MSP and Information Management Workshop, Dar es Salaam Nov 29th

WIO Symphony co-development

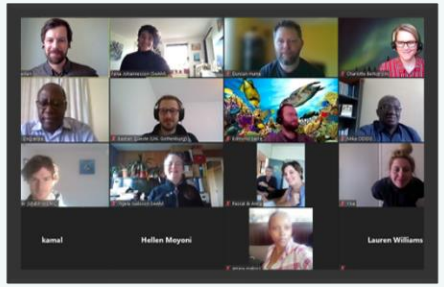
Introduction by Gustav Kågesten et al.

www.nairobiconvention.org/wio-symphony

Swedish Agency
for Marine and
Water Management

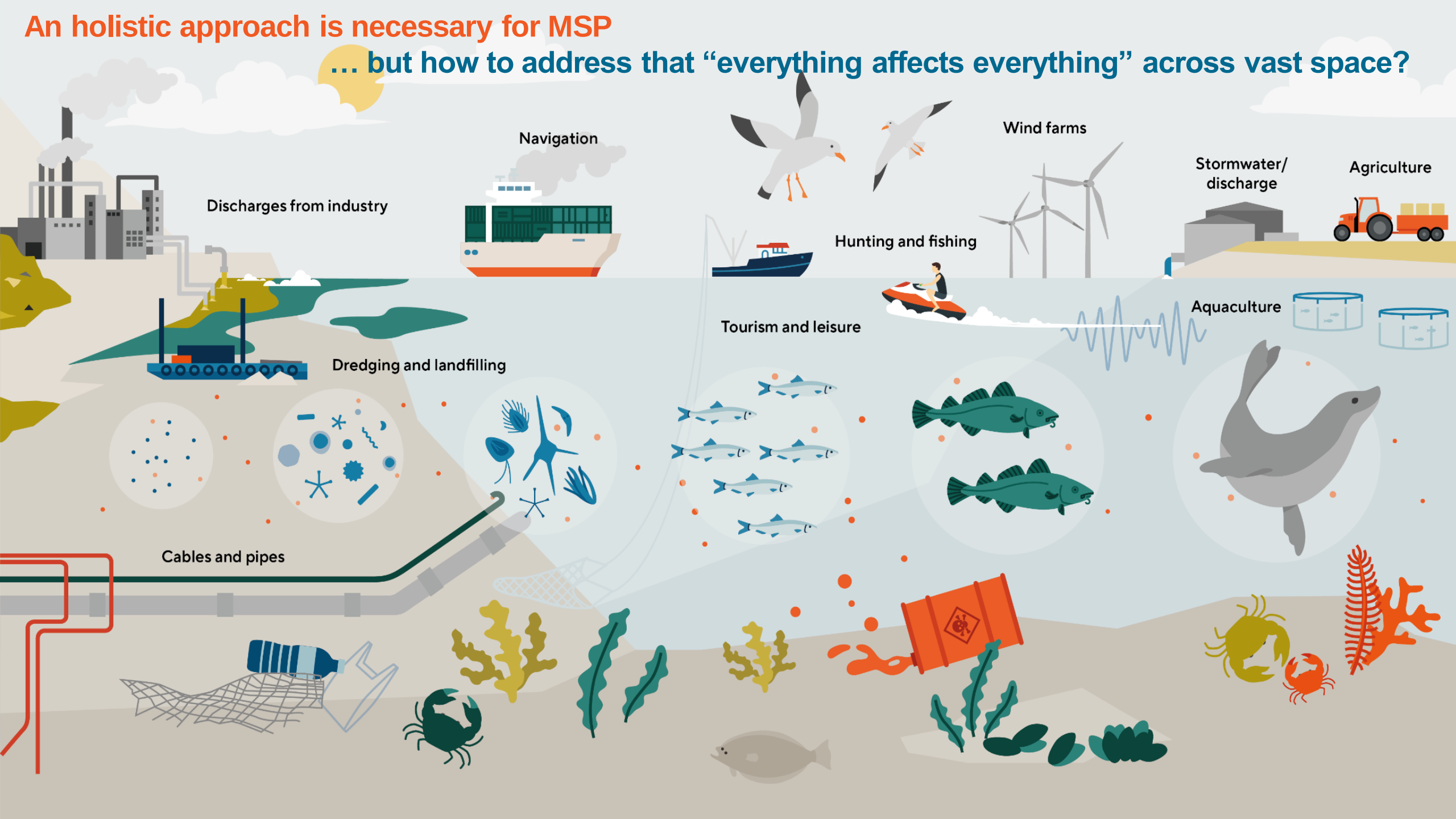
An holistic approach is necessary for MSP

… but how to address that “everything affects everything” across vast space?

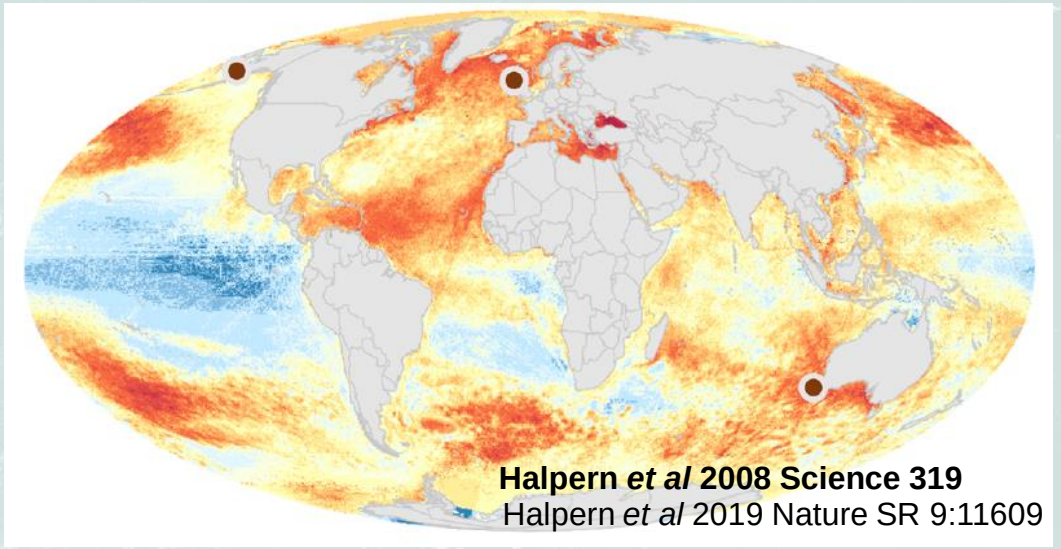


An holistic approach is necessary for MSP

… but how to address that “everything affects everything” across vast space?



Cumulative impact assessment



Halpern *et al* 2008 Science 319
Halpern *et al* 2019 Nature SR 9:11609

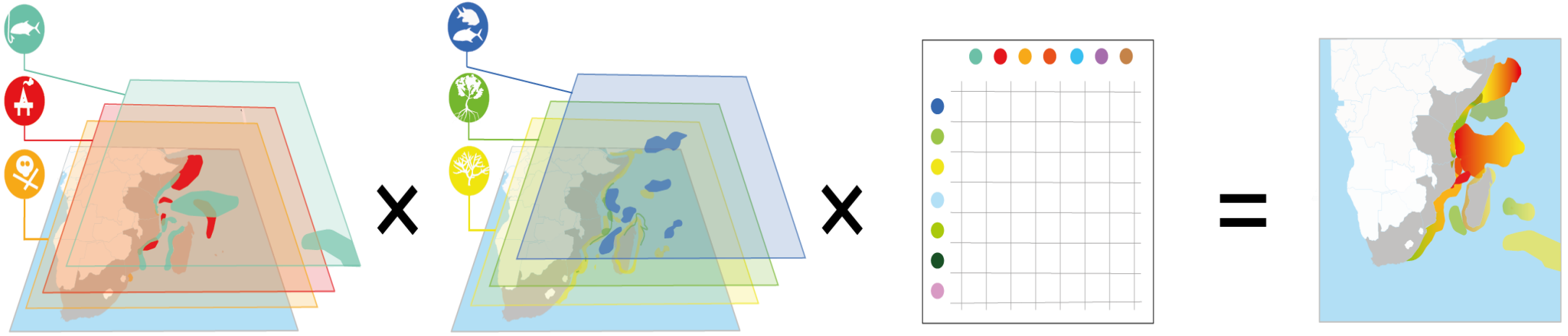
Models behind the map

Environmental pressures
From human activities

Ecosystem components
Nature values

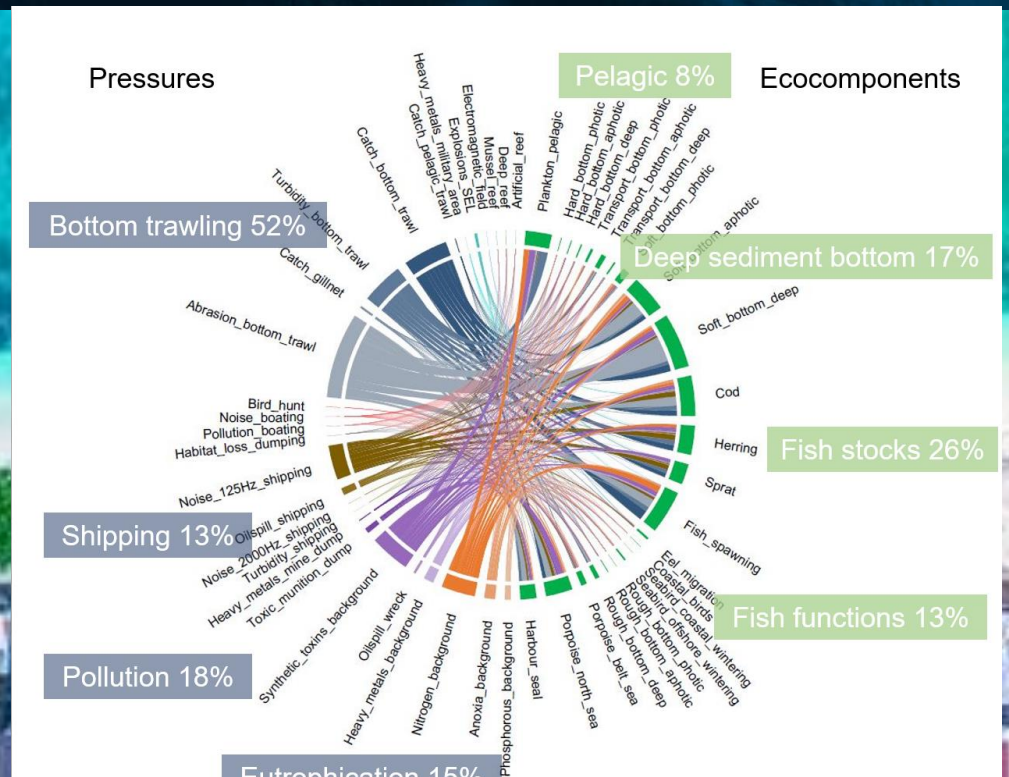
Sensitivity matrix
The specific effect of each pressure on each eco-component

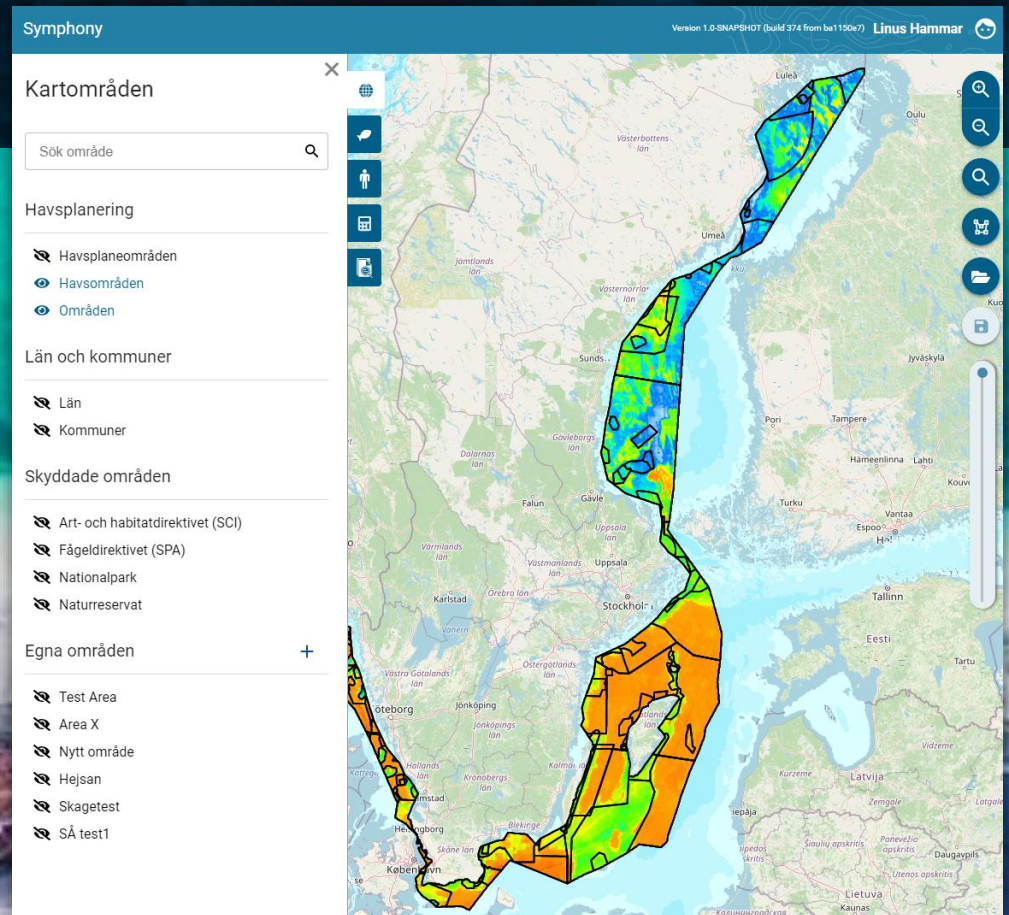
Results
Figures and tables



Development of Symphony in Sweden

We collected a lot of spatial data, produced maps, and developed an analytic tool (software)





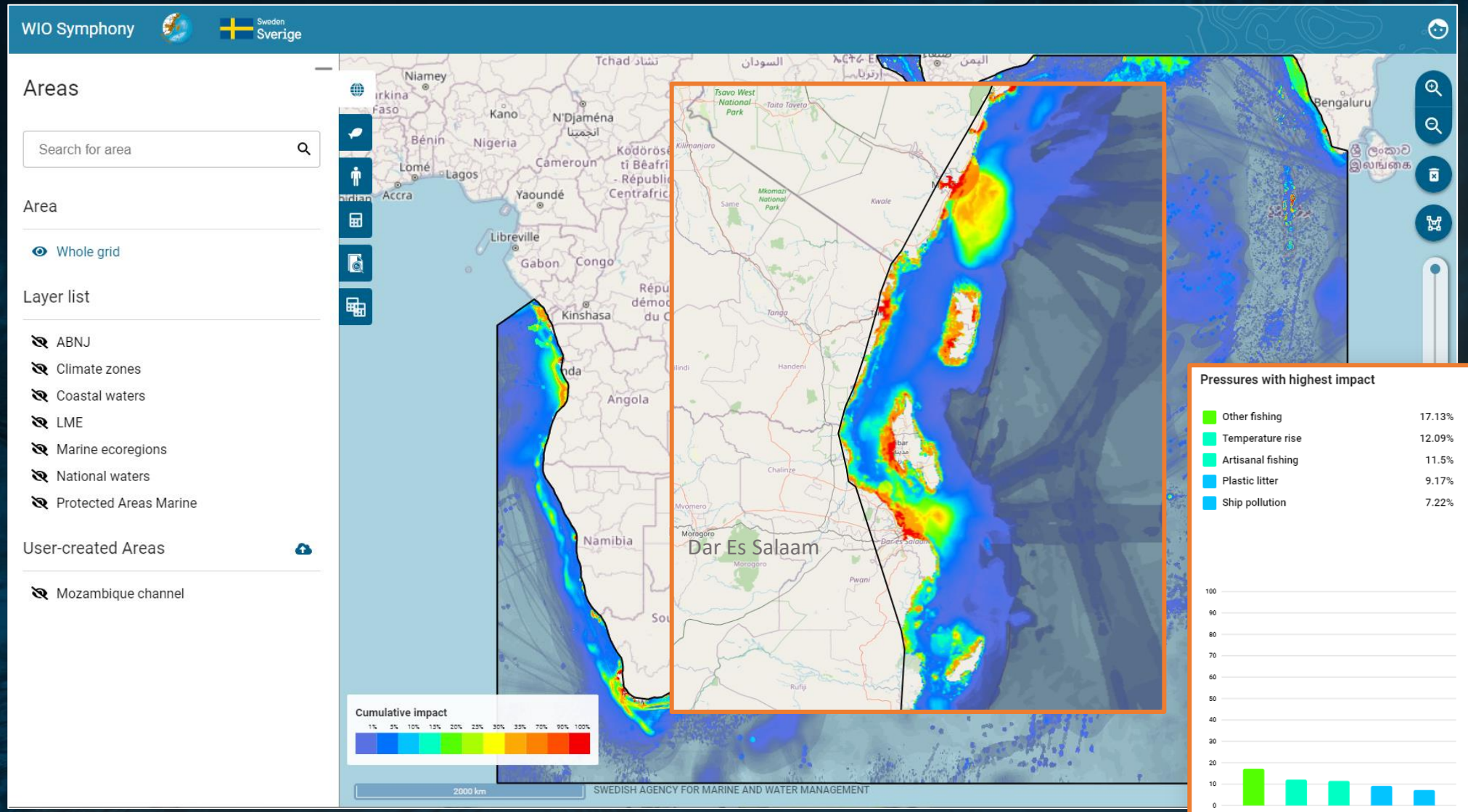
WIO Symphony

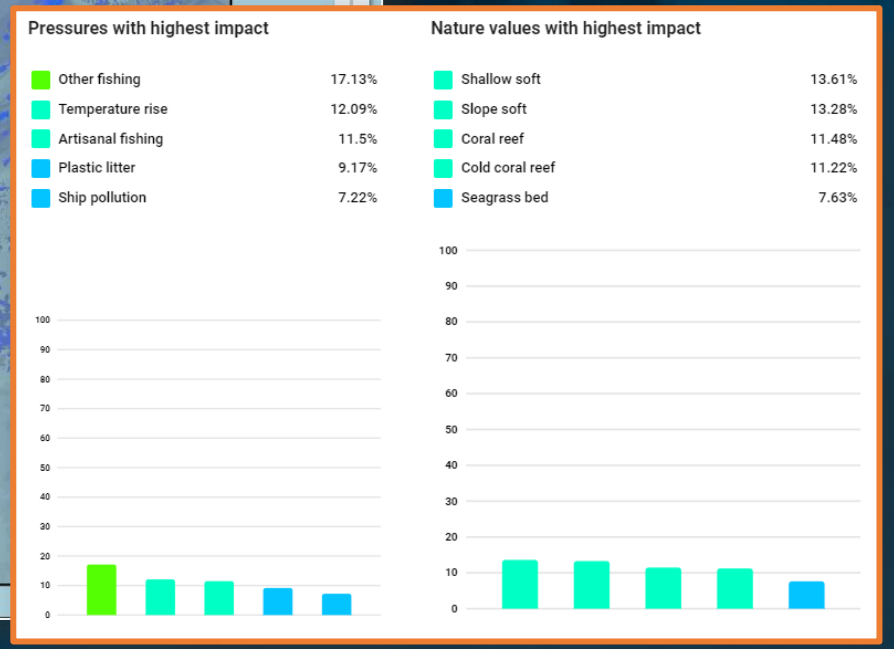
Nairobi Convention

UN environment programme

Sweden Sverige

Swedish Agency for Marine and Water Management





DEMO

UN environment programme

Sweden Sverige

Swedish Agency for Marine and Water Management

WIO Symphony

Sweden Sverige

Areas

Search for area

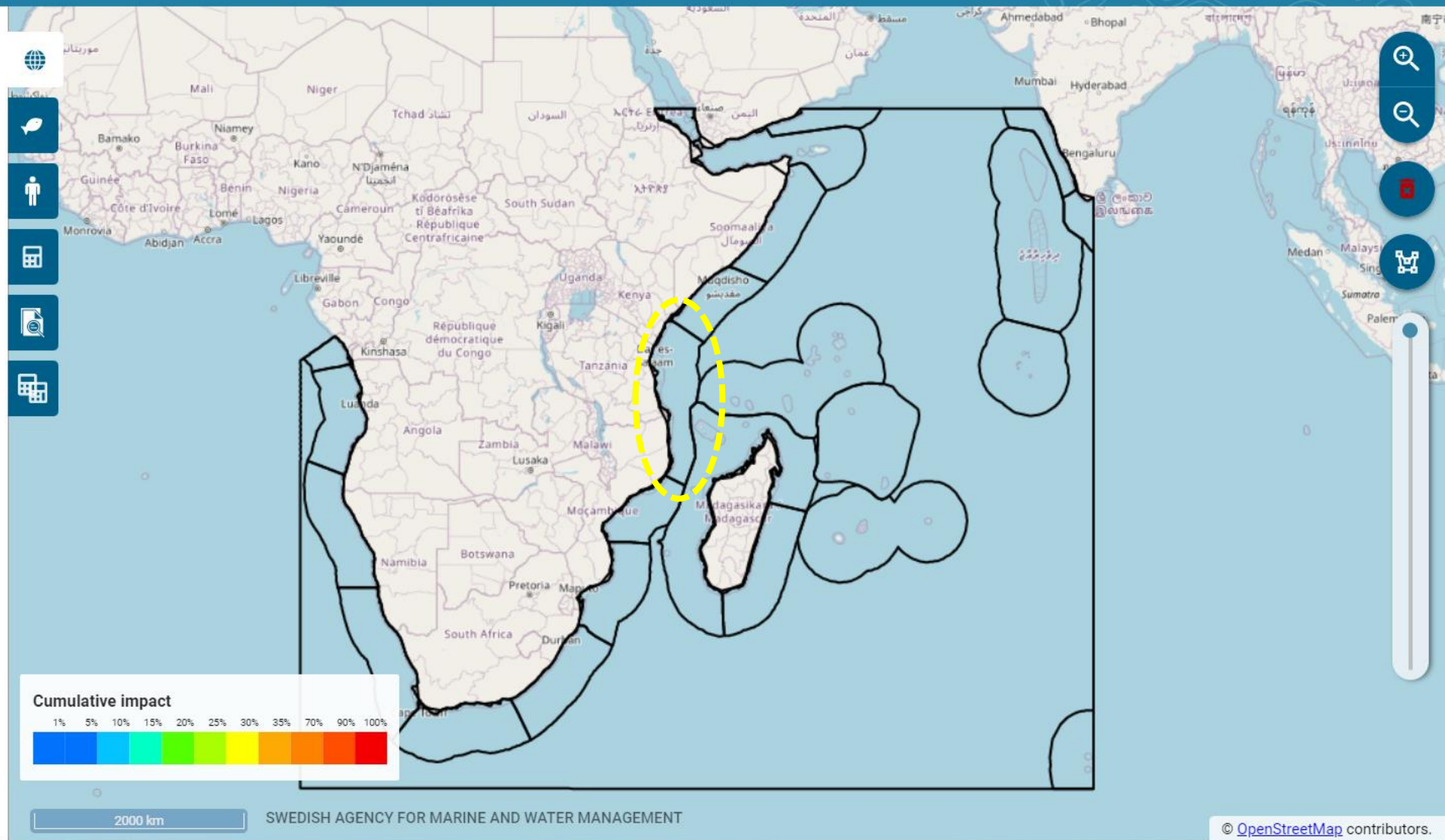
Area

Whole grid

Layer list

- ABNJ
- Climate zones
- Coastal waters
- LME
- Marine ecoregions
- National waters
- Protected Areas Marine

User created areas



DEMO

UN environment programme

Sweden Sverige

Swedish Agency for Marine and Water Management

WIO Symphony

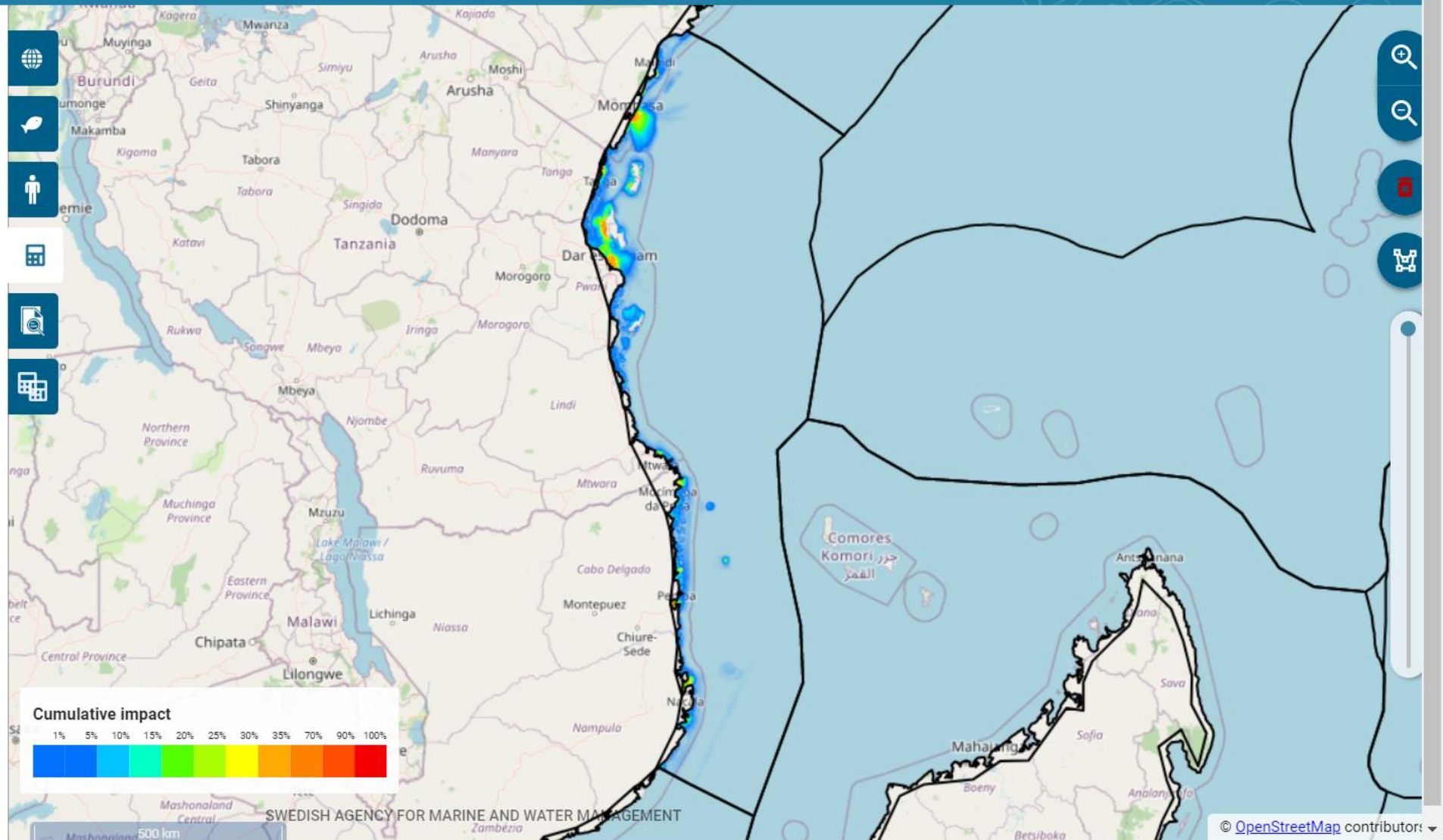
Sweden Sverige

Scenarios

No area selected

User scenarios

Baseline East African Coral Coast (200...
2022-10-11 09:35



DEMO

UN environment programme

Sweden Sverige

Swedish Agency for Marine and Water Management

WIO Symphony

No scenario changes

Select an area and make changes in the Ecosystems Components or Pressures tab

Sensitivity Matrix

- (•) Default matrix (Western Indian Ocean)
- ( ) User-defined matrix

Välj matris

EDIT MATRIX

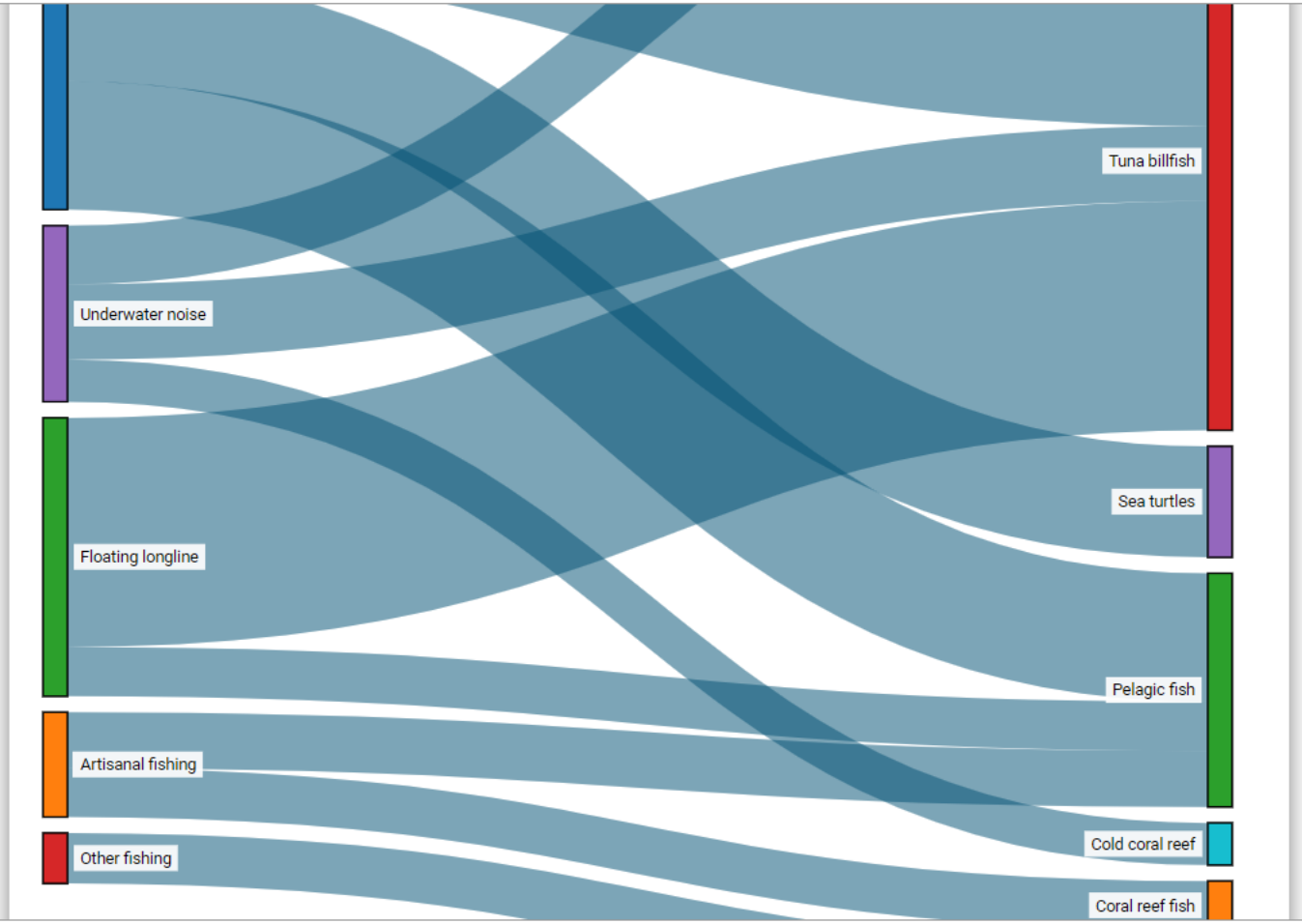
Result Colormap

Set maximum value based on:

- ( ) Maximum value in MSP area
- (•) Maximum value in computed area
- ( ) User-defined value

DELETE CALCULATE

Calculation Report



OPEN IN NEW TAB | EXPORT AS CSV | EXPORT AS GEOTIFF | PRINT

© OpenStreetMap contributors.

@ the Convention

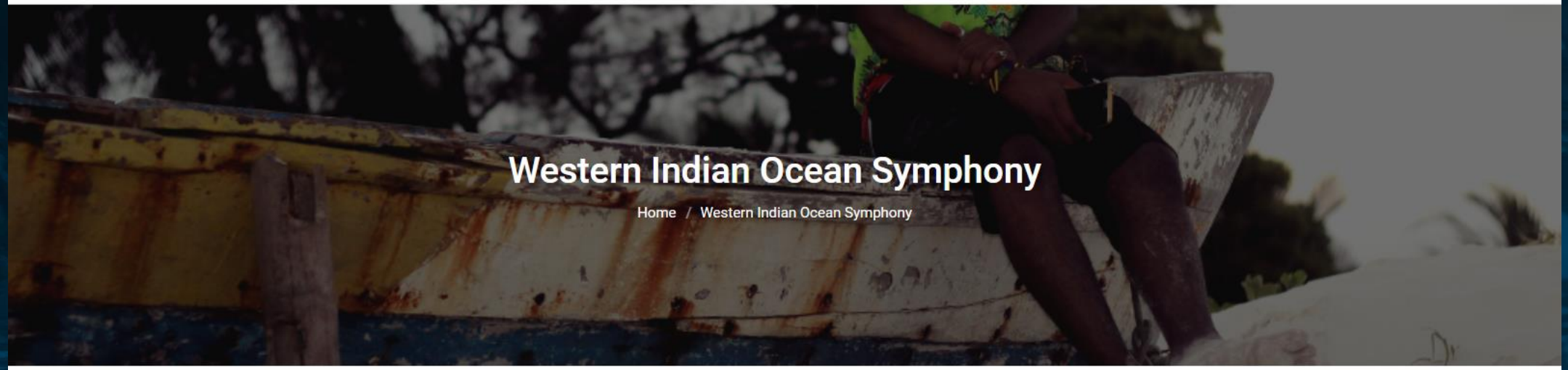
UN environment programme

Sweden Sverige

Swedish Agency for Marine and Water Management

NAIROBI CONVENTION

Who we are | What we do | News | Events | Clearinghouse Mechanism



Western Indian Ocean Symphony

Home / Western Indian Ocean Symphony

– a tool for ecosystem-based marine spatial planning –

WIO Symphony is a tool based on more than 60 ecology and human activity maps. It supports ecosystem-based Marine Spatial Planning by calculating cumulative impact over large areas and illustrating those that are under specific pressures. The tool also shows how different planning and policy measures can lead to a positive environmental impact in an area.

WIO Symphony co-development

- **Technical Working Group** (TWG) through Nairobi Convention provides the core, representing 10 countries in WIO
- **Swedish team** has experience of developing the Swedish Symphony tool
- **Regional experts** and **national teams** add scientific information and advice
- I**nternational marine community** essential for data and collaboration
- **Activities** include Workshops – Thematic Groups – Trainings – Data collection – Modeling – Review – Implementation

Nairobi Convention Secretariate

Online workshop series 2020-2022

Mombasa workshop 2022

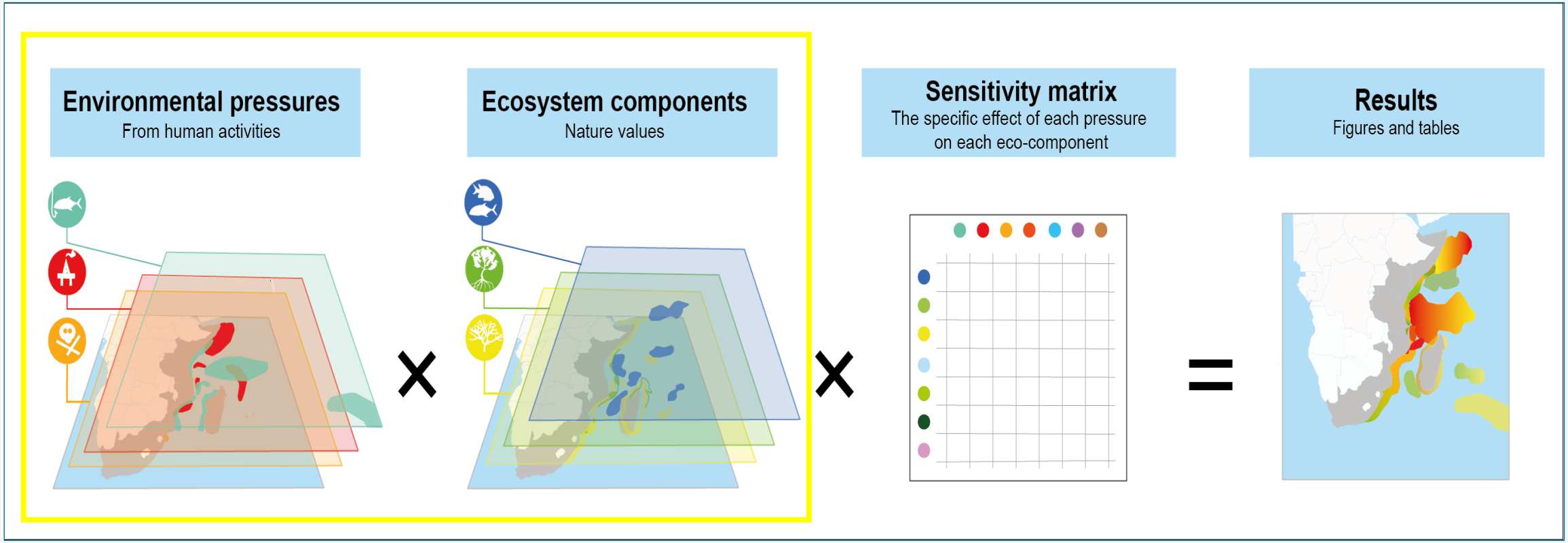
Comoros training 2022

WIO Symphony process

Open & inclusive, tailored for MSP

Transparent and reproducible

github.com/WIOSymphony



Framing the problems and possibilities

WIO Symphony data workshops

*"Areas with **strong commercial interests** might be more **difficult to obtain data** from, for example the oil or mining industries."*

"**Funding needed** to give other data managers **incentives to contribute data**. Gap in human activities at a regional scale - how do we fill that management gap?"

"It is important to **clarify the intention of data usage early** on in order to gain confidence and through that participation from data owners"

"A lot of **trust issues**, people are not used to data sharing. Scientist **concerns about "perfect data"**

"Most of the **data** will **have to be desensitized** to remove commercially sensitive information

"The **main task** would be to have formalize a task team responsible for **collating data** that is collected at a **local level** into a coherent **national dataset** which could then be provided nationally. Data copyrights is not an issue here"

"Mapping of existing data and establishing collaboration and collection of that data is resource demanding, **the more restricted the more resource demanding** the process"

"Some data may be commercially sensitive or government owned. **The lack of central archives can be a challenge."**

*"**The openness of data may depend on who asks for it** and in which format the request is presented. Sometimes a national country level demand has an easier path communicating on government level, sometimes a request from an organization such as the Nairobi convention might be more successful than a request from an internal national government agency"*

"The **challenge** with regional data sharing platforms is the **difference in data policies for member states** that limit national agencies capacity to share data."

Coastal Development
Shipping
Thematic workshops
> Tailor the tool to WIO MSP
Reptiles
Open ocean habitats
Mammals
Fish
Temperate habitats
Recreation
Offshore
Invertebrates
Fishing
Pollution & litter
Tropical habitats
Climate change
Seabed mining
Survey
Deep sea
Aquaculture

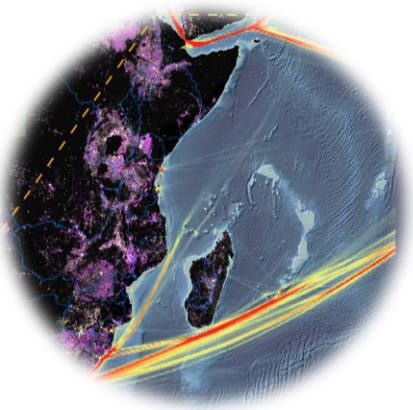
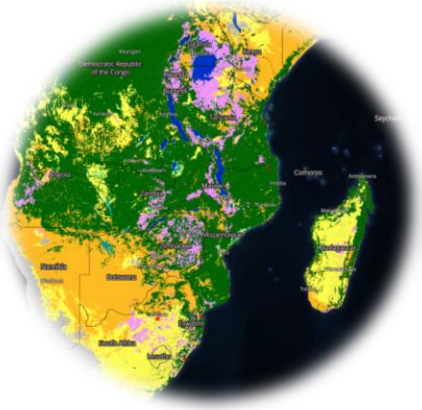
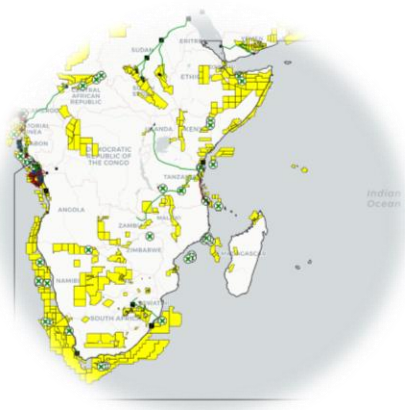
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

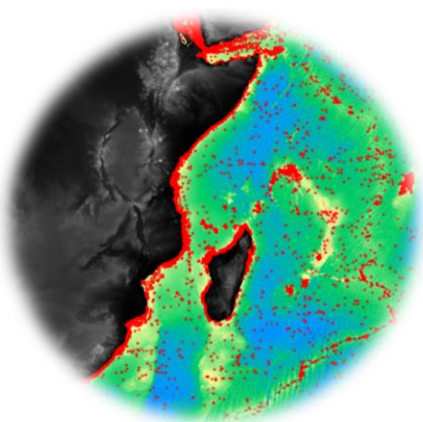
The decade of Ocean Science..

The dawn of digitalisation..

Open data is the fuel!

THE GLOBAL GOALS



WIO Symphony data contributors and counting…

Copernicus Europe's eyes on Earth
General Bathymetric Chart of the Oceans GEBCO
HUB Ocean Centre for the Fourth Industrial Revolution
IUCN
OBIS OCEAN BIODIVERSITY INFORMATION SYSTEM
UNEP WCMC
dbSeabed
INSTAAR
COLORADOSCHOOLOFMINES EARTH • ENERGY • ENVIRONMENT
Global Fishing Watch
SEABED 2030
GLOBAL MANGROVE ALLIANCE
NASA
NOAA
ALLEN CORAL ATLAS
The Nature Conservancy
WWF
PURE EARTH
WORLD RESOURCES INSTITUTE
MapStand
olwg
IH Ocean InfoHub
ODINAFRICA
USGS
K.M.F.R.I
GRID ARENDAL
WIOMSA
PANGAEA.
SANBI
koordinates
FRAPEDIA
OpenStreetMap

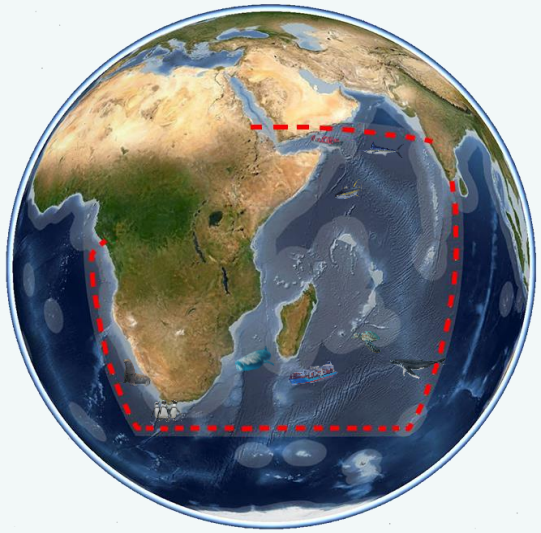
and more...

WIO Symphony grid

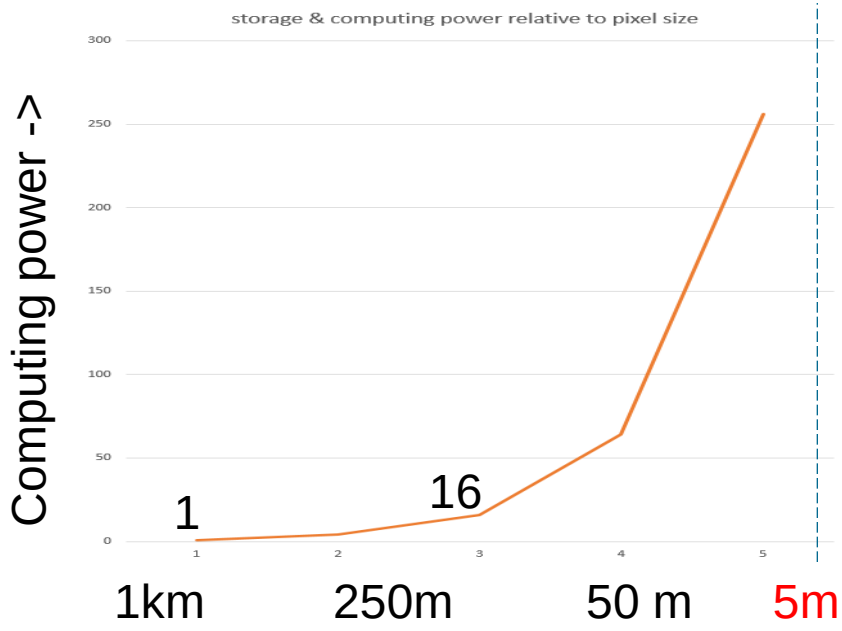
Habitat to management scale – local to regional

Data collection ~2 deg > Analysis area
Lat 42 S, 18 N
Long 6 E, 80 E

Projection: Lambert Cylindrical Equal Area
Resolution: **~1km,** 250m, 50m
Limited by data, not grid resolution
Shoreline: SRTM Water Body (~30m)



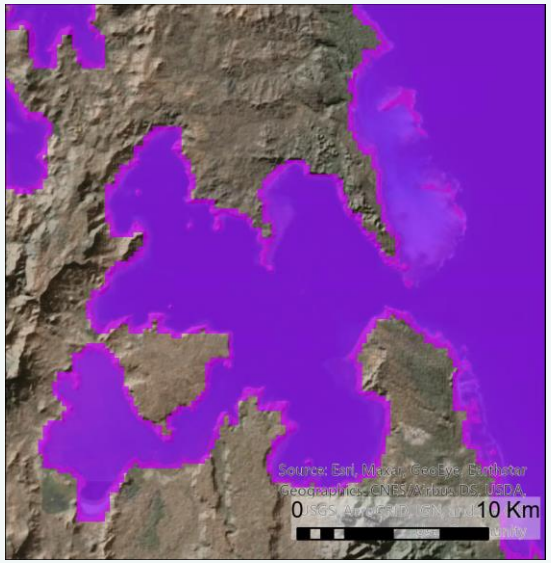
The data resolution challange 60 000



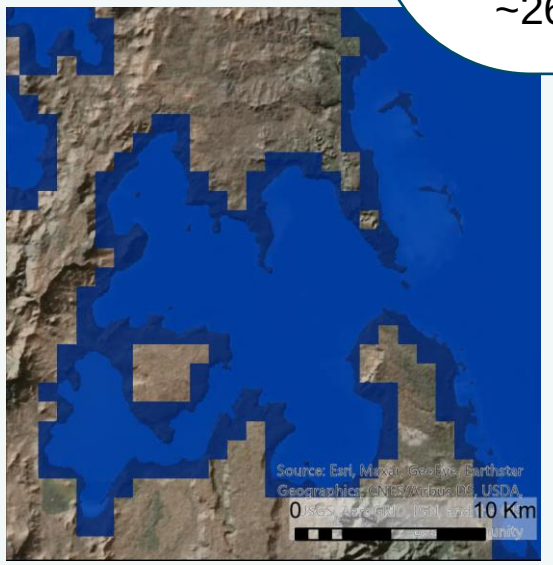
~26M cells (1km) ~1 550 000 M cells (5m)

SRTM water mask (~30m res)

250m grid & water mask



1km grid & water mask

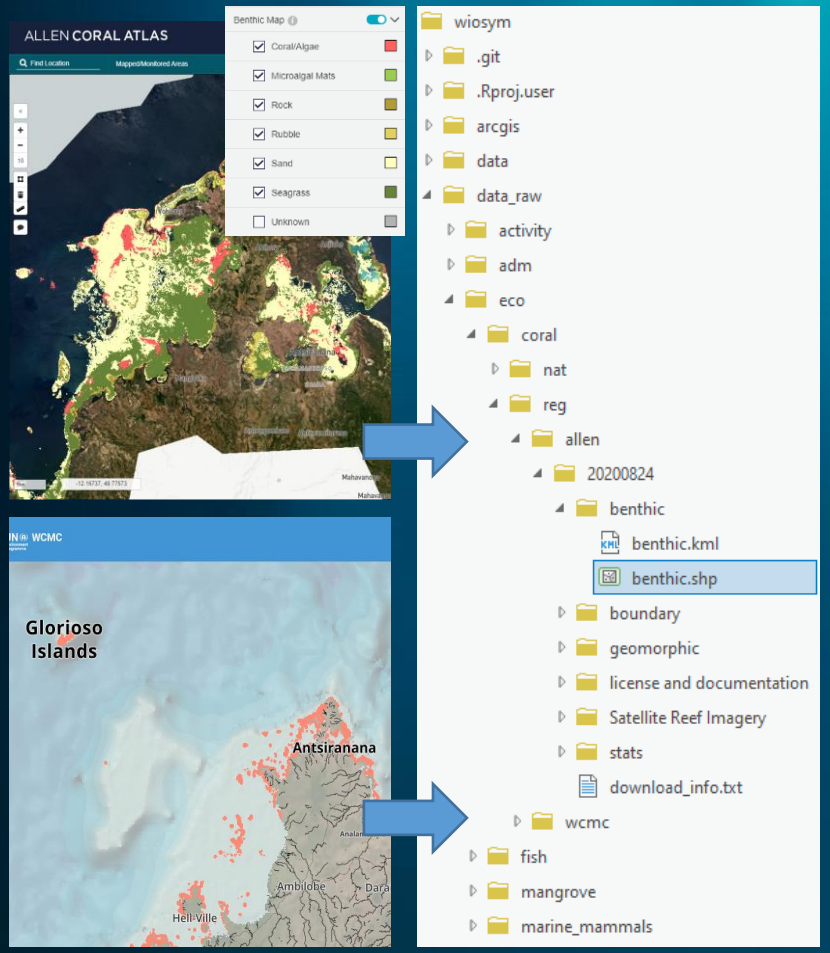


Future update could improve delineation of the estuarine environments

WIO Symphony Data Process

from habitat scale to management scale

Fresh ingrediens and a *well organised* kitchen

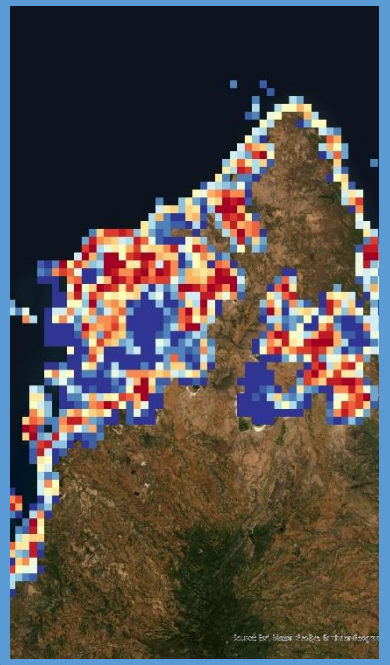


Cookbook & oven

Data processing
-open source
-reproducible

Main course

Maps of corals
- combined sources
- standardised



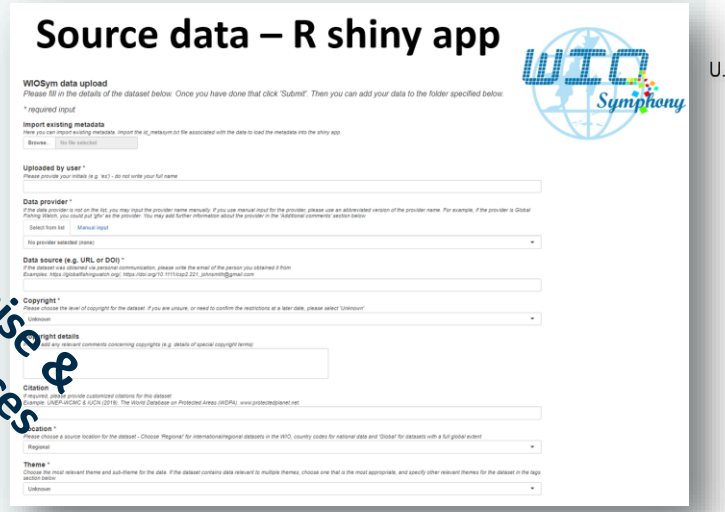
Side dish

Maps of potential corals
- env. proxy
- caution areas

Precautions

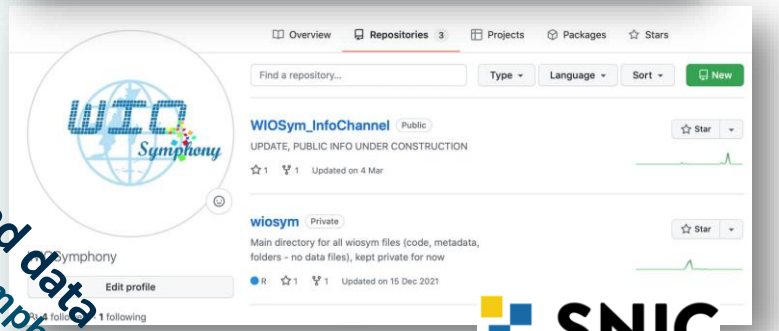
Uncertainty
- maps
- metadata

App to organise & track data sources



Open code and data

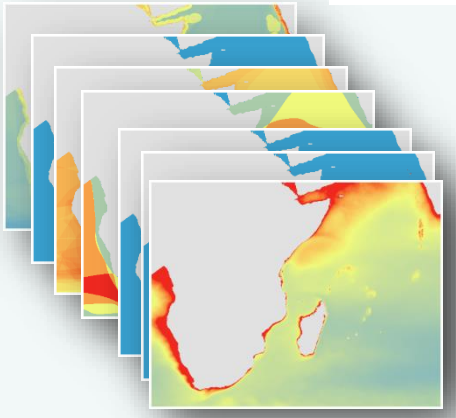
github.com/WIOSymphony



SNIC
Swedish National Infrastructure for Computing

Products

Made to be remade...



World Wide Fund for Nature
World Resources Institute
UNEP World Conservation Monitoring Centre
U.S. National Oceanic and Atmospheric Administration
The Nature Conservancy

Other providers

Ocean Biogeographic Information System

NASA Earth Observations

Literature

International Union for the Conservation of Nature

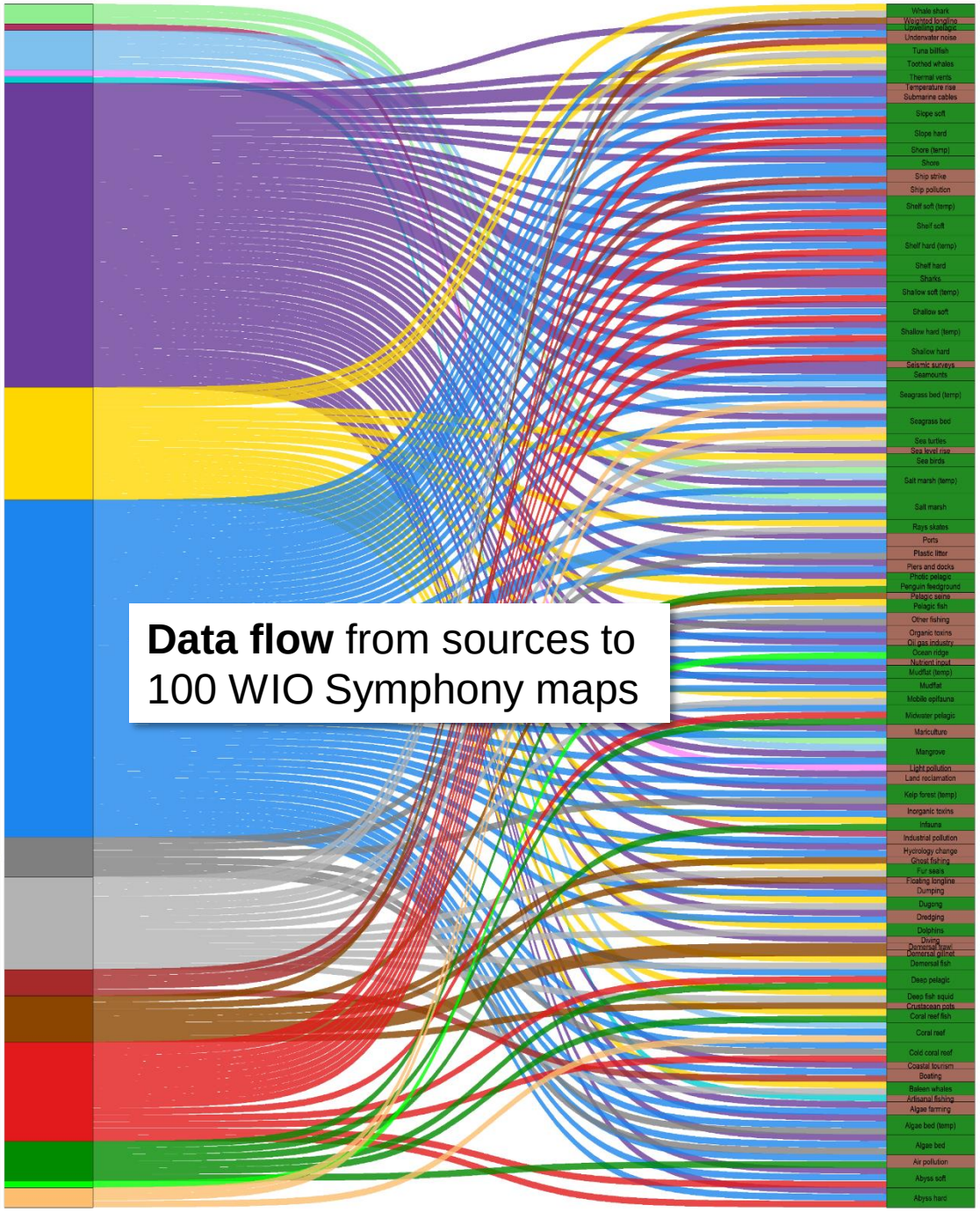
HUB Ocean

Global Fishing Watch

General Bathymetric Chart of the Oceans

EU Copernicus

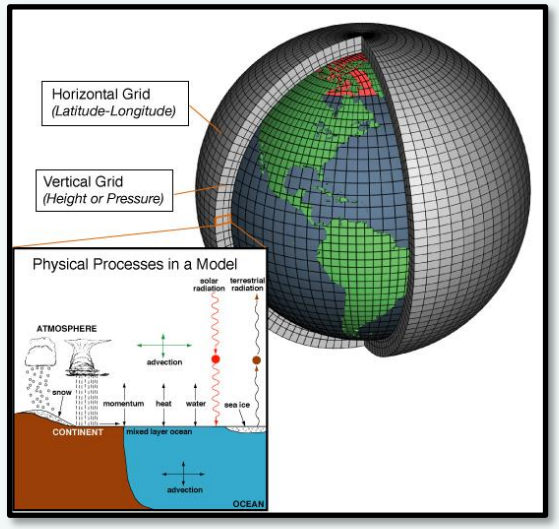
Blue Habitats
Allen Coral Atlas



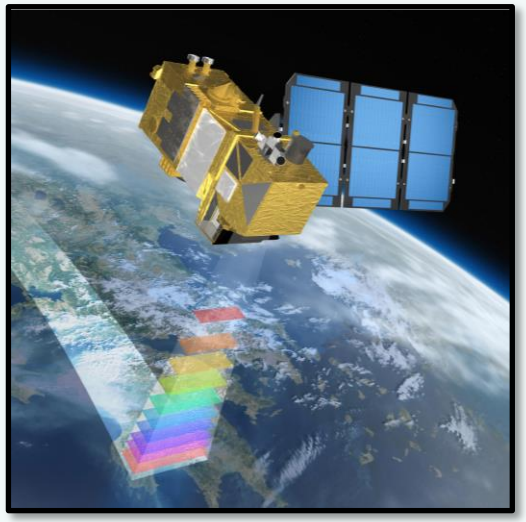
Data flow from sources to 100 WIO Symphony maps

Pelagic habitats

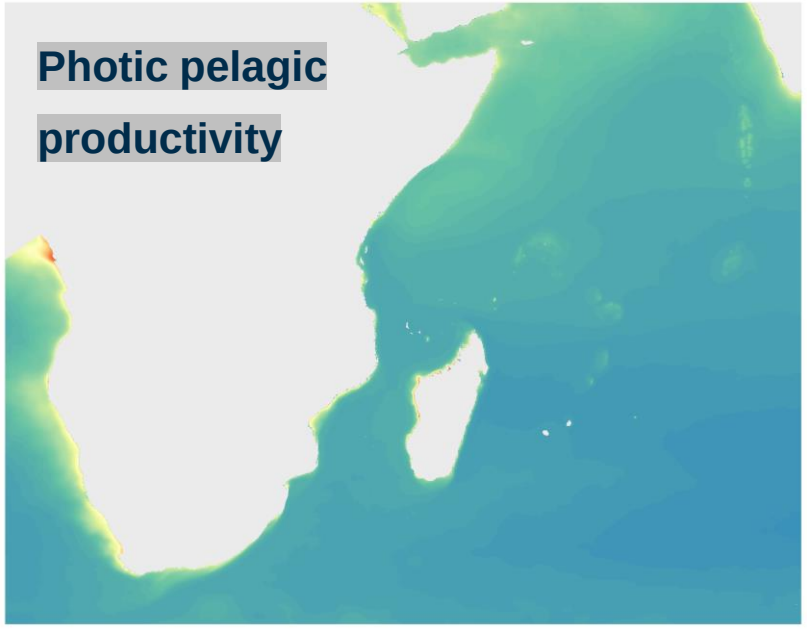
Sourced & compiled into yearly averages directly from Copernicus Marine Service

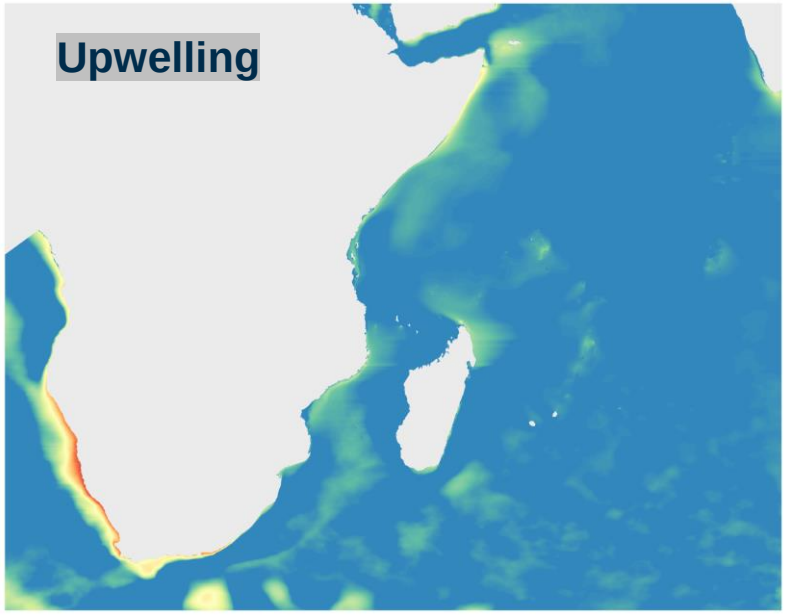


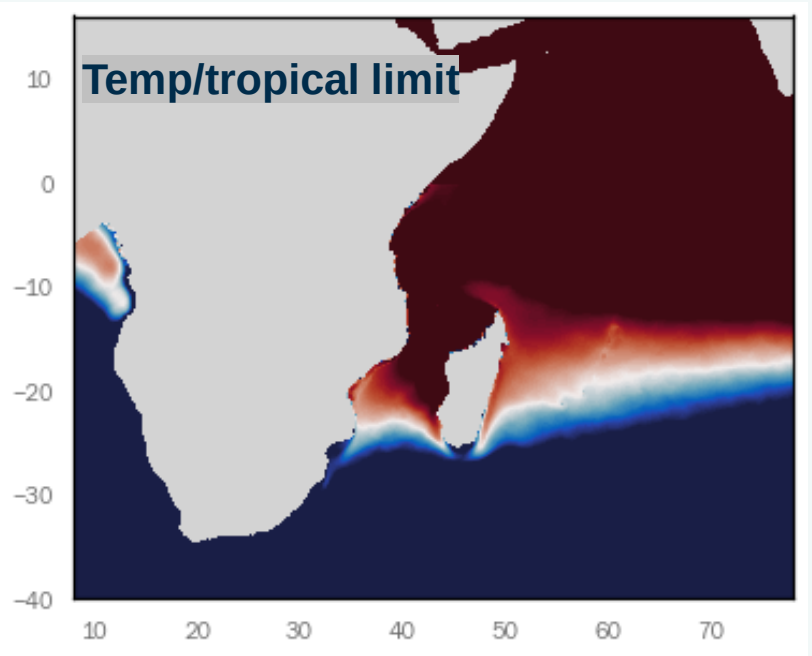
Copernicus Marine Service



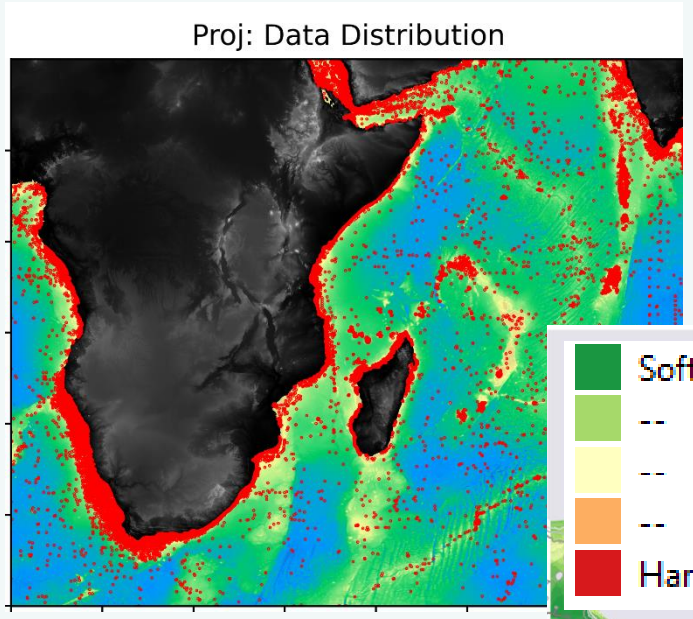
Processing by Dr. B. Queste, Gothenburg University

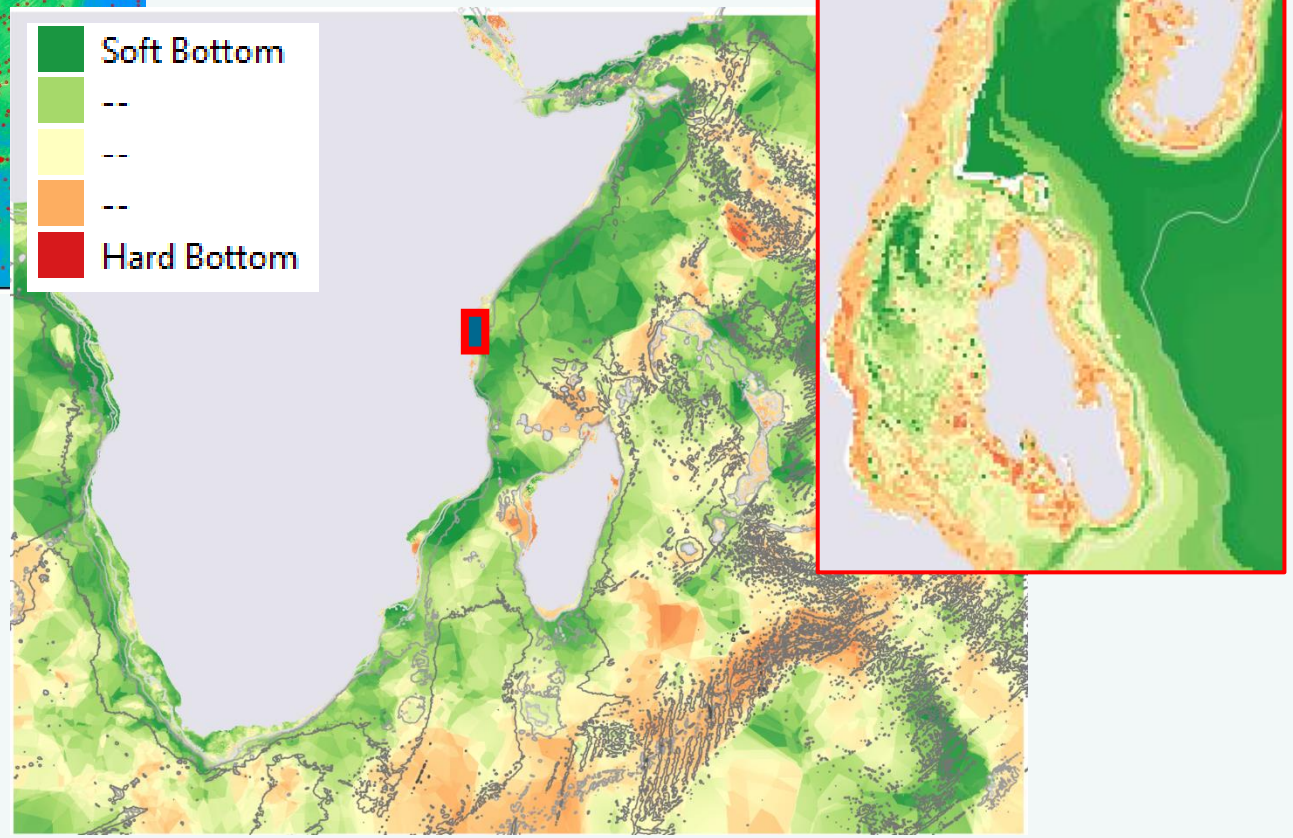






A new WIO substrate model developed





WIO: 498+ datasets,
167,000+ observations

dbSEABED database – worldwide coverage
"tinyurl.com/dbseabed/
"

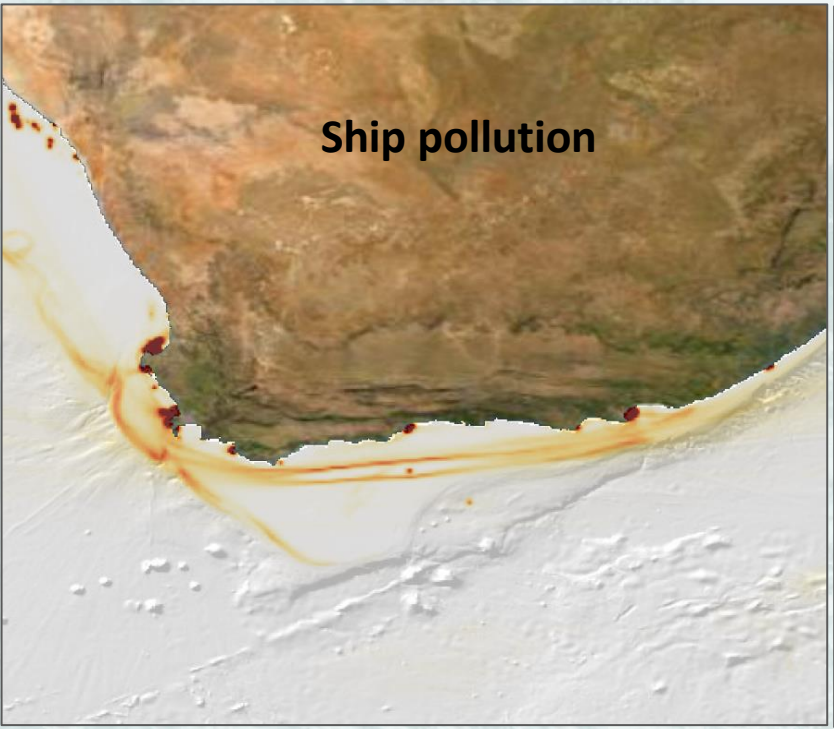
Seafloor type: hard vs soft bottom

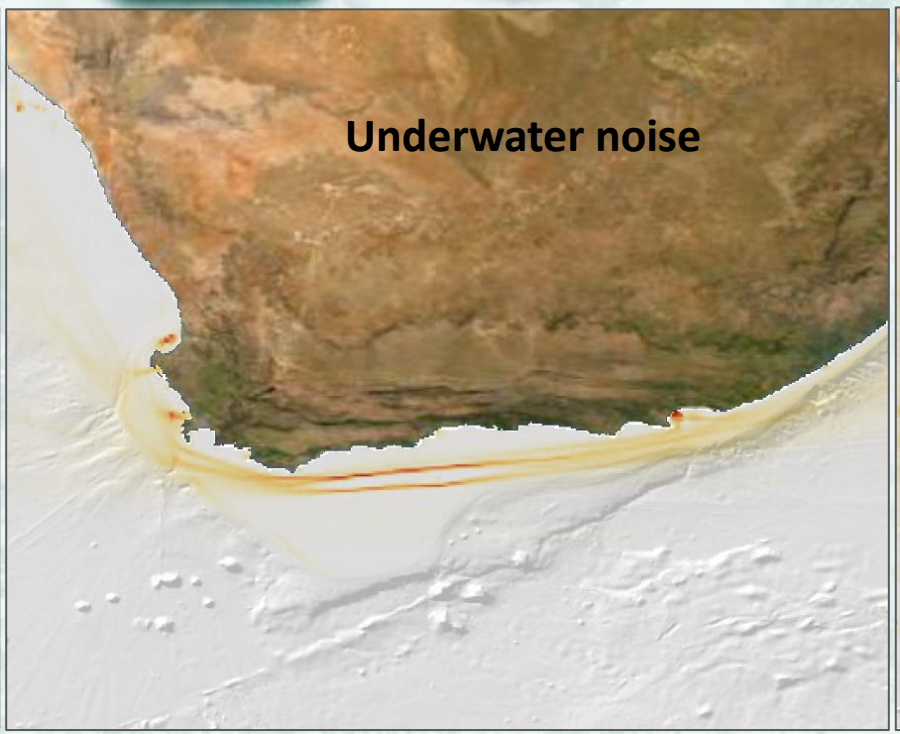
dbSEABED
Based in Boulder Colorado, but with many international partners
Dr. Chris JENKINS, PI

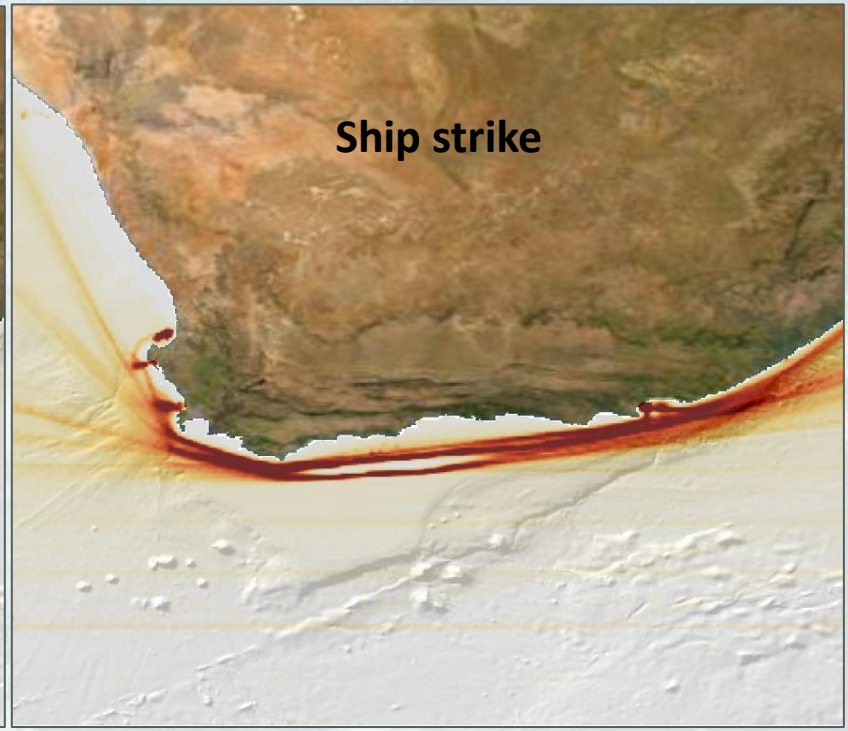
Shipping - pressures from activities

HUB Ocean
Centre for the Fourth Industrial Revolution

AIS data 2020-2022 provided by hubocean.earth







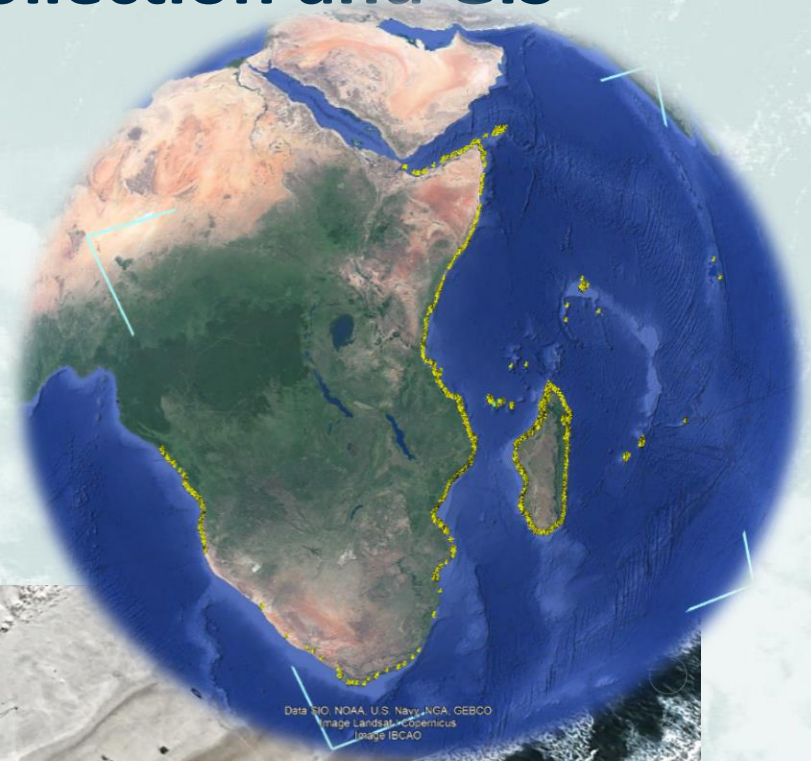
Manual data collection and GIS

Aquaculture

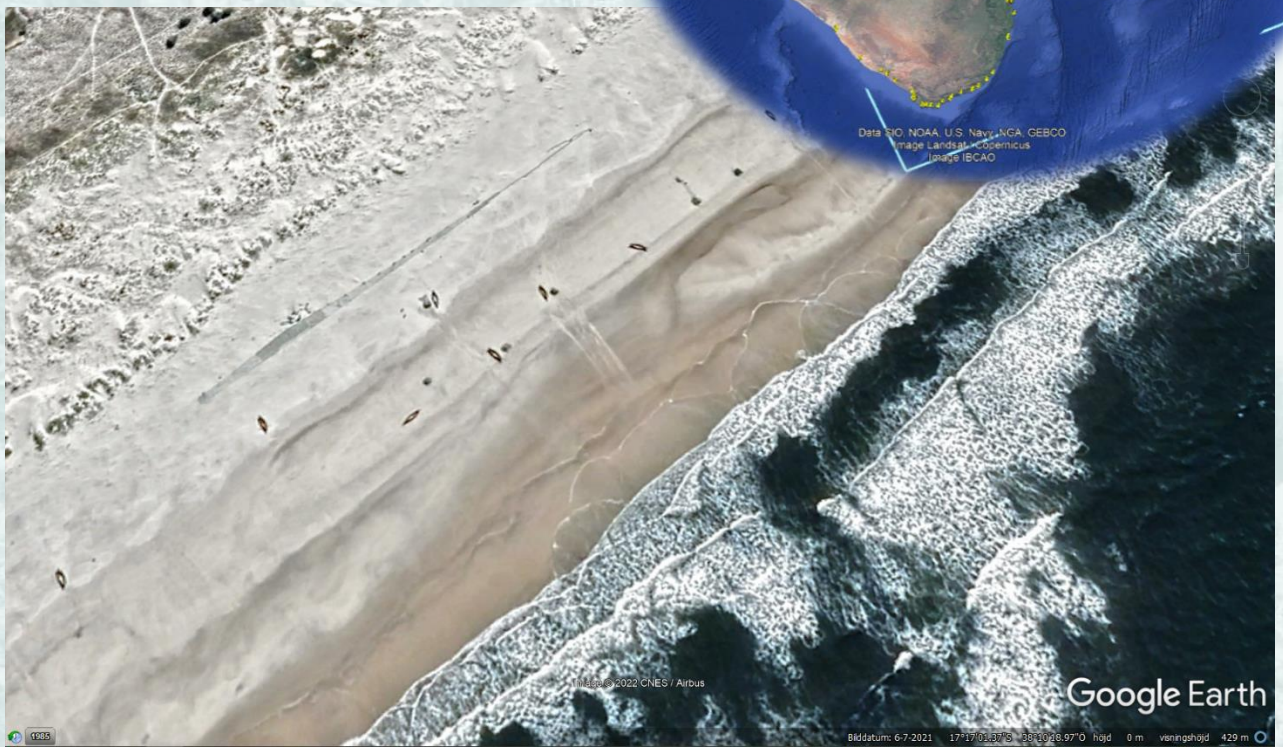
Artisanal fishing

Tourism

Piers and docks

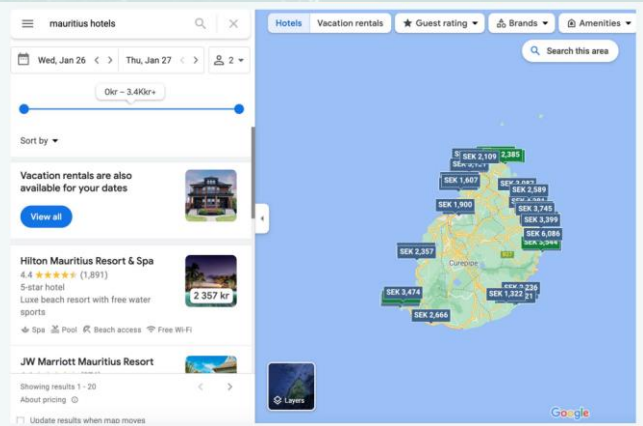


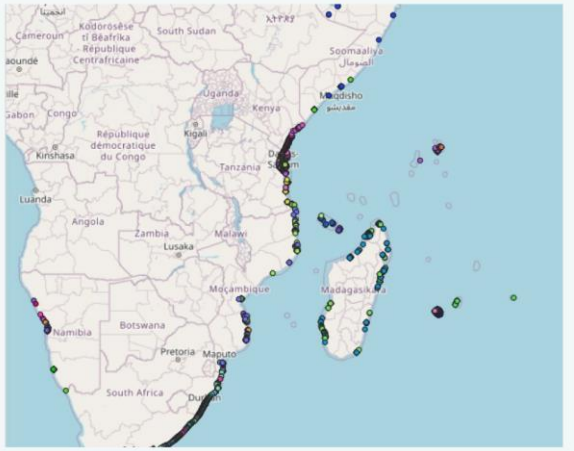
Artisanal fishing



Coastal tourism

- Remote sensing satellite photos
- Google Maps and Google Earth
- Searching for hotels within 1 km from the shoreline





N
Image © 2022 Maxar Technologies
Google Earth
1985
Bilddatum: 15-6-2004 21°50'34.90"S 35°26'58.56"Ö höjd 0 m visningshöjd 81 m

Machine learning
Modelling new maps from observations

Nairobi Convention

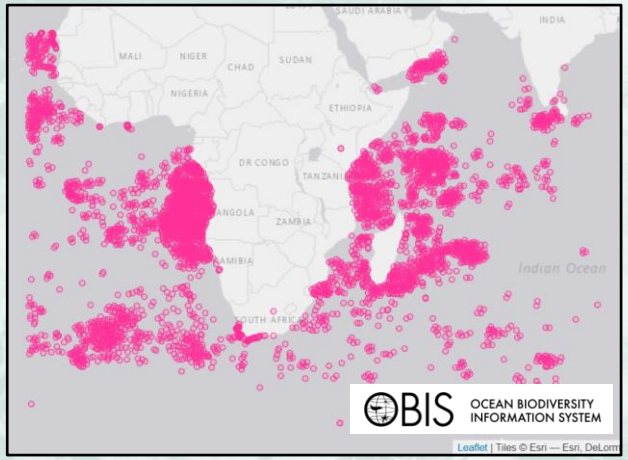
UN environment programme

Sweden Sverige

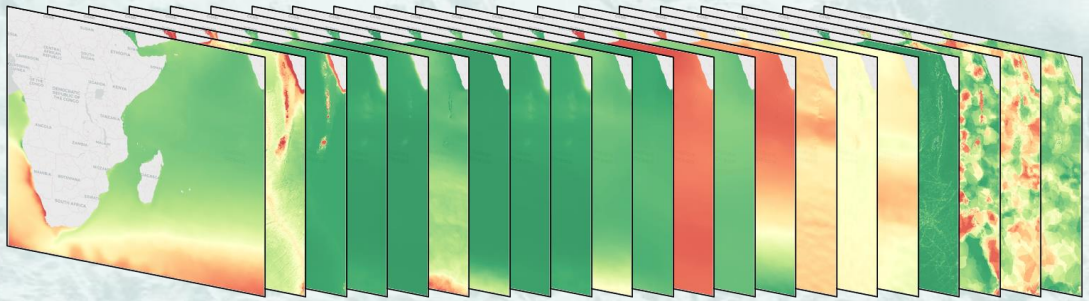
Swedish Agency for Marine and Water Management

Sperm whales

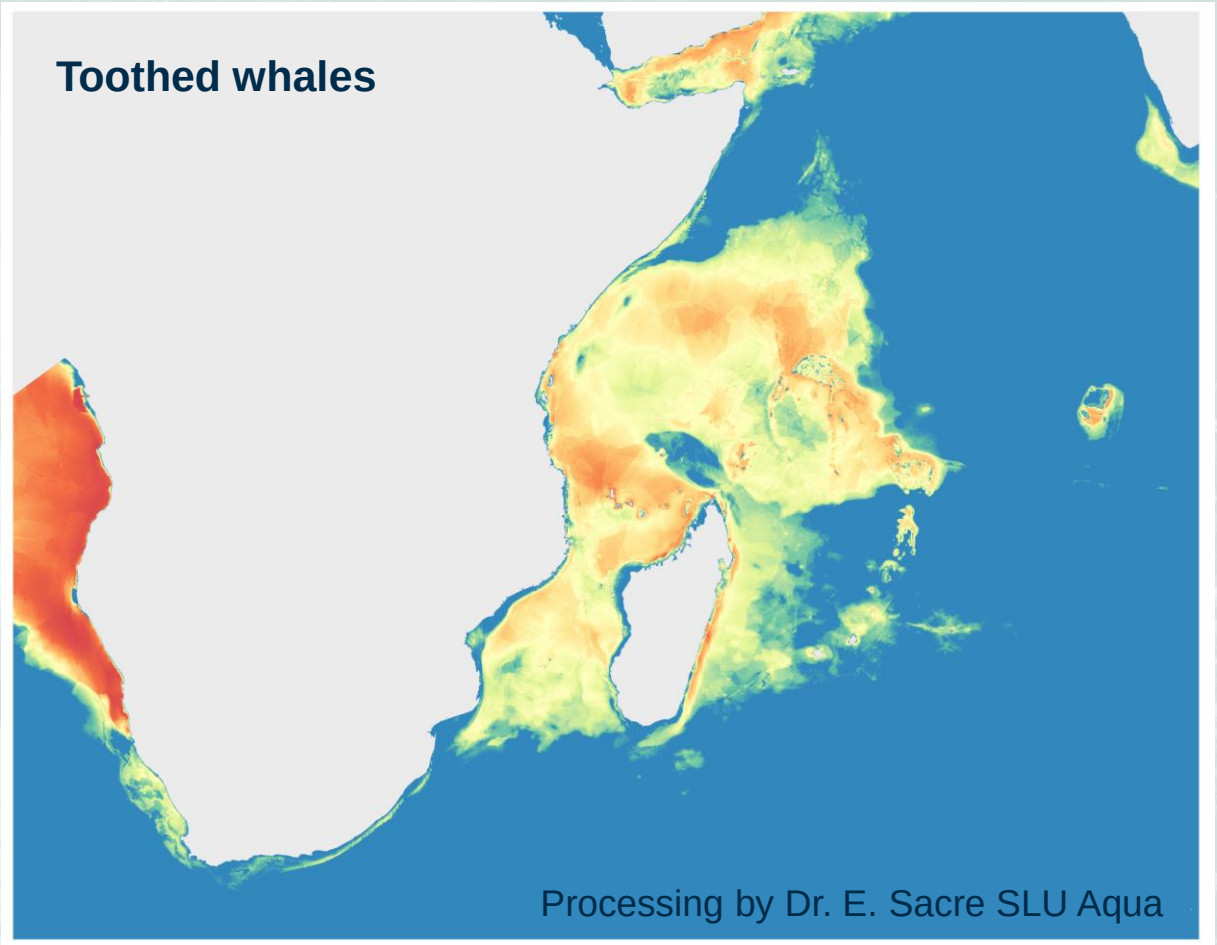
Observations



Predictor layers (temperature, salinity, productivity, etc.)



Predicted map

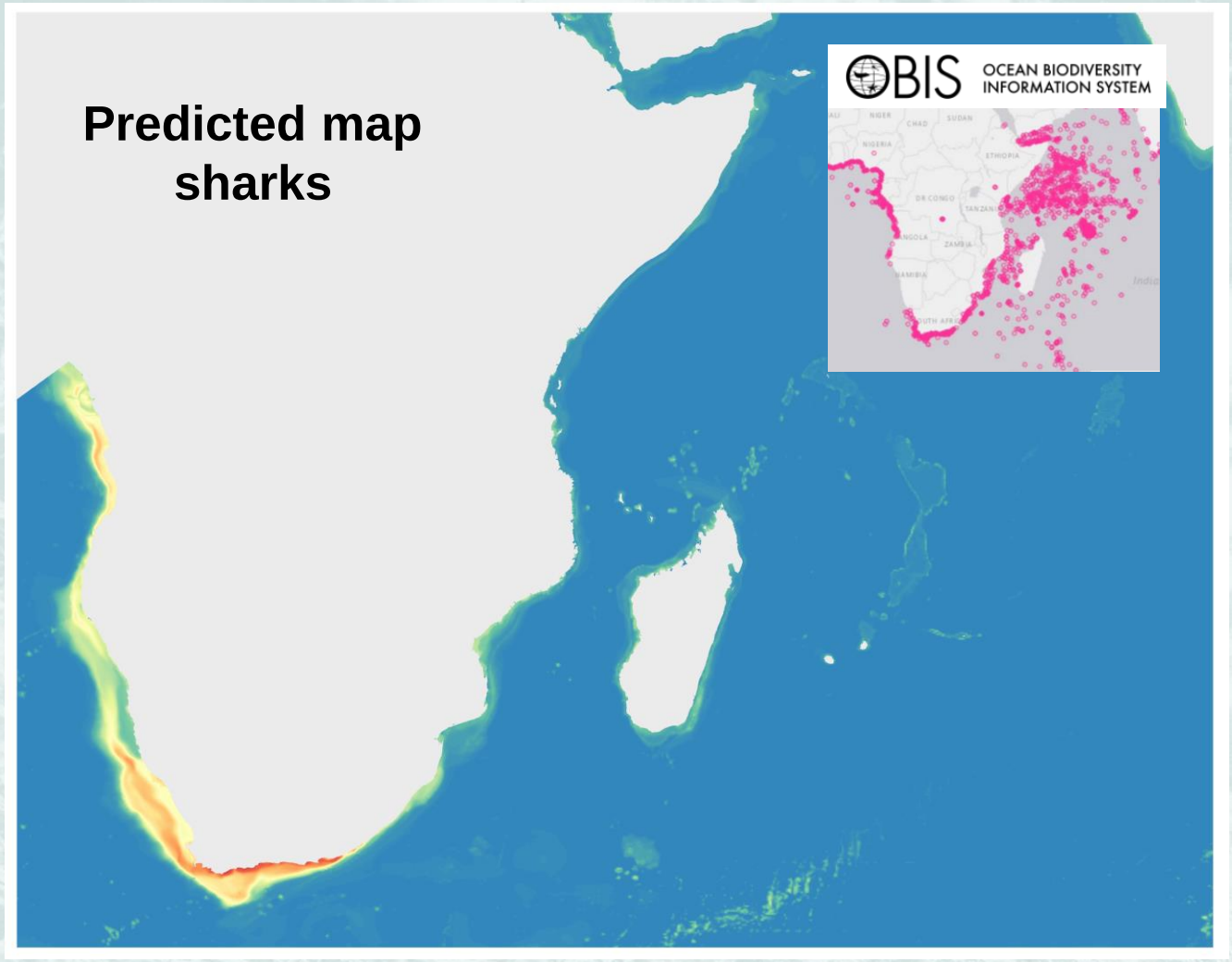


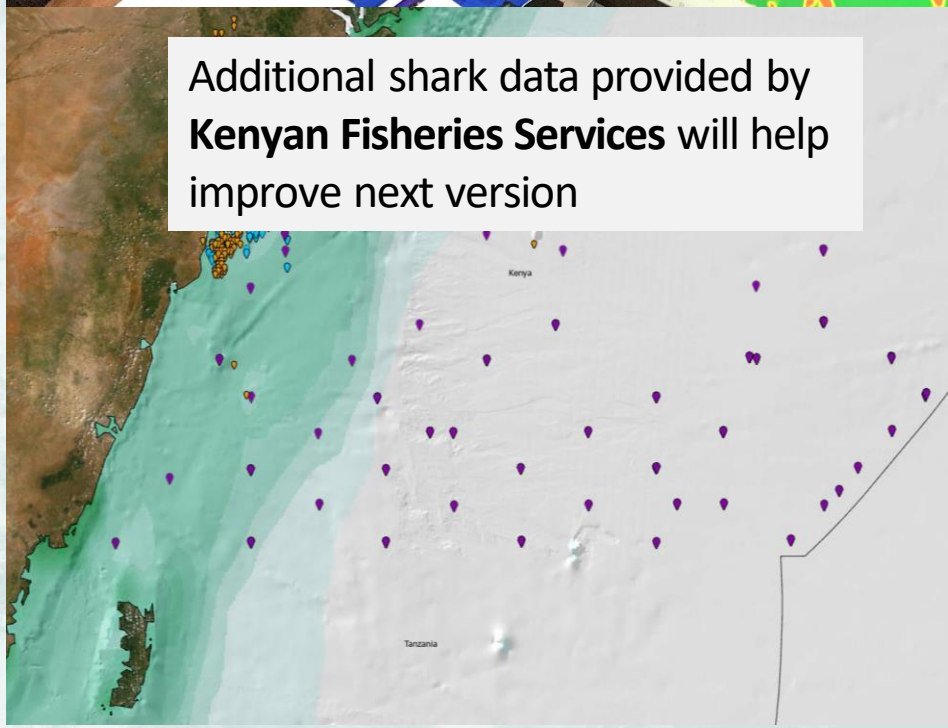
Predictive modelling help unlock data from global to local dataset

Potential future updates

Reef fish collaboration with CORDIO

Improved shark model (new data from KeFS)



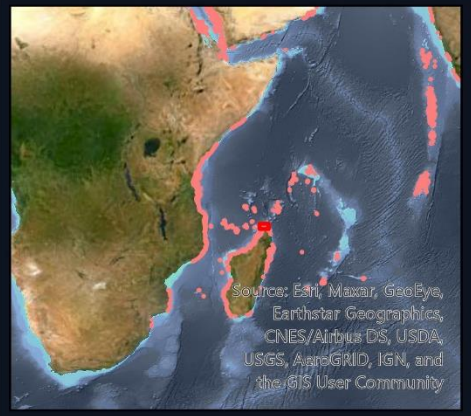


Additional shark data provided by **Kenyan Fisheries Services** will help improve next version

Data Process – combining sources

Illustration of coral data processing

1. Gather data – Source 1: Global data from WCMC



Kilometers

0 2,5 5 10 15 20

WCMC CoralReef2018

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

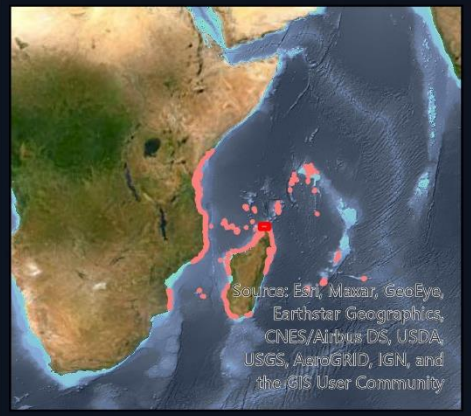


Illustration of coral data processing

2. Gather data – Source 2 : New high resolution data from Allen Coral Atlas (published Aug 2020)

Kilometers
0 2,5 5 10 15 20

Allen coral atlas

class

- Coral/Algae
- Microalgal Mats
- Rock
- Rubble
- Sand
- Seagrass
- Unknown

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

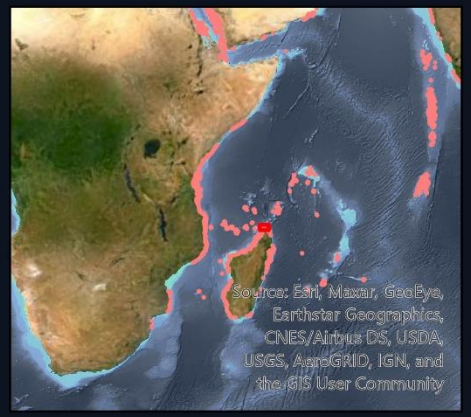


Illustration of coral data processing

3. Combine data. Move from high resolution vector data to a management scale raster data

Kilometers
0 2,5 5 10 15 20

coral wcmc grid 250m
1

coral Allen grid 250m
1

coral overlap
1

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

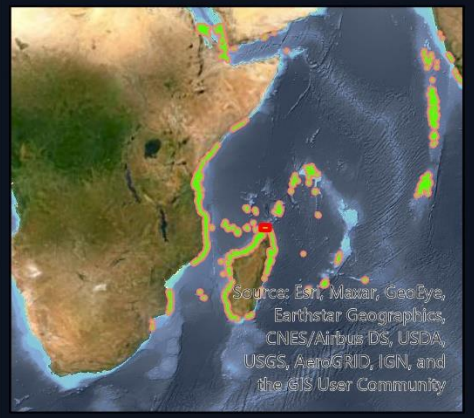


Illustration of coral data processing

4. Combine data. Use data quality and expert knowledge to create a final coral layer.

Kilometers
0 2,5 5 10 15 20

coral combined grid 250m
- shallow habitat
- coral

mangrove gmw2016, tnc2014 - grid 250m
- 1

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

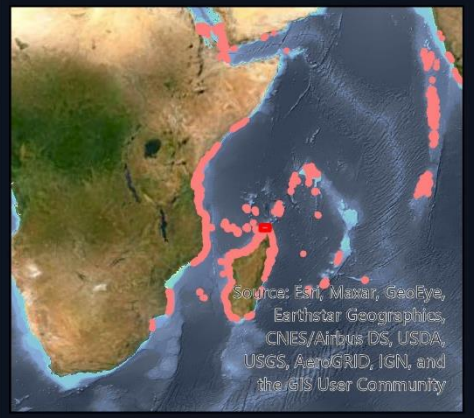


Illustration of coral data processing
5. Aggregate data to analysis grid

Kilometers
0 2,5 5 10 15 20

coral combined proportions grid 1km
Value
1
0

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

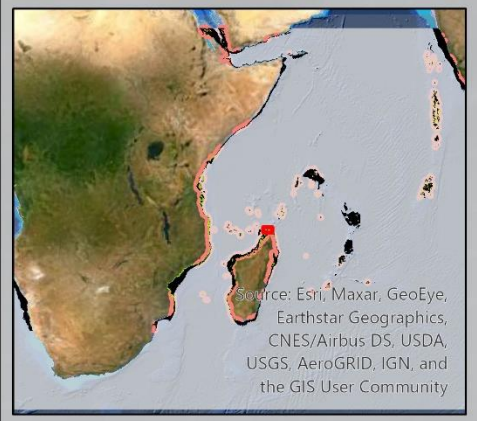


Illustration of coral data processing

Step 8. Uncertainty map

-> Show where coral reefs might occur, but data is missing

Kilometers
0 2,5 5 10 15 20

coral uncertainty
- outside range
- very good model
- good model
- no data

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

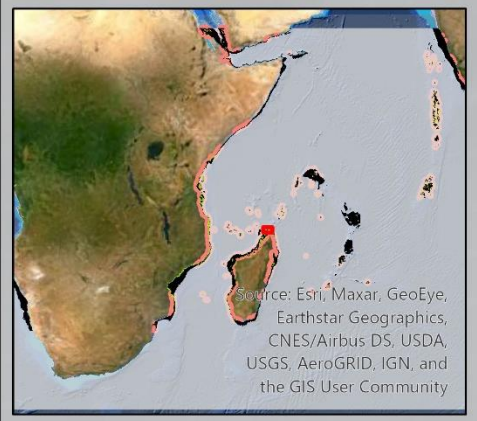


Illustration of coral data processing

Step 8. Uncertainty map

-> Show where coral reefs might occur, but data is missing

Kilometers

0 2,5 5 10 15 20

coral uncertainty
outside range
very good model
good model
no data

Large ”no data” areas

Mesophotic Coral

Map **Empty** in v01

more data needed..

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Review process:

Engage and make final improvements, create ownership

https://wiosym.shinyapps.io/wiosym/

WIO Symphony review

?

List of layers

Select theme

All layers

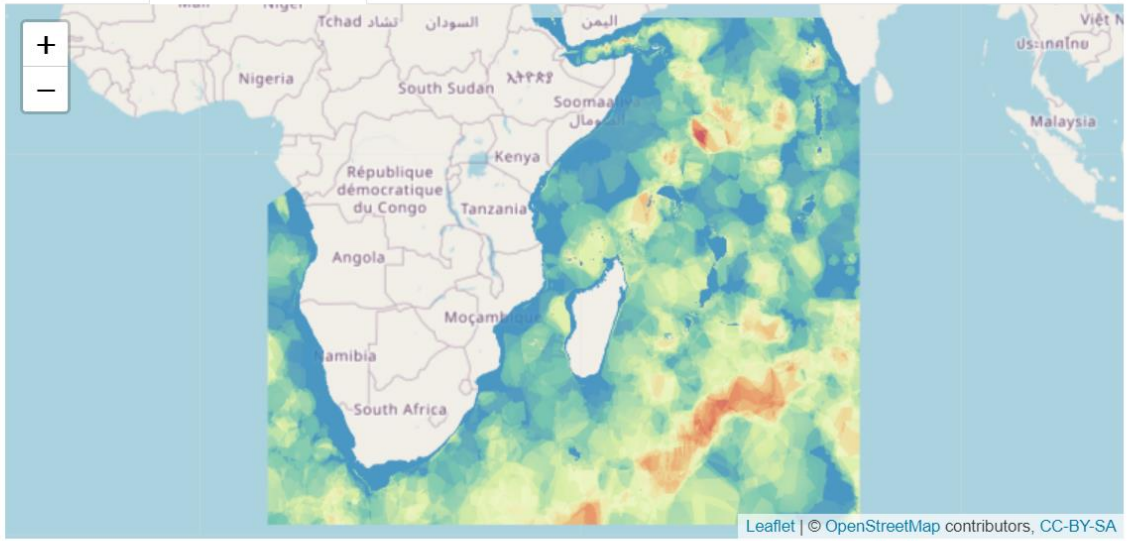
Component

- Abyssal rock (deep hard bottom) 11
- Abyssal plain (deep soft bottom) 2
- Air emissions 1
- Algae farming
- Baleen whales 3
- Cold-water coral reef 1
- Coral reef 5
- Crustacean fishing (selective) 2

Layer information

Add comment

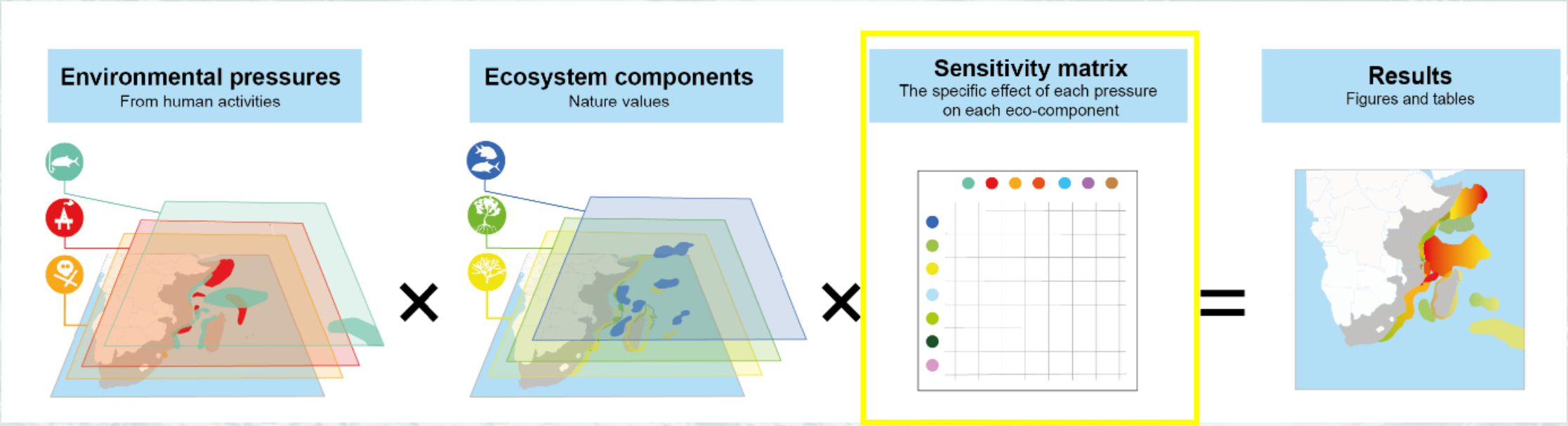
Overview | Distribution map | Uncertainty map | Sensitivity



Sensitivity = expected effect from exposure to a defined pressure of a certain magnitude

E.g. 130 dB noise at 125 Hz OR *baited floating longline at maximum fishing intensity*

What is sensitivity score



Swedish Agency

Number of respondents

Coastal development

Shipping

Fishing

Recreation

Survey

Aquaculture

Offshore development

Pollution

Climate Change

	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	COASTAL DEVELOPMENT	SHIPPING	SHIPPING	SHIPPING	FISHING	FISHING	FISHING	FISHING	FISHING	FISHING	FISHING	FISHING	FISHING	RECREATION	RECREATION	RECREATION	LITTER	SURVEY	SURVEY	AQUACULTURE	AQUACULTURE	OFFSHORE DEVELOPMENT	OFFSHORE DEVELOPMENT	OFFSHORE DEVELOPMENT	OFFSHORE DEVELOPMENT	OFFSHORE DEVELOPMENT	BIOLOGICAL DISTURBANCE	MINING	POLLUTION	POLLUTION	POLLUTION	POLLUTION	NUTRIENTS	CLIMATE CHANGE	CLIMATE CHANGE	CLIMATE CHANGE	CLIMATE CHANGE	
	Ports	Piers and docks	Land reclamation	Water flow changes	Light pollution	Industrial pollution	Dredging	Dumping	Ship pollution	Underwater noise	Ship strikes	Pelagic trawl fishing	Pelagic seine net fishing	Floating Long-line	Pelagic gill net	Demersal trawl fishing	Weighted Long-line fishing	Demersal gill net	Crustacean fishing (selective)	Artisanal fishing (mixed methods)	Ghost fishing	Recreational fishing	Recreational boating	Tourism	Diving and snorkelling	Shark control	Plastic waste	Seismic survey	Research	Mariculture	Algae farming	Infrastructure	Submarine cables	Oil and gas	Renewable energy	Impulsive noise	Invasive species	Sea bed mining	Oil spill	Organic toxins	Inorganic toxins	Air emissions	Nutrient input	Temperature rise	Sea level rise	Ocean acidification	Storm surges	Average
Mammals - Baleen whales																																														
Mammals - Toothed whales																																														
Mammals - Sea otters																																														
Mammals - Seals																																														
Reptiles - Turtles																																														
Fish - Tuna & billfish																																														
Fish - Pelagic fish (other)																																														
Fish - Deep-sea fish & squid																																														
Fish - Small pelagics																																														
Fish - Coral reef fish																																														
Fish - Sharks (predatory)																																														
Fish - Rays																																														
Fish - Ray/ skate/ manta																																														
Invertebrates - Mobile epifauna																																														
Invertebrates - Infauna																																														
Tropical - Shore																																														
Tropical - Mudflats																																														
Tropical - Shallow soft bottom																																														
Tropical - Shallow rocky bottom																																														
Tropical - Deeper (>40m) soft bottom																																														
Tropical - Deeper (>40m) rocky bottom																																														
Tropical - Mangrove																																														
Tropical - Seagrass bed																																														
Tropical - Coral reef shallow (<40m)																																														
Tropical - Coral reef deep (>40m)																																														
Tropical - Macro algae bed																																														
Tropical - Salt marsh																																														
Open ocean - Continental slope soft bottom																																														
Open ocean - Continental slope rocky bottom																																														
Open ocean - Abyssal plain (deep soft bottom)																																														
Open ocean - Abyssal rock (deep hard bottom)																																														
Open ocean - Gyres/ circulations																																														
Open ocean - Mid-ocean ridge																																														
Open ocean - Cold-water coral reef																																														
Open ocean - Seamounts																																														
Open ocean - Deep-sea hydrothermal vents																																														
Open ocean - Pelagic midwater																																														
Open ocean - Pelagic deep water																																														
Open ocean - Pelagic upwelling																																														
Temperate - Shore																																														
Temperate - Mudflats																																														
Temperate - Shallow soft bottom																																														
Temperate - Deeper (>40) soft bottom																																														
Temperate - Deeper (>40) rocky bottom																																														
Temperate - Kelp forest																																														
Temperate - Seagrass bed																																														
Temperate - Salt marsh																																														
Temperate - Penguins feeding area																																														
Temperate - Sea birds																																														
Average																																														

Mammals & reptiles

Fish & invertebrate

Tropical habitats

Open ocean habitats

Temperate habitats

Definition of sensitivity scores for habitats and species:

0 = **No sensitivity** (essentially no change, no response)

1 = **Marginal** (subtle stress)

2 = **Moderate** (some damage, clear stress)

3 = **Detrimental** (damage, some mortality)

4 = **Severe** (vast damage, high mortality, slow recovery)

5 = **Catastrophic** (devastation, complete mortality, very slow recovery)

Sensitivity score (mean)

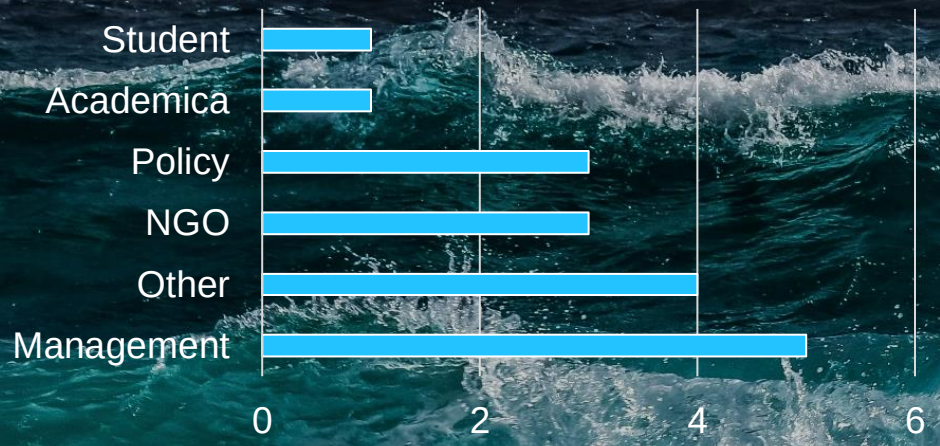
Coastal development
Shipping
Fishing
Recreation
Survey
Aquaculture
Offshore development
Pollution
Climate Change

Mammals & reptiles
Fish & invertebrate
Tropical habitats
Open ocean habitats
Temperate habitats

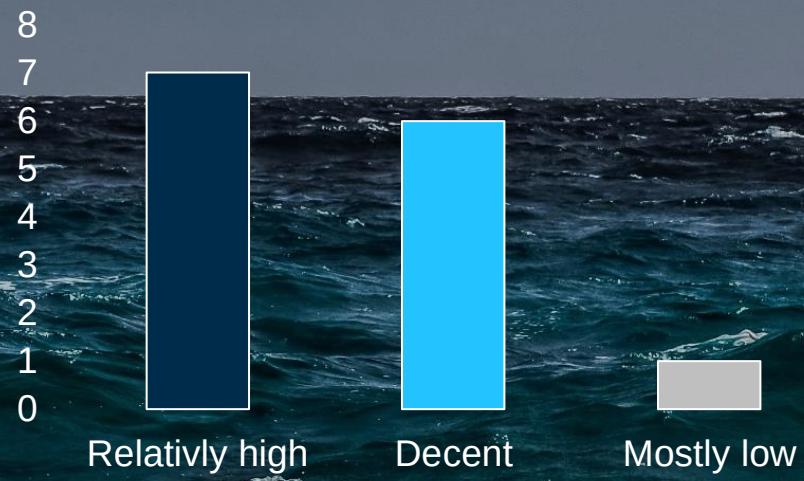
	Ports	Piers and docks	Land reclamation	Water flow changes	Light pollution	Industrial pollution	Dredging	Dumping	Ship pollution	Underwater noise	Ship strike	Pelagic (mid) fishing	Pelagic seine net fishing	Floating Long-line fishing	Pelagic gill net	Demersal trawl fishing	Weighted Long-line fishing	Demersal gill net	Crustacean fishing (selective)	Artisanal fishing (mixed methods)	Ghost fishing	Recreational fishing	Recreational boating	Tourism	Diving and snorkelling	Shark control	Plastic waste	Seismic survey	Bycatch	Mariculture	Algae farming	Infrastructure	Submarine cables	Oil and gas	Renewable energy	Impulsive noise	Invasive species	Seabed mining	Oil spill	Organic toxins	Inorganic toxins	Air emissions	Nutrient input	Temperature rise	Sea level rise	Ocean acidification	Storm surges	Average
Mammals - Baleen whales	2,5	1,8	1,5	1,3	1,5	2,8	1,7	1,7	2,3	2,7	2,7	1,3	2,7	2,3	2,5	1,3	2,0	2,7	1,7	1,7	2,3	1,3	2,0	2,0	1,7	2,7	2,7	3,8	0,8	1,3	1,3	1,7	1,3	2,3	1,3	2,3	1,3	2,0	2,7	2,7	2,7	1,7	2,0	2,0	1,0	2,3	3,0	2,0
Mammals - Baleen Whales	1,5	1,5	1,3	1,3	1,3	2,5	2,7	2,0	4,0	3,3	3,7	1,3	1,3	2,0	2,5	1,7	2,0	2,7	1,3	1,3	1,7	1,3	1,7	1,0	1,0	1,7	3,0	3,5	0,8	2,0	1,0	1,7	1,3	3,0	1,3	2,0	2,0	2,0	2,0	3,3	3,3	1,7	3,3	1,7	1,0	2,3	3,0	2,0
Mammals - Toothed whales	1,5	1,3	1,3	1,0	1,3	2,3	1,7	2,0	3,3	2,7	3,3	1,0	1,3	2,0	2,5	1,3	2,0	1,7	0,7	0,7	1,7	1,0	1,7	1,0	1,0	1,7	2,7	3,5	0,8	1,5	1,0	1,7	1,7	3,0	1,3	2,0	1,3	2,0	2,3	3,0	3,0	1,7	3,0	2,0	1,0	2,3	3,0	1,8
Mammals - Sea otter	1,5	1,5	1,8	1,3	1,5	2,8	2,0	2,0	3,0	2,7	2,7	2,0	2,0	2,0	2,5	1,7	2,0	1,7	1,0	1,0	2,0	1,0	1,7	1,0	1,0	1,7	2,3	3,0	0,8	1,3	1,3	1,7	1,3	2,0	1,3	2,0	1,3	2,0	2,3	2,3	2,3	1,7	2,0	1,7	1,7	2,3	3,0	1,8
Mammals - Seals	1,0	1,0	1,0	0,7	1,5	3,0	2,0	2,0	4,0	2,0	4,0	3,0	3,0	3,0	3,0	2,0	2,0	2,0	0,0	0,0	2,0	1,0	2,0	1,0	1,0	3,0	4,0	2,5	1,0	2,0	1,0	3,0	1,0	3,0	1,0	3,0	2,0	2,0	3,0	4,0	4,0	1,0	2,0	0,0	0,0	3,0	2,0	2,0
Reptiles - Turtles	2,0	1,8	1,8	1,3	3,0	3,0	3,0	2,0	4,0	2,3	3,0	3,3	3,3	2,0	2,5	2,0	2,0	2,7	1,3	1,7	2,0	1,3	1,7	1,0	1,0	1,7	2,7	2,5	0,8	2,0	1,0	1,7	1,3	2,0	1,3	2,0	2,0	2,0	2,3	3,3	3,3	1,7	2,7	3,0	2,0	2,7	3,5	2,2
Fish - Tuna & billfish	1,4	1,0	0,6	0,5	1,3	1,9	1,6	1,0	1,3	2,0	1,1	2,9	2,8	3,9	3,2	1,3	1,4	1,7	0,3	2,5	1,3	2,8	1,0	0,5	0,3	1,0	1,8	1,6	0,5	0,7	0,3	0,6	1,0	1,2	1,0	1,2	1,0	1,8	2,2	2,0	2,5	0,8	1,0	1,8	0,8	2,5	1,8	1,5
Fish - Pelagic fish (other)	1,7	1,1	0,9	0,5	1,2	2,2	1,8	1,3	1,6	1,3	0,9	3,2	2,8	2,0	2,8	1,7	0,4	2,1	0,8	3,3	1,4	1,4	0,9	0,5	0,4	1,0	2,1	2,2	0,6	1,0	0,3	0,7	0,8	1,5	1,0	1,5	1,8	2,7	3,0	1,9	2,3	1,0	1,4	2,1	1,2	2,7	1,8	1,5
Fish - Oily species (sardine & scad)	1,2	0,5	0,3	0,7	1,7	2,0	2,5	1,7	1,3	1,5	0,4	1,5	1,7	1,8	1,0	3,7	2,3	2,8	1,7	2,7	1,3	1,8	0,3	0,0	0,5	1,0	1,6	1,8	0,5	0,5	0,0	0,3	0,7	1,0	0,7	1,0	1,3	2,5	2,7	2,0	2,8	0,0	1,0	2,0	0,7	3,0	1,0	1,4
Fish - Demersal fish	1,4	1,3	3,1	2,0	1,9	2,6	3,3	1,8	2,0	1,5	0,8	1,0	1,0	2,0	1,8	3,8	3,0	3,6	2,3	2,8	1,5	1,6	0,8	0,5	1,0	1,3	1,5	2,4	1,0	1,0	0,5	1,3	0,8	1,8	1,0	1,5	1,3	3,2	2,7	2,1	2,7	1,0	2,0	2,7	1,5	3,2	1,8	1,8
Fish - Coral reef fish	2,1	1,8	2,9	2,0	1,9	2,0	2,9	2,0	2,3	1,8	1,0	1,6	1,4	2,1	2,0	3,0	2,8	2,7	1,2	2,8	2,1	2,0	1,2	1,2	1,2	1,3	2,0	2,5	1,0	0,9	0,5	1,2	1,2	1,8	1,2	1,5	1,5	2,4	2,8	2,1	2,7	0,8	1,8	2,5	1,2	2,9	1,6	1,9
Fish - Sharks (predatory)	1,4	1,0	1,5	1,6	1,3	1,8	1,4	1,2	1,8	2,0	1,4	3,0	2,6	3,1	3,0	1,8	2,3	2,3	0,8	2,5	2,7	1,8	0,8	1,0	0,8	2,0	1,4	2,0	0,7	0,8	0,4	0,8	1,2	1,2	1,0	1,2	1,0	1,7	2,4	1,8	2,2	0,8	1,5	2,0	1,2	2,3	1,8	1,6
Fish - Small pelagics	0,7	0,7	0,8	1,0	1,0	1,7	1,9	1,4	1,6	2,2	2,1	2,7	2,2	1,7	2,8	2,0	0,8	2,0	1,0	2,3	1,2	1,3	1,2	1,0	1,0	1,4	1,9	2,0	0,8	0,7	0,4	0,6	1,0	1,4	1,0	1,4	1,0	1,5	2,2	1,7	2,4	1,0	1,4	2,0	1,0	2,3	1,8	1,5
Fish - Ray/Skate/Manta	1,2	1,0	1,3	1,0	1,5	1,5	1,3	1,2	1,6	2,2	1,4	2,4	2,2	2,1	2,8	2,7	2,5	2,7	0,8	2,8	2,7	1,6	0,8	0,6	1,0	1,8	1,5	2,0	0,7	0,8	0,4	0,8	1,2	1,2	1,0	1,2	1,0	1,8	2,2	1,8	2,1	0,8	1,6	2,0	1,0	2,5	1,8	1,6
Invertebrates - Mobile epifauna	2,0	1,7	3,4	2,0	1,4	2,9	2,8	2,8	2,2	1,4	0,6	0,4	0,4	0,6	0,5	2,8	1,5	1,4	3,8	3,8	1,5	1,2	0,6	0,8	1,0	0,6	1,7	2,2	0,8	1,3	0,8	1,0	1,2	1,6	1,0	1,0	1,6	2,7	2,4	2,3	2,8	0,8	2,5	2,4	1,4	2,8	2,0	1,7
Invertebrates - Infauna	2,0	1,8	3,2	2,4	0,8	2,5	3,2	2,8	2,4	1,4	0,6	0,4	0,4	0,3	0,5	2,4	0,5	0,6	1,0	2,5	0,8	1,2	0,6	1,0	0,8	0,4	1,7	2,2	0,5	1,3	1,0	1,2	1,4	1,8	1,2	1,0	1,6	2,8	2,6	2,5	3,2	0,8	3,0	2,6	1,6	2,5	2,0	1,6
Tropical - Shore	2,1	2,6	3,3	2,3	1,3	2,0	2,3	2,0	2,0	1,4	1,4	0,4	0,4	1,0	1,0	1,0	1,0	1,0	0,8	1,0	1,6	1,4	1,3	2,0	0,4	0,7	2,4	1,0	1,0	1,2	1,4	2,0	1,2	1,3	1,3	2,5	1,8	1,2	3,2	2,4	2,4	1,6	2,2	2,3	3,7	2,5	3,3	1,7
Tropical - Mudflats	2,3	2,0	3,5	2,3	0,5	2,0	2,0	1,3	1,3	0,3	1,0	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,7	0,7	1,0	1,0	1,0	1,3	0,0	0,5	1,8	0,0	1,3	1,0	0,8	1,5	0,5	0,5	1,0	2,0	1,0	0,5	2,8	2,0	1,8	1,0	1,5	2,0	3,0	1,7	2,5	1,3
Tropical - Shallow soft bottom	1,7	1,3	1,7	2,3	0,5	1,5	2,8	1,3	1,8	0,5	1,0	1,3	1,3	2,0	2,0	3,3	2,3	2,5	1,8	1,5	1,3	1,5	1,0	1,8	1,5	1,0	1,8	1,0	1,5	1,6	1,3	2,3	2,3	1,0	1,0	1,0	1,8	3,0	2,0	2,0	2,3	0,8	1,5	1,0	1,0	2,0	0,5	1,6
Tropical - Shallow rocky bottom	1,5	2,8	3,2	0,7	0,5	0,7	2,0	1,3	1,5	0,5	2,0	1,0	1,0	1,5	1,5	3,3	2,3	2,0	1,8	1,3	1,5	1,0	1,0	1,0	1,3	1,0	0,5	1,0	1,3	1,2	1,3	2,8	2,3	2,8	1,0	1,0	1,0	3,0	1,8	1,5	1,5	1,3	1,5	1,0	1,0	2,0	0,5	1,5
Tropical - Deeper (>40m) soft bottom	1,8	2,0	2,3	0,7	0,5	1,0	2,8	0,8	2,0	0,5	1,0	1,3	1,3	2,0	2,0	3,3	2,3	2,3	1,5	1,5	2,3	1,5	0,7	1,5	1,3	1,0	1,5	2,0	1,3	0,8																	1,3	0,5	1,5
Tropical - Deeper (>40) rocky bottom	2,0	2,2	2,5	0,7	0,5	1,2	2,8	0,8	2,0	0,5	2,0	0,8	0,8	1,8	1,8	3,3	1,8	1,5	1,5	2,3	1,0	0,7	1,0	0,8	1,0	0,3	2,0	1,3	0,8																	1,7	0,5	1,4
Tropical - Mangrove	3,2	3,0	4,3	3,5	0,5	2,8	1,8	3,3	1,3	0,5	2,0	0,7	0,7	0,7	1,0	2,0	0,7	1,3	1,5	2,8	2,8	1,3	1,0	2,5	1,8	2,0	2,8	1,0	1,5	2,0																	2,7	3,0	2,0
Tropical - Seagrass bed	2,4	3,0	3,8	2,3	1,3	2,5	3,4	3,0	2,6	1,4	3,0	1,3	1,3	1,4	1,2	2,7	1,2	2,3	1,8	1,4	2,6	1,4	1,4	2,0	1,8	1,3	1,7	1,8	1,2	1,1																	2,4	2,5	2,1
Tropical - Coral reef Shallow	2,4	3,0	3,6	1,8	0,5	3,0	4,0	2,5	2,8	2,2	2,0	2,8	1,3	1,7	2,0	4,0	3,0	2,7	2,3	2,0	2,8	1,5	1,7	2,0	2,5	3,0	2,5	2,0	2,0	1,5																	3,4	3,0	2,4
Tropical - Coral reef deep (>40m)	1,5	2,0	3,0	1,0	0,5	3,0	4,2	2,2	2,8	2,2	2,3	3,0	0,0	1,0	1,0	4,5	3,7	2,0	3,0	3,0	3,0	1,5	1,0	0,5	1,3	3,0	1,7	2,3	1,3	0,7																	3,3	1,0	2,1
Tropical - Macro algae bed	2,3	1,6	3,0	1,7	0,5	3,0	2,3	1,3	1,3	1,5	1,3	0,5	0,5	1,0	1,0	3,0	1,0	2,0	1,5	1,5	2,3	1,0	0,7	1,0	0,8	1,0	2,3	1,0	1,5	1,3																	2,7	2,5	1,5
Tropical - Salt marsh	2,2	1,8	3,0	2,3	0,5	2,3	2,3	1,5	1,5	1,5	1,3	0,5	0,0	1,0	0,5	2,5	0,5	2,0	1,5	1,5	1,5	1,0	1,0	1,5	1,5	1,0	1,5	1,7	0,7	1,3																	2,3	2,0	1,6
Open ocean - Continental slope soft bottom	1,0	1,0	0,0	1,0	0,0	0,5	1,7	2,0	1,0	1,3	0,0	3,0	3,0	3,0	3,0	3,7	2,3	3,0	1,3	0,7	2,3	1,0	2,0	0,0	0,0	0,0	2,3	1,0	0,8	0,0																	2,0	0,0	1,3
Open ocean - Continental slope rocky bottom	0,0	0,0	0,0	1,0	0,0	0,3	1,0	2,7	1,0	0,7	1,0	2,0	2,0	2,0	1,0	4,0	2,0	1,7	1,7	1,0	1,7	1,0	1,3	0,0	0,0	0,0	1,7	1,0	0,3	0,0																	2,0	0,0	1,1
Open ocean - Abyssal plain (deep soft bottom)	1,0	0,0	0,0	0,0	0,0	0,8	3,0	1,7	1,0	1,3	0,0	3,0	3,0	3,0	2,0	3,0	3,0	3,0	0,5	0,5	2,3	1,0	0,0	0,0	0,0	0,0	2,3	1,0	0,8	0,0																	1,0	0,0	1,3
Open ocean - Deep rock (seamounts)	1,0	0,0	0,0	0,0	0,0	0,8	3,0	1,7	1,0	1,3	0,0	2,0	2,0	3,0	2,0	3,0	3,0	3,0	1,0	1,0	2,0	0,0	0,0	0,0	0,0	0,0	1,7	1,0	0,3	0,0																	1,0	0,0	1,1
Open ocean - Seamounts	0,0	0,0	0,0	0,0	0,0	0,5	3,0	1,0	1,0	1,3	0,0	2,7	3,0	3,0	2,0	3,3	2,7	3,0	1,3	1,0	1,7	0,0	0,0	0,0	0,0	0,0	1,7	1,5	0,3	0,0																	1,0	0,0	1,1
Open ocean - Coldwater coral reef	1,0	1,0	3,3	0,0	0,0	3,0	5,0	3,0	1,0	1,7	0,0	3,0	4,0	1,0	1,0	4,0	1,7	4,0	3,0	1,0	2,7	2,0	0,0	0,0	0,0	0,0	3,0	1,0	1,0	0,0																	2,0	0,0	2,0
Open ocean - Pelagic	0,0	0,0	0,0	0,0	0,0	1,5	3,0	1,7	1,0	1,5	0,0	2,0	2,0	1,0	1,0	3,7	1,7	2,7	1,7	0,0	1,5	1,0	0,0	0,0	0,0	0,0	1,7	1,0	0,5	0,0																	2,0	0,0	1,2
Open ocean - Pelagic photic zone	2,0	2,0	0,0	0,0	0,5	2,0	0,0	2,0	1,0	0,0	0,0	2,3	2,7	1,0	1,0	1,0	0,0	0,0	2,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0	2,0	0,0	0,5	0,5																	2,0	0,0	1,0
Open ocean - Pelagic midwater	1,0	1,0	0,0	0,0	0,0	1,0	0,0	1,0	1,0	0,0	0,0	2,0	1,7	1,0	1,0	1,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,5	0,0																	2,0	0,0	0,7
Open ocean - Pelagic deep water	0,0	0,0	0,0	0,0	0,0	0,5	0,0	1,0	1,0	0,0	0,0	2,3	3,0	0,0	1,0	1,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,5	0,5	0,0																	2,0	0,0	0,7
Open ocean - Pelagic upwelling	1,0	1,0	0,0	0,0	0,0	1,0	0,0	3,0	1,0	0,0	0,0	2,0	2,0	1,0	1,0	0,0	0,0	0,0	2,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0	2,0	0,0	0,5	0,5																	2,0	0,0	0,9
Temperate - Shore	5,0	3,5	3,5	2,5	2,0	1,5	3,5	2,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	2,0	0,0	0,0	2,0	0,0	1,0	1,0																	1,0	4,0	1,3
Temperate - Mudflats	5,0	3,0	3,0	3,5	1,5	1,5	3,0	2,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	1,0	2,0	0,0	0,0	2,0	0,0	1,0	1,0																	1,0	4,0	1,3
Temperate - Shallow soft bottom	2,0	2,0	3,0	3,0	1,5	1,5	3,5	3,0	1,0	1,0	1,0	0,0	0,0	0,0	0,0	4,0	1,0	2,0	1,0	1,0	1,0	1,0	1,0	1,0	0,0	1,0	2,0	1,0	1,0	1,5																	1,0	1,0	1,5
Temperate - Deeper (>40m) soft bottom	3,0	2,0	2,5	2,0	1,5	0,5	2,0	3,0	1,0	1,0	2,0	0,0	0,0	0,0	0,0	4,0	2,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	2,0	1,0	1,0	1,0																	1,0	1,0	1,5
Temperate - Deeper (>40) rocky bottom	3,0	1,5	2,5	1,0	1,0	1,0	2,0	2,0	1,0	1,0	1,5	0,0	0,0	0,0	0,0	4,0	0,0	1,0	1,0	1,5	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,5																	1,5	1,0	1,2
Temperate - Kelp forest	4,0	2,0	2,5	1,0	1,0	1,0	2,5	2,0	1,0	1,0	1,0	0,0	0,0	0,0	0,0	4,0	1,0	2,0	3,0	3,0	1,0	1,0	1,0	1,0	1,0	1,0	2,0	1,0	0,5	1,5	1,5	1,5	2,0	2,0	1,0	2,0	3,0	2,0	3,0	3,0	1,0	2,0	2,0	1,0	1,0	2,0	1,6
Temperate - Seagrass bed	3,0	2,0	3,0	2,5	1,0	2,0	2,7	2,5	1,0	1,5	2,0	0,0	0,0	1,0	1,0	3,0	1,0	2,0	2,0	2,5	1,5	2,0	1,0	2,0	1,5	2,0	1,5	2,0	0,5	1,3	1,7	2,0	2,5	2,0	1,0	2,0	3,0	4,0	2,0	2,0	1,5	2,5	2,0	2,0	2,0	2,0	1,9
Temperate - Salt marsh	4,0	2,5	3,0	3,5	1,0	1,5	3,0	2,0	1,0	1,0	2,0	0,0	0,0	0,0	0,0	3,0	0,0	2,0	2,0	2,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,5	1,5	1,5	1,0	1,0	2,0	1,0	1,0	3,0	4,0	2,0	2,0	2,0	2,0	2,0	3,0	2,0	2,0	1,6
Temperate - Penguins feeding area	0,0	2,0	1,5	0,0	0,5	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,5	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Temperate - Sea birds	0,0	2,0	1,5	1,5	0,5	0,5	2,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	1,0	0,0	0,0	0,0	0,0	0,5	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,3
Average	1,7	1,5	1,9	1,3	0,9	1,7	2,4	1,8	1,6	1,3	1,3	1,5	1,4	1,4	1,4	2,4	1,5	1,8	1,4	1,5	1,5	1,1	0,9	0,9	0,7	1,0	1,8	1,5	0,8	0,9	0,7	1,6	1,3	1,7	1,1	1,2	1,4	2,4	2,4	2,2	2,3	0,9	1,6	1,7	1,2	2,0	1,5	1,5

The WIO Symphony expert panel

AREA OF PROFESSION

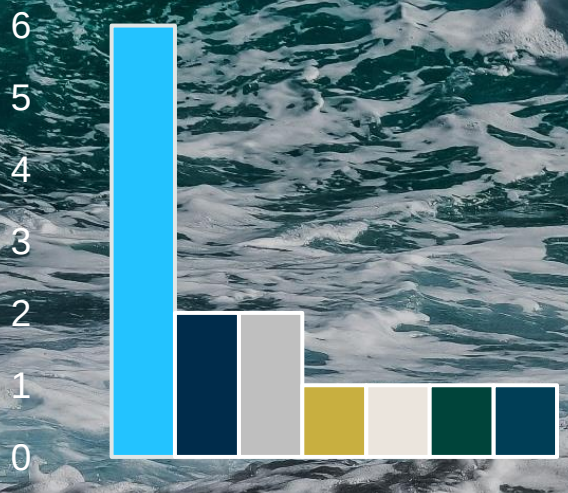


CONFIDENCE

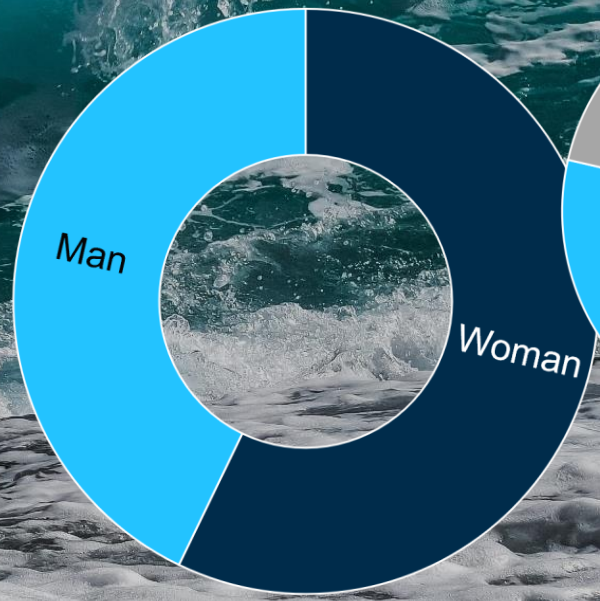


19 respondents

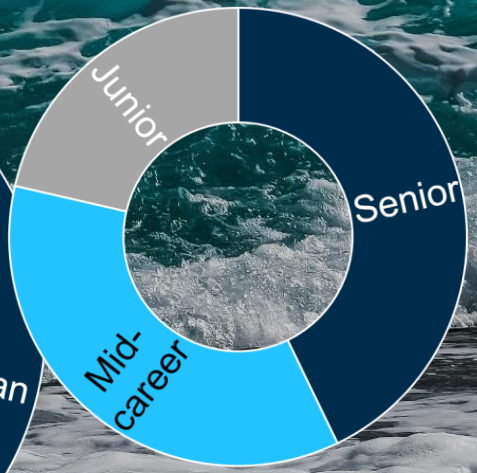
COUNTRY



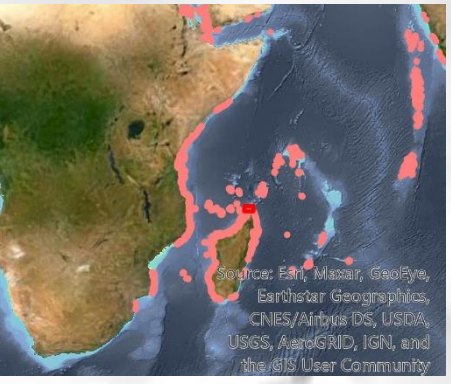
GENDER



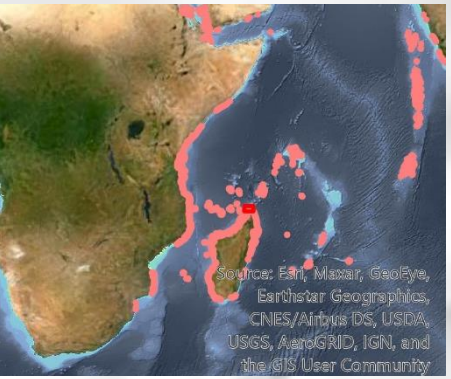
CAREER



Coral reef map



Cumulative pressure
Coral reef



Pressures with highest impact

Dredging	19.69%
Land reclamation	18.01%
Underwater noise	17.63%
Ship pollution	17.49%
Hydrology change	9.5%

UN environment programme

Sweden
Sverige

Swedish Agency
for Marine and
Water Management

allmodelsarewrong
someareuseful