CoastPredict
with The Global Ocean Observing System

CoastPredict: Empowering coastal communities to address global challenges

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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

This programme is endorsed by the **UN Decade of Ocean Science**

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Outline

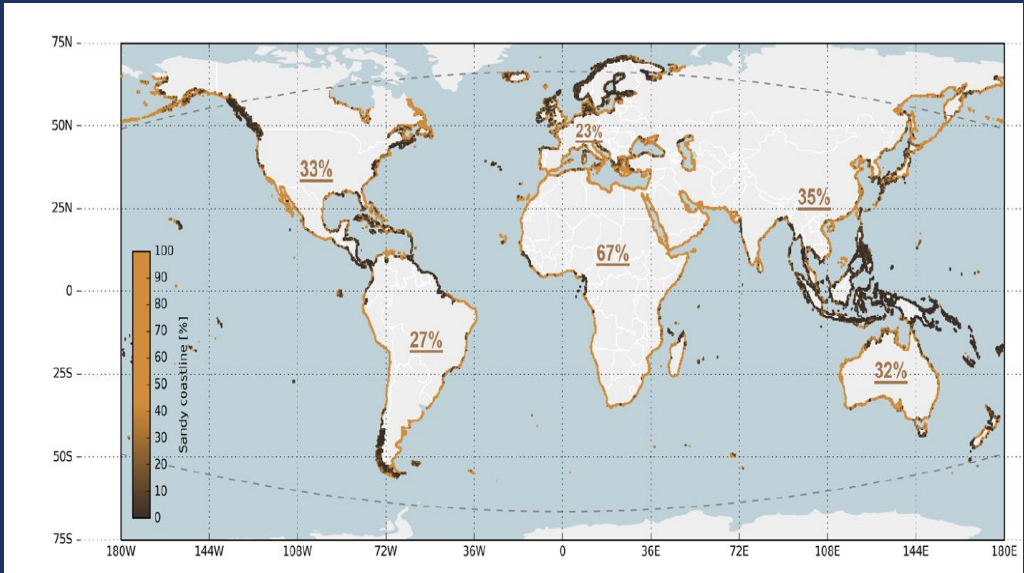
The concept of the Global Coastal Ocean

The knowledge and technology gaps

The UN Decade for ocean science

The CoastPredict Solutions

Outlook



Sandy coastlines

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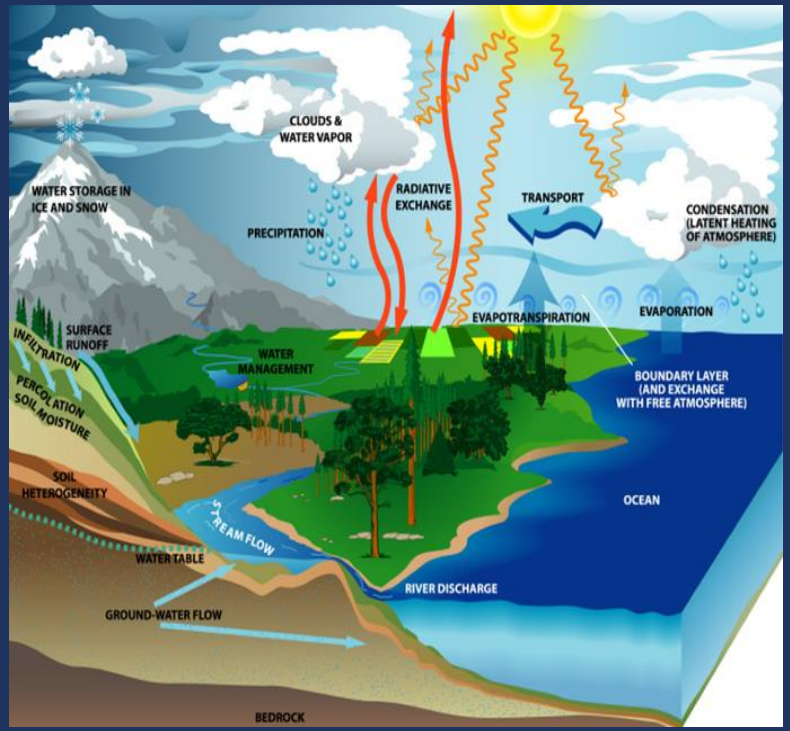
THE GLOBAL COASTAL OCEAN
(The Sea, Vol 10 and 11)

PRESENT NON-UNIFORM TERMINOLOGY
the coastal ocean, coastal zone, coastal margin, continental shelf, continental margin, shelf sea

PROPOSED DEFINITION:
the coastal ocean - that area, extending ***inshore*** *from the estuarine mouths* ***to river catchment, to the urban settlements*** *on the one side and on the other to the* ***offshore,*** *from the* ***surf zone to the continental shelf and slope*** *where waters of continental origins meet open ocean currents.*



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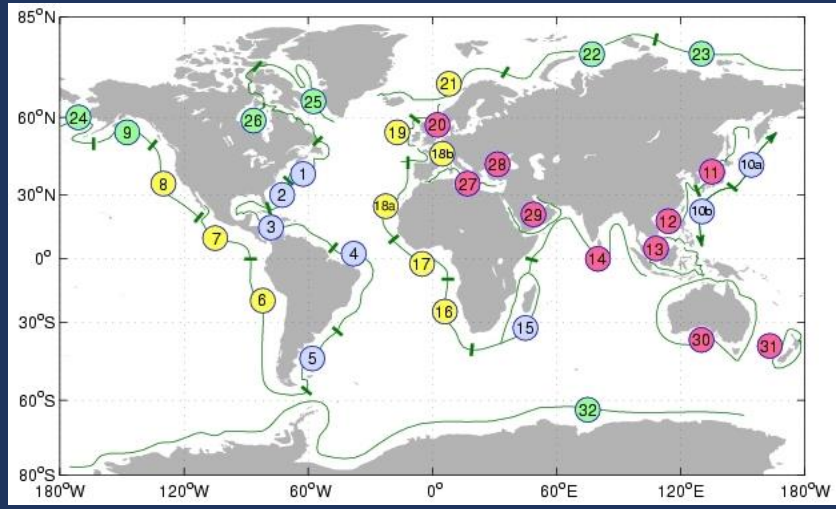
First Classification of subregions done by geomorphology, geography and dynamical processes (The Sea Vol. 14)

- **4 panregions** - eastern and western boundaries, polar, semi-enclosed seas/islands;
- **5 physical processes** - boundary layers, tides, **rivers,** wind and buoyancy forcing, boundary currents;
- **6 offshore zones** - near shore, **freshwater influence**, well mixed, tidal fronts, thermally stratified, shelf-edge;
- **7 biogeochemical processes** - subtropical shelf pumps, temperate shelf: biology or physics dominant, upwelling: biology or physics dominant, coral reefs, polar ice pump;



Western boundary – blue
Eastern boundary – yellow
Polar boundary – green
Semi-enclosed seas and islands- red

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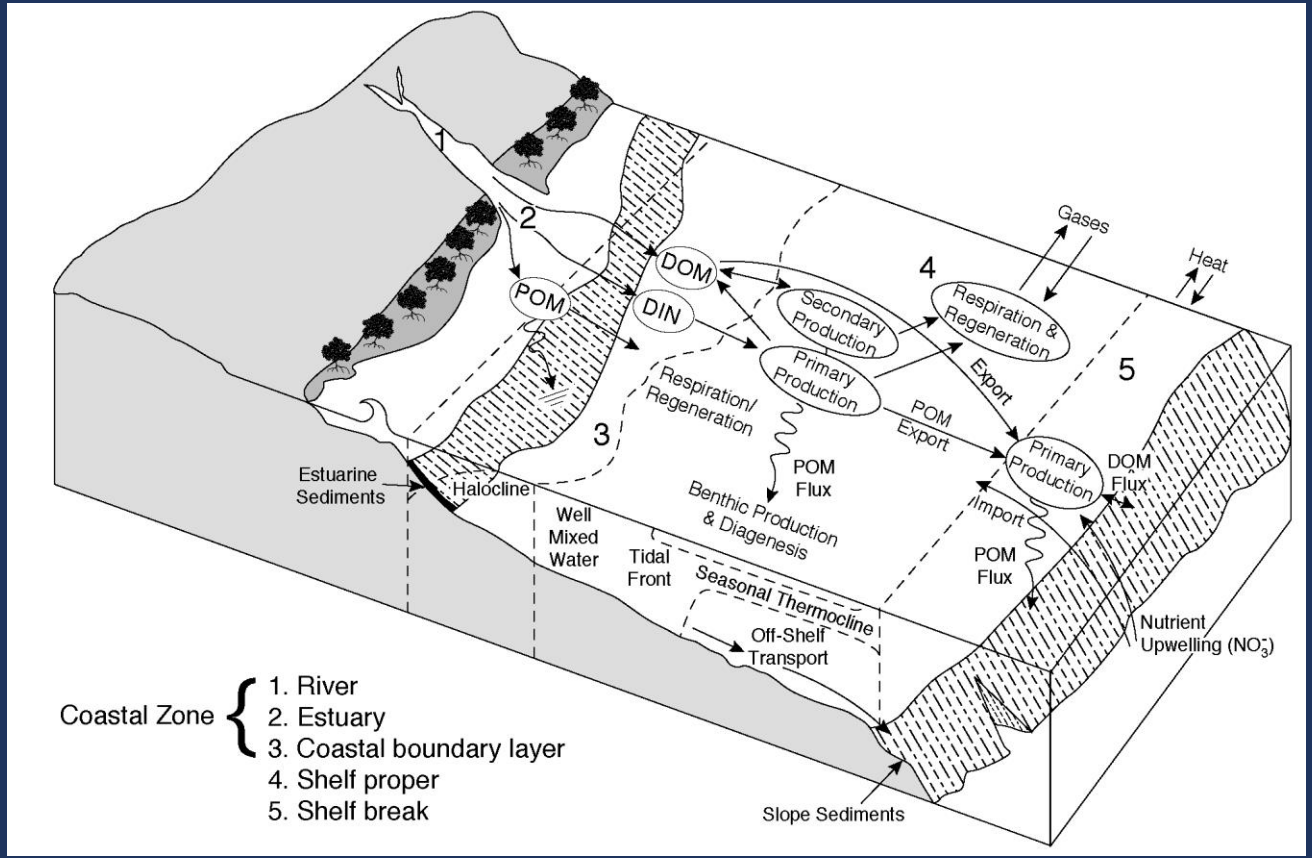
Key processes linking land, sea and atmosphere



The new concept: the Coastal Ocean includes the *coastal zone* and it extends to the shelf and slope

Alongi, The Sea, Vol 13

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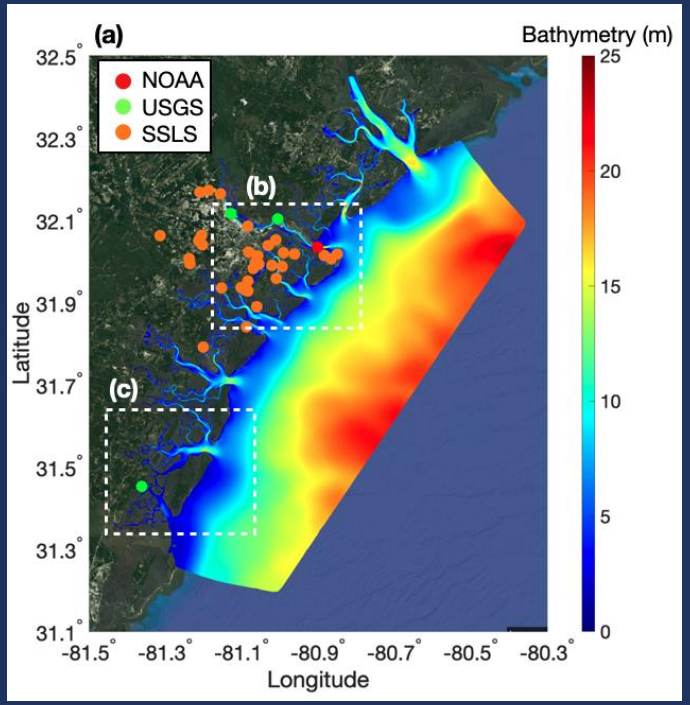
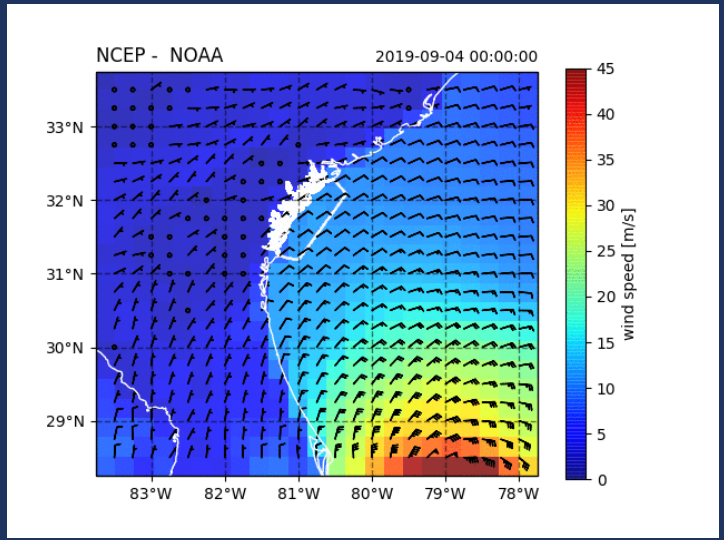
Why do we need the shelf and the slope?
A recent example from Hurricane induced storm surges

Park et al, Coastal Engineering, 2022





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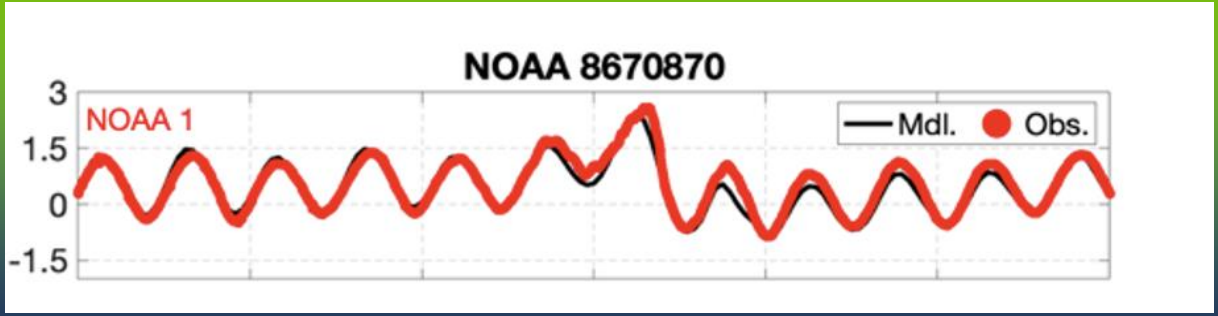
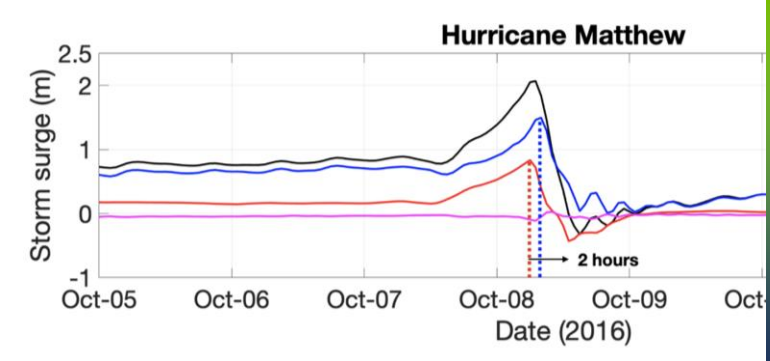


Model vs observations



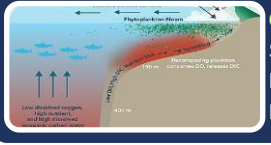
Black: total surge

Blue: hurricane track sea level

Red: Local hurricane winds

THE COMMON OR ESSENTIAL VARIABLES/INFORMATION FOR THE GLOBAL COASTAL OCEAN: in the river, estuary and shelf (revised from COOP Implementation Plan, 2005)

Geophysical
Bathymetry and shoreline positions
Sediment quality and quantity
River discharge
Temperature, salinity, currents , sea level and waves



Chemical
Sediment organic content
Dissolved inorganic nitrogen, phosphorous and silicon
Dissolved oxygen

Biological
Benthic biomass and habitats
Phytoplankton biomass
Fecal indicators

Biophysical
Attenuation of solar radiation

Human activities
Aquaculture sites
Maritime transport routes
Coastal Tourism socio-economy

In addition to:
atmospheric monitoring including air quality

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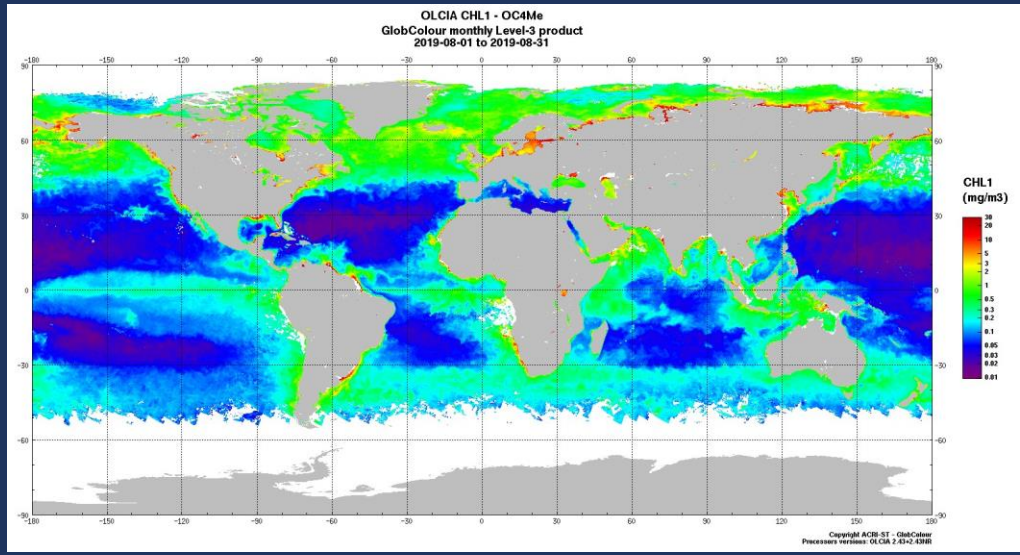
Status of knowledge

The coastal ocean's role in the global carbon cycle
The coastal ocean has probably become a net sink of CO_2 to the atmosphere (Bauer et al., 2013)

High coastal ocean biological production
Most biologically productive part of world's oceans
Processes which drive productivity not yet globally well known

Natural ecosystem variability
Regime shifts pre-date significant human influences
Physical-biological-sediments couplings are evolving with the climate

The role of the bottom and the rivers
Coupling of bottom to water column poorly quantified on a global scale
River influences on coastal erosion are an emerging issue



Chlorophyll

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Gaps and possible way forward

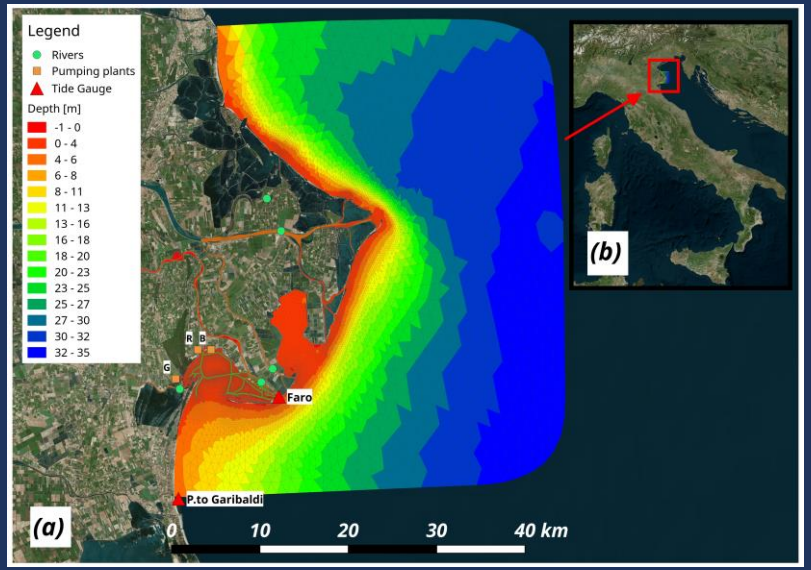
Standardize the essential common variables of interest

Define the observational, modeling and data assimilation system requirements together

Design innovative coupled/linked models (especially for underground waters links with the sea waters)

Assess sources of uncertainties

Develop coastal operational oceanography



New model grids, Maicu et al., 2021

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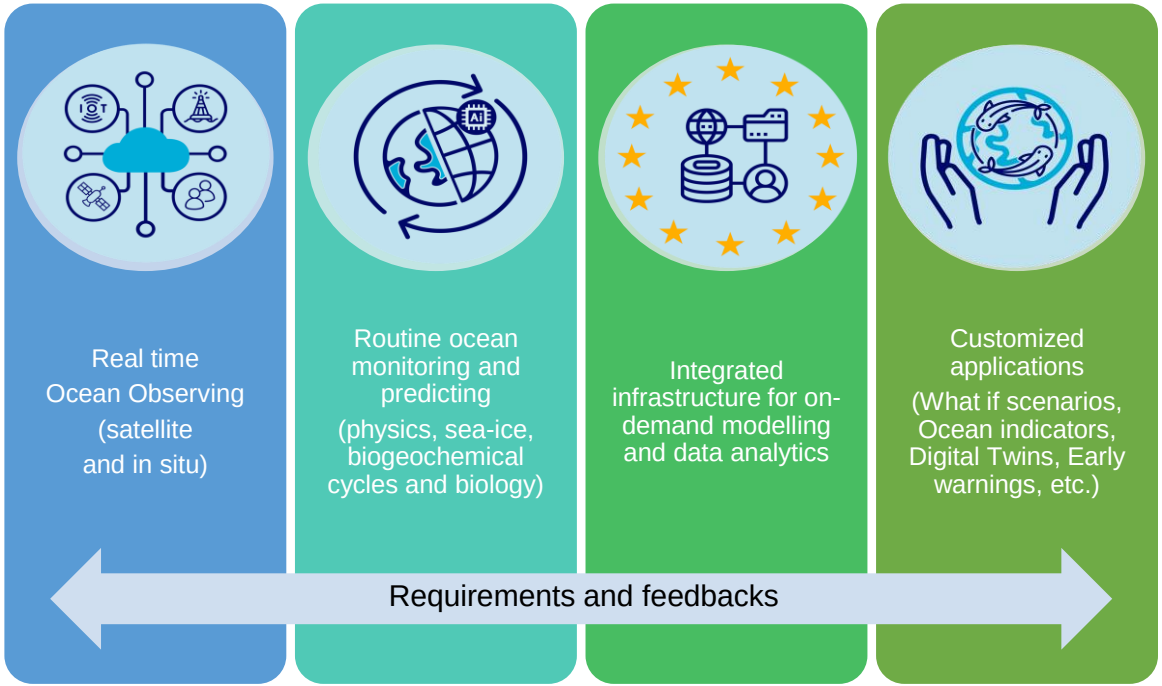
The game changer: open ocean operational oceanography

The ocean value chain: from knowledge to societal benefit products



The routine ocean monitoring and predicting: 1-10 km scale, hours and days

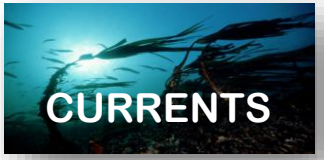
Open and free access information, public good system

QC OBSERVATIONS in real time and 10-20 years t.s.

ANALYSES Daily/weekly

FORECASTS 2 to 10 days

REANALYSES 10 to 45 years



DISCOVER

VIEW

DOWNLOAD

Open & Free

opernicus
The European Earth Observation Programme

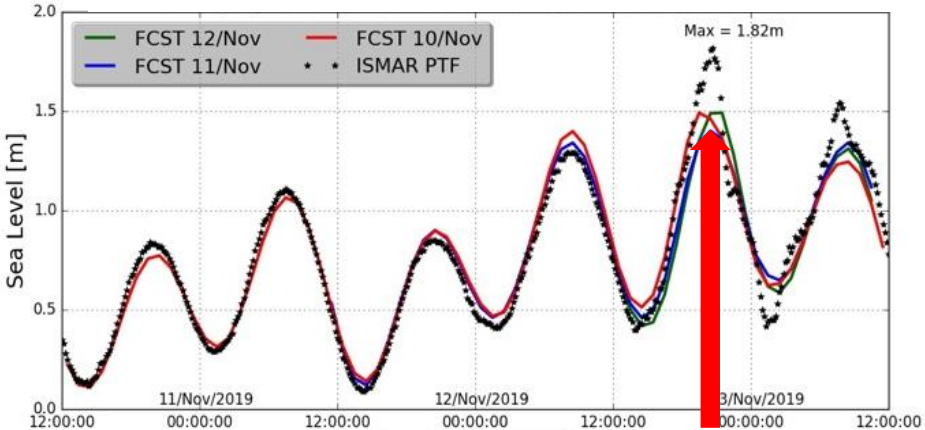
http://marine.copernicus.eu/

Why open ocean predictions are a game changer paradigm?

Venice extreme Acqua Alta event, November 12, 2019, @ 23:55

The City of Venice local forecast:
Start of forecast at 11:00 am Nov. 12

CMEMS-CMCC forecas
Start of forecast at 12:00 am Nov. 10



In conclusion: local, coastal forecasting models have less accuracy than large scale models and have shorter lead times

Decade of Ocean Science for Sustainable Development

Mission

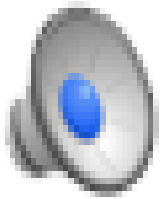
Transformative ocean science solutions for sustainable development, connecting people and our ocean

CoastPredict - Integrated Global Coastal Ocean Observing and Forecasting

Chairs: Nadia Pinardi (IT) and Villy Kourafalou (USA) and Joaquin Tintore (ES)

Theme: A predicted global coastal ocean where society understands and can respond to changing ocean conditions

Synergistic Partners: GOOS, OceanPredict, Ocean Visions, EquiSea, Ocean Best Practice System, CEOS-COAST, Geo-Blueplanet



CoastPredict: an endorsed UN Decade Programme

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Web Link to more program information

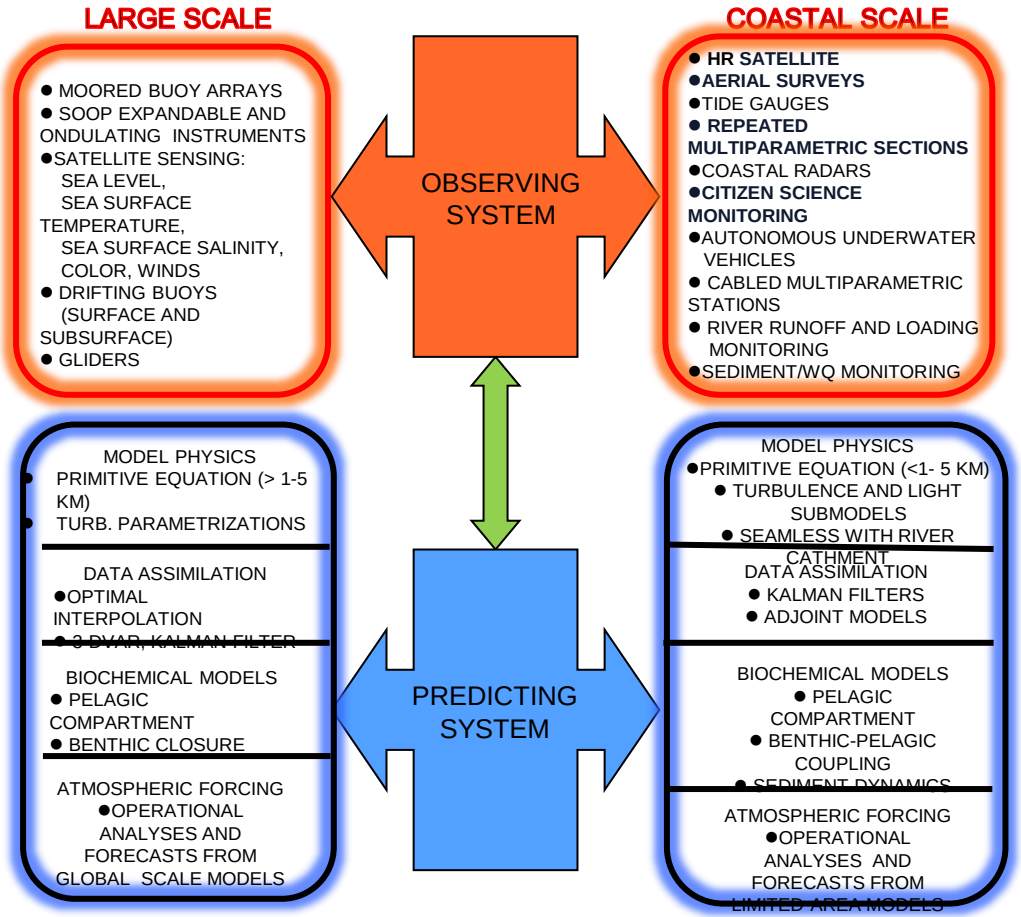
https://www.coastpredict.org/

CoastPredict high level objectives

1. A **predicted** global coastal ocean;
2. The upgrade to a **fit-for-purpose** oceanographic information **infrastructure**;
3. Co-design and implementation of an **integrated coastal ocean observing and forecasting system** adhering to **best practices and standards**, designed as a global framework and implemented locally.

The CoastPredict solution: seamless observing practices

The challenge: expand operational oceanography to the global coastal ocean

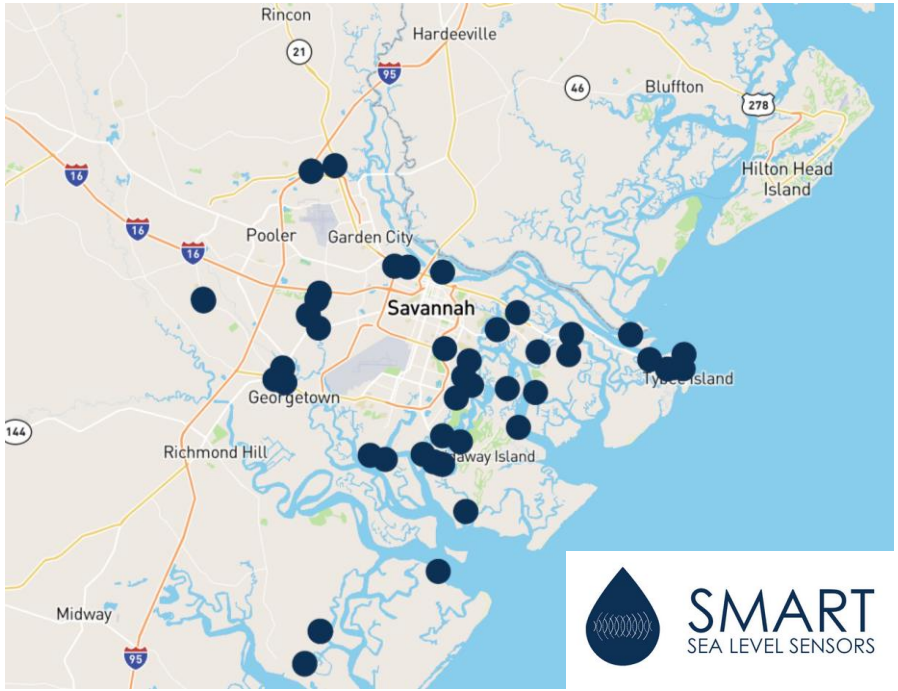


Real time with international standards and protocols, open and free data

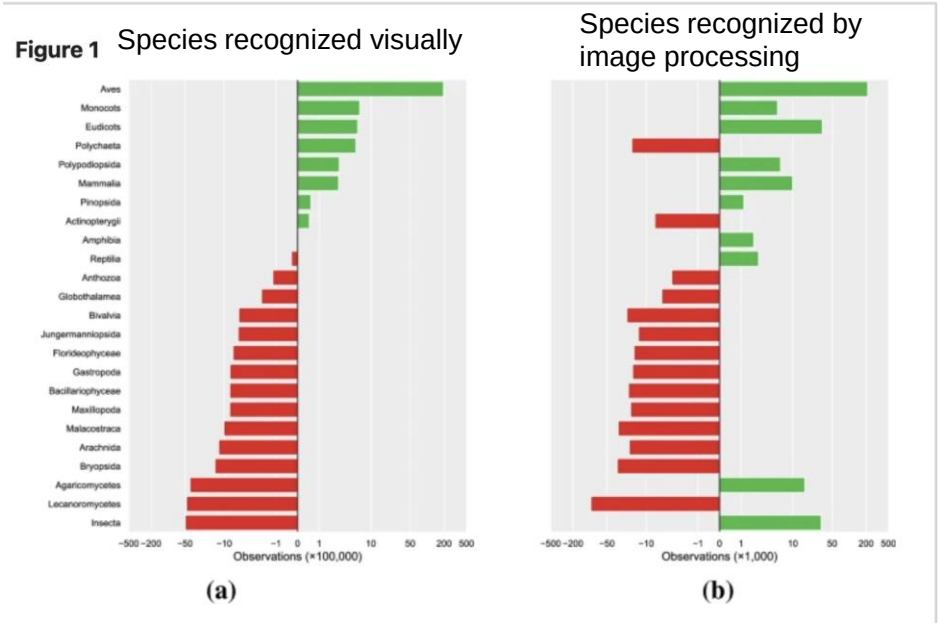
Short term predictions and climate coastal downscaling

The CoastPredict solution: transform the OBSERVING

Example: Internet sea level low-cost Sensors (USA)



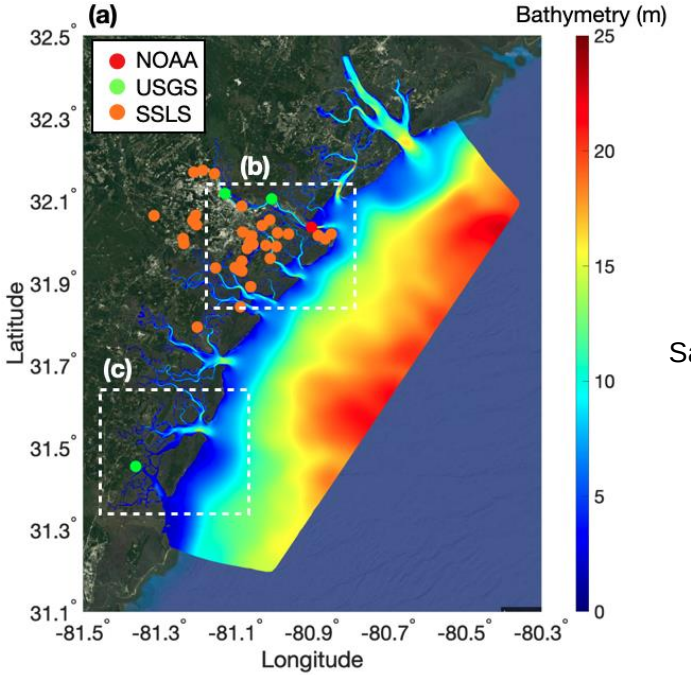
Example: the Species Observation System for taxa recognition (Norway)



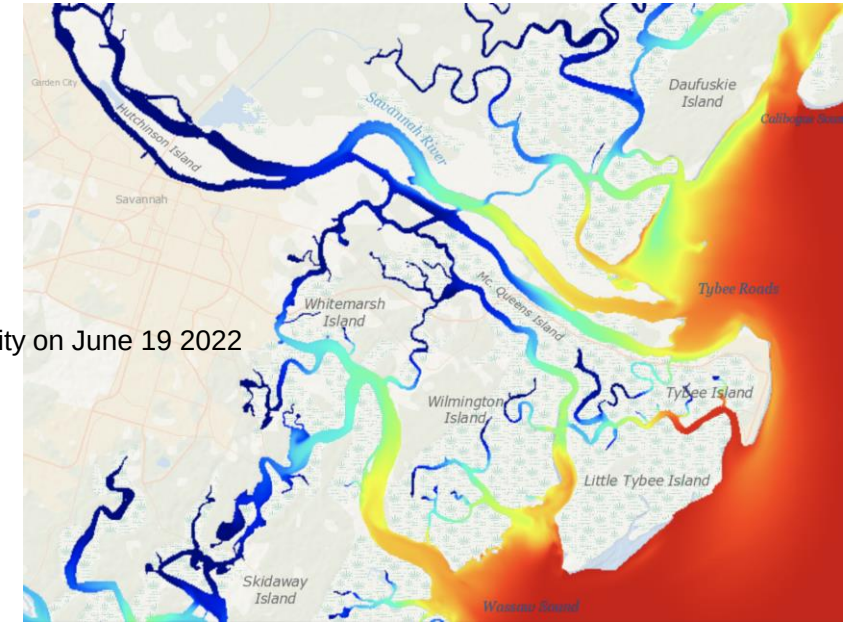
Koch, W.,*et al.Sci Rep* **12,** 7648 (2022)

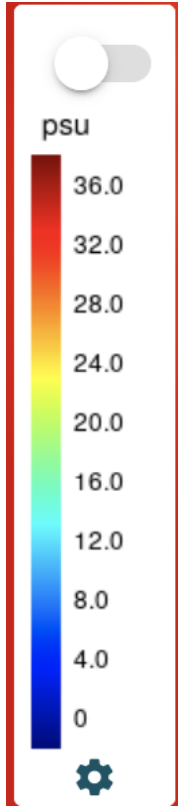
The CoastPredict solution: transform the MODELLING

Every day a seamless forecast of sea level and salt wedge
in the estuaries and the coastal zone. Operational: https://savannah.cmcc.it/



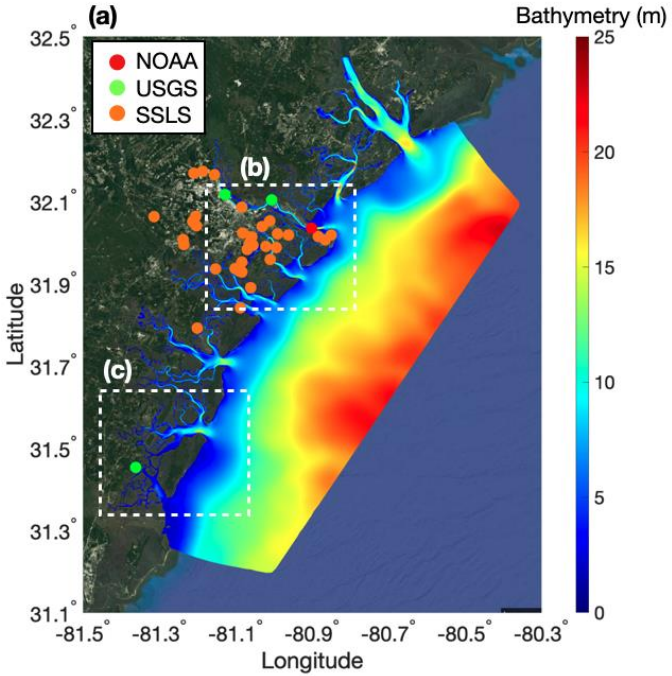
Salinity on June 19 2022



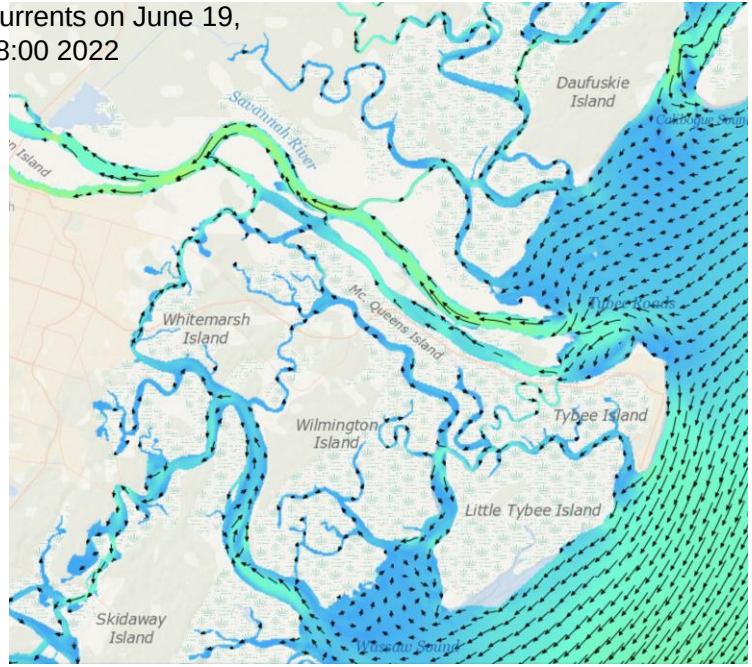


The CoastPredict solution: transform the MODELLING

Every day a seamless forecast of salt wedge and currents
in the estuaries and the coastal zone. Operational: https://savannah.cmcc.it/

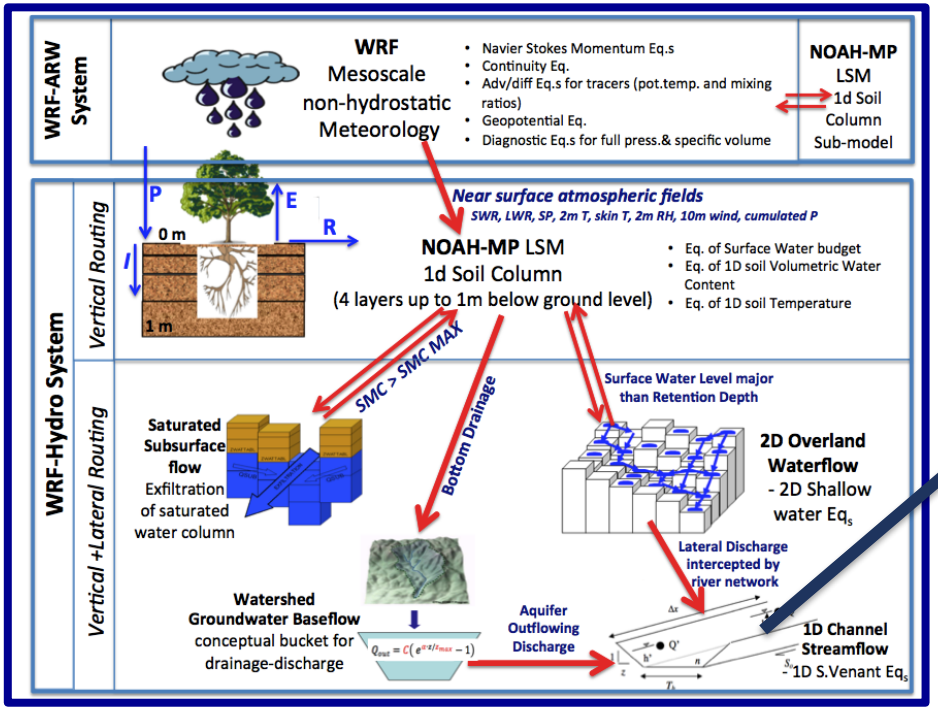


Currents on June 19, 18:00 2022

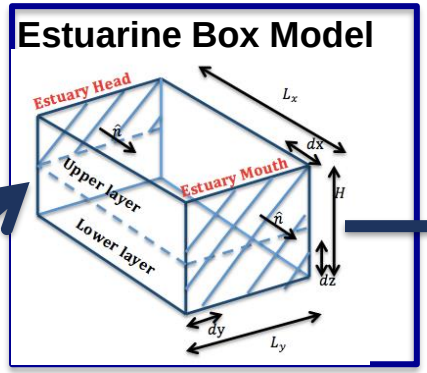


The CoastPredict solution: transform the MODELLING

New water coupled modelling systems: the WHYDE system (Verri et al., 2019)



The WHYDE system

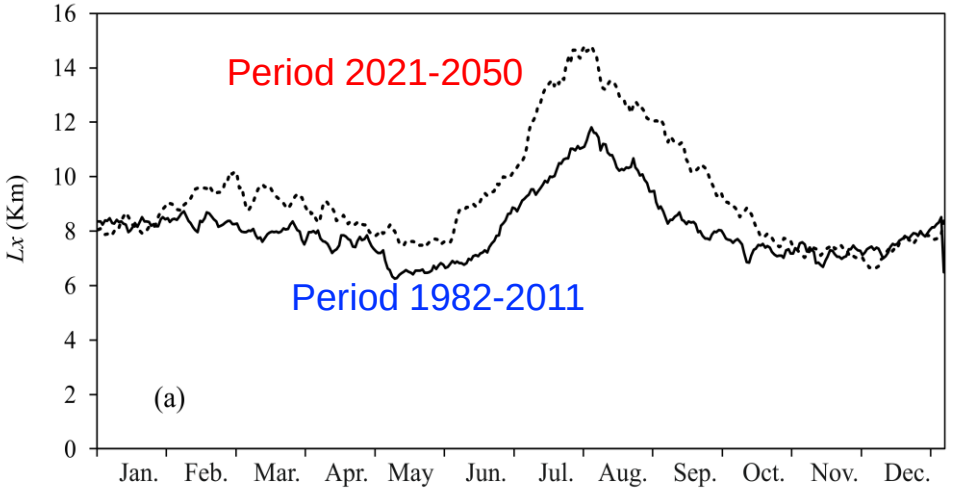


Regional ocean model

The CoastPredict solution: transform the MODELLING

Use WHYDE to predict impacts of climate change on salt wedge intrusion

Case study of Po river Delta: how much will the salt intrusion change in the future climate change RCP8.5 scenario?



The CoastPredict solution: Digital Twin methodology to test coastal Nature Based Solutions

Solution to be tested

Are local seagrass types capable to decrease wave energy?

Digital Twin Modelling framework

Wind-wave model (WW3) with seagrass

Circulation model (SHYFEM) with seagrass

Calibration/ Validation With local observations

Nesting in CMEMS large scale model data

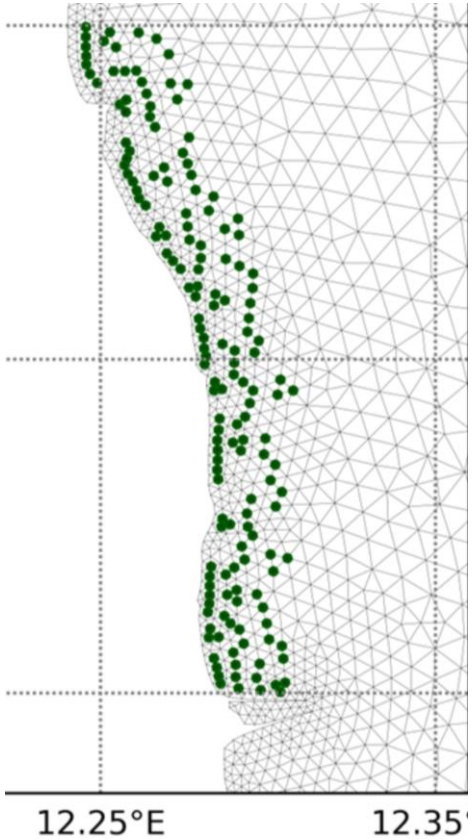
What if scenarios

What is the wave/surge/ current reduction due to different seagrass types

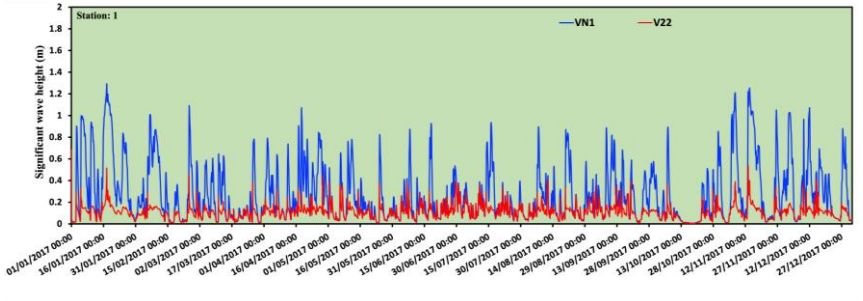
What is the wave/surge/ current reduction due to seagrass landscaping

The CoastPredict solution: Digital Twin methodology to test coastal Nature Based Solutions

Model grid and vegetation landscaping



Station 1 –
blue no vegetation / red with vegetation



Umesh et al, 2022 in press

Outlook

- The Global Coastal Ocean concept has started to be defined
- CoastPredict solutions are being devised and will be implemented world wide
- We need to undertake these developments with the hydrological and environmental engineering community to reach the wanted SDG targets

goosocean.org →

unesco Intergovernmental Oceanographic Commission

WORLD METEOROLOGICAL ORGANIZATION

UN environment programme

International Science Council

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