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

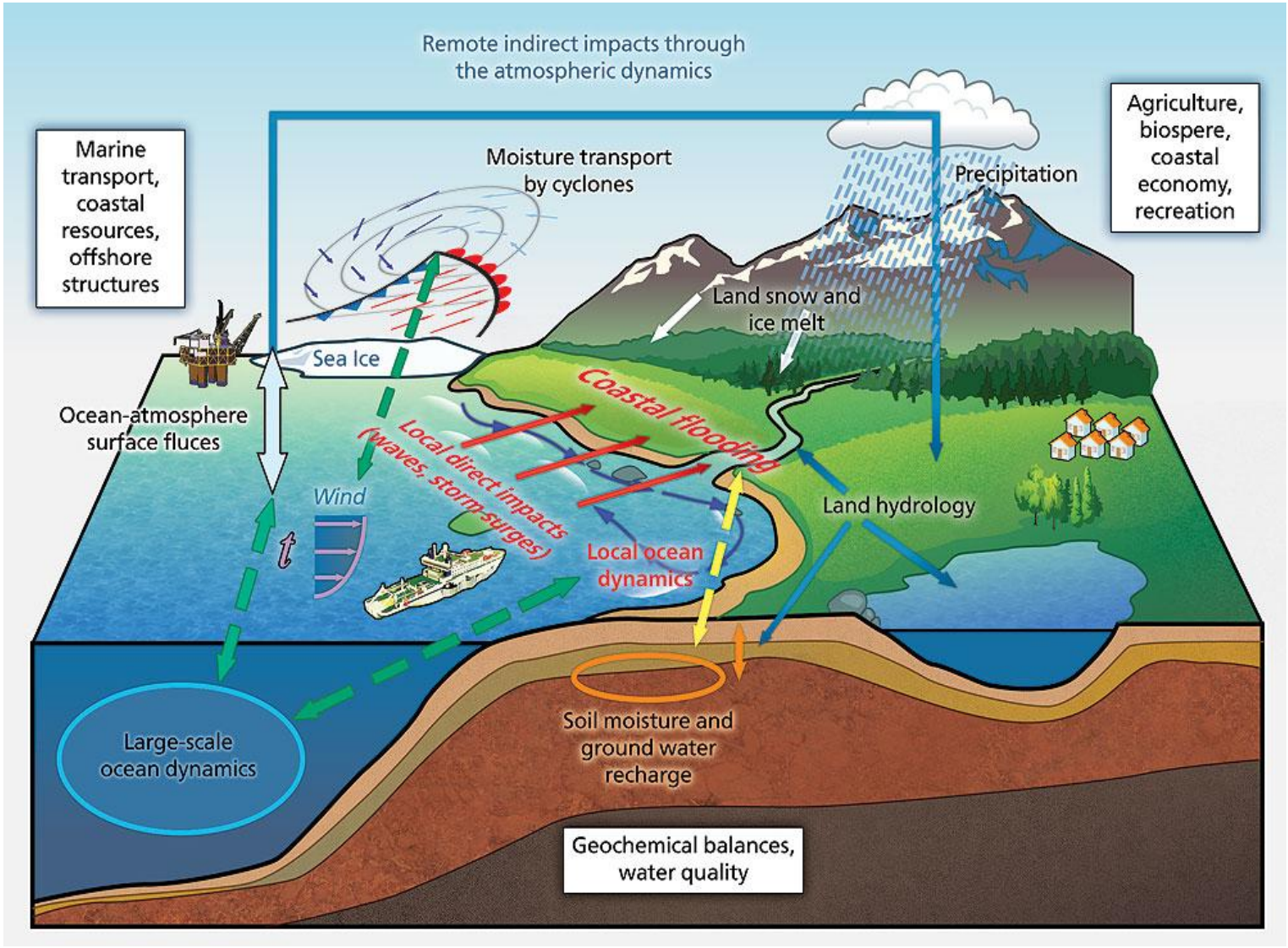
Claudia G. Simionato

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

Carrasco, Montevideo, March 20th 2014

The coastal zone is one of the most dynamic natural systems



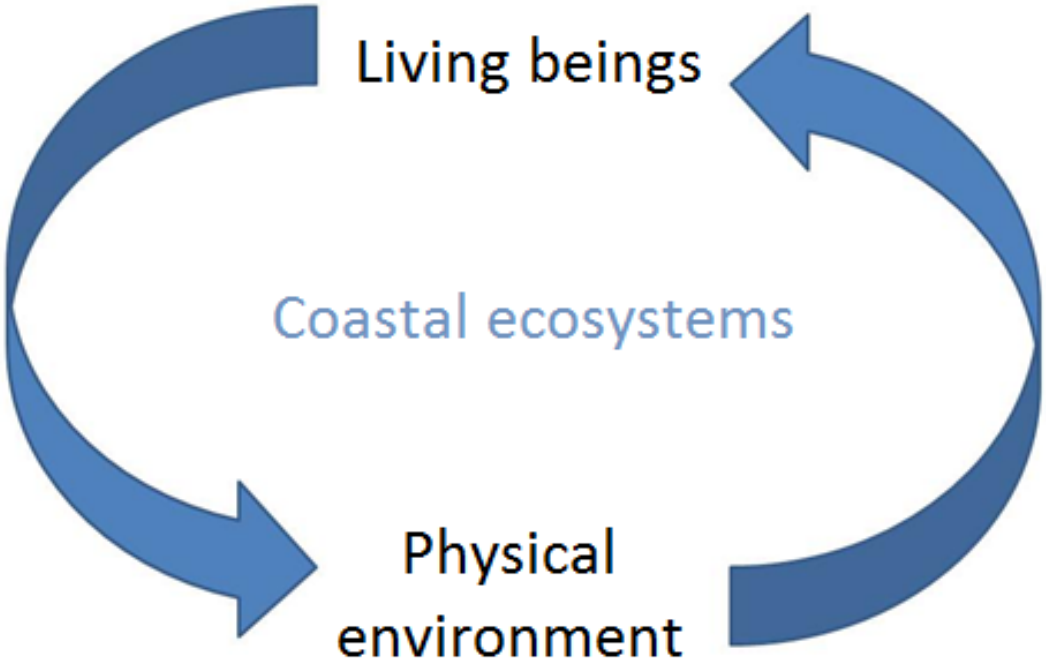
=> Interconnected systems

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*…"


Living beings
Coastal ecosystems
Physical environment

Coral reefs


Seagrass beds

Barrier islands

Rocky coasts

Cliffs

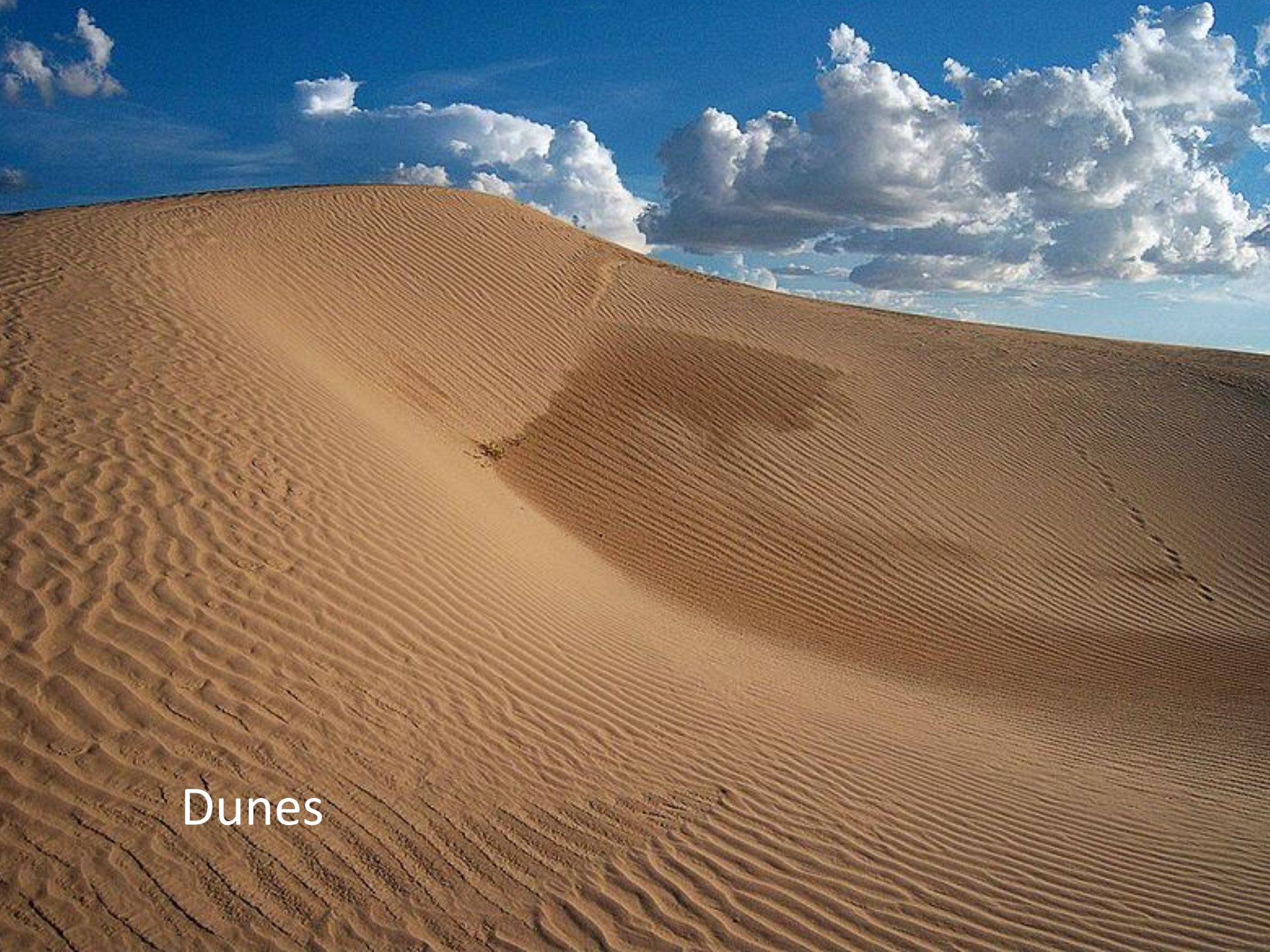

Intertidal flats


Rock pools

Sandy beaches

Rocky beaches


Pebble beaches


Dunes


Coastal lagoons
Google


Estuaries

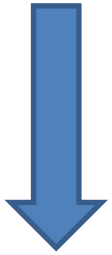

Coastal river floodplains


and mangrove forests

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

Ecological and socioeconomic importance

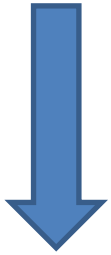
Ecological and socioeconomic importance



Sustain economies
and
provide livelihoods

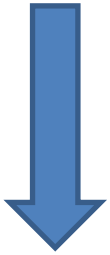
Harbors
Fisheries
Tourism
Other industries…

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 and provide livelihoods

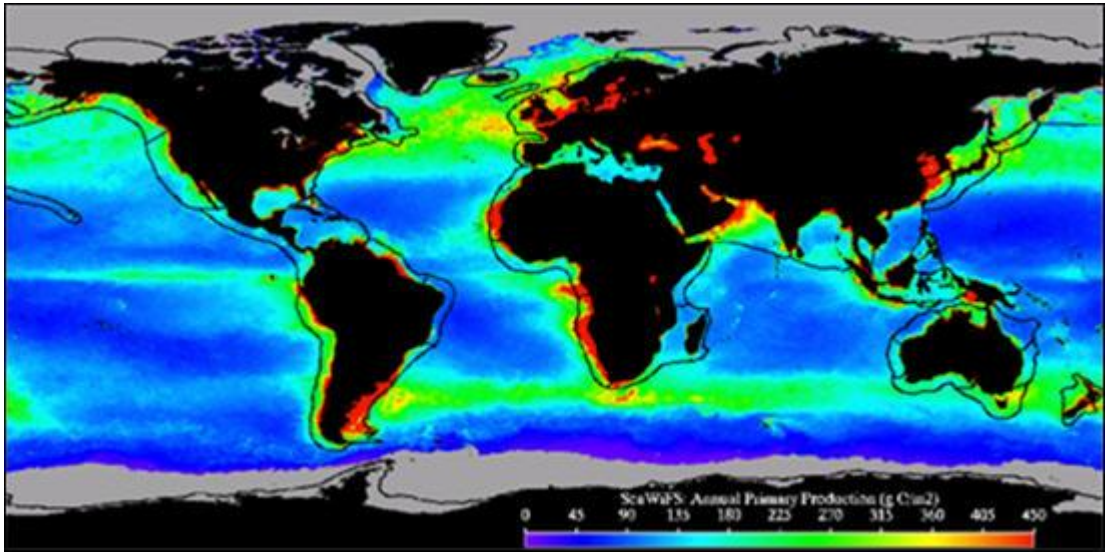
Harbors
Fisheries
Tourism
Other industries…

Provide ecosystem services

Providing food
Regulating atmospheric composition
Cycling of nutrients and water…

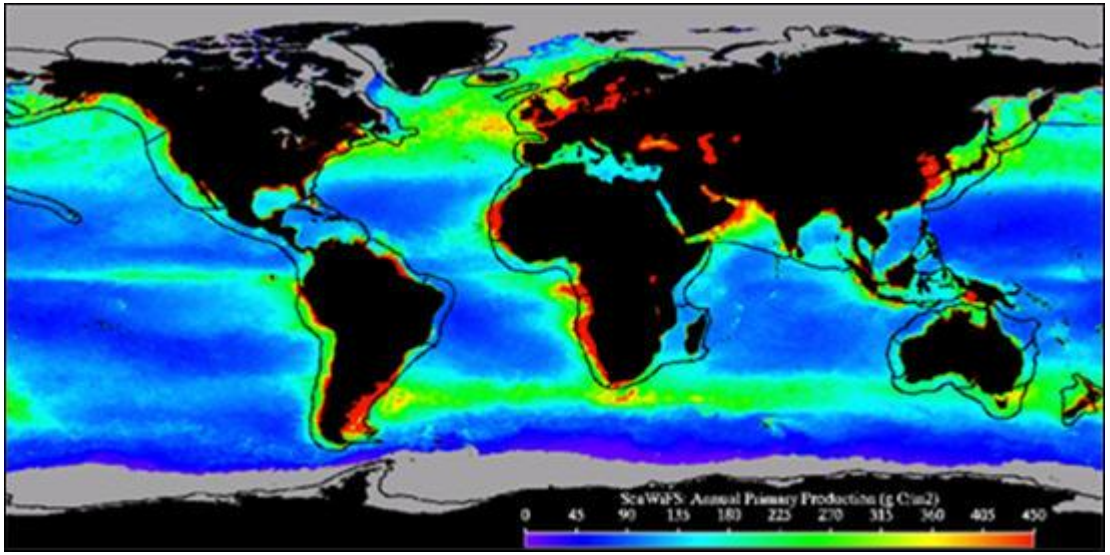
Also have cultural and aesthetic value

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



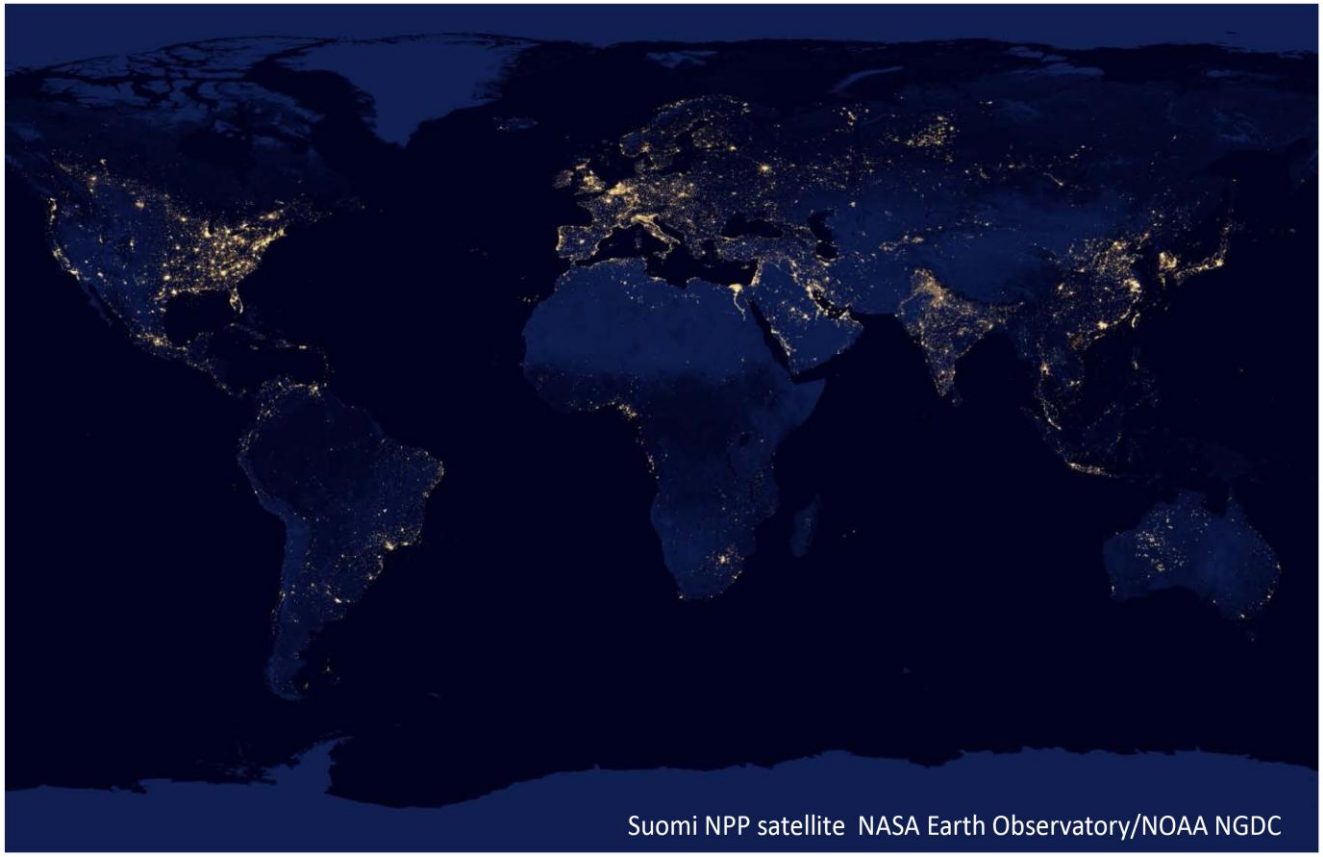
Global map of average primary productivity and the boundaries of the 64 Largest Marine Ecosystems of the world (www.lme.noaa.gov). The annual productivity estimates are based on Sea WiFS satellite data and the model developed by M. Behrenfeld and P.G. Falkowski (Limnol. Oceangr. 42(1): 1997, 1-20). The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

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. Oceangr. 42(1): 1997, 1-20). The color-enhanced image provided depicts a shaded gradient of primary productivity from a high of 450 $gCm^{-2}yr^{-1}$ to a low of $10gCm^{-2}y^{-1}$.

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



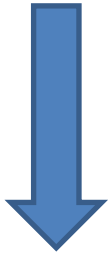
Nearly half the world's major cities are located within 50 kilometers of a coast;
It has been estimated that 40% of the human population lives within 100 km to the coast.

Top Ten Largest Cities → eight of them are coastal

Tokyo, Japan (coastal); Mexico City, Mexico; Mumbai, India (coastal); Sáo 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

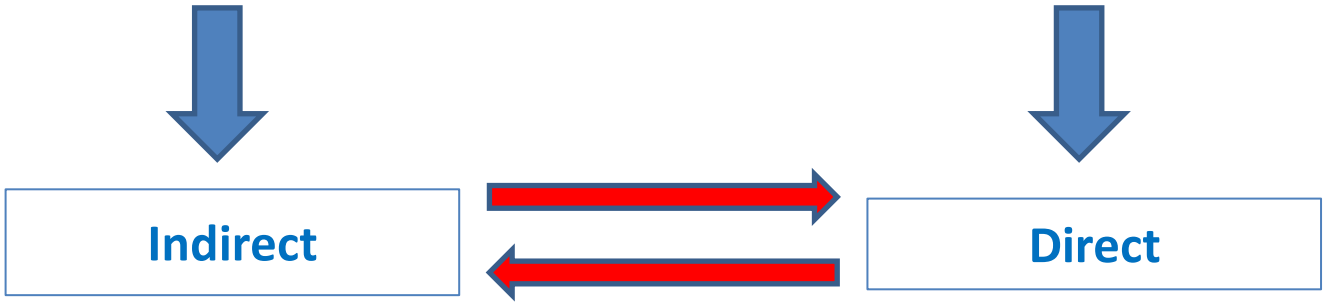
Population expansion
Distribution of wealth and social inequalities
Policy failure
Market failure and/or distortions
Globalization
Poor development model

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



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.

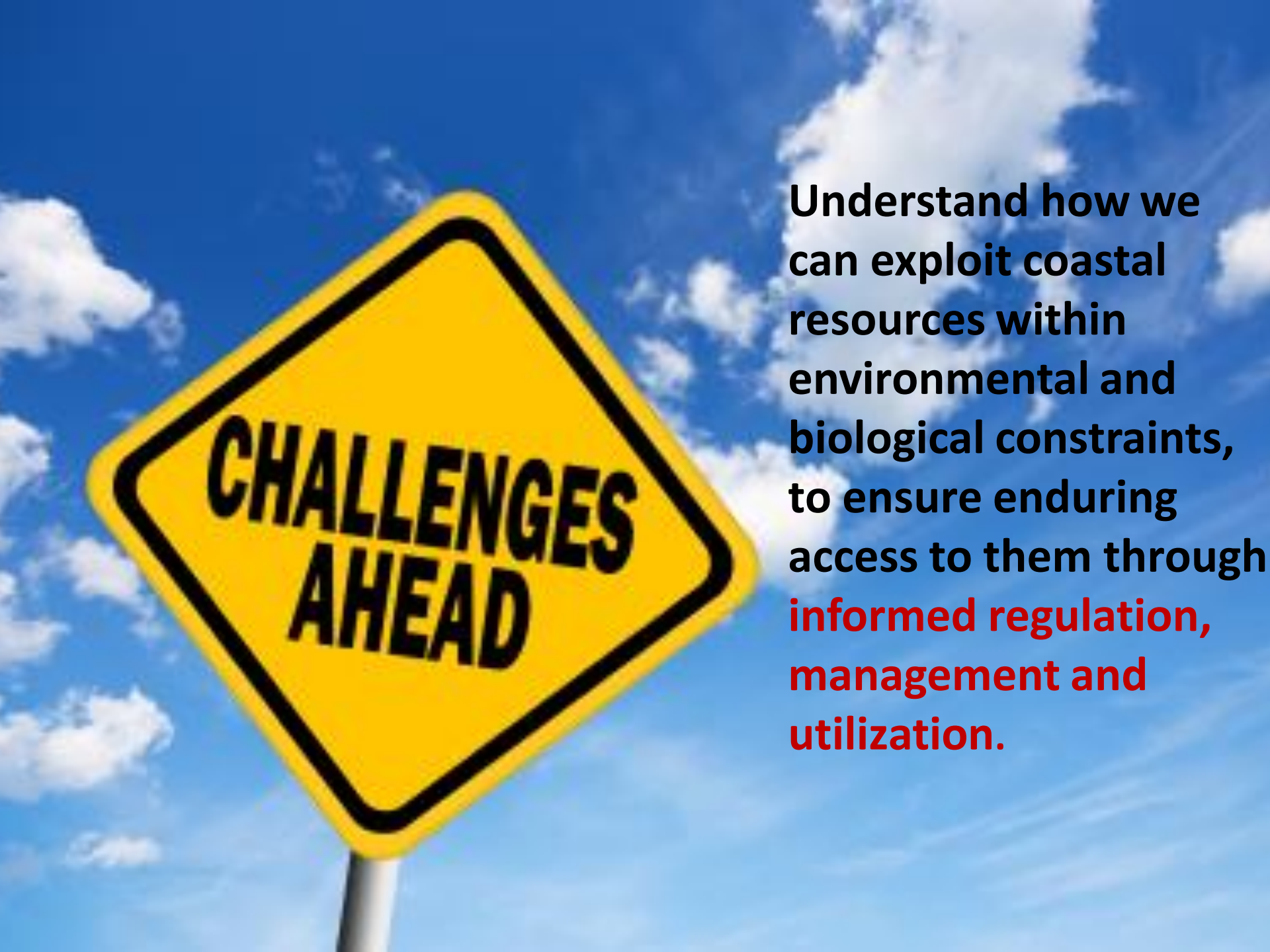
Shifts in weather patterns.

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

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.

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.

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.

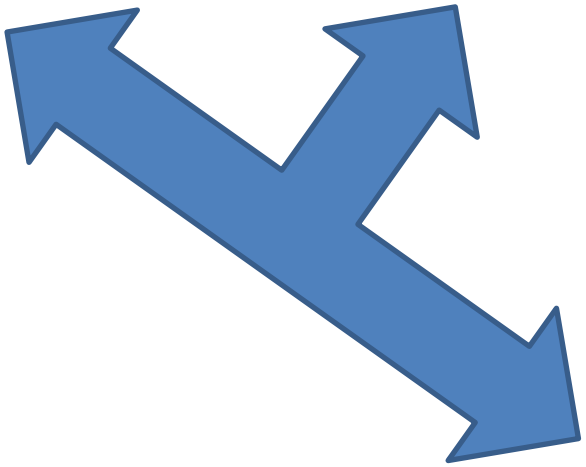
Understanding the interconnectedness between coastal systems, including human activities.

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

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


UNIVERSITY OF NORTH DAKOTA
WARREN ENGINEERING
SCIENTIFIC MEASURING SYSTEMS

(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.

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.

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.

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.

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