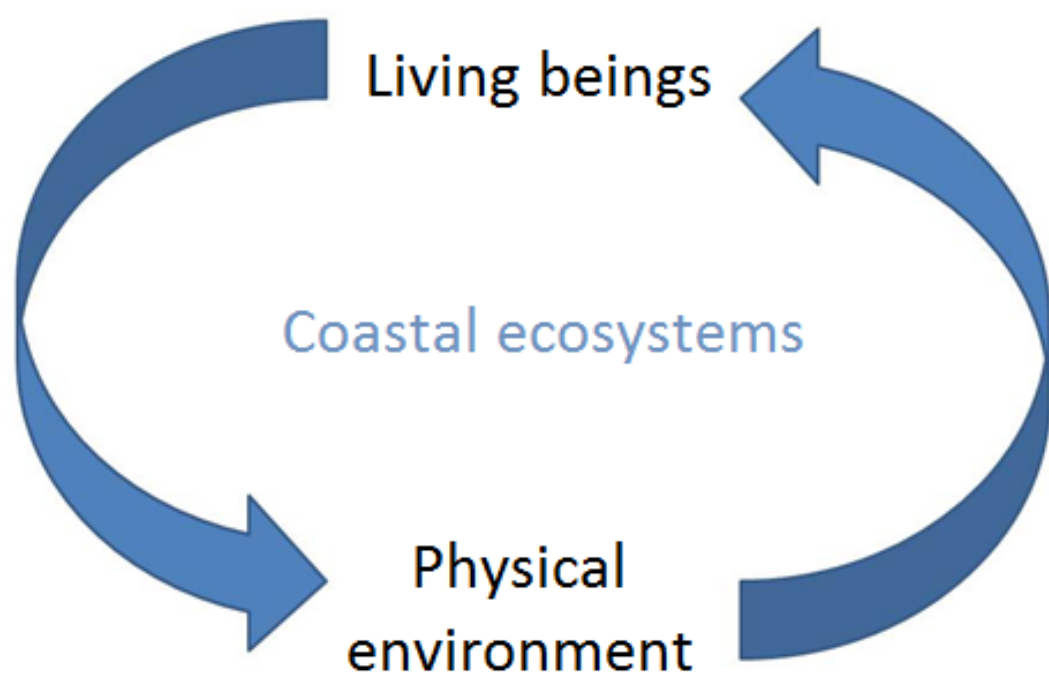
Definition

“the inland extent of coastal ecosystems is defined as *the line where land-based influences dominate* up to a maximum of 100 kilometers from the coastline or 50-meter elevation (whichever is closer to the sea), and with the outward extent as the 50-meter depth contour. Marine ecosystems begin at the low water mark and encompass the high seas and deepwater habitats”.



Definition

“coastal systems are considered as *the interacting low-lying areas and shallow coastal waters, including their human components...*”



Coral reefs



Seagrass beds



Barrier islands



Rocky coasts



Cliffs



Intertidal flats



Rock pools



Sandy beaches

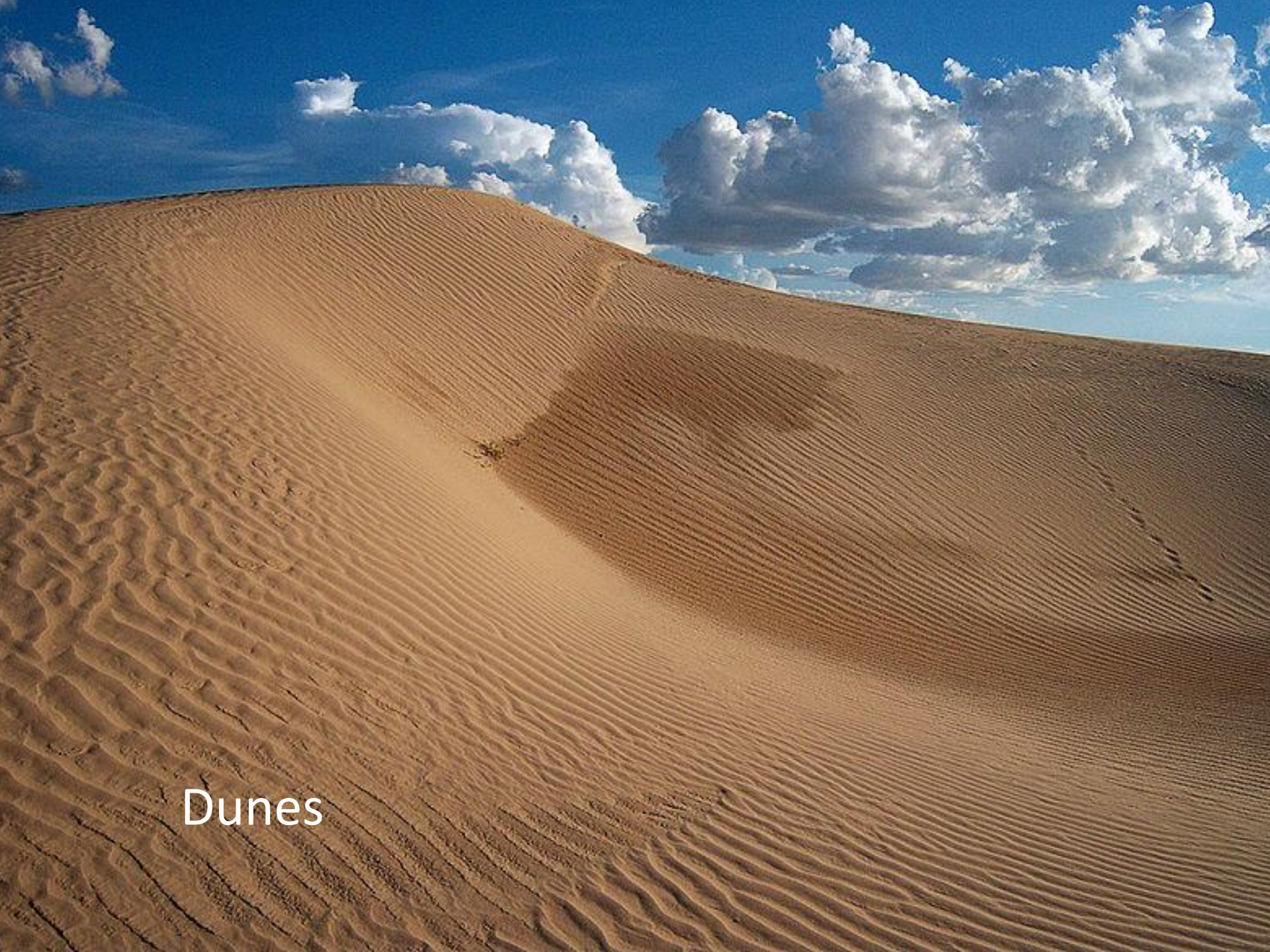


Rocky beaches





Pebble beaches



Dunes



Coastal lagoons

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30°34'44.88"N 87°12'43.01"W, elev. 10 m

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Estuaries



Coastal river floodplains

and mangrove forests

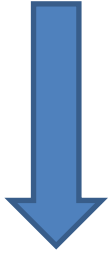




...of which have been highly modified over millennia by human activities.

Ecological and socioeconomic importance

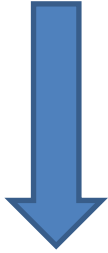
Ecological and socioeconomic importance



**Sustain economies
and
provide livelihoods**

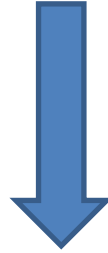
Harbors
Fisheries
Tourism
Other industries...

Ecological and socioeconomic importance



**Sustain economies
and
provide livelihoods**

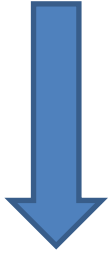
Harbors
Fisheries
Tourism
Other industries...



**Provide ecosystem
services**

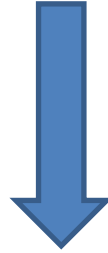
Providing food
Regulating atmospheric
composition
Cycling of nutrients and water...

Ecological and socioeconomic importance



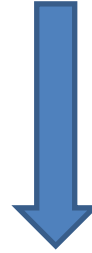
**Sustain economies
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Harbors
Fisheries
Tourism
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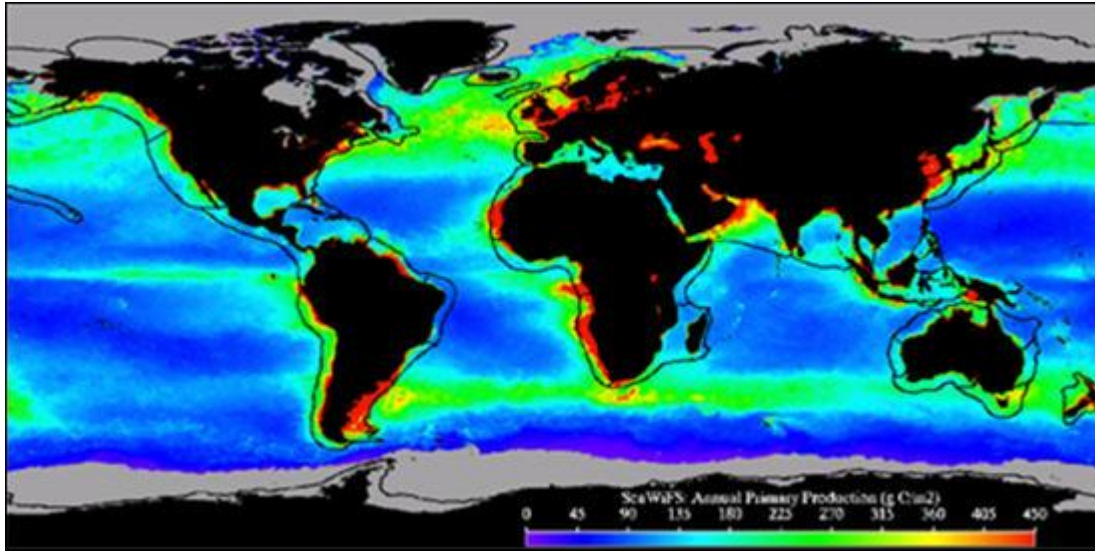
**Provide ecosystem
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Providing food
Regulating atmospheric
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Cycling of nutrients and water...



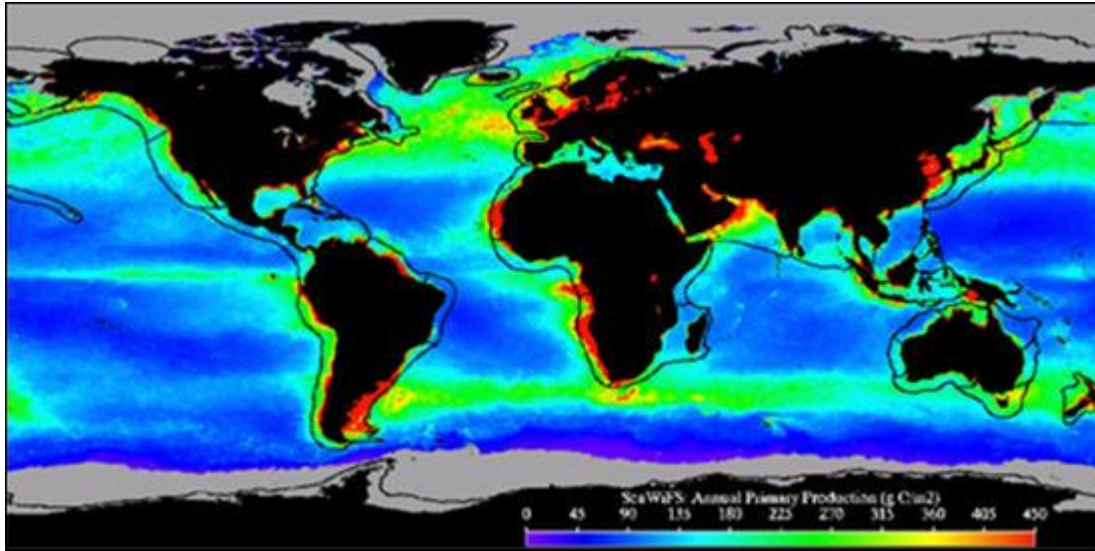
**Also have cultural and
aesthetic value**

These areas have been
centers of human
settlement since the dawn
of civilization



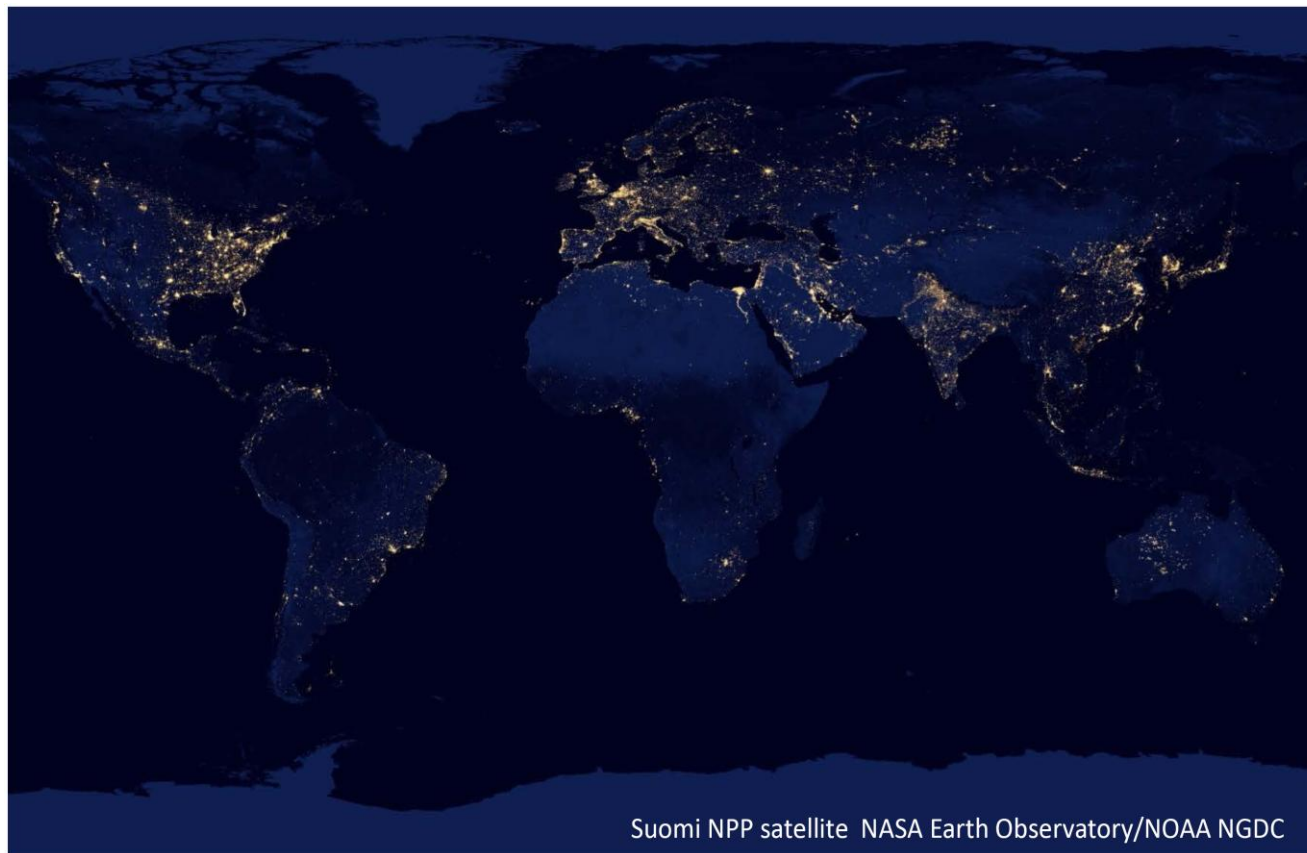
Global map of average primary productivity and the boundaries of the 64 Largest Marine Ecosystems of the world (www.lme.noaa.gov). The annual productivity estimates are based on SeaWiFS satellite data and the model developed by M. Behrenfeld and P.G. Falkowski (Limnol. Oceanogr. 42(1): 1997, 1-20). The color-enhanced image provided depicts a shaded gradient of primary productivity from a high of 450 gCm⁻²yr⁻¹ to a low of 10gCm⁻²y⁻¹.

Coastal ocean are repositories of biological diversity and provide a wide range of goods and services.



Global map of average primary productivity and the boundaries of the 64 Largest Marine Ecosystems (LMEs) of the world (www.lme.noaa.gov). The annual productivity estimates are based on Sea WiFS satellite data and the model developed by M. Behrenfeld and P.G. Falkowski (Limnol. Oceanogr. 42(1): 1997, 1-20). The color-enhanced image provided depicts a shaded gradient of primary productivity from a high of $450 \text{ gCm}^{-2}\text{yr}^{-1}$ to a low of $10 \text{ gCm}^{-2}\text{yr}^{-1}$.

Coastal margins equate to only 8% of the planet surface area but provide 25% of global productivity.



Nearly half the world's major cities are located within 50 kilometers of a coast;
It has been estimated that 40% of the human population lives within 100 km to the coast.

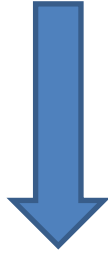
Top Ten Largest Cities → eight of them are coastal

Tokyo, Japan (coastal); Mexico City, Mexico; Mumbai, India (coastal); São Paulo, Brazil; New York City, USA (coastal); Shanghai, China (coastal); Lagos, Nigeria (coastal); Los Angeles, USA (coastal); Calcutta, India (coastal); Buenos Aires, Argentina (coastal)



External influences on coastal systems

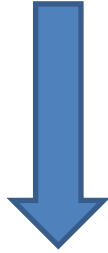
External influences on coastal systems



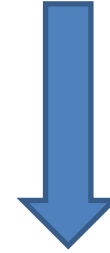
**Terrestrial influences
(mostly anthropogenic
in nature)**

They include land use changes
and all the consequences of
changing hydrological regimes and
nutrient loading from sediment
transport, runoff, and reduction of
sediments through rivers.

External influences on coastal systems



**Terrestrial influences
(mostly anthropogenic
in nature)**



**Marine influences,
(mostly natural
phenomena)**

Such as climate variability, weather events (storms and cyclones), tsunamis, and wave patterns and coastal and ocean currents that affect the processes of nutrient, material, and heat transfer and mediate geomorphological changes.

Drivers and stressors of coastal zone ecosystems



Indirect



Direct

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion



increase of populations is followed by
increased demands for resources

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities



the poor often must emphasize survival over sustainability, while the wealthy are far removed from the consequences of overexploitation of resources

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure



policies that do not take into account the
inherent characteristics of ecosystems
permit their unsustainable exploitation

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion

Distribution of wealth and social
inequalities

Policy failure

Market failure and/or distortions ➡

ecosystem goods and services mostly
bypass markets and thus are often
undervalued and underpriced
=> the costs of environmental destruction
are not reflected in the market

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion

Distribution of wealth and social
inequalities

Policy failure

Market failure and/or distortions

Globalization



trade and market liberalization have created a global system in which commodities and their prices are highly influenced by international pressures that do not usually take local and regional environmental impacts of production into account

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion

Distribution of wealth and social
inequalities

Policy failure

Market failure and/or distortions

Globalization

Poor development model →

a development model that equates
increased consumption rates with growth
and advancement

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model



Direct

Loss, fragmentation, and
degradation of habitats

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model



Direct

Loss, fragmentation, and
degradation of habitats
Overexploitation of resources

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model



Direct

Loss, fragmentation, and
degradation of habitats
Overexploitation of resources
Pollution



waste, nutrient enrichment by land-based
use of chemical fertilizers and sewage and
from toxins such as pesticides and
hazardous chemicals

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model



Direct

Loss, fragmentation, and
degradation of habitats
Overexploitation of resources
Pollution
Introduction of alien invasive
species



this can be considered a form of biological
pollution

Drivers and stressors of coastal zone ecosystems



Indirect

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model



Direct

Loss, fragmentation, and
degradation of habitats
Overexploitation of resources
Pollution
Introduction of alien invasive
species
Climate change and variability



interact with the previous factors listed, in
many cases reinforcing their impacts

Drivers and stressors of coastal zone ecosystems



Indirect



Direct

Population expansion
Distribution of wealth and social
inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model

Loss, fragmentation, and
degradation of habitats
Overexploitation of resources
Pollution
Introduction of alien invasive
species
Climate change and variability

Agents of global change

Consequences (observed and/or predicted)

Changes in species distribution, organism metabolism and ecological processes such as productivity and species interactions.

Changes in ocean chemistry, eutrophication and acidification, hypoxia.

Rising Sea Level.

Chronic erosion and contamination.

Shifts in weather patterns.

Greater spreading of exotic species.

Ecosystems often exhibit nonlinear responses brought on by crossing thresholds that alter their composition and key processes



Affect ecosystem stability, resilience, and functions

Once some critical threshold is passed, even relatively small stresses may trigger rapid ecosystem degradation and loss of integrity.



Understand how we can exploit coastal resources within environmental and biological constraints, to ensure enduring access to them through informed regulation, management and utilization.

SCIENCE => INFORMATION



**expanding the knowledge base of coastal physical
and biological resources**

**Better define the ecosystems and understand the
effects of environmental variability and change, and
human activities**

Information to aid improving coastal management

Information to aid improving coastal management



Establishing an integrated temporal and spatial baseline of biological and physical resources, as well as human activities, as a basis for understanding the dynamics and sensitivities of ocean and coastal systems.

Information to aid improving coastal management



Establishing an integrated temporal and spatial baseline of biological and physical resources, as well as human activities, as a basis for understanding the dynamics and sensitivities of ocean and coastal systems.

Key issues

Developing integrated information systems to synthesize, analyze and make available data
Strategic collection of data to address gaps and priorities
Developing robust monitoring and assessment programs

Information to aid improving coastal management



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Understanding the interconnectedness between coastal systems, including human activities.

Information to aid improving coastal management



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Understanding the interconnectedness between coastal systems, including human activities.

Key issues:

Identify the processes that drive biophysical variation

Increased understanding of ecosystem services and resilience

Better understanding pressures, risks and threats

Determine stress thresholds

Forecasting impacts of human and natural processes

Information to aid improving coastal management



Establishing an integrated temporal and spatial baseline of biological and physical resources, as well as human activities, as a basis for understanding the dynamics and sensitivities of ocean and coastal systems.



Understanding the interconnectedness between coastal systems, including human activities.



Enhancing the evidence base to inform management and policy frameworks to optimize the sustainable use and conservation of coastal resources.

Information to aid improving coastal management



Establishing an integrated temporal and spatial baseline of biological and physical resources, as well as human activities, as a basis for understanding the dynamics and sensitivities of ocean and coastal systems.



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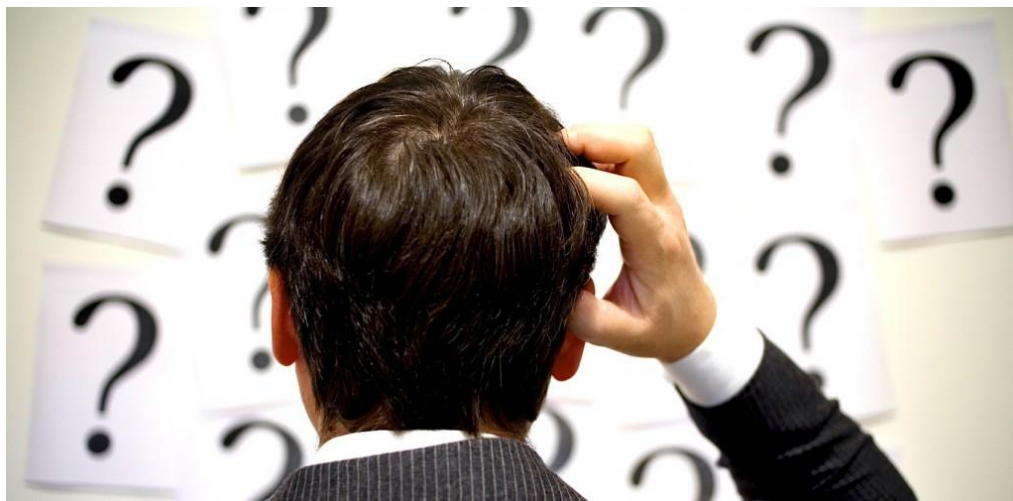
Key issues:

Identify appropriate management targets based on environmental thresholds and values

Innovation in resource use and rehabilitation

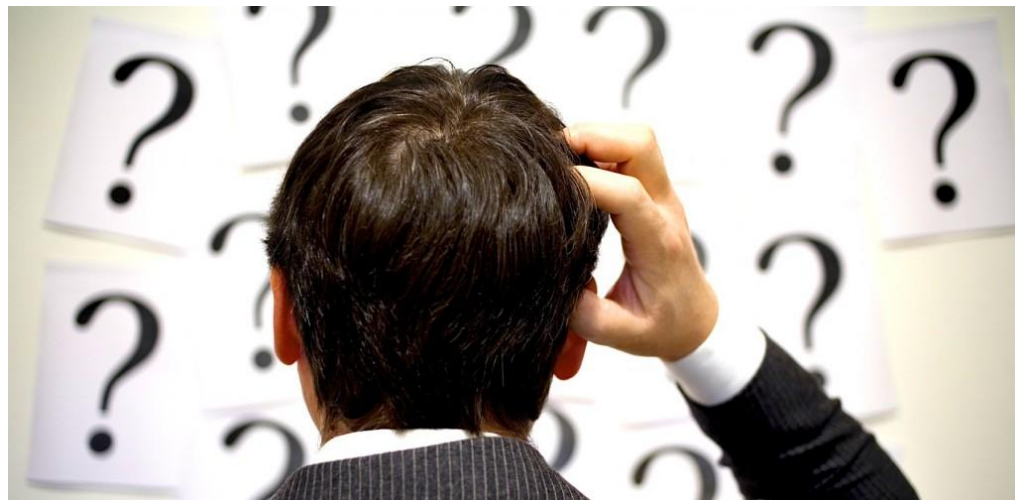
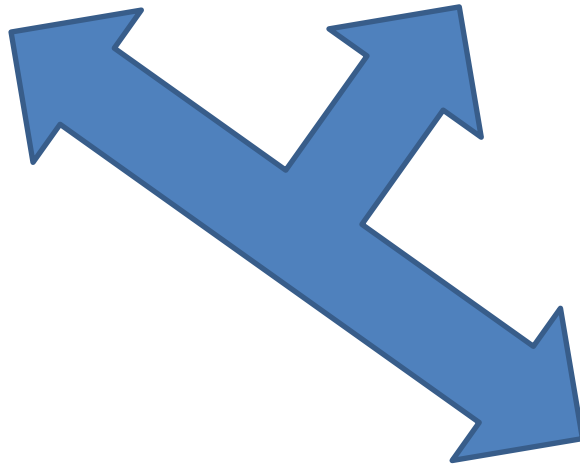
Quantifying and communicating uncertainty and risk

Increasing value of resources and optimizing efficiencies in the value chain, to improve the overall sustainability of resource use





(COASTAL?) SERVICES



It must be ensured that scientific information is used in decision-making effectively.

A key on-going problem lies in the way information is presented to those who formulate and implement policy and take management decisions.

Data alone are not enough!

Most people need help turning scientific information into information that can be used when making important decisions about coastal management.

Application of science



No only providing information on the state of the coastal environment, identifying indicators for assessing environmental change or developing mechanisms for monitoring and predicting the effect of policy and management options.

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But information must also inform the analysis of issues, help the user to ask the right questions and then provide signposts to where appropriate data can be found.

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But information must also inform the analysis of issues, help the user to ask the right questions and then provide signposts to where appropriate data can be found.

This has important implications for all data providers, research workers and those attempting to define indicators and develop management tools.
It is one the biggest challenges when thinking about effective services.

Thank you