



UNIVERSITY OF LISBON
INTERDISCIPLINARY STUDIES
ON SUSTAINABLE ENVIRONMENT AND SEAS



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University Network for Innovation,
Technology and Engineering



UNIVERSIDADE
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MARINE RESOURCES

(an overview)

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Overview

oceans as heterogeneous
1 and dynamic systems

2 food
resources

3 mineral
resources

4 energy
resources

5 hydric
resources

6 marine
transport

ecosystem
7 services

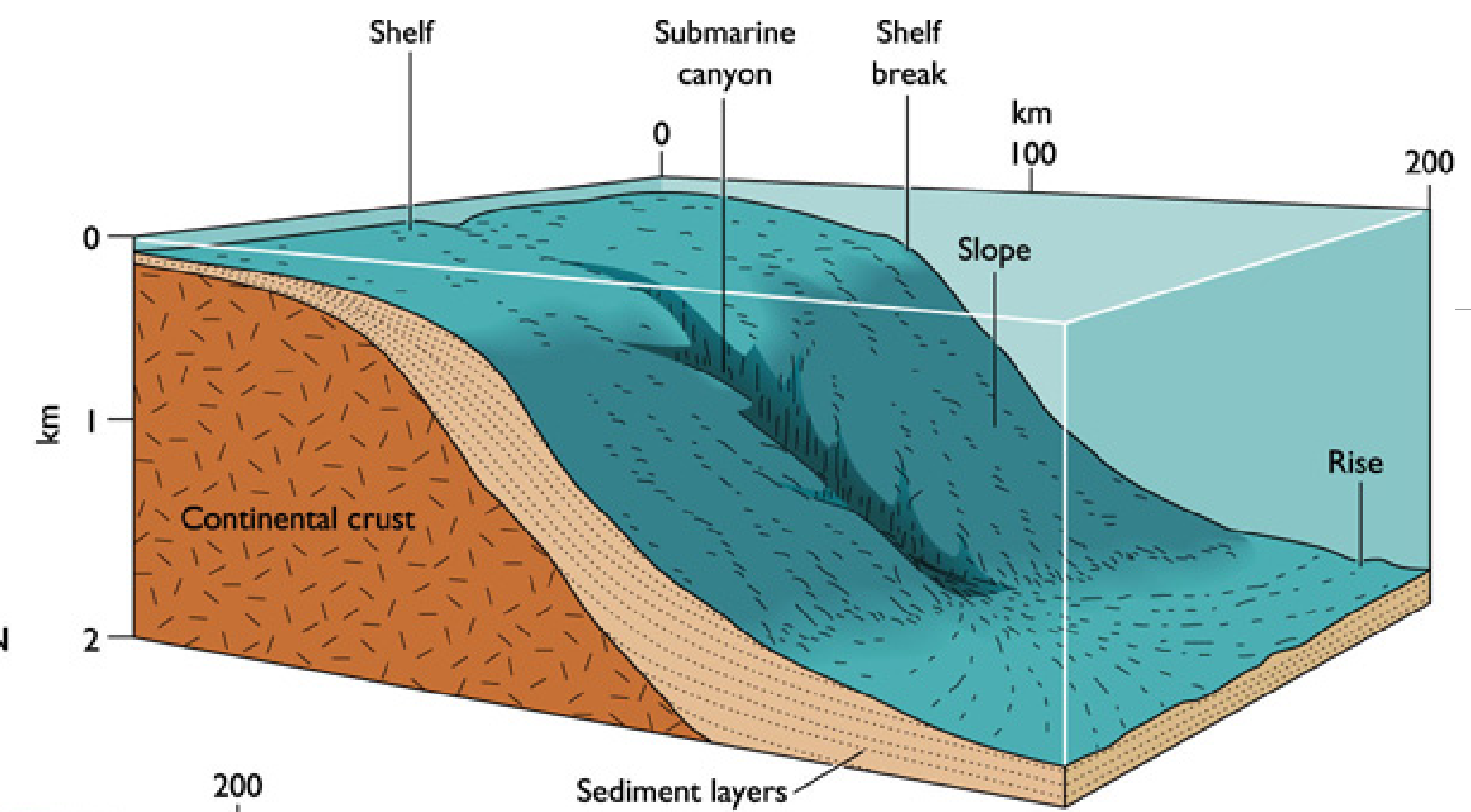
8 ocean
monitoring



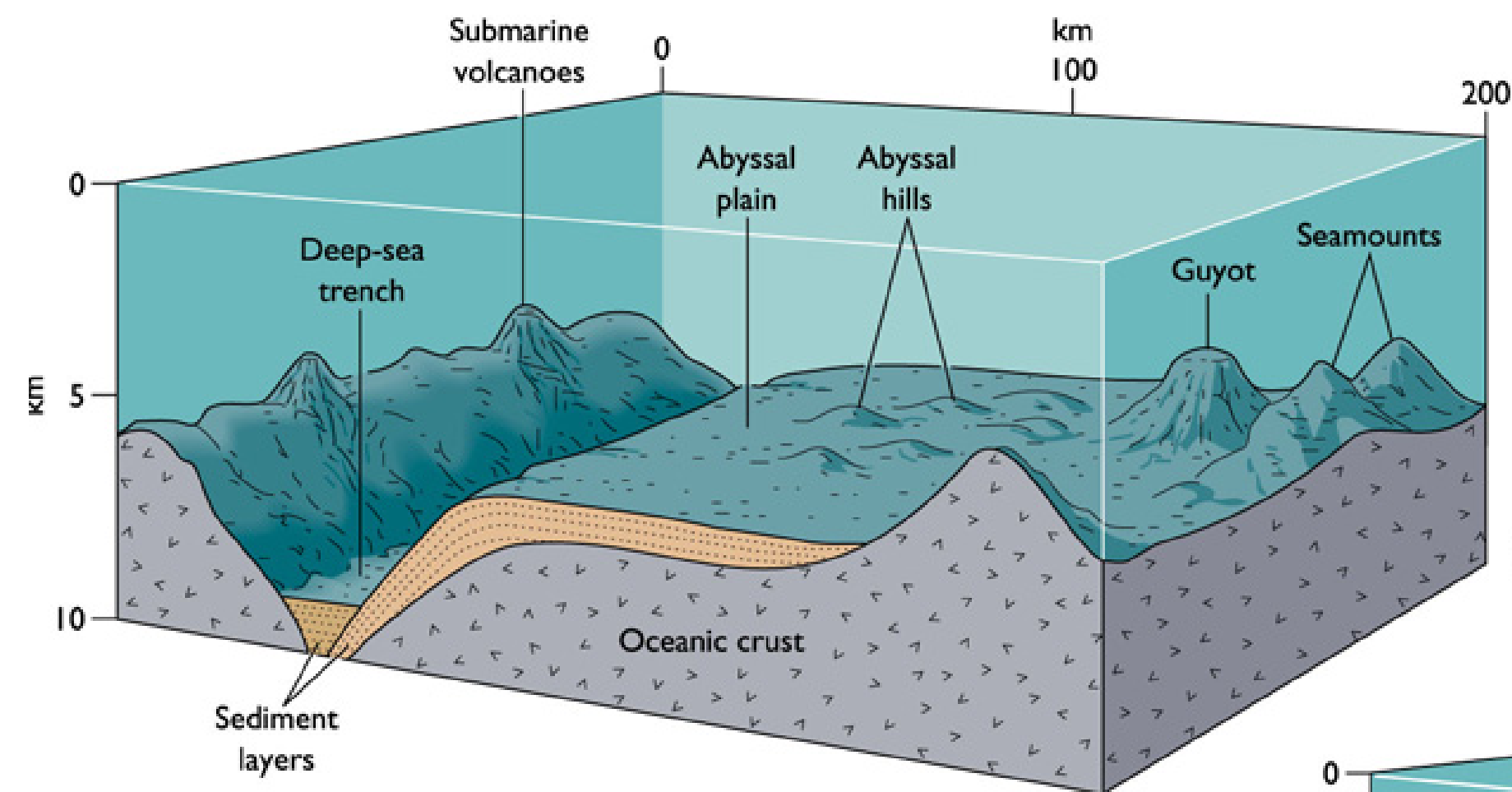
Marine Resources

The oceans and the seas are dynamic and heterogeneous systems – **marine resources** are a consequence of that

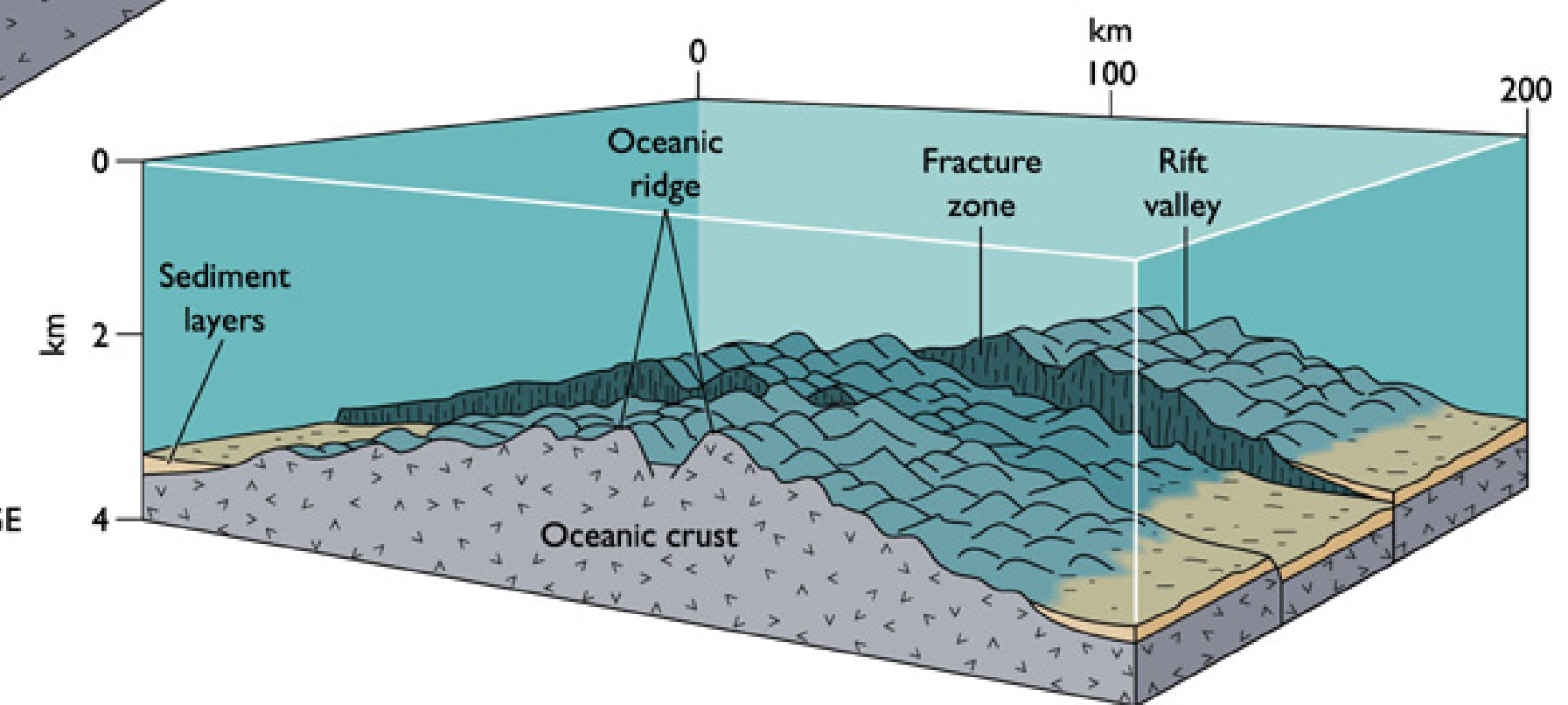




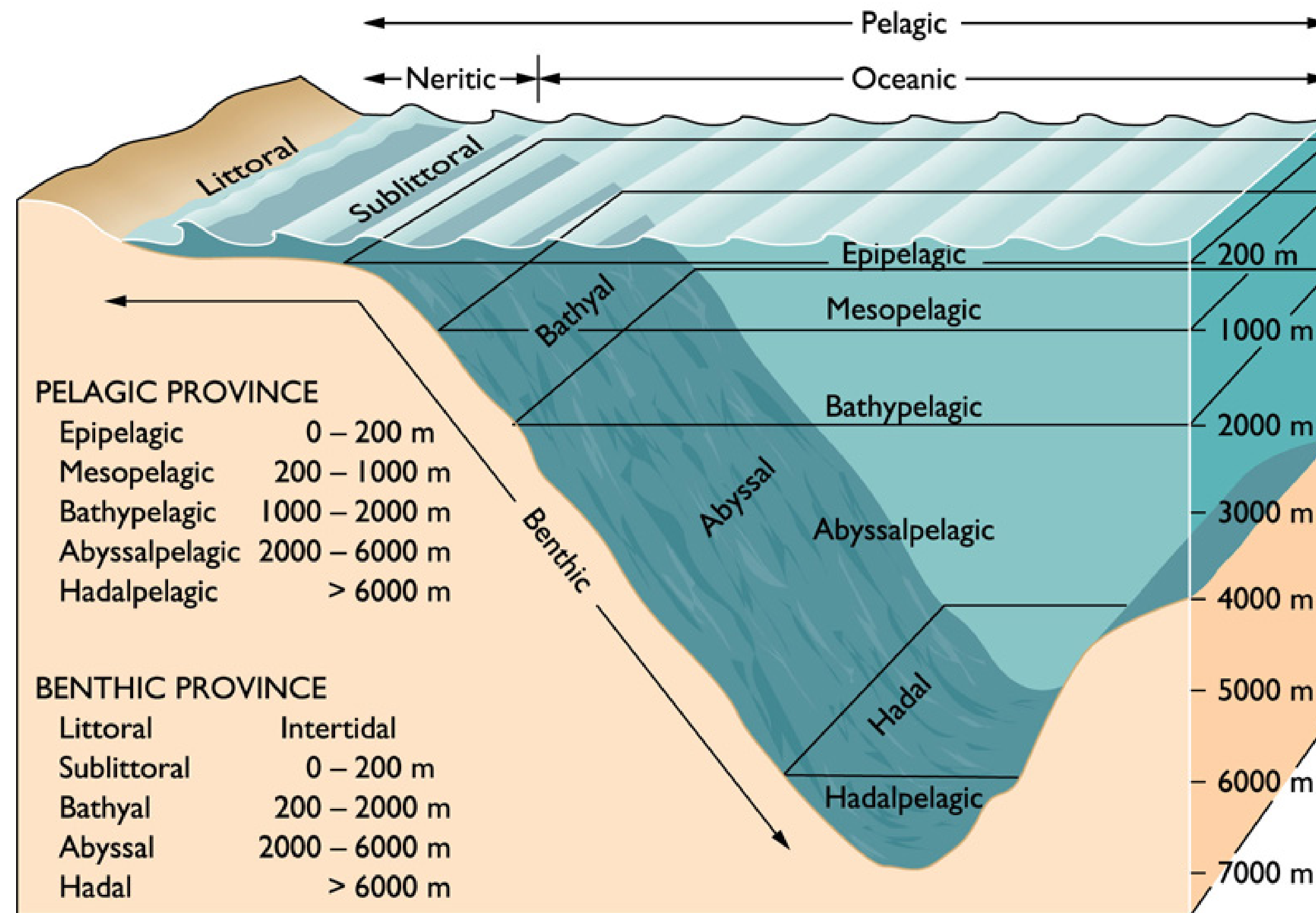
(a) CONTINENTAL MARGIN



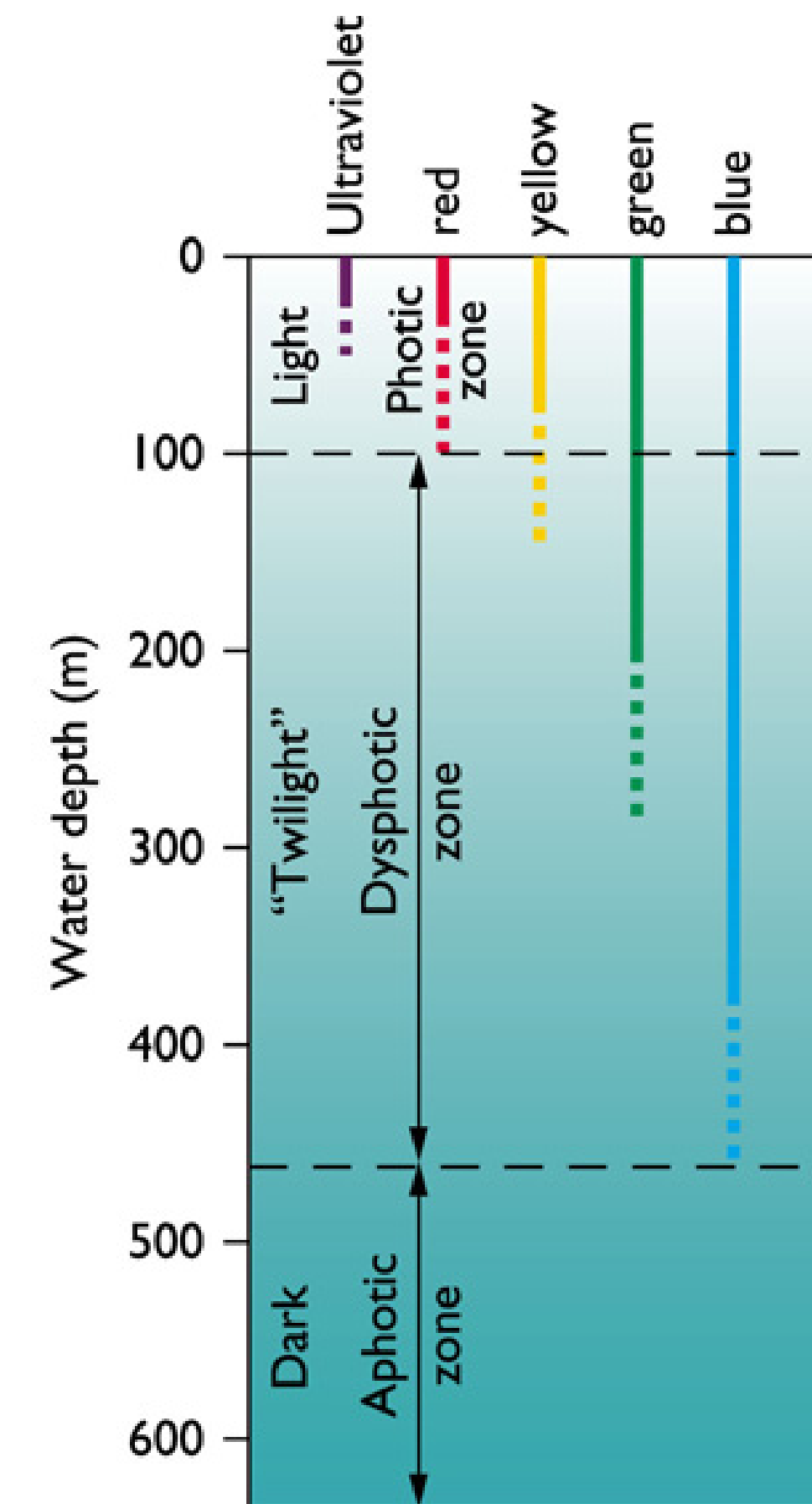
(b) DEEP-OCEAN BASIN



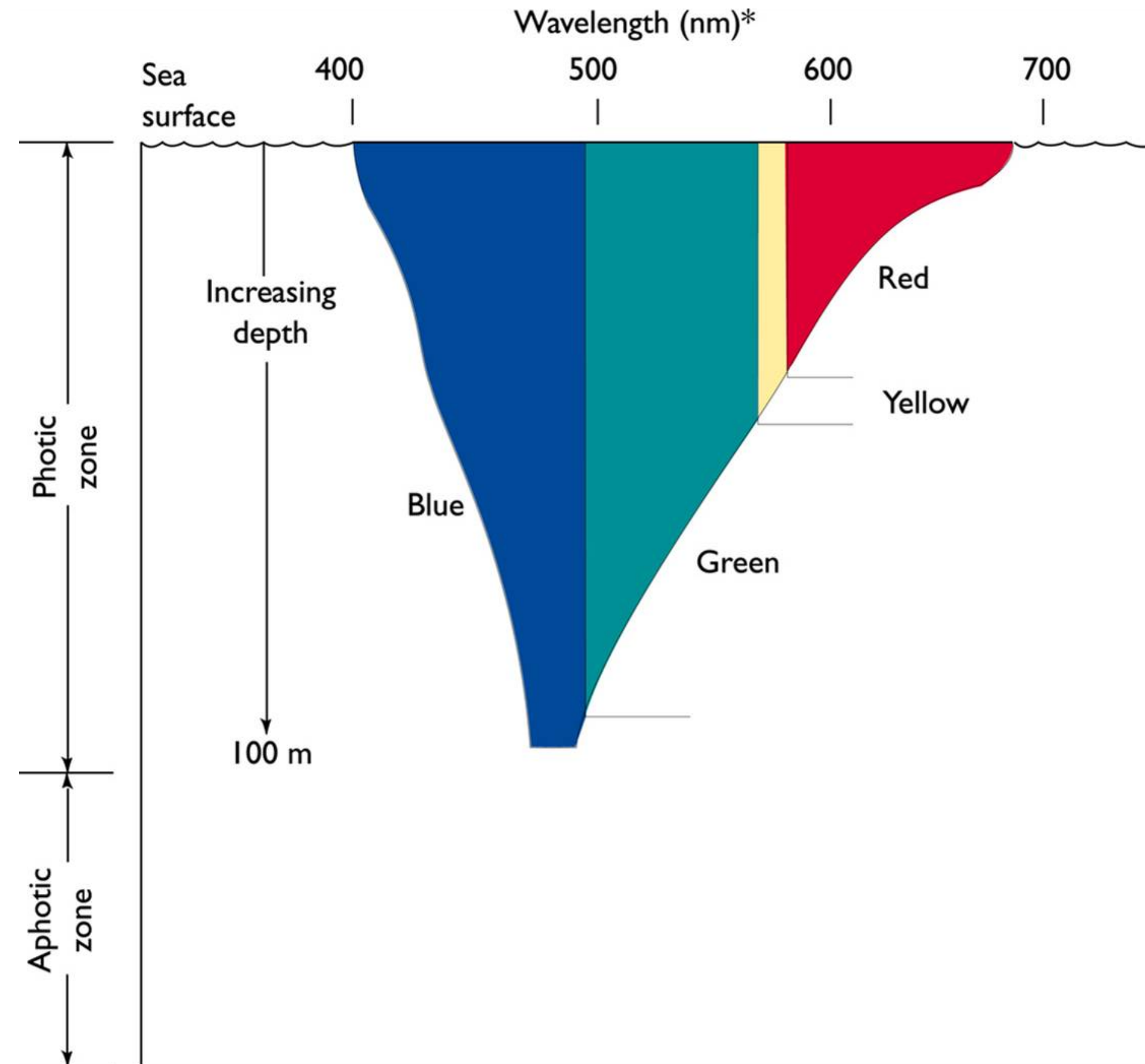
(c) MIDOCEAN RIDGE



(a) BIOZONES

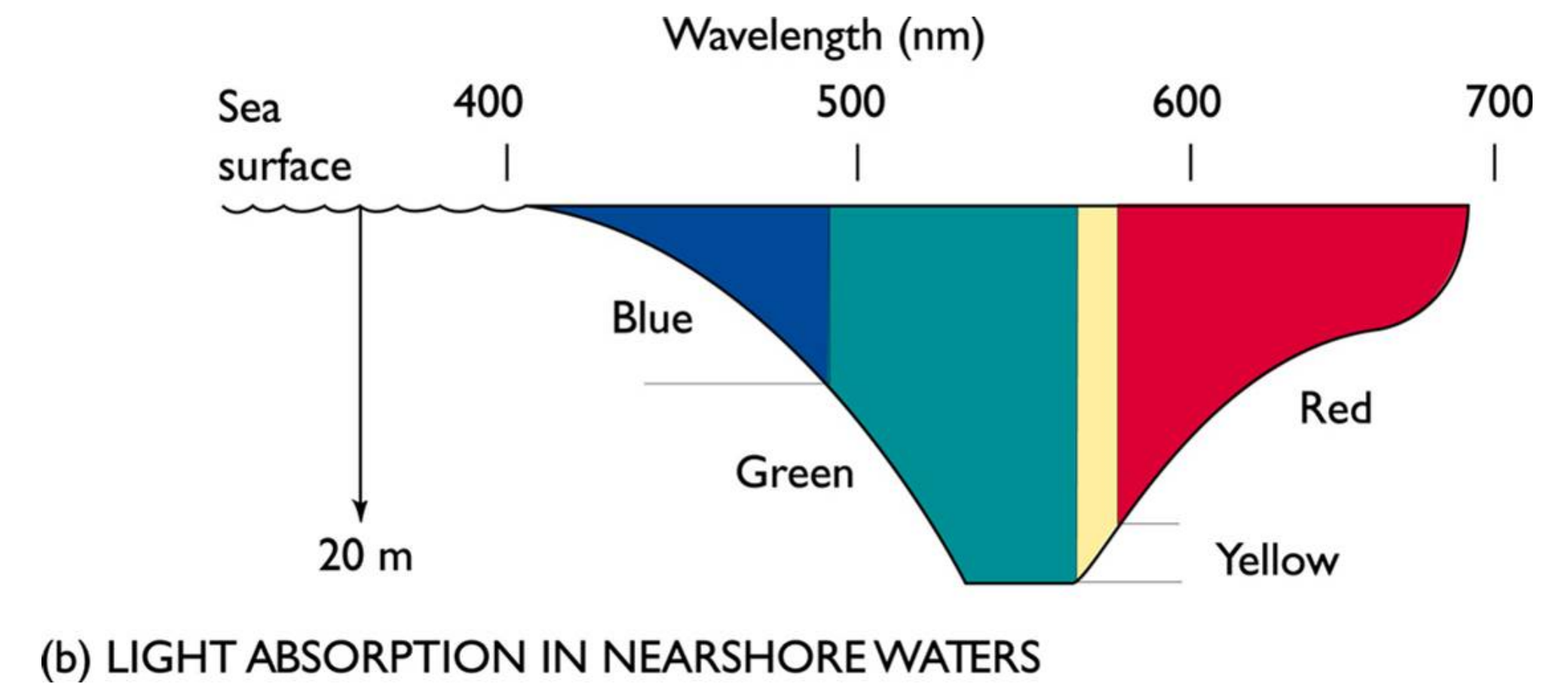


(b) LIGHT ZONES



* nm = nanometer (one billionth of a meter)

(a) LIGHT ABSORPTION IN THE OPEN OCEAN



EXPLORING the Ocean Floor

Earth's oceans are thousands of kilometers wide. To show the width of the ocean floor in this illustration, the vertical and horizontal scales are not the same. The vertical scale, showing depth, has been stretched. The horizontal scale, showing distances, has been squeezed.

Volcanic island

When volcanoes on the ocean floor erupt, they can create mountains so high that their peaks break the surface of the ocean. As the lava cools and hardens, an island forms.

Mid-Ocean ridge

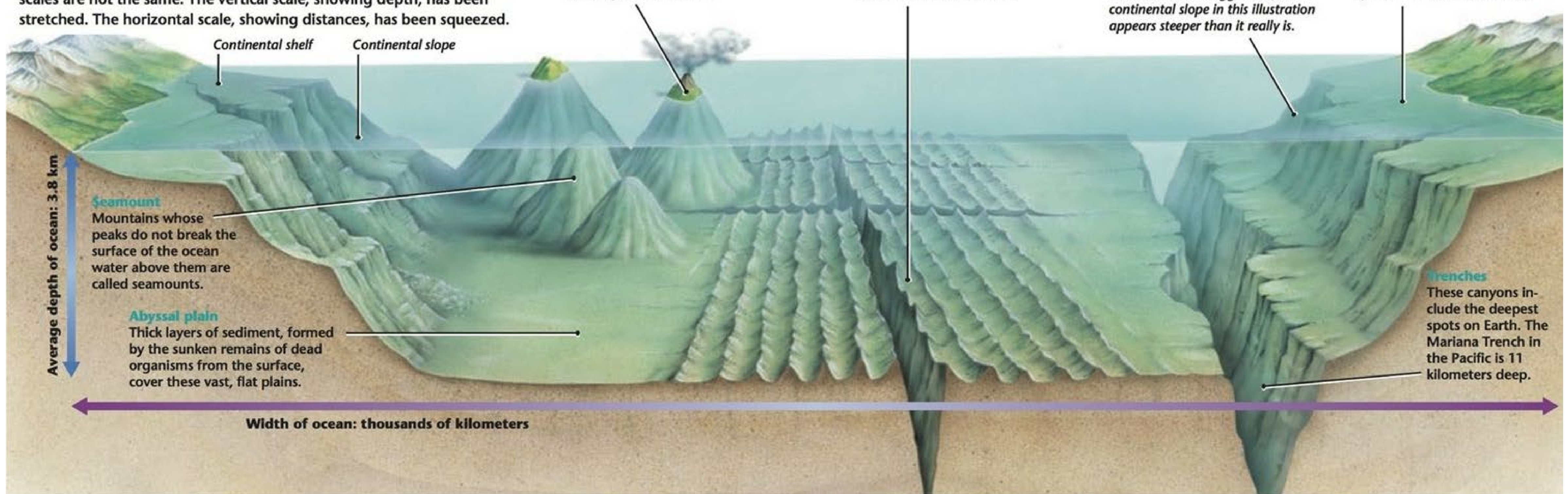
The mid-ocean ridge consists of many peaks along both sides of a central valley. This chain of undersea mountains runs all around the world.

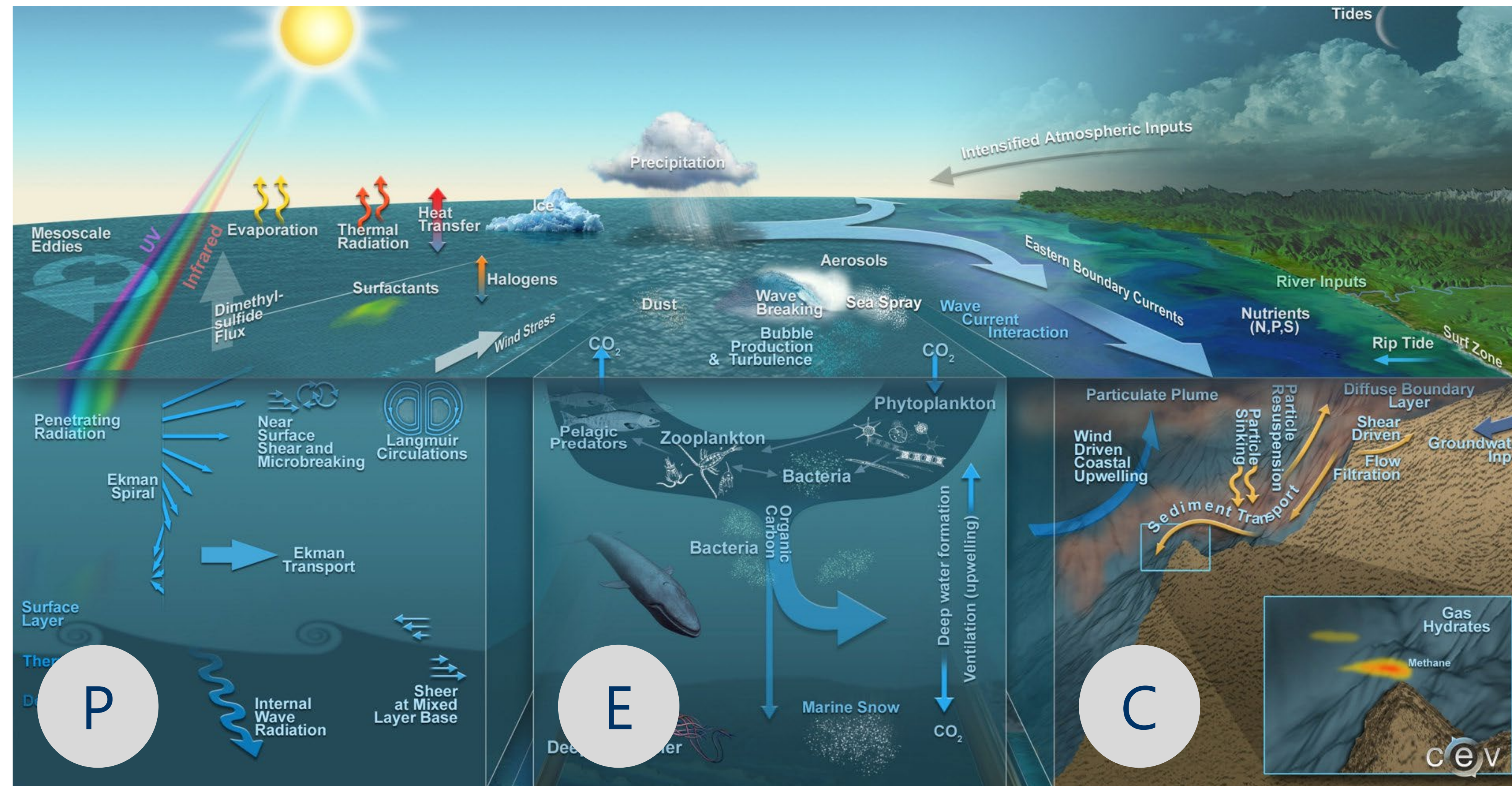
Continental slope

A steady incline marks the continental slope. Continental slopes in the Pacific Ocean are steeper than those in the Atlantic Ocean. *Note: Because the vertical scale is exaggerated, the continental slope in this illustration appears steeper than it really is.*

Continental shelf

This gradually sloping area borders each continent. Its width varies from just a few kilometers to as much as 1,300 kilometers from shore.





Physical

Ecological

Chemical

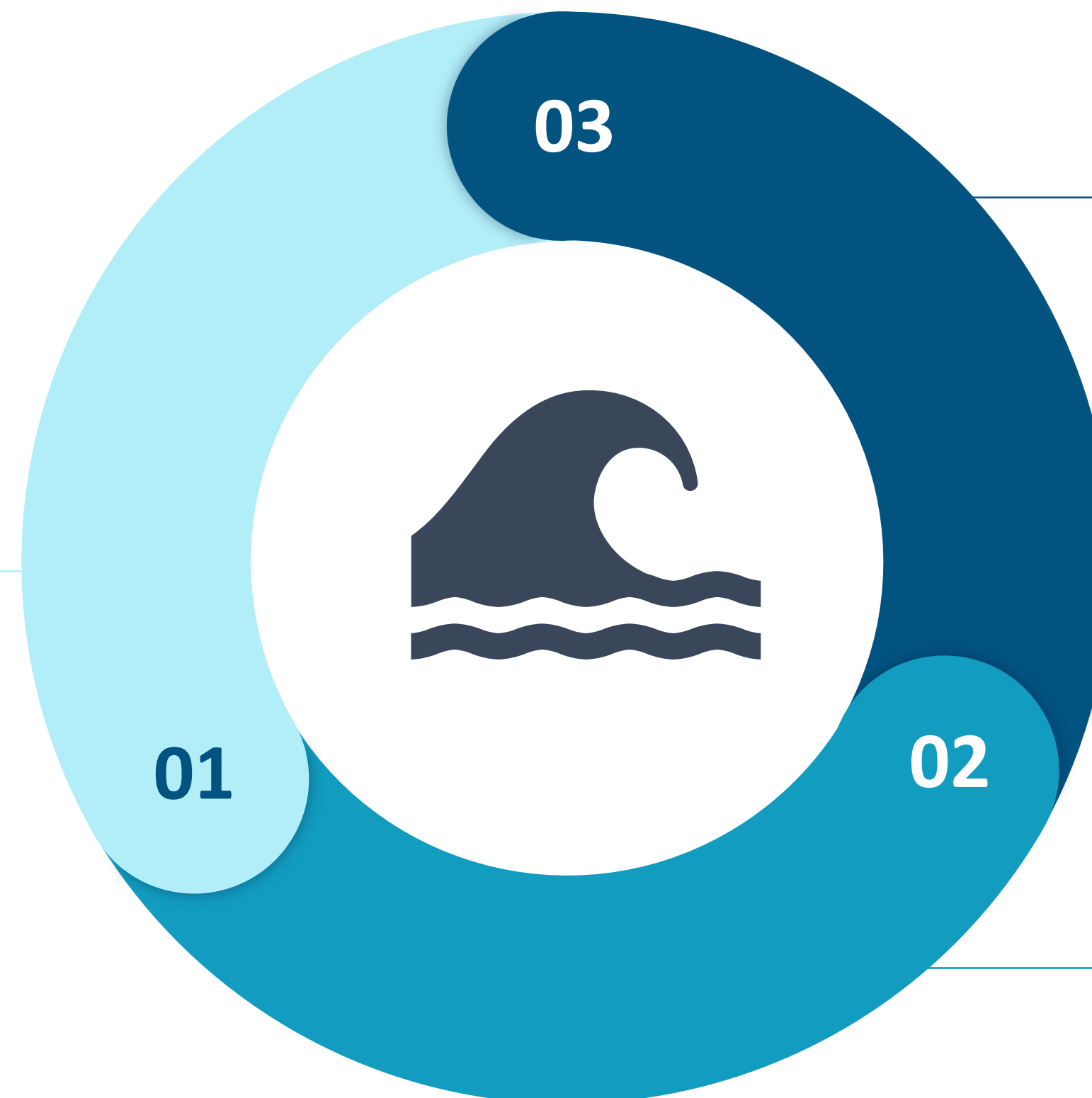
Marine systems...

- are dynamic systems shaped by an interplay of complex physical, chemical and ecological processes, occurring at different time scales
- vary significantly in space (latitude, longitude and depth) and in time (e.g., seasonal patterns)
- can only be managed and their resources harvested with intensive ocean monitoring



Food Resources

Plants, algae and marine organism (or their derivatives) used to feed humans and animals alike



Mineral Resources



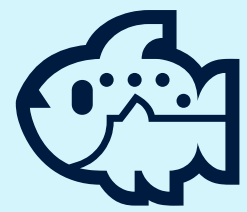
Concentrations of ore (mainly metallic) whose characteristics make its extraction technically and economically viable

Energy Resources



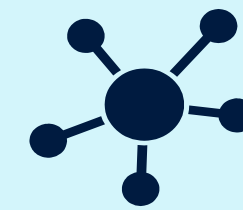
Any natural resources that can be used to obtain energy (both renewable and non-renewable)

Food



Plants, algae and marine organism (or their derivatives) used to feed humans and animals alike

Minerals



Concentrations of ore (mainly metallic) whose characteristics make its extraction technically and economically viable

Energy



Any natural resources that can be used to obtain energy (both renewable and non-renewable)

Fresh water



Fresh water obtained from sea water through the desalination process

Transportation



Large-scale use of oceans and seas to transport goods and people

Ecosystem



Environmental (ecosystem) services provided by nature and indispensable to man

Food resources

the seas as a source
of edible provisions



History

The oceans and seas are one of the main sources of food since the dawn of humanity

Production

Fishing and aquaculture produce $\sim 140 \times 10^6$ ton. of plants and animals annually

Organisms

Fish, molluscs, crustaceans and algae make up most of the human food with marine origin

Health

The reputation of marine food has increased in recent years, mostly because it is assumed to be healthier than other food sources

Protein

The importance of marine food in human diet varies worldwide, but remains one of the main sources of animal protein

Aquaculture

Aquaculture has steadily gained importance as a supply of marine food (having become a high profitability business)

FOOD

The ocean provides much more than just seafood. Ingredients from the sea are found in surprising foods such as peanut butter and soymilk.



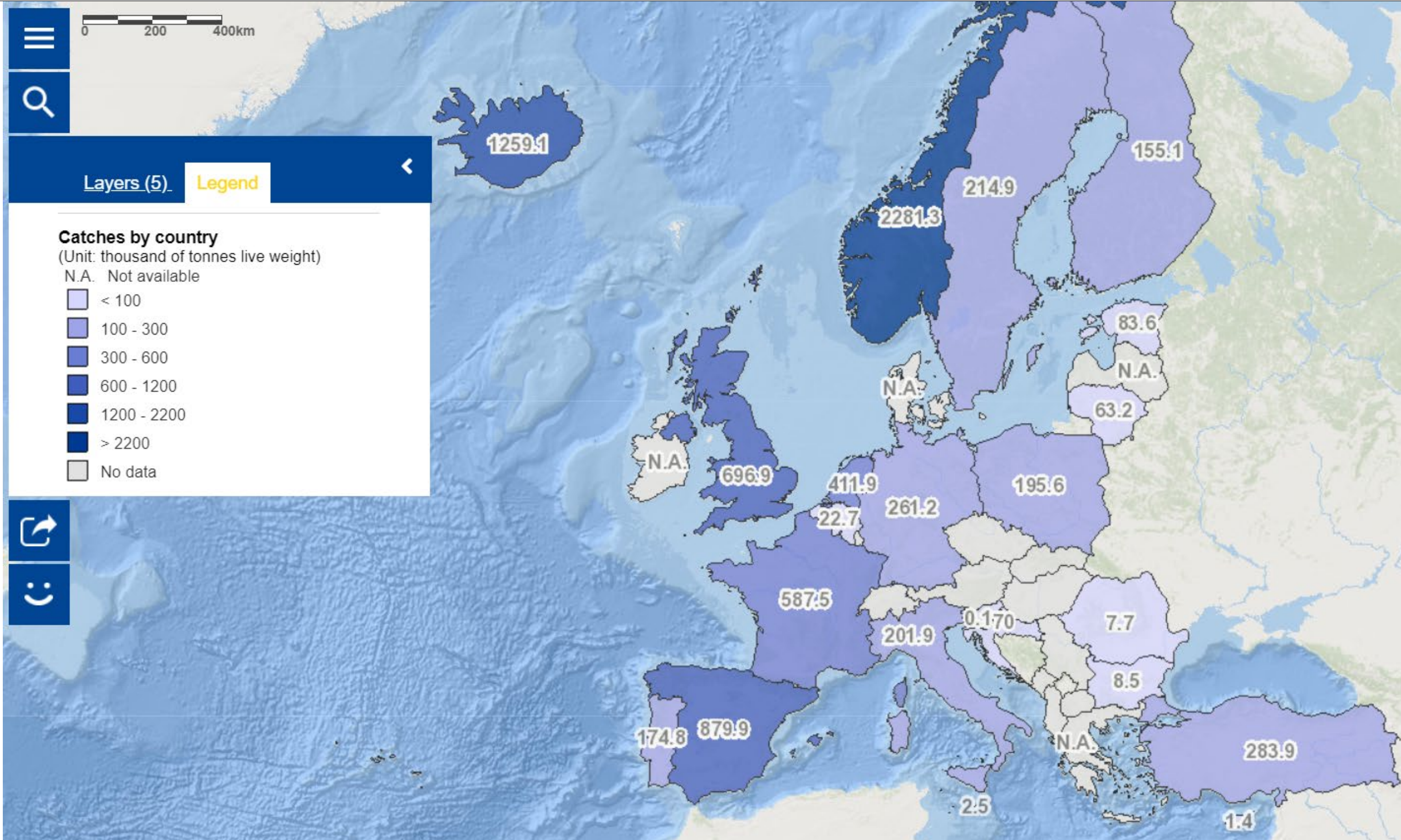
MEDICINE

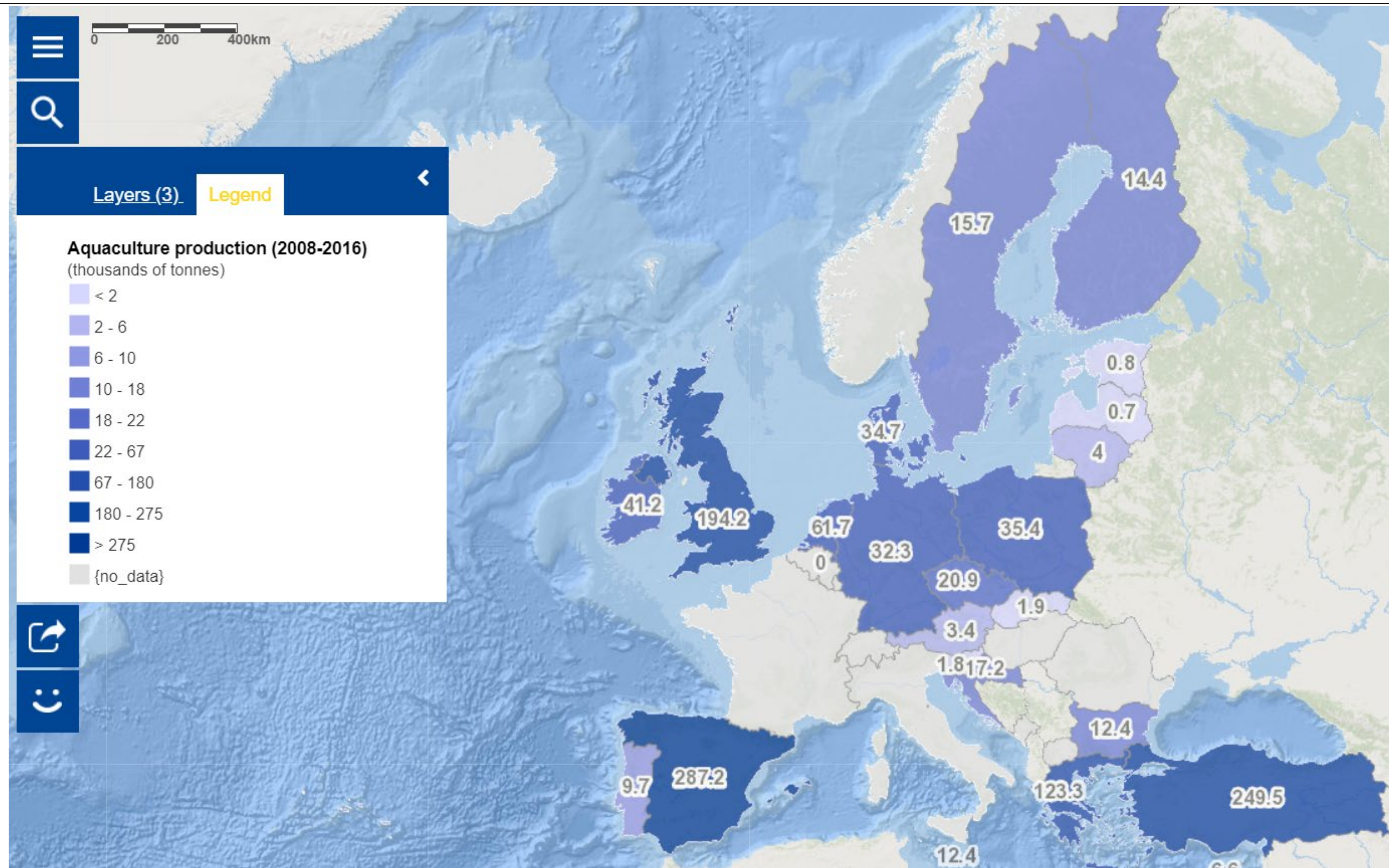
Many medicinal products come from the ocean, including ingredients that help fight cancer, arthritis, Alzheimer's disease, and heart disease.

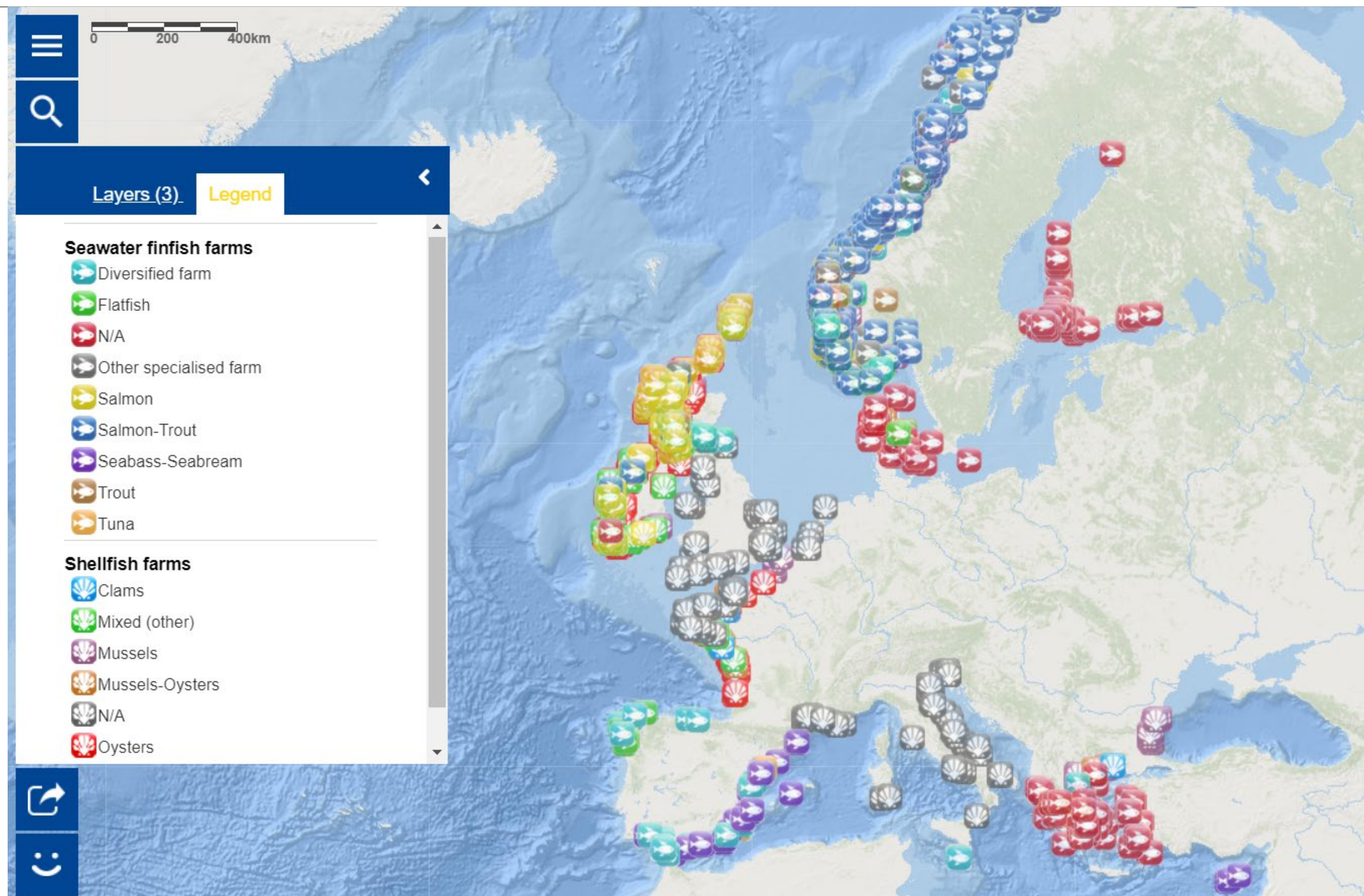


low-cost to premium
(from a few cents to hundreds of \$/kg)

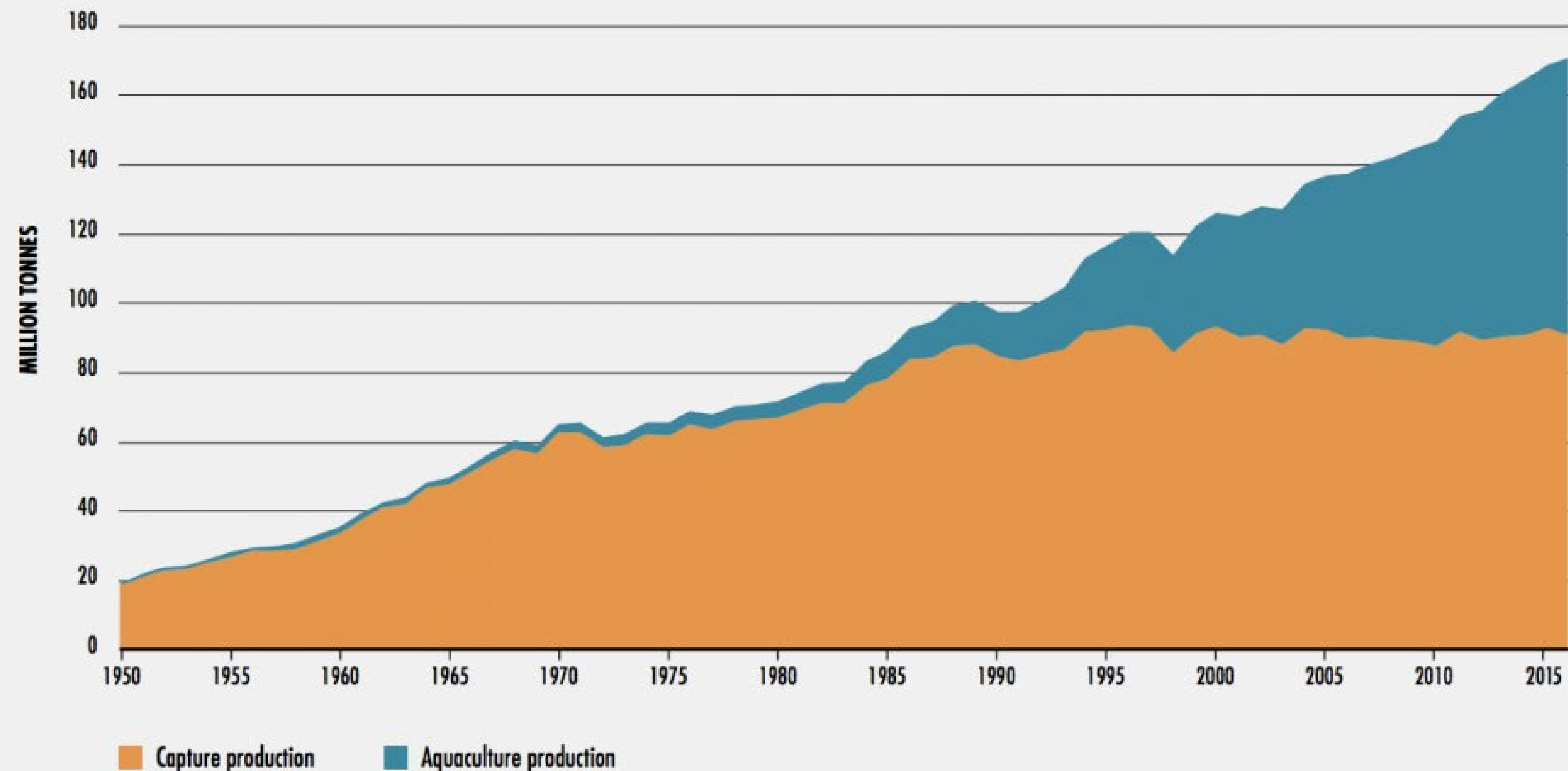




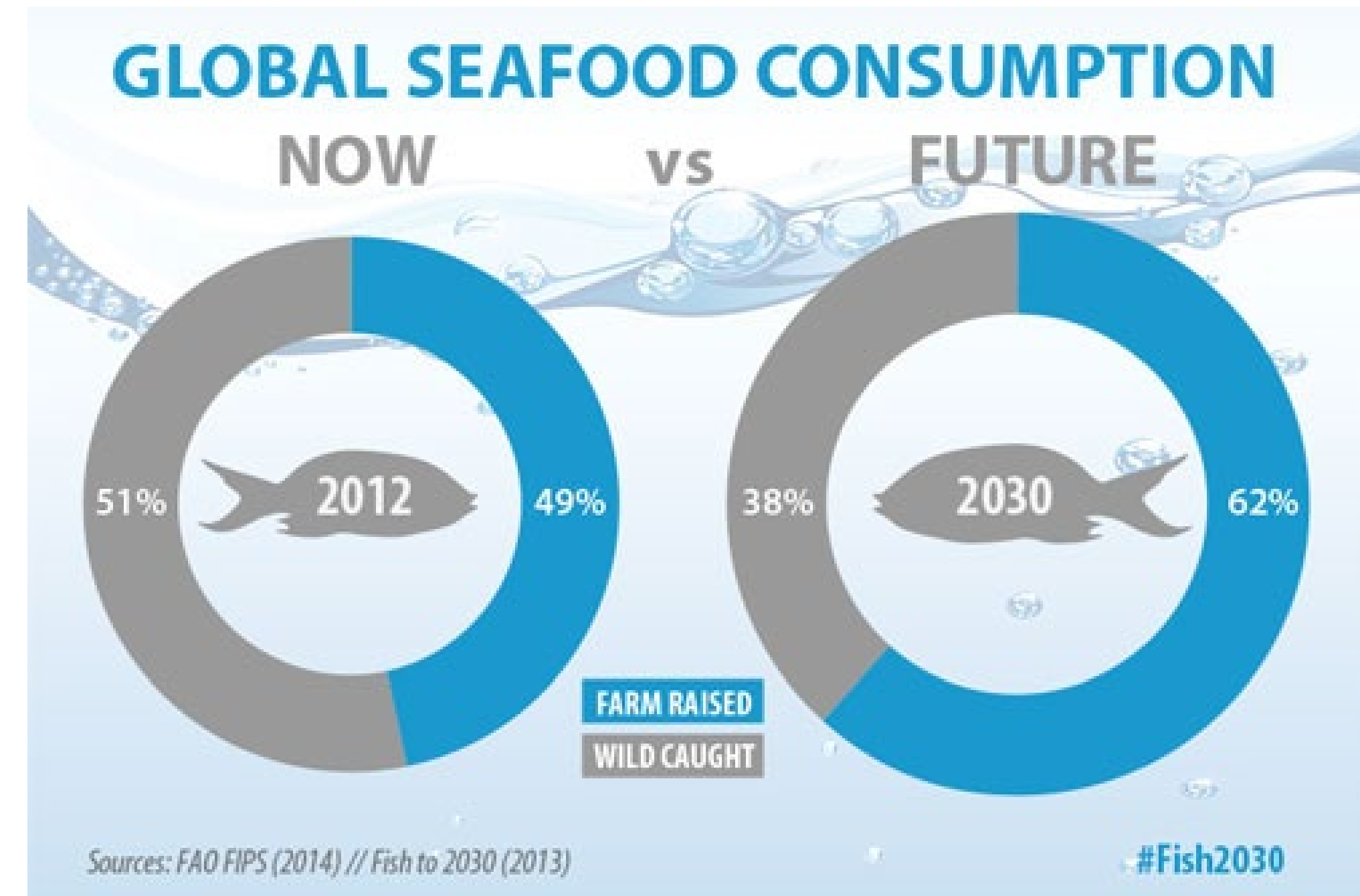


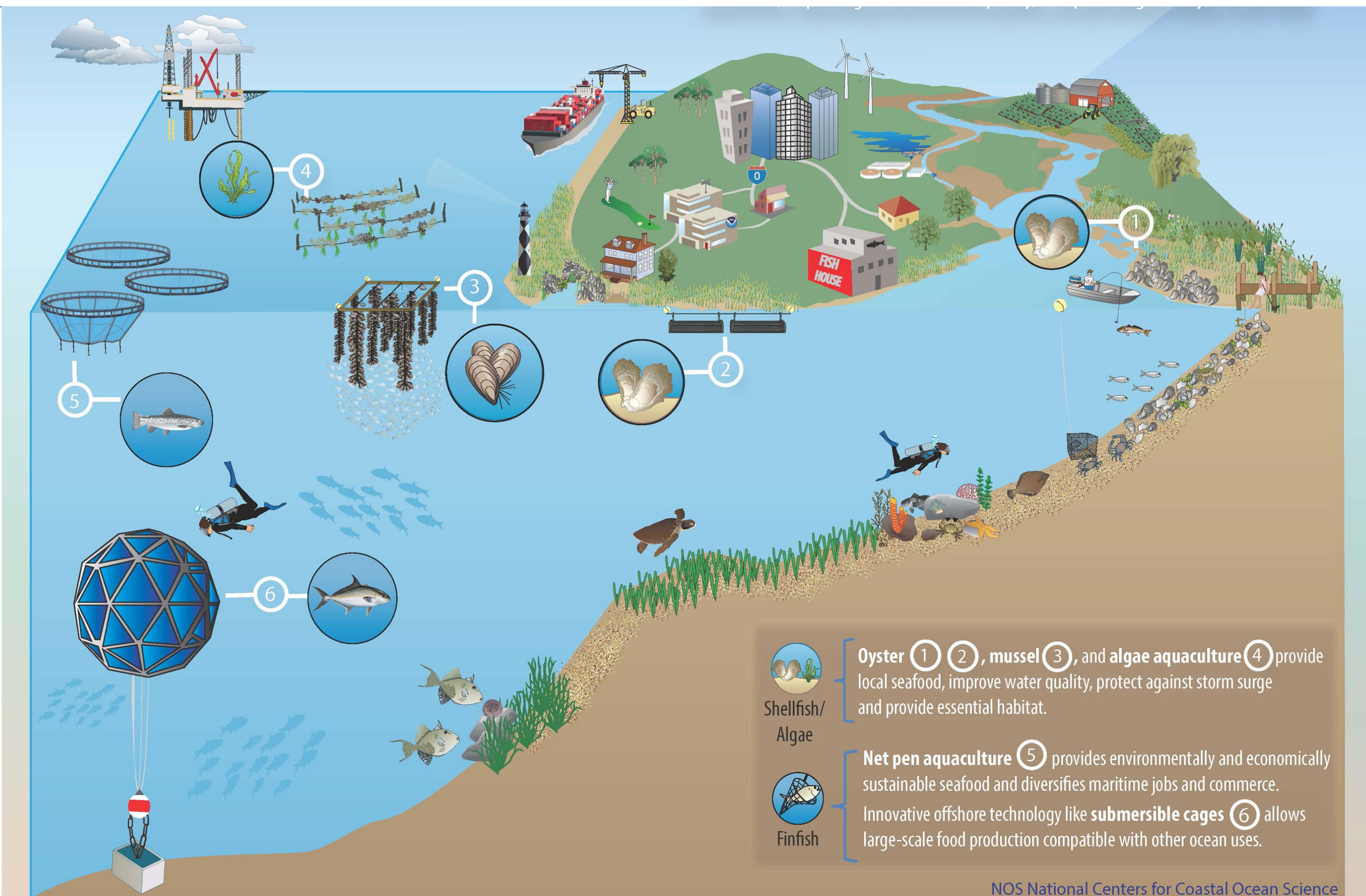


WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



NOTE: Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants





Multiple vs. conflictive use of ocean resources

Several resources can be explored in the same areas of the oceans and seas (especially coastal areas) leading to multiple or conflictive uses

Mineral resources

the seas as a source
of raw materials



Origin

A significant variety of geological processes occur in the oceans; they are responsible for the formation and concentration of mineral resources

Deposits

The oceans are also the final repository of many eroded or dissolved materials from the earth's surface

Diversity

The oceans contains large amounts of materials that are important resources for humans (magnesium, gold, tin, etc.).

Surface deposits

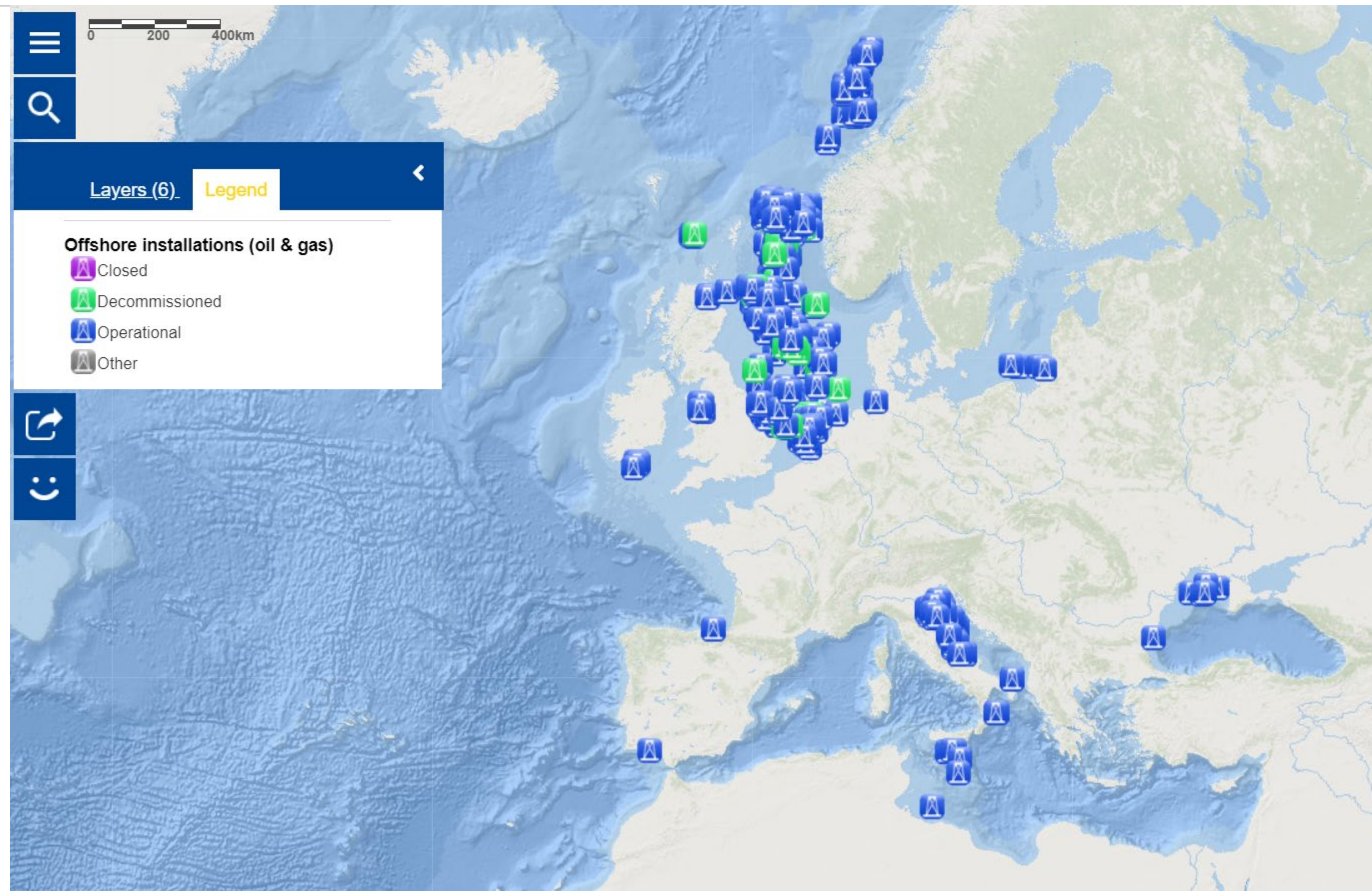
Deposits found on the continental shelf, continental slope and deep-sea area

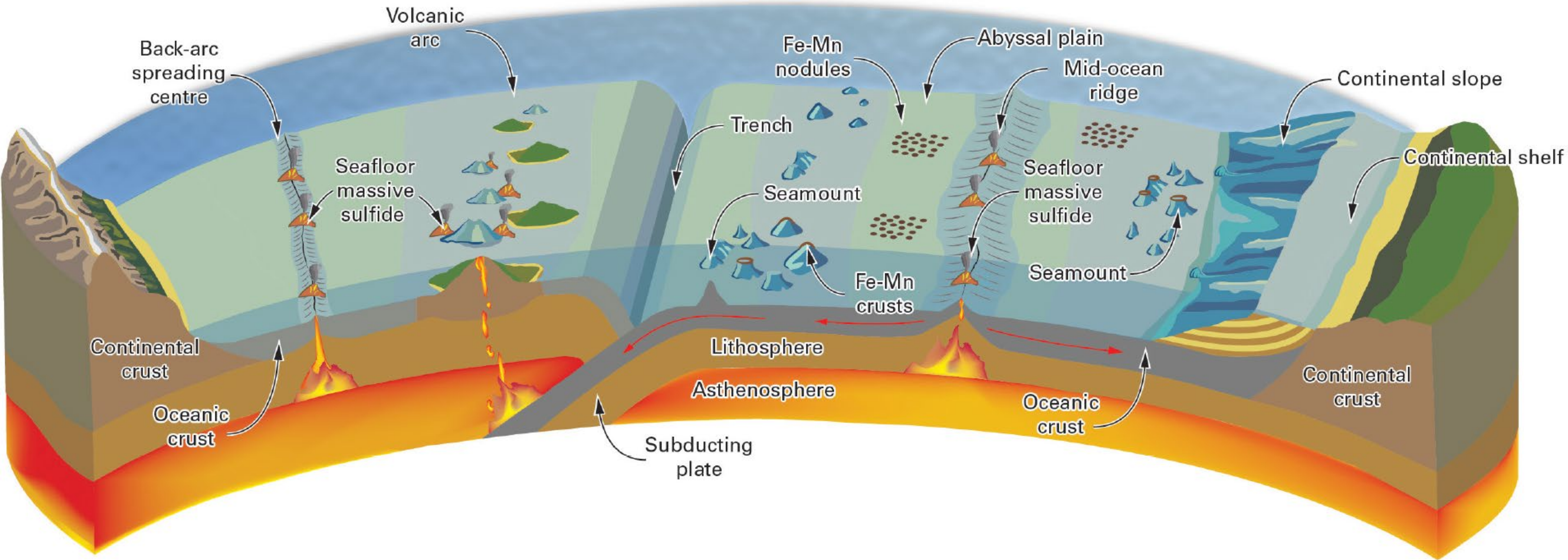


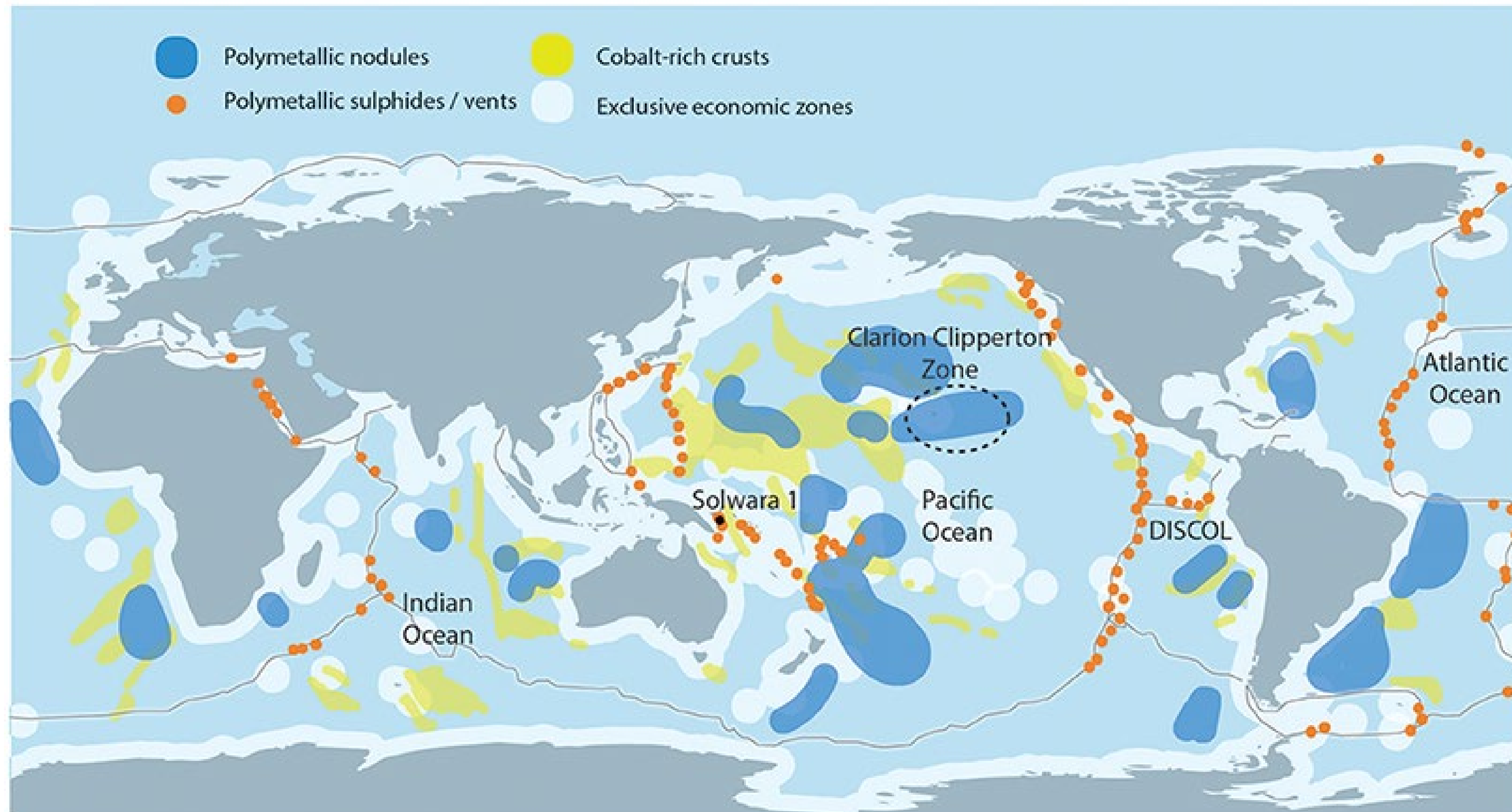
Subsurface deposits

Underground deposits (oil and natural gas); represent 90% of the mineral value currently taken from the sea





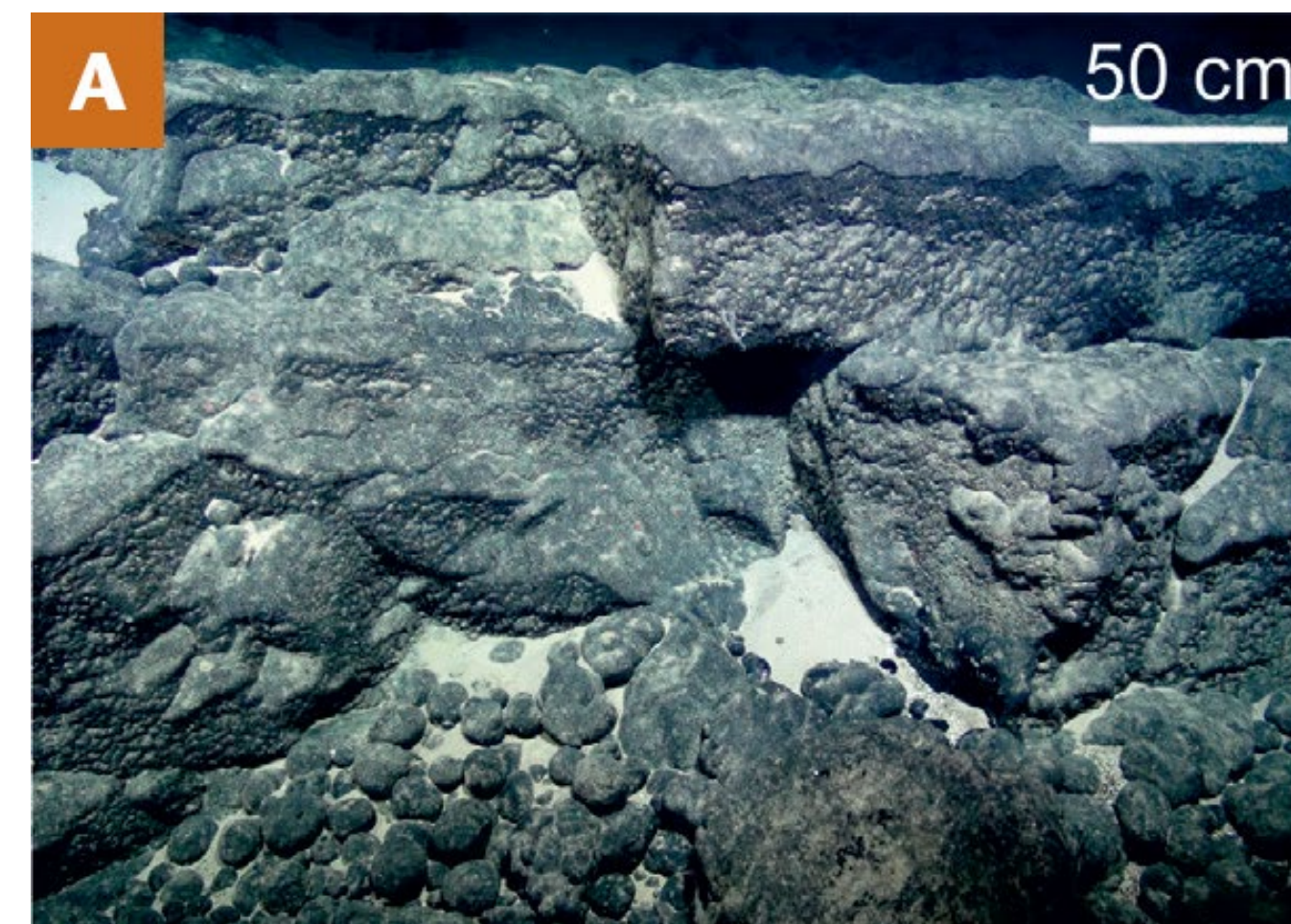
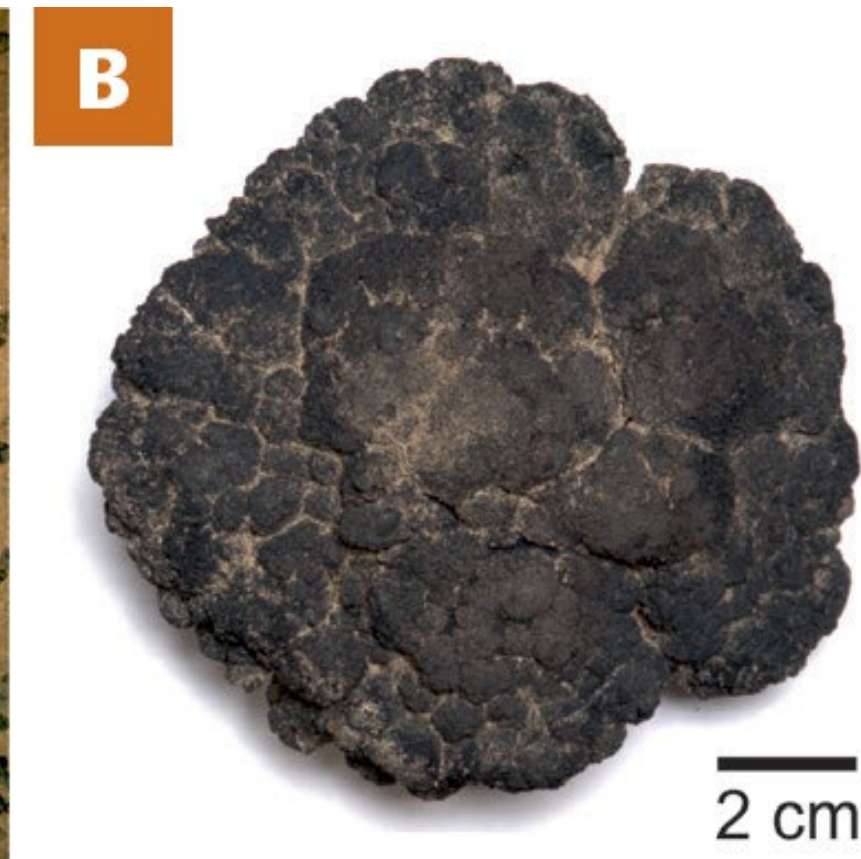
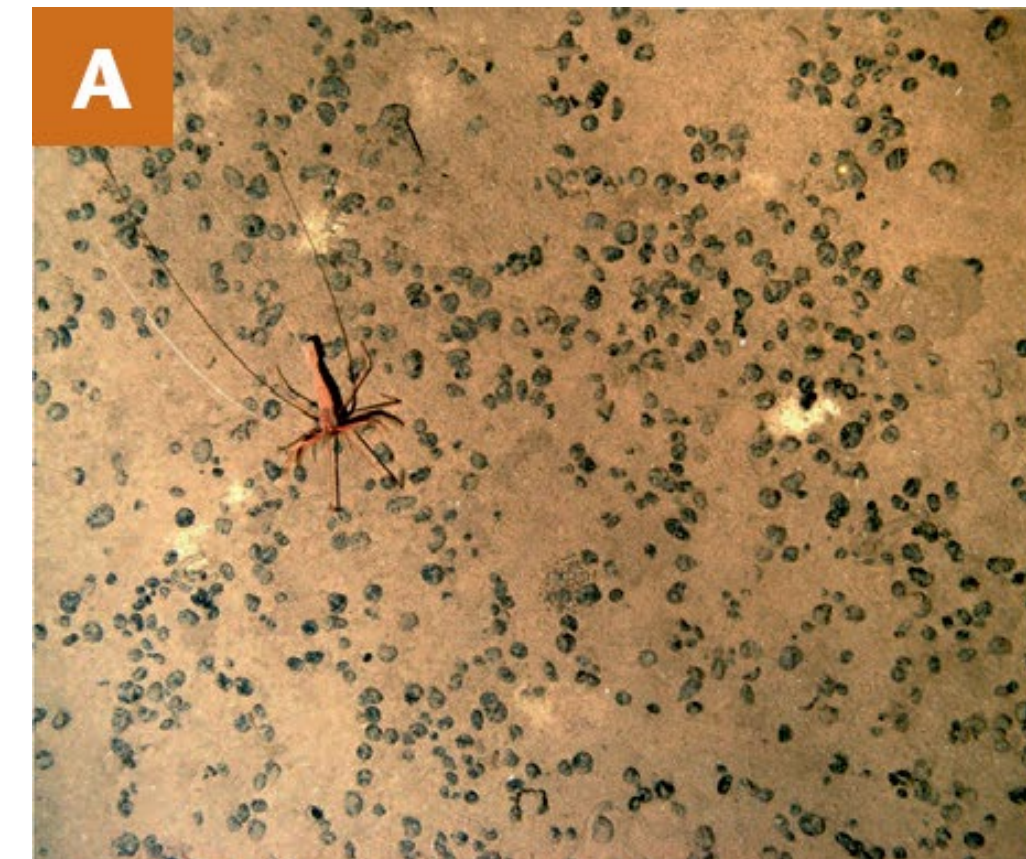
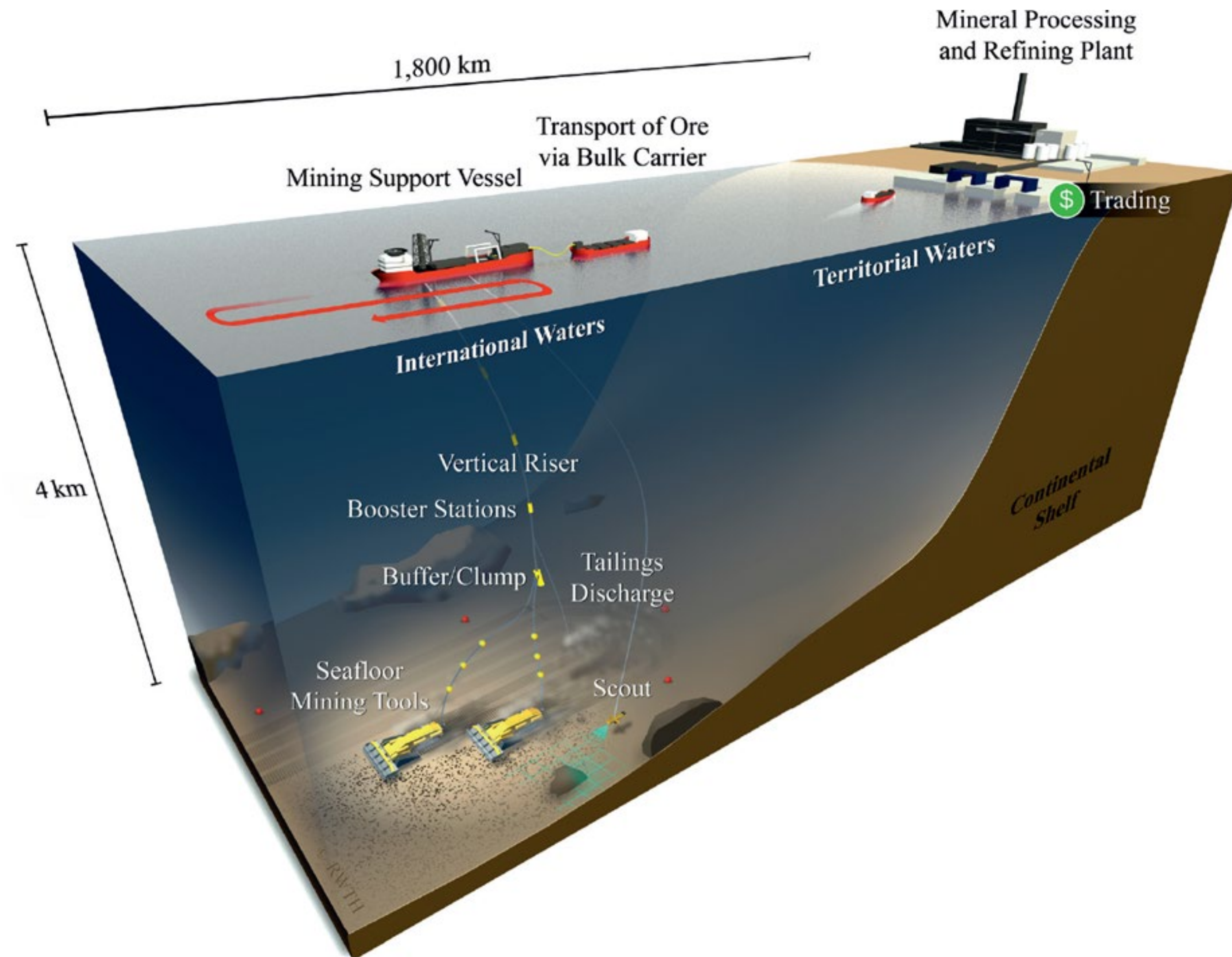




 **10^9 ton. of Fe-Mn**
nodules in the Clarion–Clipperton zone (Equatorial Pacific)

 **208×10^6 ton. of Ni**
3.5x larger than land reserves

 **40×10^6 ton. of Co**
5.5x larger than land reserves





Energy resources

the seas as a source
of energy



Renewable energy

The sea is an inexhaustible source with the potential to provide a substantial amount of new renewable energy

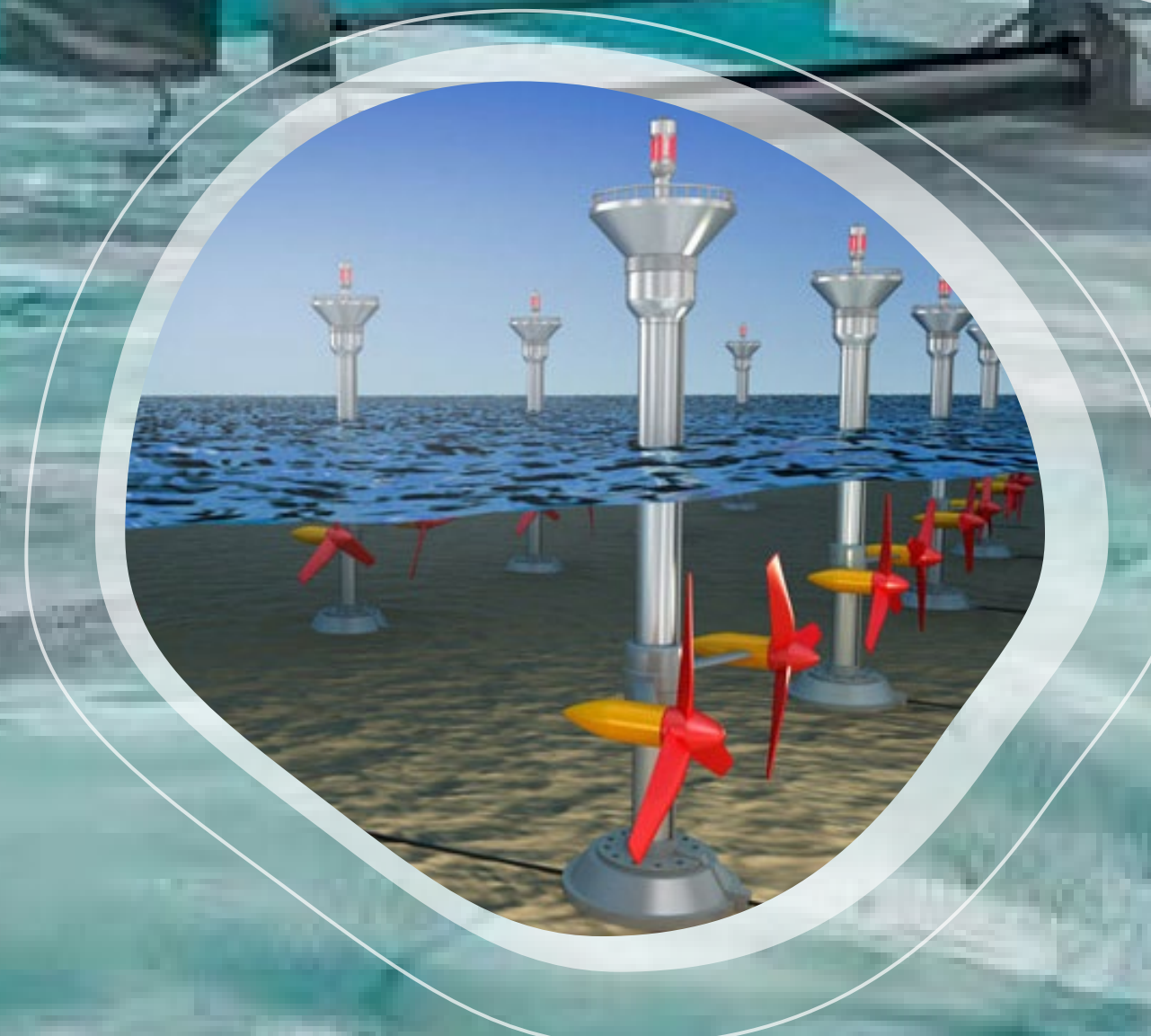
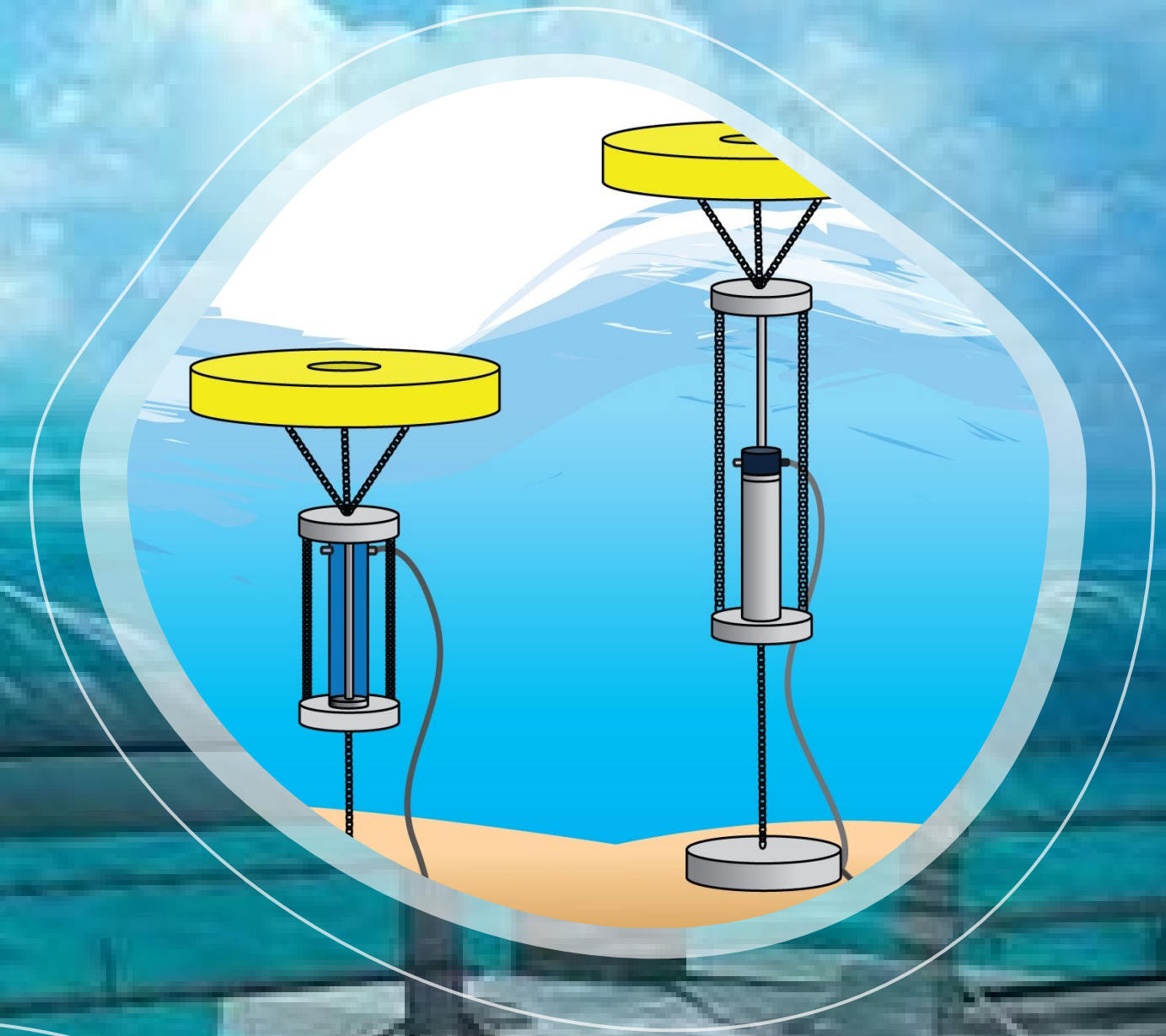
Waves and tides

Wave and tidal energy can be harnessed to generate electricity to power homes, transport and industries

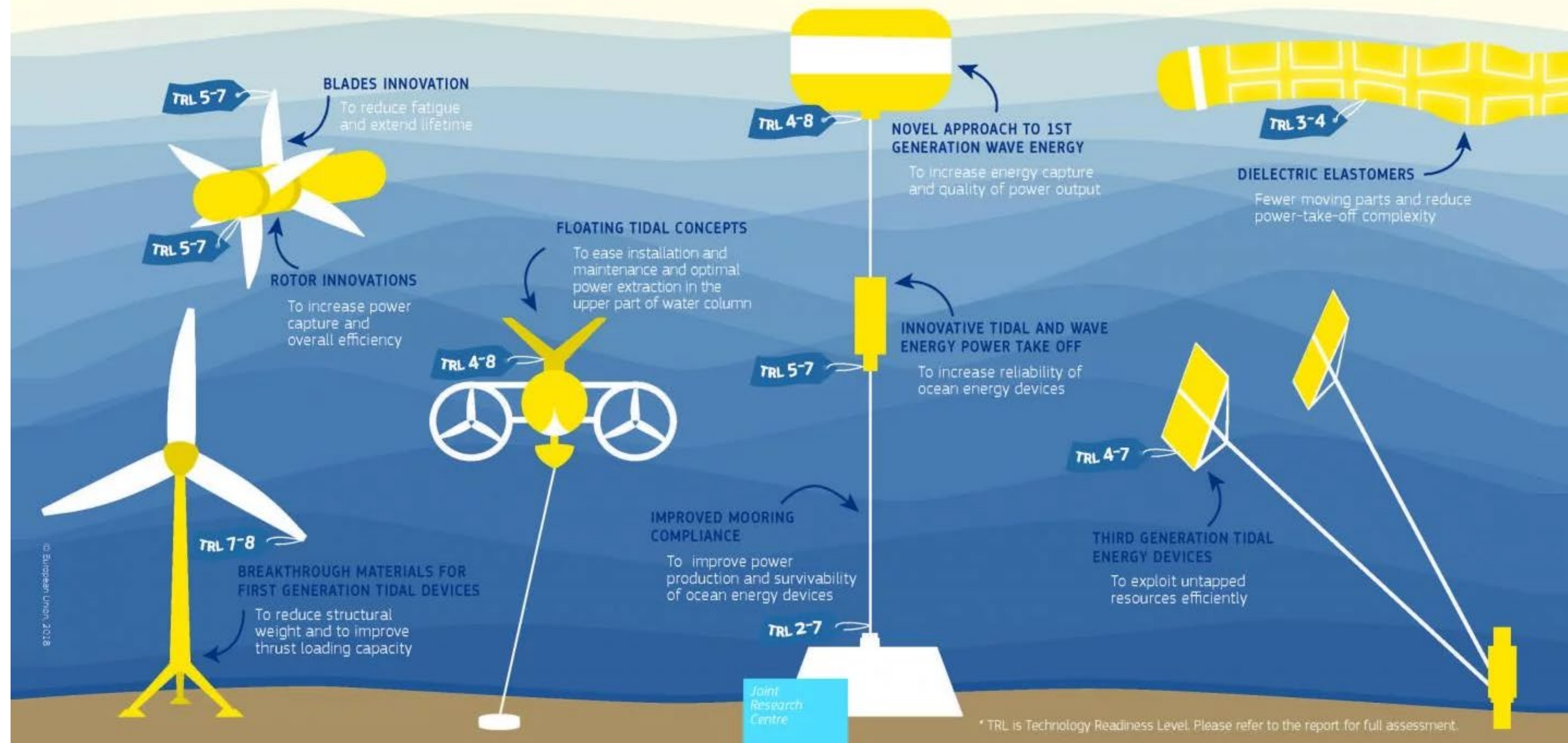
Other sources

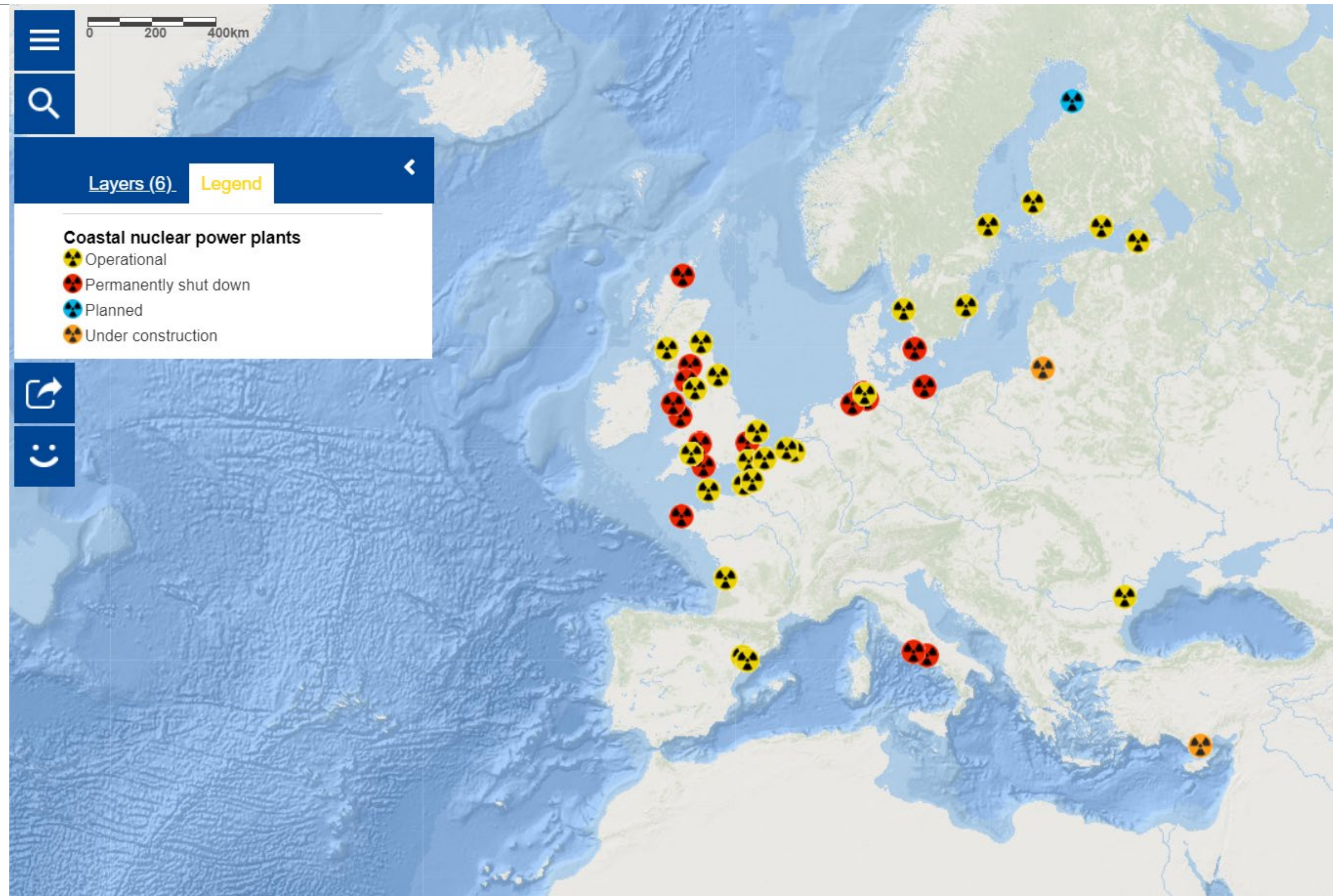
Marine energy also encompasses, or is associated with, other energy sources (thermal, wind, nuclear, etc.).

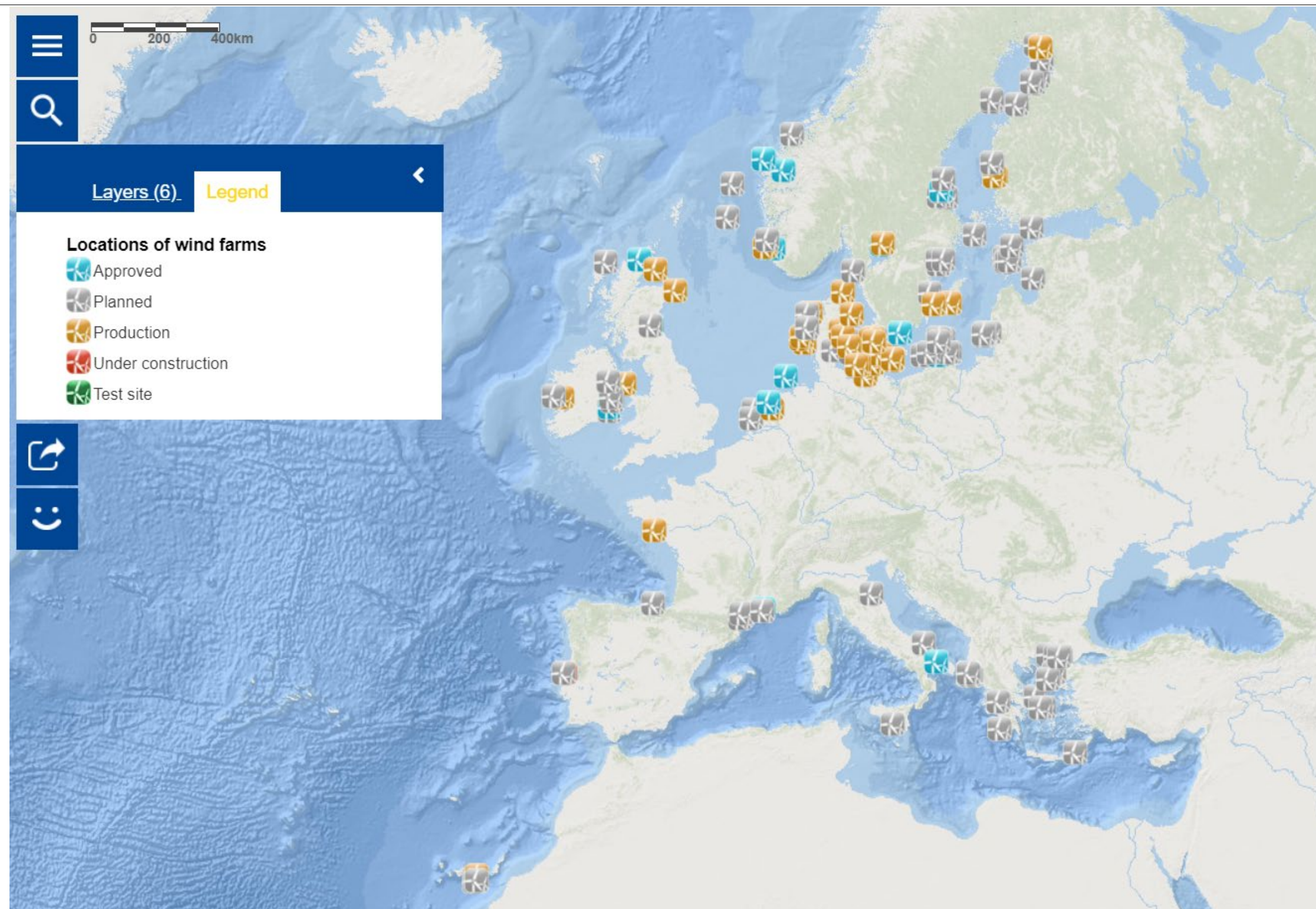
Energy resources

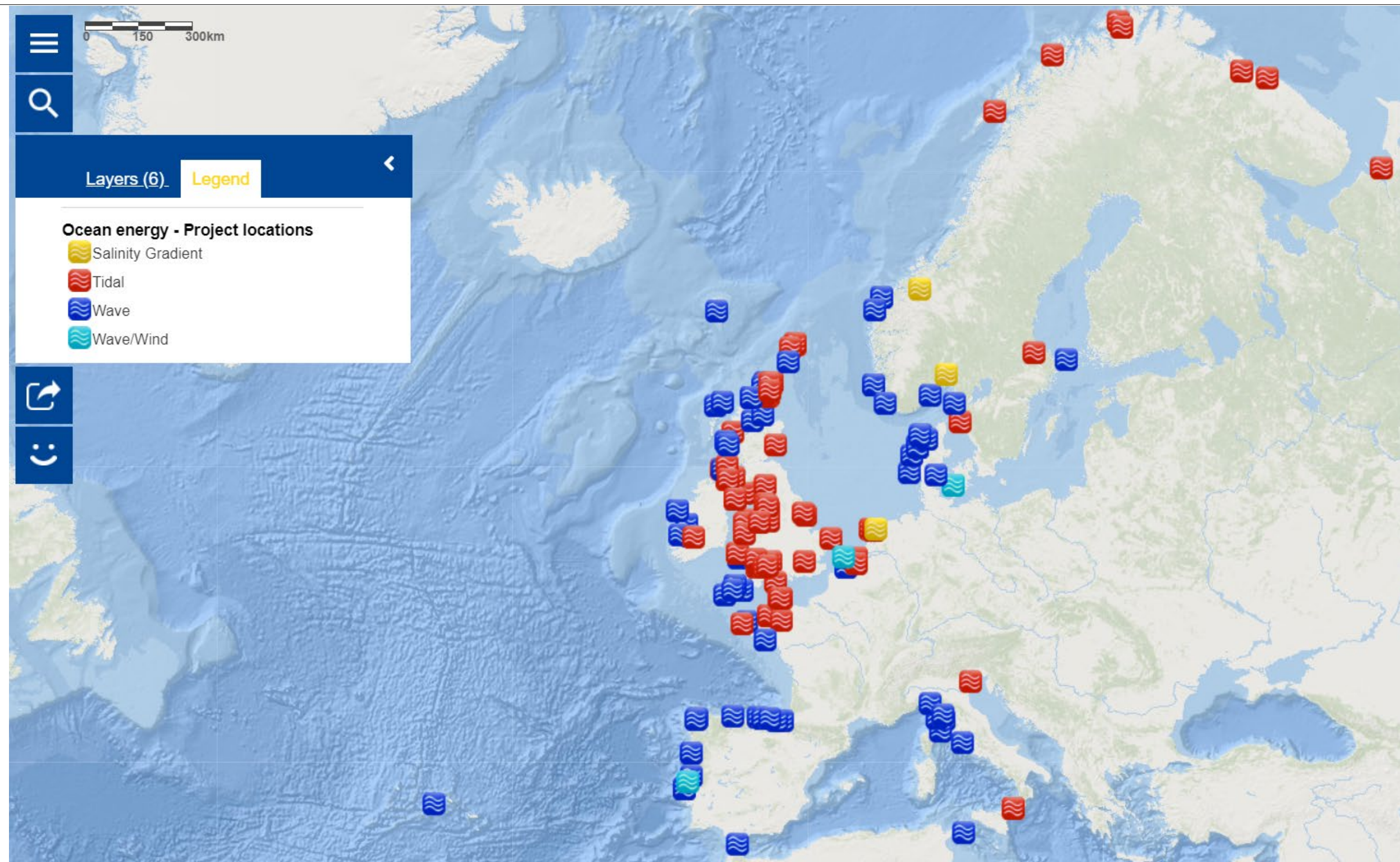


How is research tackling the need for **cost reduction** and **reliability** of ocean technologies?









Hydric resources

the seas as a source
of fresh water



Abundance

The seas contain about 1,386,000,000 km³ of water (approximately 97.2% of the world's total water resources)

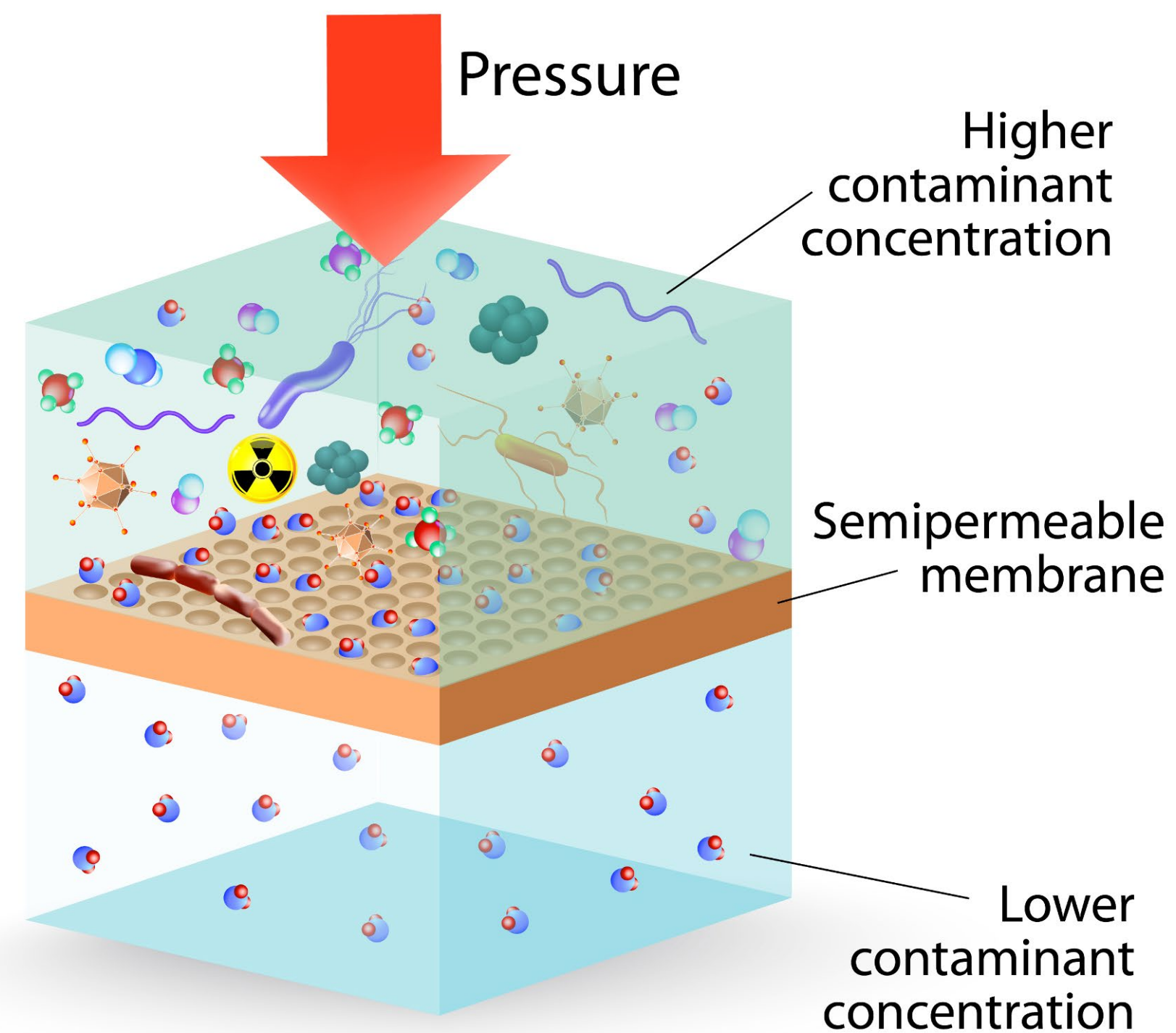
The problem

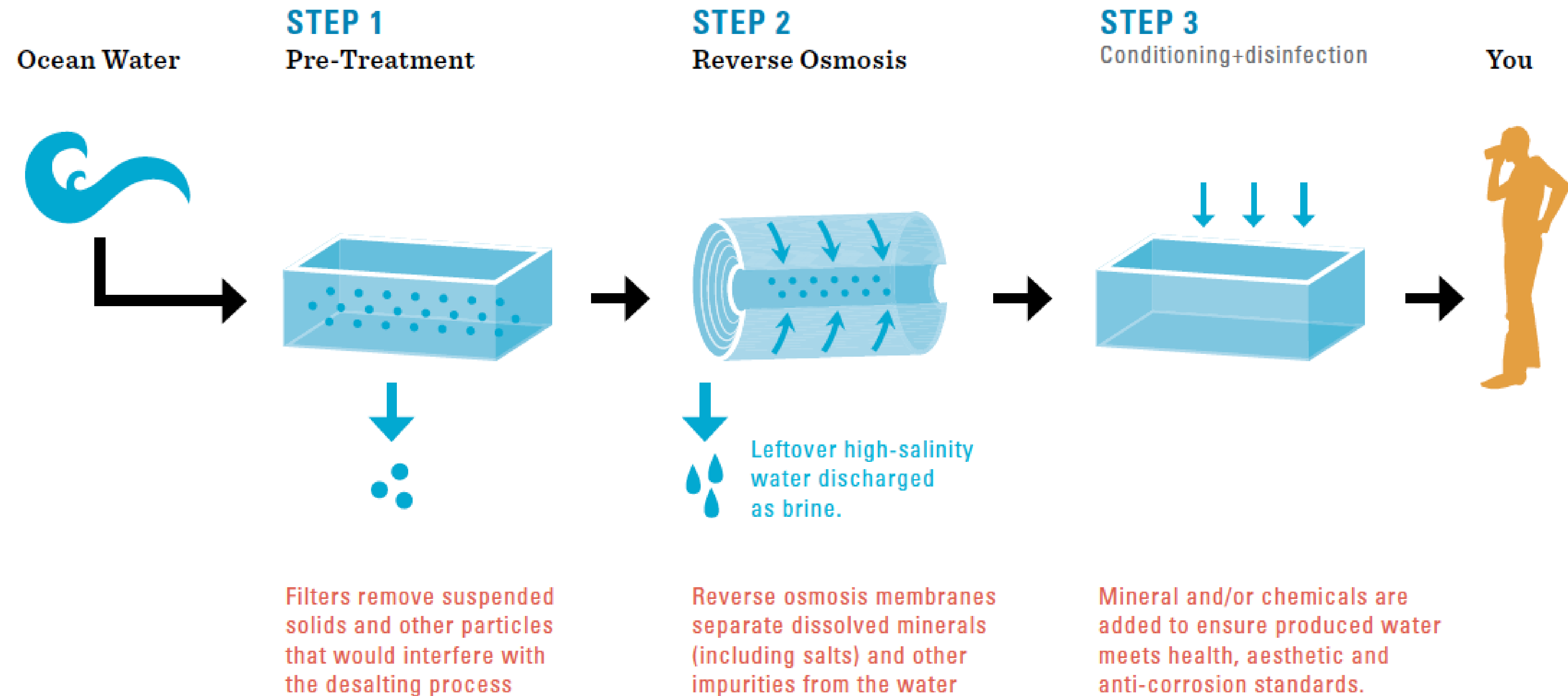
This water, however, is not suitable for human and animal consumption, nor to be used in agriculture

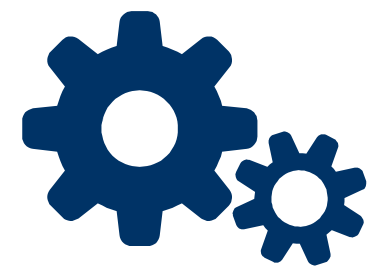
The solution

With technology, saline water can be converted into fresh water through desalination

REVERSE OSMOSIS







20500

desalination units around the world



$122 \times 10^6 \text{ m}^3/\text{d}$

total accumulated desalination capacity



150

countries where desalination is done



300×10^6

people who daily depend on desalinated water

Maritime transport

the seas as
aquatic motorways





Transport of persons (passengers) or goods (cargo) by waterways

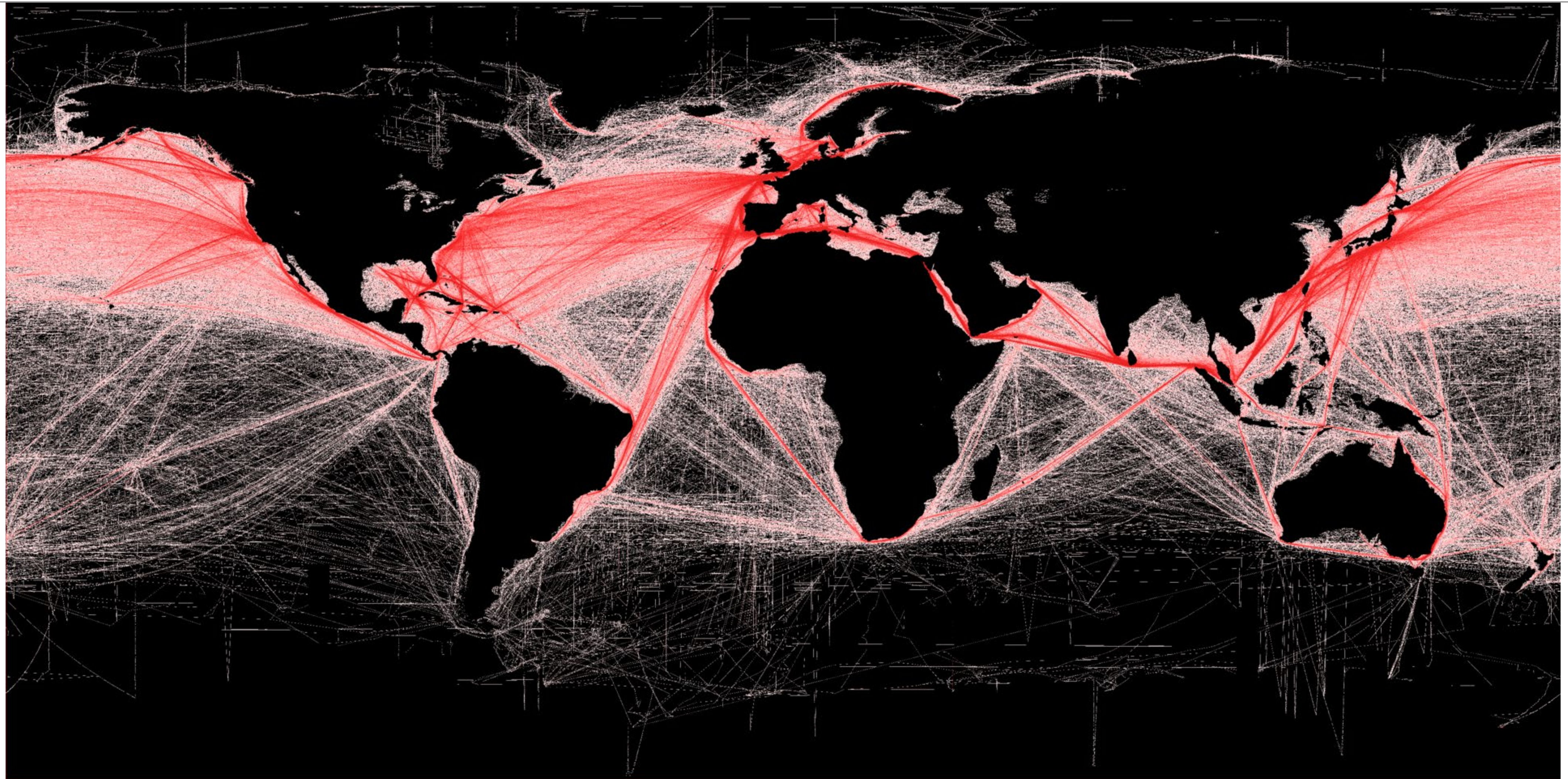


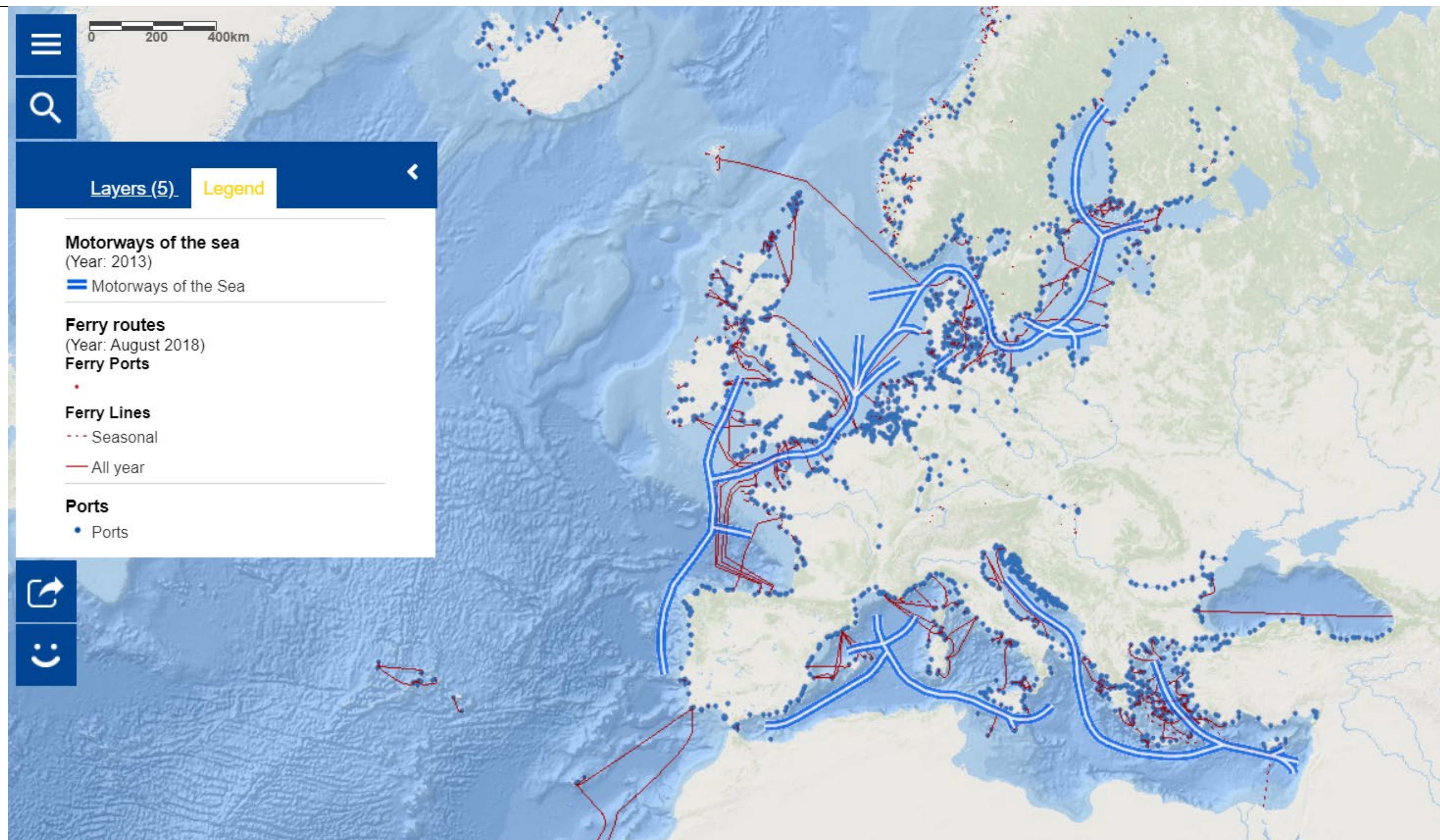
It can be carried out at any distance, by boat, ship, sailboat, etc., for trade, leisure or for military purposes

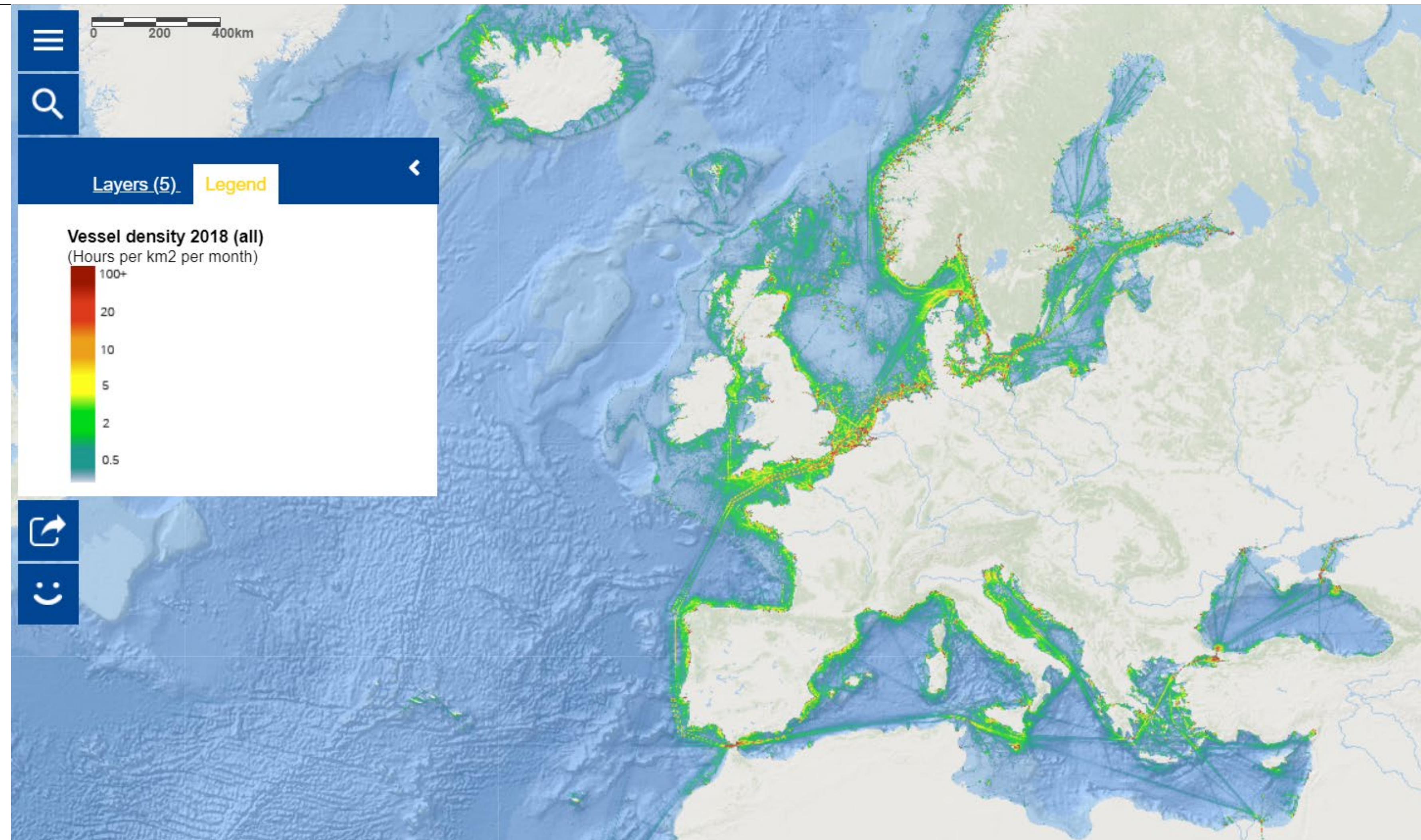


Widely used throughout history and a key component of world economies









Ecosystem services

the seas as promoters
of planetary well-being



Benefits

Ecosystem services, products, conditions or processes that directly or indirectly benefit human beings or improve social well-being; some indispensable to their survival

Undervalued

As they are not purchased and sold directly in the markets, market activities do not fully reflect the benefits they provide

Recognized

Although discussed by scientists and environmentalists decades ago, it became a customary concept in 2000s with the Millennium Ecosystem Assessment

Types of services



Provision

Services related to the ability of ecosystems to provide goods: food, raw material for energy production, biochemical resources, water, etc.



Regulation

Benefits obtained from the regulation of ecosystem processes, such as climate control, CO₂ retention, air purification, water cycle regulation, erosion and flood control, etc.



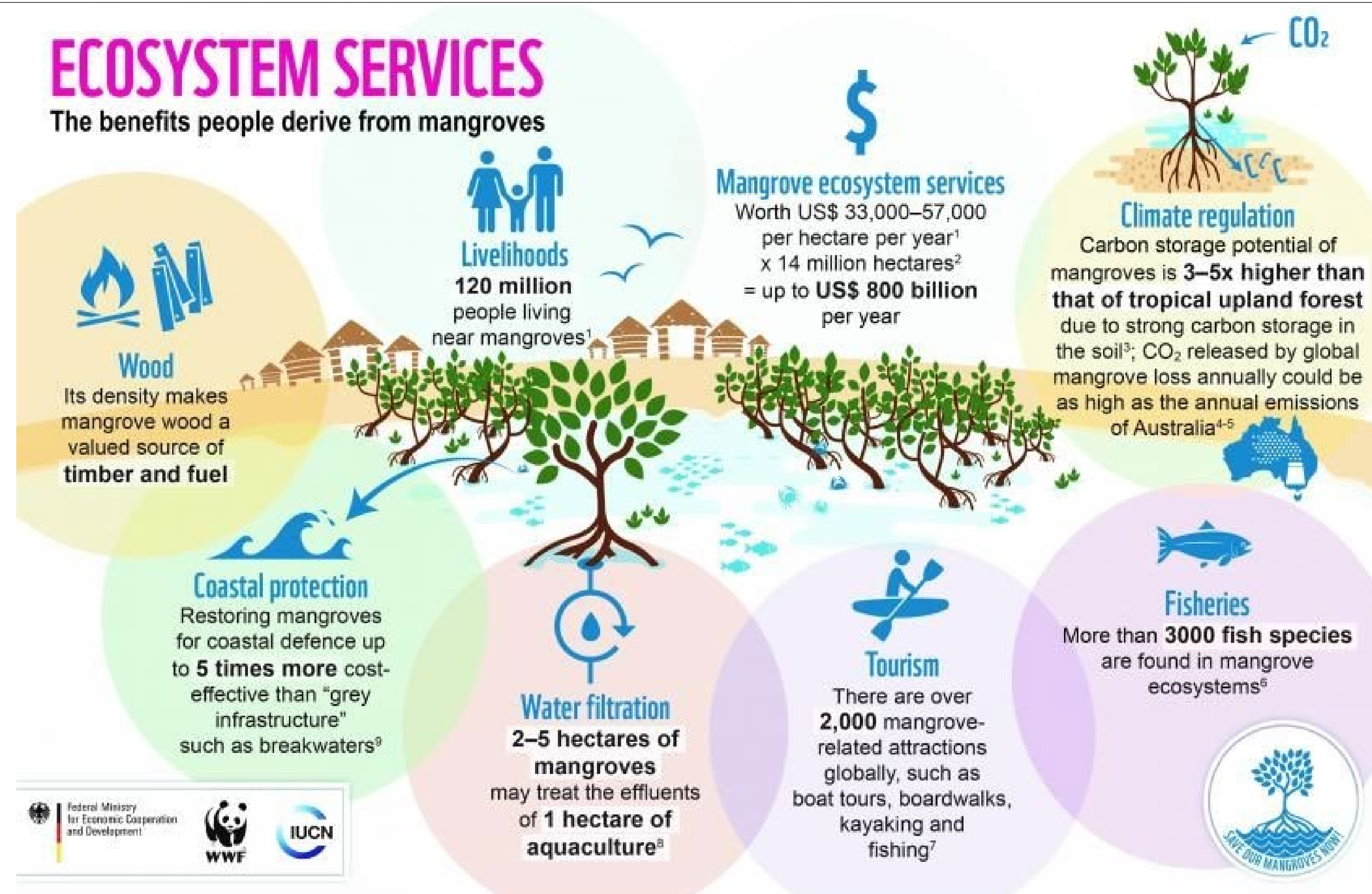
Cultural

Recreational, educational, aesthetic, spiritual benefits, etc.



Support

Services necessary for the production of all other ecosystem services, such as nutrient recycling, primary production, seed and machine dispersion, etc.



Sources: ¹ UNEP, 2014 • ² Giri et al., 2011 • ³ In the Indo-Pacific region: Donato et al., 2011 • ⁴ Up to 450 million t CO₂: Pendleton et al., 2012 • ⁵ In 2015: EDGARv4.3.2., 2018 • ⁶ Sheaves, 2017 • ⁷ Spalding et al., 2016 • ⁸ Primavera et al., 2007 • ⁹ In Vietnam: Narayan et al., 2016

Ecosystem services

MAPPING OCEAN WEALTH

COASTAL BLUE CARBON

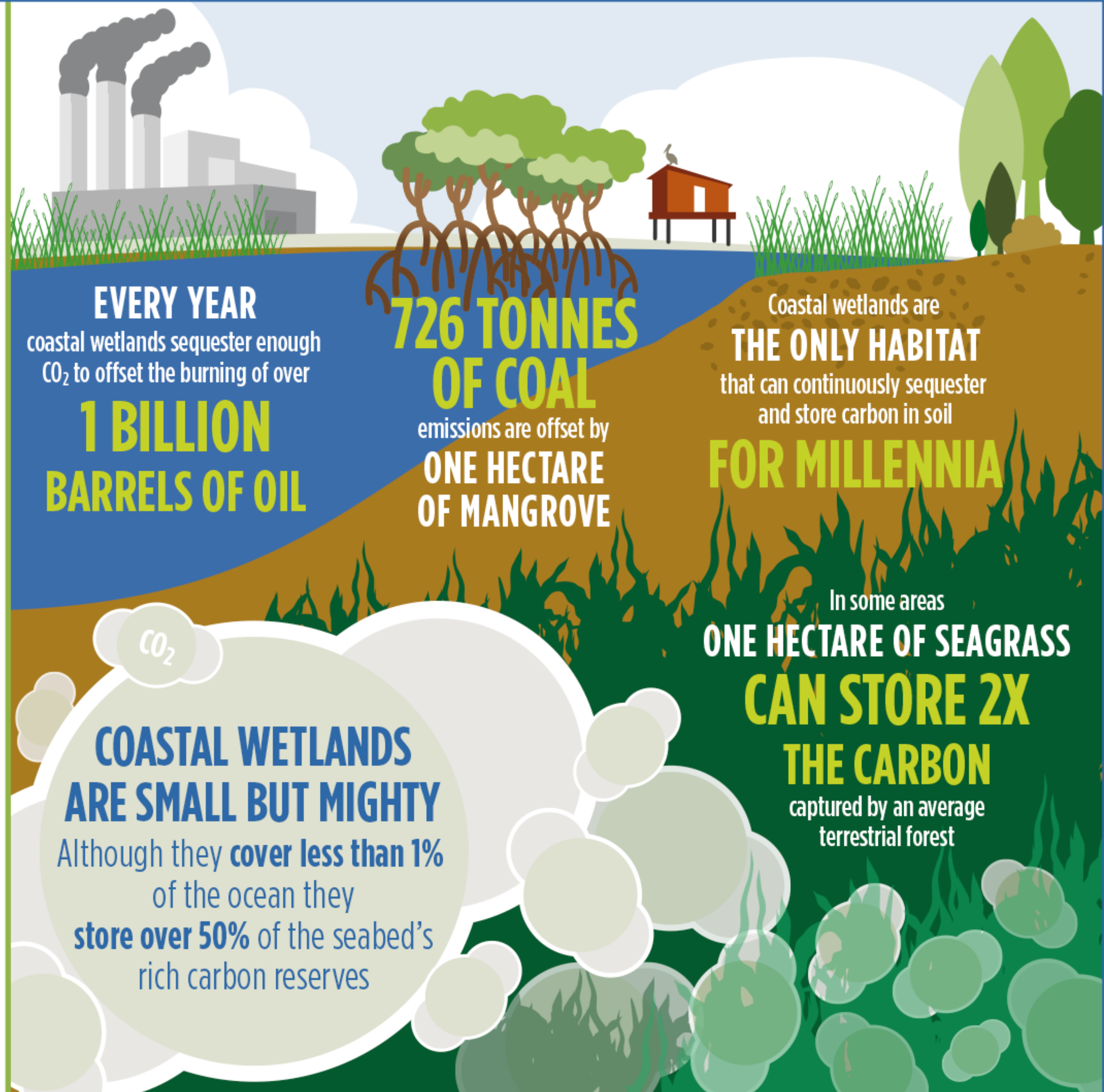
Coastal wetlands — seagrass meadows, salt marshes and mangroves — provide one of the most effective natural solutions for carbon capture and long term storage on the planet.

Policymakers, industry and coastal practitioners should begin now to preserve and restore coastal wetlands because of their climate mitigation and market potential for the benefit of local communities and economies.

Mapping Ocean Wealth demonstrates what the ocean does for us today so that we maximize what the ocean can do for us tomorrow.

oceanwealth.org @ocean_wealth

The Nature Conservancy 
Protecting nature. Preserving life.®



Ecosystem services

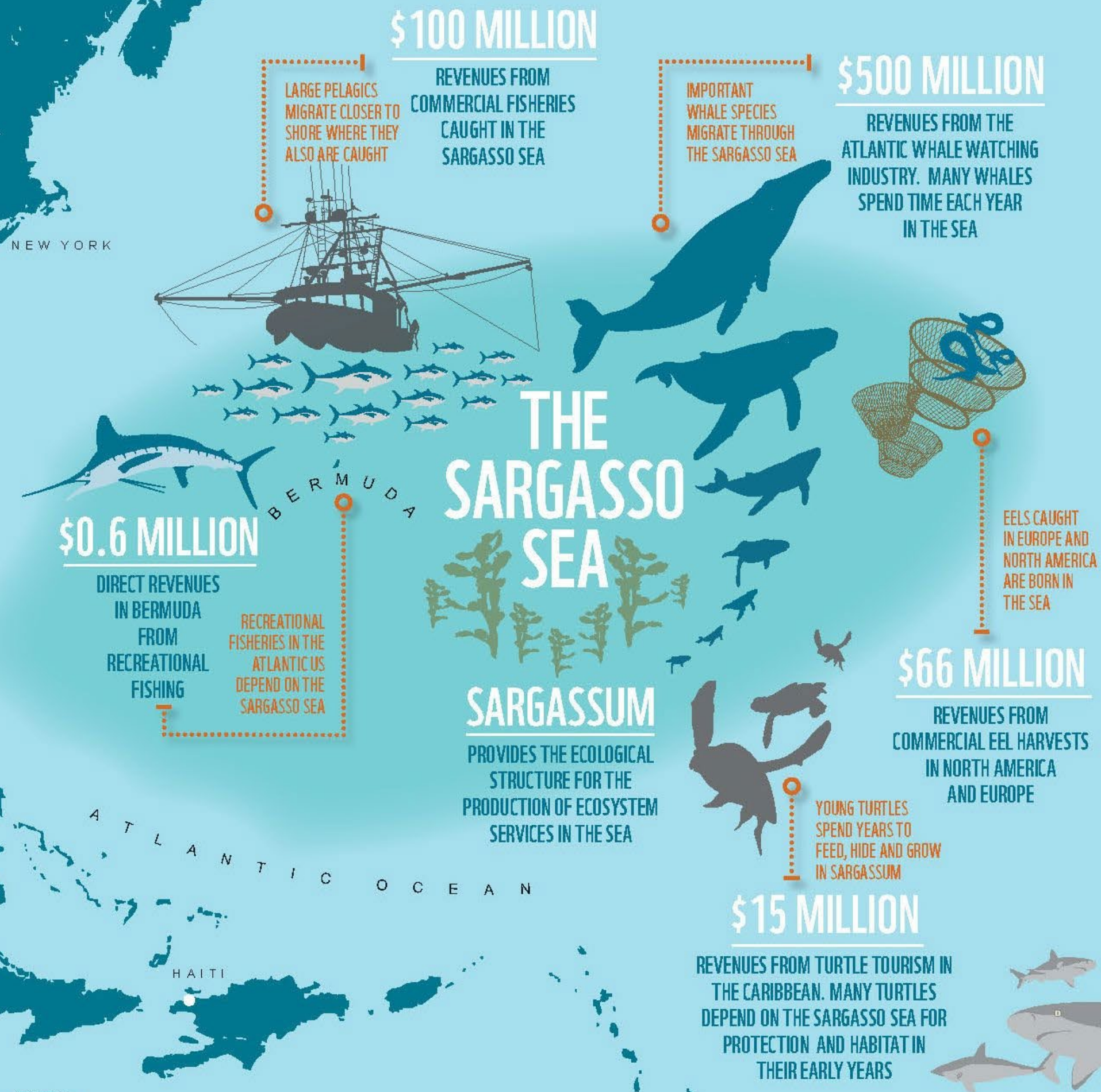
THE SARGASSO SEA A VITAL ECOSYSTEM OF GLOBAL IMPORTANCE

THE SARGASSO SEA CREATES AN ESSENTIAL HABITAT FOR WORLDWIDE SPECIES GLOBALLY, BUT WHAT IS THE ECONOMIC CONTRIBUTION OF THIS HIGH BIODIVERSE AND PRODUCTIVE AREA?

THE STUDY

THE STUDY LINKS THE ECOLOGICAL HEALTH OF THE SARGASSO SEA TO RELEVANT ECONOMIC SECTORS USING EXISTING DATA. THIS INCLUDES ECOSYSTEM SERVICES THAT ARE ENJOYED DIRECTLY WITHIN THE SARGASSO SEA. THE HEALTH OF THE SARGASSO SEA PROVIDES A FOUNDATION FOR ECONOMIC ACTIVITIES OUTSIDE OF THE SARGASSO SEA. SPECIES OF ECONOMIC INTEREST, SUCH AS EEL, BILLFISH, WHALES, TURTLES RELY ON THE SARGASSO SEA FOR SPAWNING, MATURATION, FEEDING, CRITICAL ROUTE FOR MIGRATION.

PENDLETON, L., F. KROWICKI, P. STROSSER, AND J. HALLETT-MURDOCH. ASSESSING THE ECONOMIC CONTRIBUTION OF MARINE AND COASTAL ECOSYSTEM SERVICES IN THE SARGASSO SEA. (NIR 14-05. DURHAM, NC: DUKE UNIVERSITY)



UNQUANTIFIED BENEFITS

ADDITIONALLY, THE SARGASSO SEA SUPPORTS A LARGE NUMBER OF ECOSYSTEM SERVICES THAT HAVE YET TO BE QUANTIFIED, INCLUDING:

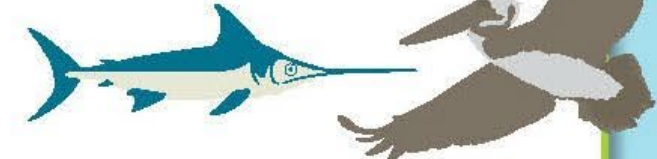
ECOLOGICAL FUNCTION

SARGASSUM CONTRIBUTES TO THE CREATION OF BEACHES AND SHORELINE PROTECTION, CARBON SEQUESTRATION, OXYGEN PRODUCTION, AND BIODIVERSITY PROTECTION



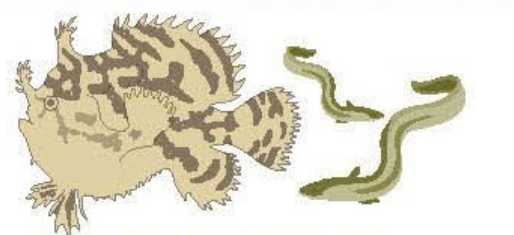
WILDLIFE

ENJOYED BY BIRD WATCHERS AND SEA LIFE VIEWED BY SCUBA DIVERS, SNORKELERS, AND OTHERS



ICONIC ORGANISMS

MORE THAN 100 SPECIES OF INVERTEBRATES, MORE THAN 280 SPECIES OF FISH, AND 23 SPECIES OF SEABIRD, INCLUDING MANY THREATENED AND ENDANGERED SPECIES



PASSIVE USE VALUES

INCLUDING THE EXISTENCE OF CHARISMATIC SPECIES AND RARE OR THREATENED SPECIES LIKE WHALES, TURTLES, SHARKS, AND EMBLEMATIC SPECIES (E.G., THE SARGASSUM ANGLERFISH) AS WELL AS POTENTIAL OPTION VALUES FOR ORGANISMS THAT ARE AS YET UNDISCOVERED. SARGASSUM PROVIDES PROTECTIVE HABITAT FOR YOUR TURTLES AND SHARKS.

Main threats to marine resources

Sewage

Discharge of waste water, sewage and toxic chemicals

Garbage

Dumping of urban and industrial solid waste from coastal cities

Plastic

Disposal of plastic materials at sea

Destruction

Coastal zone reclaimed for the expansion of ports or other land structures

Hydrocarbons

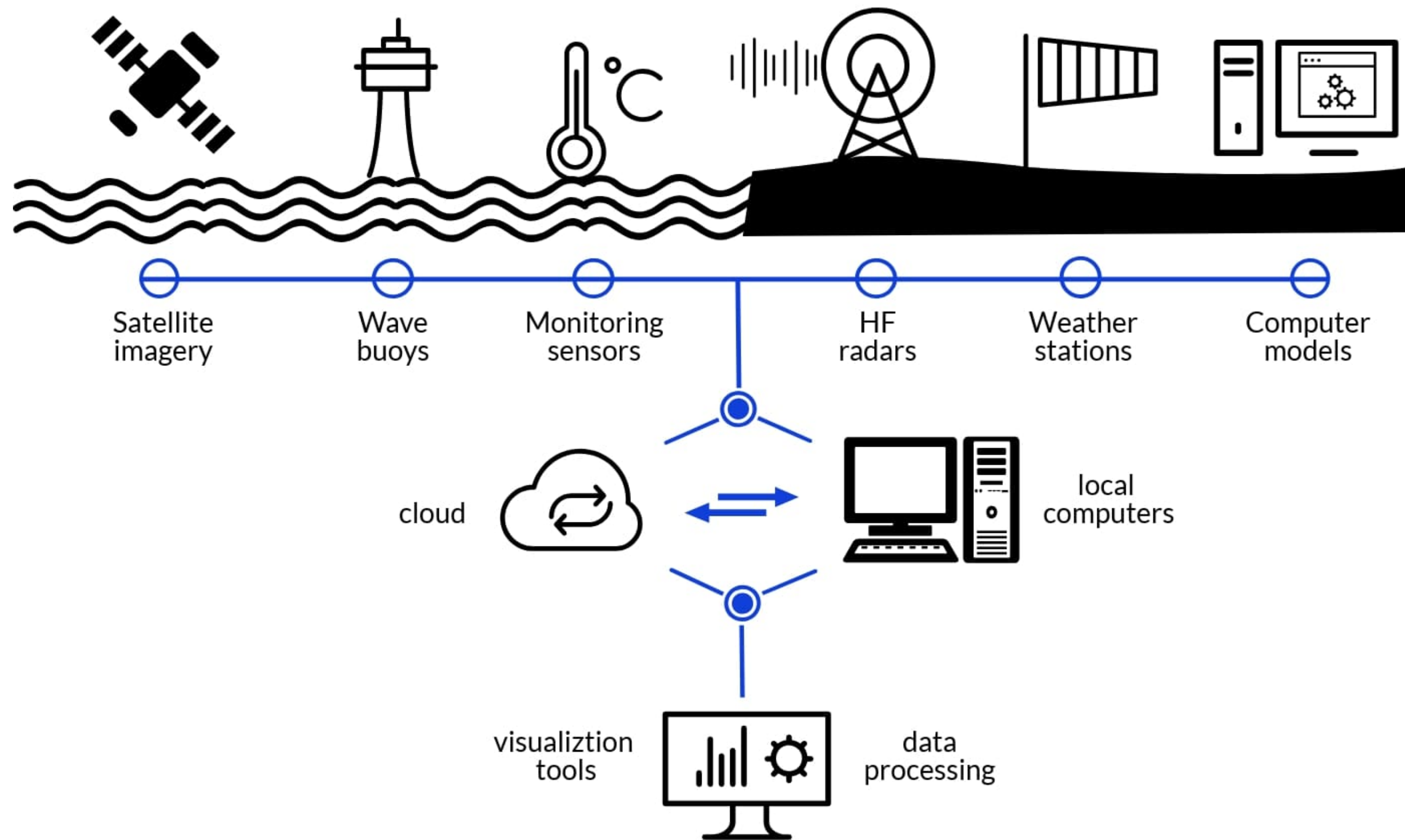
Leakage or seeping of massive amounts of oil/crude oil from offshore oil tankers and oil wells

CO₂ emissions

Increased acidity of seawater due to increased CO₂ concentration in the atmosphere

Marine systems...

- are dynamic systems shaped by an interplay of complex physical, chemical and ecological processes, occurring at different time scales
- vary significantly in space (latitude, longitude and depth) and in time (e.g., seasonal patterns)
- can only be managed and their resources harvested with intensive ocean monitoring



Constant monitoring of the ocean is the only way to know its status, assess its changes and predict its evolution

<https://marine.copernicus.eu/>



Provide products and services for all marine applications

- Ocean Products
- Ocean Monitoring Indicators
- Ocean State Reports

An underwater scene with a sea turtle swimming towards the left. The water is filled with various types of plastic pollution, including bags, bottles, and debris. The scene is dimly lit, with a blue-green tint. The turtle is in the foreground, and the pollution is scattered throughout the water column and on the sandy bottom.

Ulisses

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