AQUAE

The future is in the ocean

Consiglio Nazionale
delle Ricerche

The interactive scientific exhibition "Aquae. The future is in the ocean"

has been designed and created by

Consiglio Nazionale delle Ricerche

Communication Unit

Department of Earth System Science and Environmental Technologies

Institute of Marine Sciences

Institute for the study of Anthropical Impact and Sustainability in the Marine Environment

Institute of Polar Sciences

Institute of Marine Engineering

The exhibition

When seen from space, our Planet looks like a **big blue sphere**. Despite its name, in fact, 71% of the Earth is covered by oceans, whose role is vital for our survival.
They play a crucial regulating role on climate, host incredible biodiversity, provide sustenance for millions of people and transport 80% of global trade.
The relationship between the man and the sea is rooted in myth and the oceans were seen as the place of the unknown for many centuries. Today the sea and its seabed are fields of investigation and study of great scientific relevance not only for present times but above all for the future when the role of the ocean will become **more and more decisive** for human growth and development.
The exhibition, designed in collaboration with Cnr national scientific network, aims to describe the main characteristics of the marine environment, paying specific attention to the use and conservation of its resources for **sustainable development**.
Experiments, scientific equipment, scale models, video installations and suggestive images lead the public through a journey to the discovery of the oceans.
In particular, the first section of the exhibition introduces general themes related to the sea: geographical, physical, chemical and biological features. Some light is shed on an environment that was almost unknown until the middle of the last century: the **ocean floor**.
Interactive and video exhibits provide answers to such questions as how are waves and currents generated? What is the connection between the sea and the climate of the Planet? Which is the biological engine of the sea?
The second part of the exhibition is dedicated to the relationship between the man and the sea: the oceans have always been an invaluable resource for our species. Today science and technology are involved in the search for new methods to make sustainable use of the many resources offered by the sea and at the same time, they are developing strategies to monitor and protect the marine environment from the effects of the **anthropic impact**.
The last part of the exhibition is dedicated to research carried out by various Cnr Institutes involved in the study of sea and navigation.
Besides, it is an opportunity to consider how the future and the protection of the oceans depend on us, on our behaviour and on the policies that our governments and industries will decide to adopt.

In brief

Interactive exhibition about the oceans and the related Cnr research activities
Scientific areas: oceanography, earth physics, marine biology, environmental studies
Layout: 18 luminous panels, exhibits, prototypes and installations

Technical requirements

Areas from 300 to 600 m^2, standard electrical connections, water nearby
Set up time: 3 days. Dismantling time: 2 days
The exhibition involves scientific explainers

Target

The exhibition is aimed at an audience of alla ages and recommended for schools of all levels

We were in...

Preview: Genoa, Palazzo Ducale, Festival della Scienza 2018
Opening: Rome, Cnr headquarters 21 November 2018, in the framework of the celebrations for the 95th anniversary of Cnr with the participation of the Italian President of Republic Sergio Mattarella and the main Institutional authorities
Further releases: Venice, 18 june 2019 - 31 march 2020 Cnr - Ismar Venice headquarter

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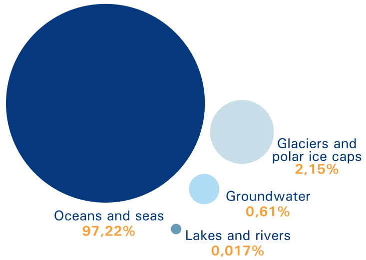
Seas and oceans

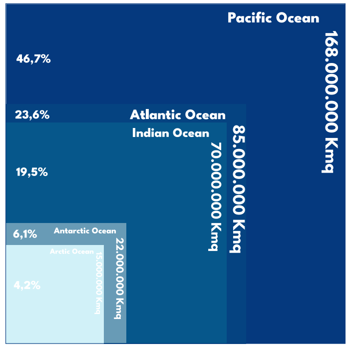
The term ocean refers to the wide expanses of salt water on the Earth's surface. The seas are instead marginal inlets of the oceans; they are smaller and the geological characteristics of their seabed are generally different.

The surface of the oceans covers 71% of the Earth's surface

OXYGEN O_2 & CO_2

The oceans produce more than 50% of the oxygen present in the atmosphere; it is generated by the green and blue algae that are part of plankton. They also store a large





CLIMATE

The oceans distribute heat on the Earth and significantly influence the climate

BIODIVERSITY

Almost half of the world's species live in the sea. This rich biodiversity is not only an ecological marvel: it is a treasure of chemical substances that can also provide cures for serious illnesses

TRANSPORT

80% of world freight transport takes place

ENERGY RESOURCES

It is estimated that in 2050 more than 50% of energy and mining resources will be extracted from the sea

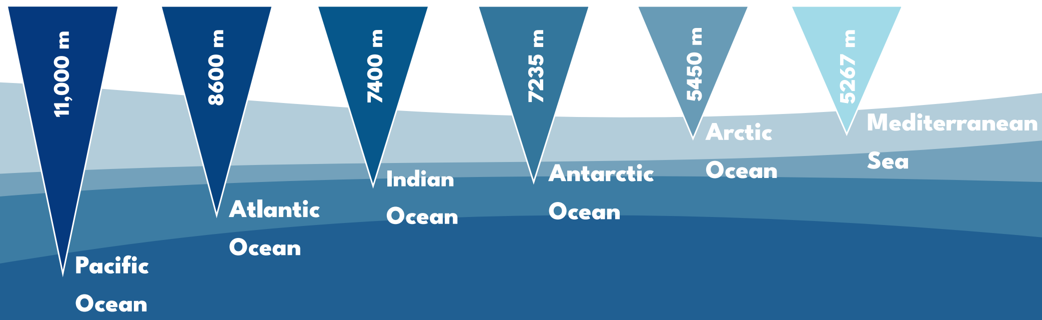
ECONOMY

The economic value of the oceans exceeds 24,000 billion dollars and will continue to grow in the future

FOOD

The oceans are one of the main sources of food

The depth of the oceans



The oceans are still a mystery. It is estimated that only 5% of the ocean floor has been systematically explored and we know more about the surface of the Moon or Mars.

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The large globe of the ocen floor

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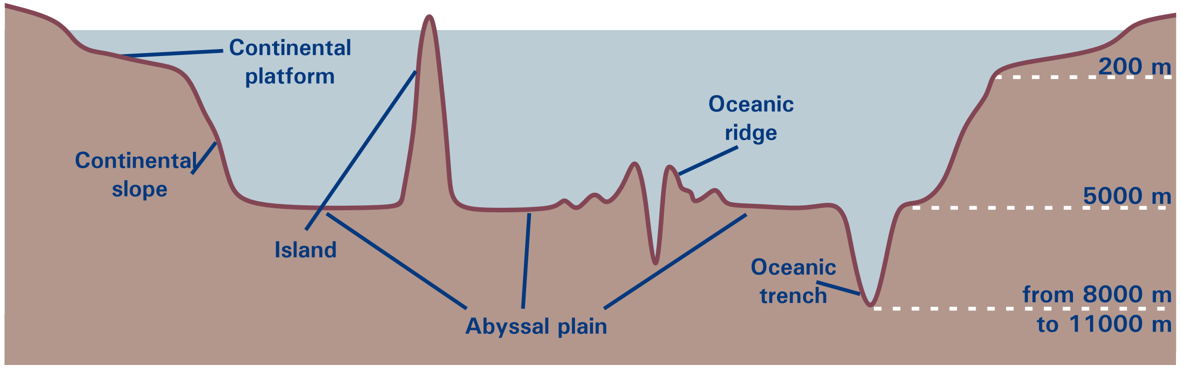
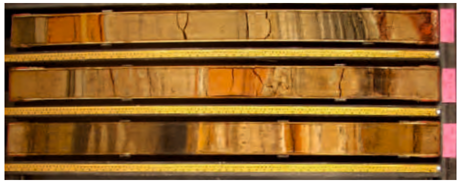
The Ocean floor

The sea naturally attracts any type of sediment, no matter how long or winding the transport phase is. Since two thirds of the Earth are covered by water, the sediments on the seabed represent the most important natural archive of the Earth's history. The investigation of the ocean floor provides documentary evidence of the climatic and environmental scenarios that have occurred over time.



Sampling is done with different techniques, the most common being that of coring which consists in taking cylindrical samples of sediment (carrots) of various diameter using instruments called core chambers.

The core samples are taken from the continental shelf to the abyssal plain. These investigations allow us to obtain information on sediments that date back to about 200 million years ago, the age of the oldest oceanic crust.

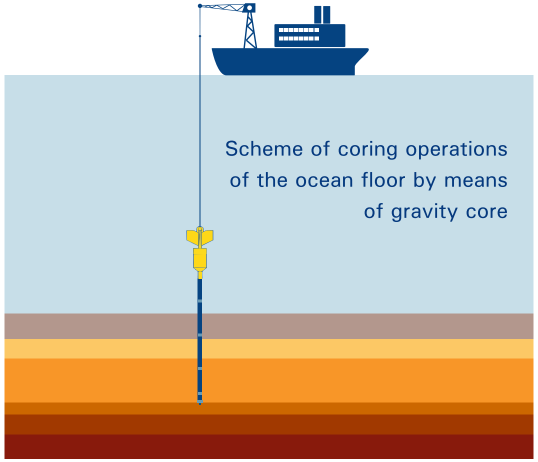


Carrot MR 83 - Marine sediments taken from the Red Sea

The development of core drilling techniques began in the 1950s and represented a major scientific revolution that changed our understanding of the way the planet Earth works. Coring is currently carried out in all oceans and seas, both in the Arctic and in Antarctica.

The investigations have provided explanations of the origins of oceans and continents, documented that the Antarctic soil remained covered in ice for several million years, demonstrated that the Mediterranean Sea dried up almost completely 5 million years ago and has since gone through several stagnation phases.

Positioning of the gravity core barrel for the coring operation



Scheme of coring operations of the ocean floor by means of gravity core

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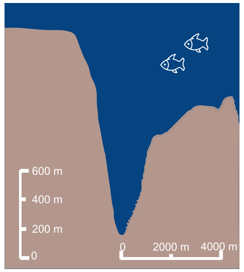
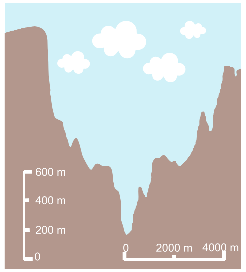
Submarine landscape

The seabed is invisible to human eyes: we can only have indirect knowledge of it thanks to geophysical instruments and to a few pinpointed immersions of scuba divers, submarines or remoted operated vehicles (ROV).
The immense and dark submarine spaces are shaped by currents and other dynamic events such as landslides, volcanic eruptions, tectonics exactly like the emerged lands that we can see with our eyes. Even if we don't see the underwater landscape, we take many decisions affecting it, based on partial and local reproductions, to

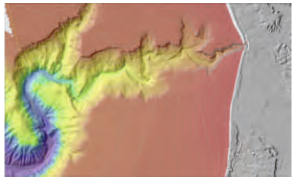
Canyon di Monterey



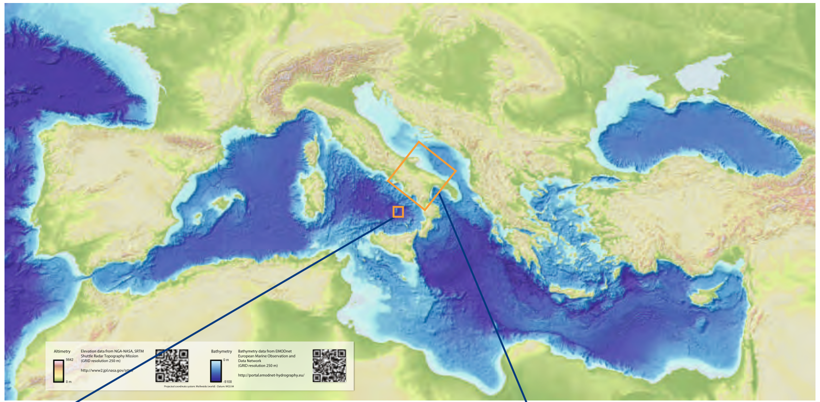
Grand Canyon



The new depth measurement techniques (bathymetric surveys) provide new unprecedented details and allow the reconstruction of the underwater landscape at decimetre resolution. However, this is an indirect knowledge, such as the one offered by satellites of the surface of Mars. For example, a submarine canyon like the one in Monterey in the Pacific Ocean is not different in size and extent from the Grand Canyon of Colorado. The difference is that we cannot have direct experience of the Monterey canyon because it is not a landscape where we can walk, that we can photograph or use as a background for a selfie. Only in very few places, bathyscaphes or underwater cameras can offer some direct images of the canyon's depths. It is like documenting the Grand Canyon of Colorado during a long trek, having only a couple of photos available.

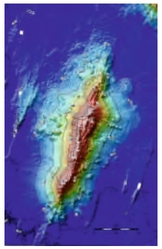


Bathymetry of the Monterey Canyon



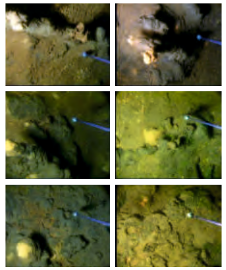
Bathymetry of the Mediterranean Sea detected with multibeam echosounders at 250 metres resolution

Marsili is the largest volcano in Europe, but you cannot see it

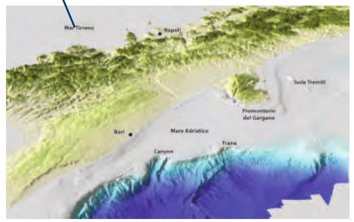


60 km long
20 km wide
3 km high
from 3400 to 489 m depth
Volume
1200 Km^3
Age
700 thousand years

It could collapse due



Photographs taken at 650 m depth of extinct chimneys of polymetallic sulphide (pyrite, galena, sphalerite) and active chimneys with oxides and hydroxides of iron and manganese



3D view of the digital model of Italy (shades of green), the continental shelf (grey) and the Apulian escarpment (blue), at 25 metres resolution; recent canyons and submarine landslides can be observed in the escarpment.
Pictures taken by underwater vehicles that document the life of corals in the darkness at 600 m depth.

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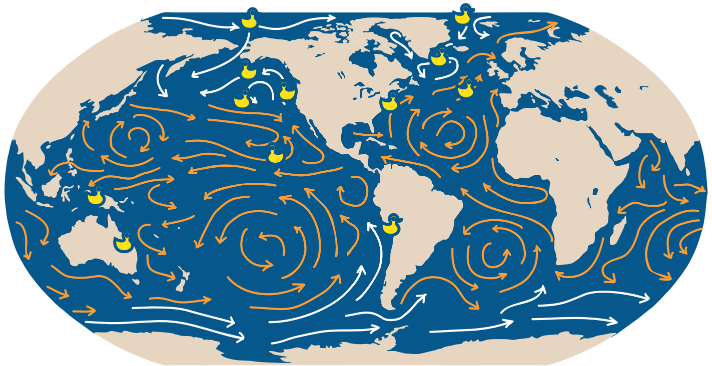
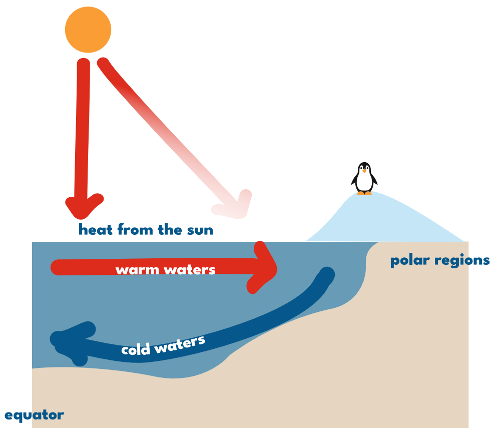
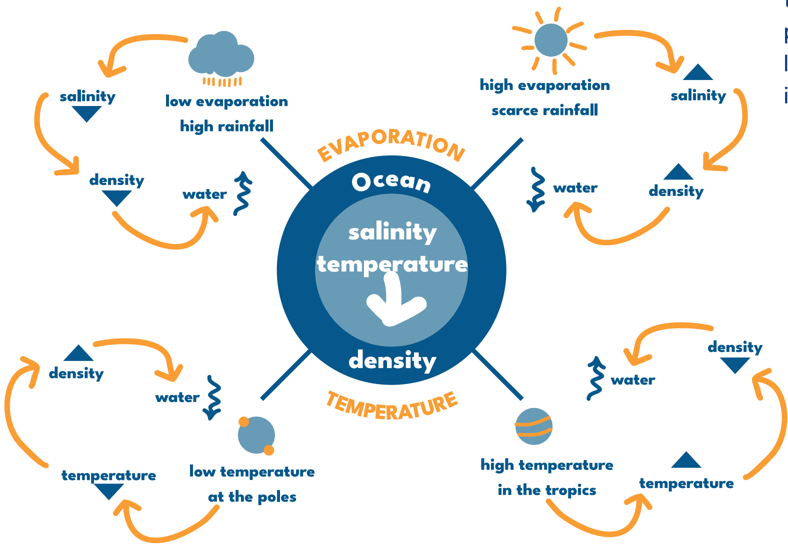
The dynamics of the oceans

"Duck Story"

UIn 1992 a ship lost at sea a container loaded with 29,000 yellow ducks. For over 20 years these toys have crossed the oceans following the global circulation, giving valuable information to scientists about ocean currents and vortices.



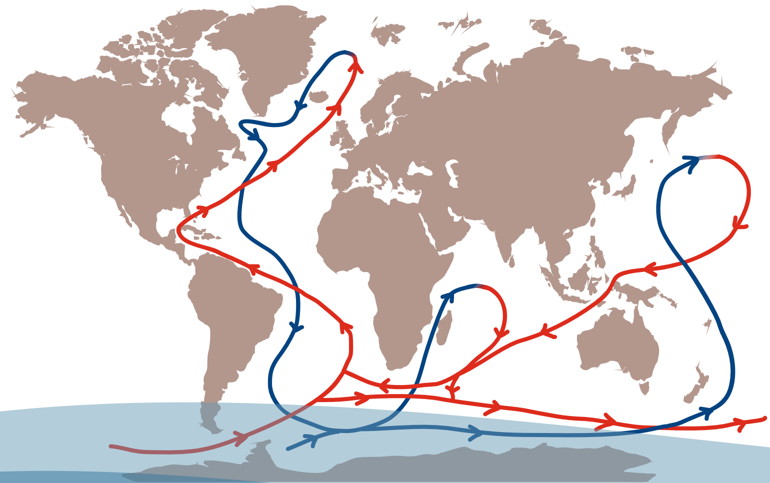




Global circulation

Ocean currents transport heat from the equator to the poles and behave as an engine for the global climate. In the oceans there are numerous currents, determined and influenced by the winds, the earth's rotation, the temperature and salinity of water. The so-called ocean conveyor belt is a simplified model of the entire global ocean circulation that derives from the combination of all these currents.

The conveyor belt is also called thermohaline circulation since the two main factors controlling it are temperature (thermo-) and salinity (-aline). Both these factors determine the density of water and it is the very different density of the oceanic strata that influence their movement, together with the action of wind which, however, does not act at all depths. The variations in water density are caused by differences in temperature and salinity which in turn are induced by evaporation, precipitation, winds and intensity of solar radiation. Hot water has a lower density and rises while cold water sinks. Water density also increases at higher concentrations of mineral salts.



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The exhibit Coriolis and Ocean turbulences

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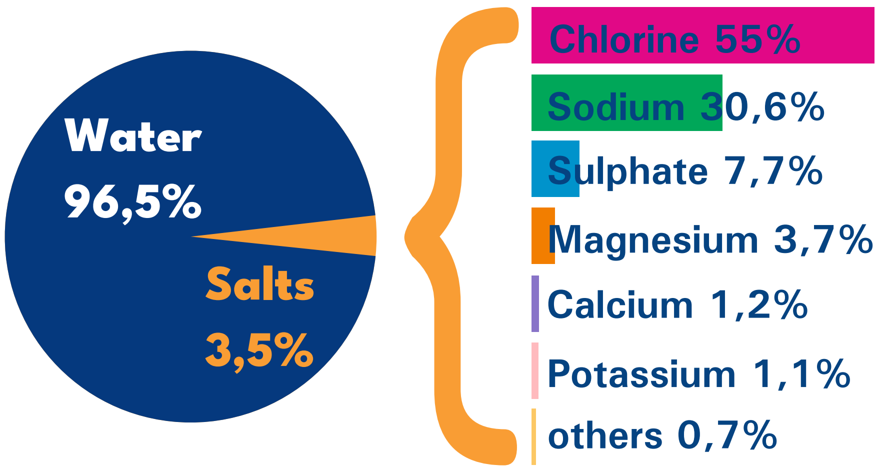
The exhibit Wave tank

Flavour of salt

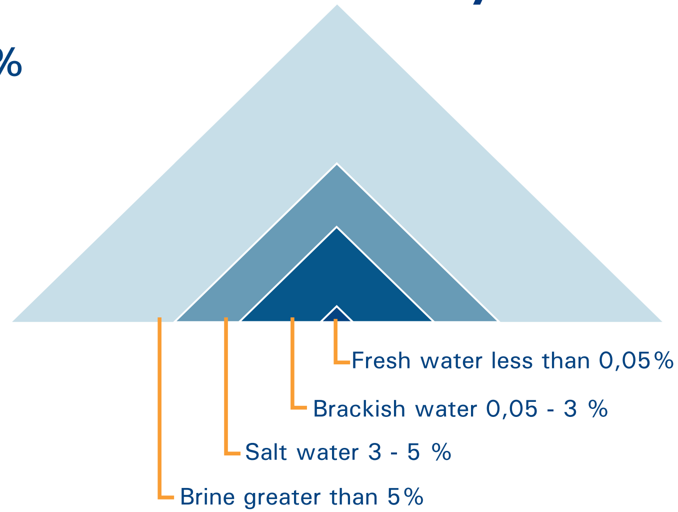
Sea water has an average salinity of 35 ‰.
This means that in 1 litre of water there are on average 35 g of mineral salts dissolved.

The salinity of seas and oceans changes with local temperature conditions. In warm seas, where surface water is subject to intense solar radiation and strong evaporation, salinity can reach very high values, while in cold seas it drops to significantly lower concentrations.
In the Dead Sea, which is actually a large lake, the salinity is very high, up to ten times greater than that of the oceans. Such a concentration of salt does not allow the development of any form of life, except for some microorganisms, algae and a species of shrimp, hence the name "Dead Sea".

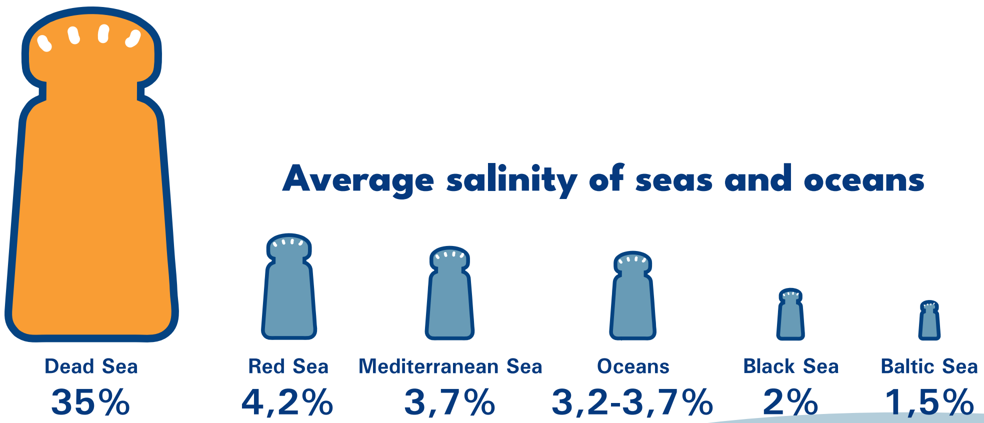
Composition of the sea



Water classification based on salinity



Average salinity of seas and oceans



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The exhibit Flavour of salt

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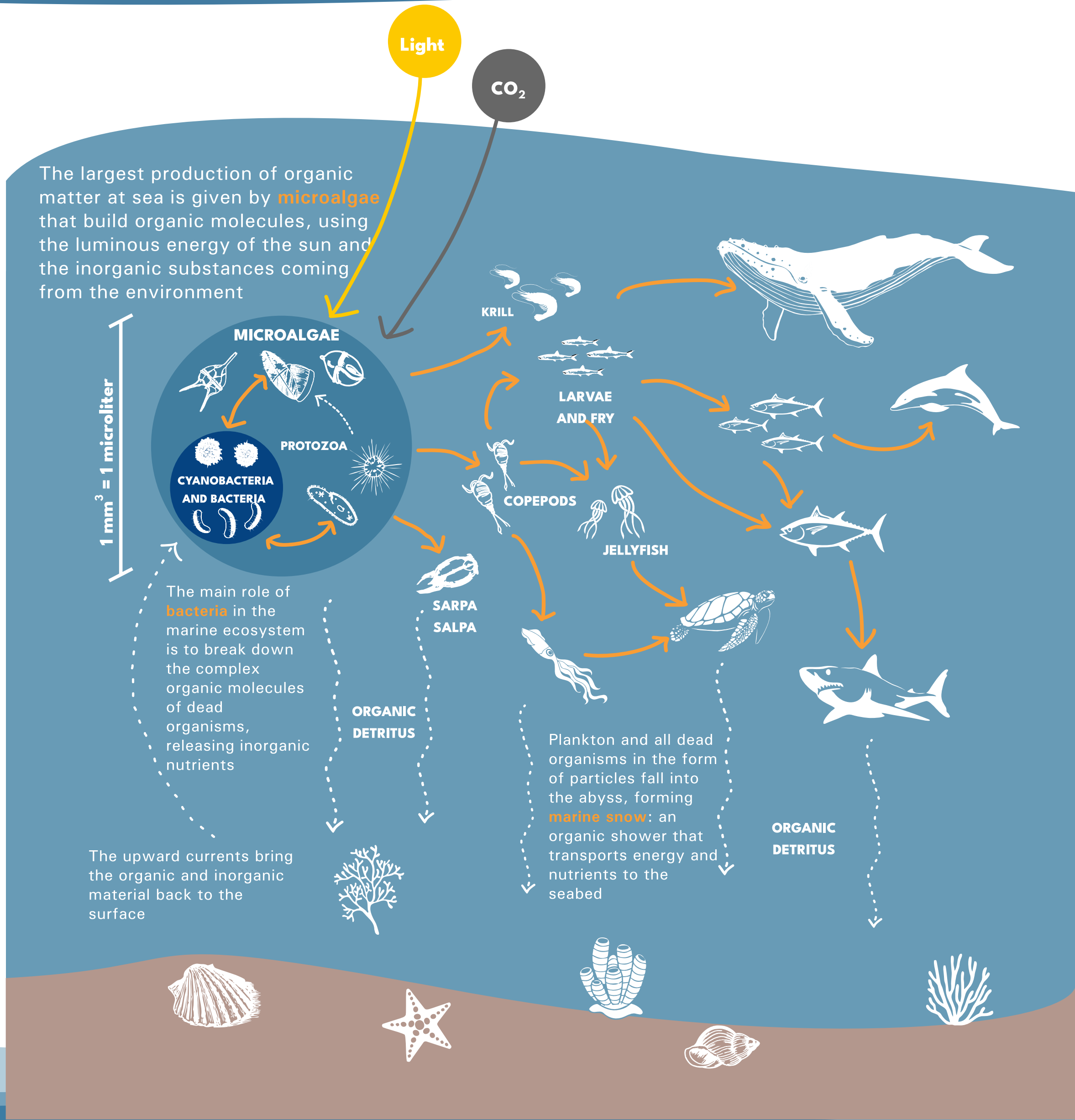
The biological engine of the sea

One microliter of ocean is the amount of sea water contained in a cubic millimeter. It hosts many microscopic organisms that can be considered the real biological engine of the marine ecosystem.



Living beings inhabiting the oceans form a huge community of organisms interconnected with the environment that surrounds them: the combination of these two components - organisms and environment - constitutes an immense ecosystem, the largest in the entire biosphere.
The relationships among marine organisms are very complex and create a series of food chains that branch out in all directions, forming real food webs.

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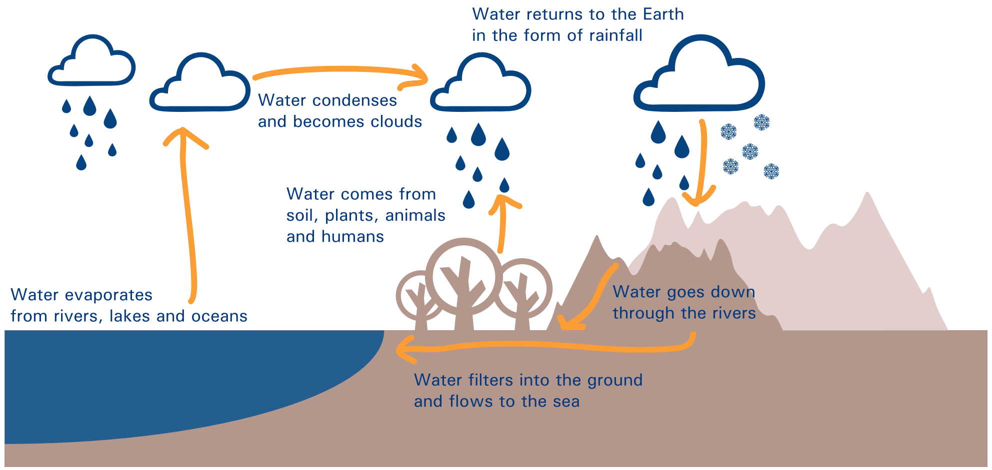
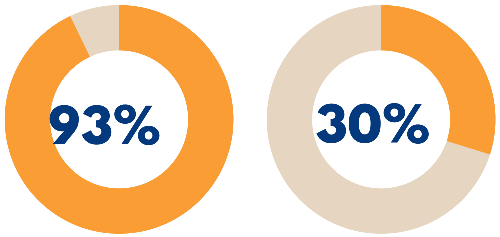
Oceans and climate

Oceans play a key role in regulating the climate on Earth. They absorb heat in warmer seasons and areas and slowly release it in colder times and regions. This action regulates the meteorological variability of seasons and influences climatic variability even in a time span of tens of years.
In other words, if the current global warming causes oceans to store too much heat, climate will change not only for the next season, but for several decades to come on the whole planet.



The ocean is the main reservoir for the water cycle and, thanks to its continuous exchanges with the atmosphere, it is closely related to the climate. When the water molecules are heated, they evaporate in the atmosphere. Almost all rain that falls on the ground originates in the oceans. Due to global warming, this cycle tends to accelerate and increase the frequency of extreme weather events such as floods, droughts or hurricanes.

The oceans absorb about

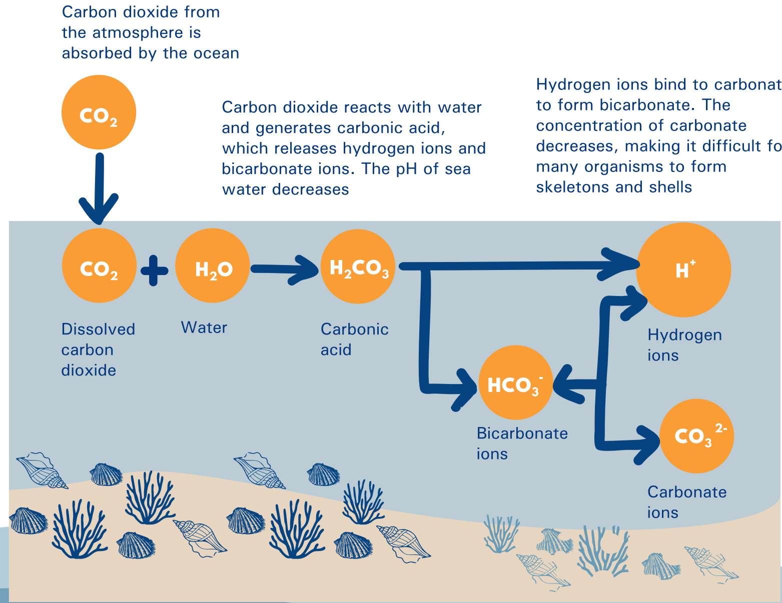


of surplus heat that reaches the Earth

of carbon dioxide emissions

The effects on the climate in different areas of the Earth are largely influenced by ocean currents, which act as a conveyor belt that moves hot water from the equator to the poles and cold water in the opposite direction.
These oceanic movements regulate the global climate, counteracting the irregular distribution of solar radiation on the Earth's surface. Without oceans and ocean currents the temperatures in the different regions of the Earth would be extreme - very hot at the equator and very cold at the poles - making these areas almost uninhabitable.

The oceans absorb large amounts of CO_2 from the atmosphere, slowing the pace of climate change. However, the benefits for climate due to this accumulation have a side effect: the acidification of the oceans.
The CO_2 dissolved in water triggers a series of reactions that lead to an increase in ocean acidity. As a consequence, the concentration of carbonate ions in sea water lowers.
Carbonate ions are an important constituent element of structures such as shells and coral skeletons. In a more "acid" ocean, with less carbonate ions available, there will be less coral reefs and a smaller number of calcareous organisms such as oysters, clams and sea urchins.



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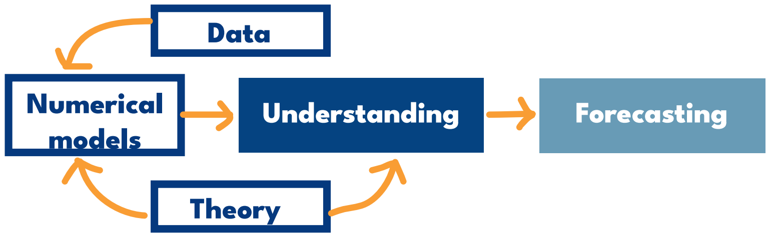
Ocean observation

Why do we study the oceans?

Oceans provide food resources: we are interested in learning the processes that influence their productivity (temperature, currents, presence of nutrients).
We use the oceans (maritime transport, oil and gas extraction, leisure): we are interested in studying the processes that can influence these activities (waves, winds, currents, temperature).
Oceans influence the climate (rain distribution, regional climate, storms and hurricanes, CO_2 absorption): we want to understand and predict these phenomena.

How do we study the oceans?



Physical Oceanography studies

The distribution of the properties of sea water, such as temperature, salinity, pressure, oxygen and other dissolved gases

Other specific properties of sea water, such as sound propagation or light penetration

The exchange of energy and matter between ocean and atmosphere

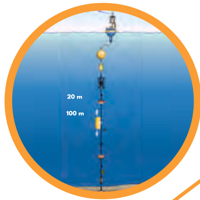
Water movements, such as tides, waves and currents

Platforms and tools

In oceanography, measurements are carried out with

Fixed autonomous systems

Oceanographic vessels
An oceanographic vessel is a ship used for marine scientific research. This type of ship is equipped with measuring instruments, laboratories and, in addition to the crew, it hosts numerous scientists and researchers



Moorings
Instrumented chains that measure a series of parameters along the water column (temperature, currents, dissolved gases, etc.)

Meteo-oceanographic buoys
"ODAS Italia1 Buoy" in the Cetaceans Sanctuary (Ligurian Sea): it is a marine offshore laboratory

"Acqua alta" oceanographic platform
The CNR platform has been operating in the Upper Adriatic since March 1970. It is located 8 sea miles off the coast in front of Venice, at 16 metres depth. Equipped with the most modern technologies, it is the only platform in the world operating in the open sea that can host researchers and technicians on board during the measurement campaigns and in all weather and sea conditions

Airplanes
Airplanes used for monitoring marine and coastal areas and for data collection by means

Satellites
They can measure the sea level, the generation and propagation of waves and other optical parameters such as the colour of the ocean, which is related to the biological productivity, to what comes from the continent and to circulation. They can also monitor the activities carried out on the oceans, such as navigation

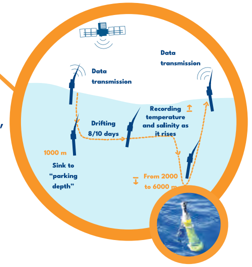
Mobile autonomous systems

Ships of opportunity
Automated data collection systems mounted on container or passenger ships that travel on predefined routes, covering large areas of the oceans

Floating buoys (drifters)
Buoys that passively follow the motion of currents, equipped with GPS antenna and temperature sensors

Autonomous underwater vehicles (Gliders)
Autonomous "active" vehicles, whose route is programmed before launch, which measure temperature, salinity, oxygen and other parameters

ARGO Floats
Subsurface autonomous instrument that measures temperature and salinity profiles. It follows the current so it is called passive



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The Current Meters

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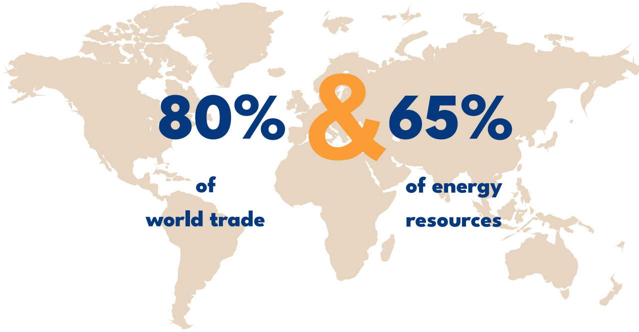
And the ship sails

Since ancient times, man has built boats to move and transport goods through the main communication route at his disposal: the sea.
After the discovery of America, navigation expanded European horizons also thanks to the progress in shipbuilding and the increase in vessel dimensions that moved from 50 tons of small Columbus caravels to 500 tons of seventeenth-century galleons.
The attempt to build larger and more advanced boats has never stopped and today boats, submarines, floating platforms and ships are increasingly complex and technologically advanced.

The oceans carry



Italy is world leader in the design and construction of ships and boats: our country manufactures 50% of the great cruise ships and the best yachts in the world and is also the first exporter.
Excellence of our country includes the design and construction of the hulls and the experimental trials, carried out on scale models tested in huge tanks and exposed to the most difficult operating conditions. This activity is carried out at CNR laboratories, better known as the Italian "Naval tank".


Greek trireme
30 meters,
5th century B.C.


Viking ship
25 meters,
10th century


Caravel
30 meters,
16th century


Galleon
70 meters,
16th century


Three-masted brig
50 meters,
19th century

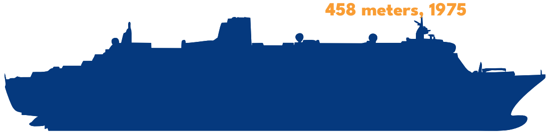

Titanic
269 meters, 1911


Aircraft carrier class CVN 68
332 meters, 1975


Seawise Giant supertanker
458 meters, 1975

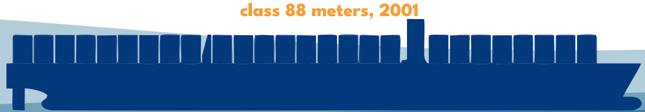

Yacht
50 meters, 21st century


Offshore patrol boat, “Comandanti”
class 88 meters, 2001


Queen Mary 2 cruise ship
339 meters, 2003


Tugboat
39 meters, 21st century


Typhoon nuclear submarine
172 meters, 1981


Mærsk Mc-Kinney Møller container ship
399 meters, 2013

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The Educational Circulating Water Channel
Cnr - Institute of Marine Engineering (subject to availability)

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Ports and infrastructures

Past

The first ports developed when some human communities decided to settle along the coasts, in **sufficiently protected** areas, to take advantage of direct access to resources -such as fishing- and to open medium and large-scale trade routes.
Those that we now call ports were in the past real cities facing the sea and equipped with tangible and intangible infrastructures to support trade by sea.

Ports were **places to exchange** goods, not only transfer them somewhere else: this entailed the added value deriving from the exchange of cultures, experiences and knowledge. In fact, in the past, it was not uncommon that port cities would permanently host communities coming from trading partner Countries.

Present

The rapid development of global economy since the post-war period has led to a dramatic increase in the exchange of goods by sea: today sea transport is still the cheapest and cleanest.
This has led to the construction of ever larger ships that required to upgrade **logistic infrastructures** of port areas and a corresponding development of **technological equipment**, determining the concentration of port services in large global centres.
Today the port has become an infrastructure designed to ensure the smoothest and **fastest transfer** of goods.
In many cases, port activities were moved from historic urban centres towards new areas that better fit the circuit of large global business. This caused the **separation** of the physical symbiosis of city and port which characterised the identity of seaside cities for thousands years.
The consequence of these epochal changes has been, in many cases, the **abandonment** of vast urbanized areas, previously directly or indirectly connected to the ports. This phenomenon has produced a high need for regeneration that is still difficult to face.

Traffic in millions of TEUs in 2017

The TEU is the standard volume measure of container transport and corresponds to a 20-foot container for a volume of approximately 40 cubic meters

17,000 ships navigate the European Union waters

The future

Regeneration of disused or **neglected** urban port areas in order to favour a new connection between city and port

Presence of an enormous **cultural heritage**, both material and immaterial, within historic port cities, which can be used to stimulate new economic development

Reconnection between city and port as a first step to revamp the idea of a port as a place of **exchange** of goods and not only of crossing

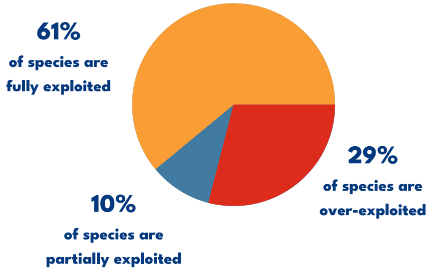
Ports as "hubs" (nuclei) able to direct the demand for **innovation** and development of wider territorial areas, thus also restoring an ancient link between seaside cities and inland areas

Knowledge economy makes this exchange possible again. It invests above all in innovation, networks of knowledge, communities of discussion, experimentation and practice. In this respect, ports are still privileged places, as transports attract a huge amount of funds for **research** and innovation

Fishing

For thousand years, fishing has provided food to populations living near lakes, seas or rivers. Fish is the main source of protein for three billion people and this makes it the most traded natural product in the world.
However, the global dependence on this important resource is also the biggest threat to the survival of fish populations.

State of fish stocks in the world



Each person eats on average 19.2 kg of fish per year, about twice as much as 50 years ago

Over 90 million tons of fish are caught every year in the oceans

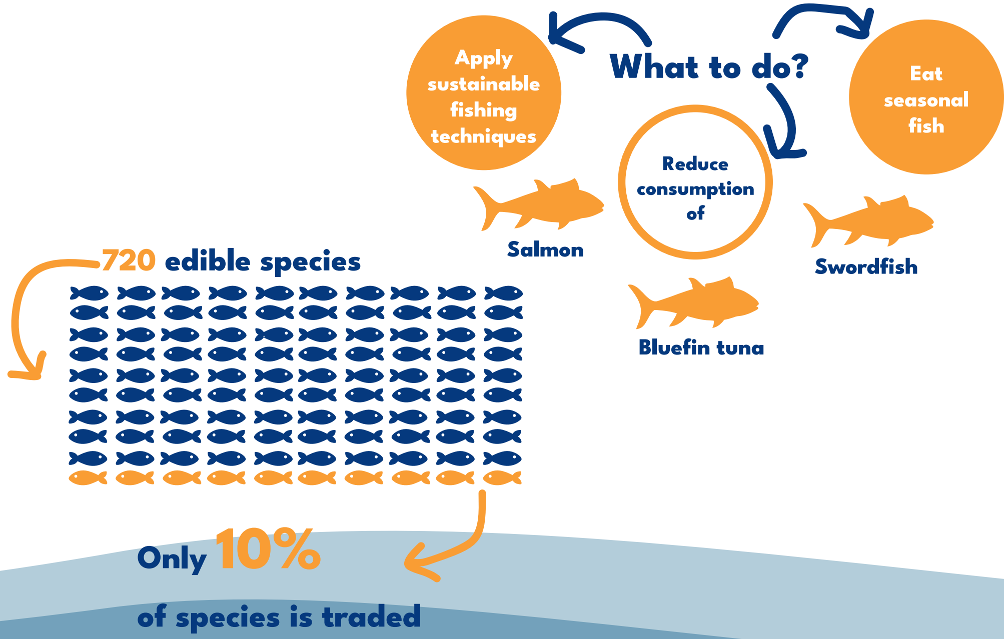
About 38.5 million tons of non-tradable fish are caught each year and often thrown back into the sea

260 million people are directly or indirectly employed in the fishing activity

4.7 million fishing vessels are active worldwide

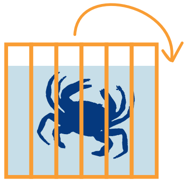
The Mediterranean Sea is currently facing a situation of instability due to ongoing political conflicts that exacerbate the problem of migration across the sea. At the same time, bridging the gap in the rate of development of the various sub-regions of the Mediterranean Sea remains a top priority. In particular, Fishery plays an important role in this strategy, as it is crucial for sustenance, food security and long-term sustainable development of the Mediterranean area.

Fishing in the Mediterranean Sea has a crucial cultural, social and economic importance, as it provides an important source of income and supports the traditions and lifestyle of many coastal communities. However, fishing in the Mediterranean Sea is facing important challenges: around 90% of the exploited stocks are outside safe biological limits and captures begin to decrease. In September 2015, during the United Nations Summit on Sustainable Development in New York, world leaders presented a series of 17 sustainable development goals to end poverty, fight inequality, injustice and tackle the problem of climate change by 2030. Goal 14, entitled "Conserve and sustainably use the oceans, seas and marine resources", is of particular relevance for the management of fishing activities in the Mediterranean Sea and sets ambitious objectives that promote the health of marine ecosystems.



Marine alien species

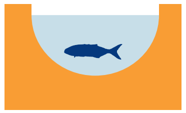
Alien species include all those organisms, deliberately or unintentionally, introduced by man into a region different from that of their natural distribution. Alien species are considered one of the main causes of reduction of biodiversity due to the alteration of prey-predator balances, to the competition on resources and the spread of pathogens. In some cases, these effects can have health and economic repercussions on the various productive sectors.



Aquaculture

Species traded for aquariums

How do they reach the Mediterranean Sea?



Construction of channels

Navigation

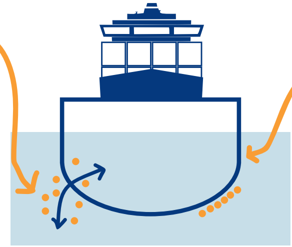
Live shellfish trade

50%

of alien species travel on ships

Where do they find a lift?

In ballast water which is loaded on the ship in the port of departure and unloaded in the port of arrival in order to stabilize the ship during navigation or during loading and unloading operations



Attached to the hull as "bio-fouling" Every object immersed in the sea, and therefore also the hull of a ship, is covered by a heterogeneous series of marine organisms that choose that uninhabited surface, as the definitive site of their existence

How many potentially alien organisms can travel on a ship?

Let us figure a modern cargo ship

CMA CGM Jules Verne
Length: 396 meters
Ballast water volume: about 45,000 m^3
Surface of the hull available for "bio-fouling": 20,300 m^2

Transported marine organisms
1,129 organisms/m^2 on the hull
from 3,000 to 50,000 individuals/m^3 in ballast water

Attached to the hull	In ballast water	
20.300 X 1.129 =	45.000 X 3.000 =	45.000 X 50.000 =
22.918.700	**135.000.000**	**2.250.000.000**

Total * potentially traveling organisms on megacargo

from 157.918.700 to 2.272.918.700

* Worst scenario:
hull without effective antifouling protection
absence of a ballast water treatment plant

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Marine pollution

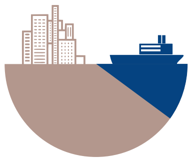
Human activities and the growing demand for resources is putting enormous pressure on the marine ecosystem.

From plastic bags to pesticides and to petrochemicals, most of the waste produced by humans ends up, one way or another, at sea.

Ocean pollution is due to both land and marine activities

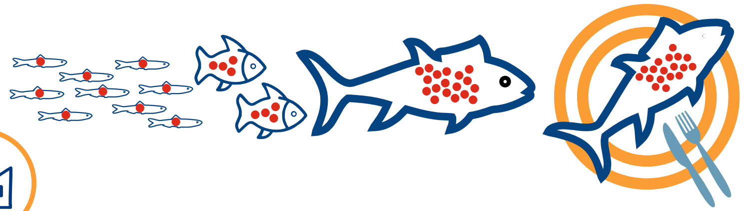
80%

of sea pollution comes from the mainland



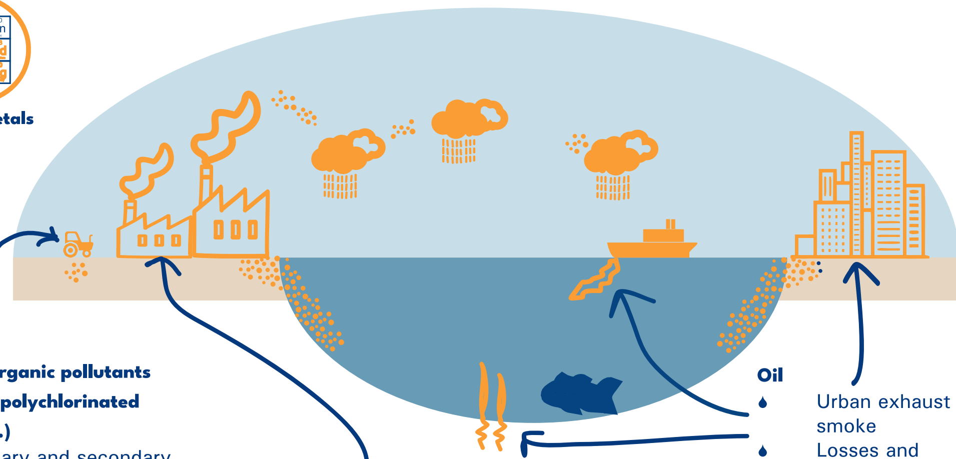
20%

of sea pollution comes from sea activities such as fishing, aquaculture, maritime transport, oil extraction etc.



Bio-accumulation
Some pollutants can enter the marine food chain and accumulate in the body of larger predators

Industry and transport emissions in the atmosphere are another significant source of pollution from human activities. Once emitted, many chemical compounds (copper, nickel, mercury, cadmium, lead, zinc and synthetic organic compounds) remain in the air for weeks, if not longer. Transported by the winds, they fall into the oceans. All these pollutants and waste are then redistributed on the Earth surface by seas currents.



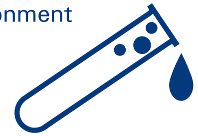
Persistent organic pollutants (pesticides, polychlorinated biphenyls ...)
- Primary and secondary industrial activities
- Agricultural activities

Heavy metals
- Industrial and extractive activities
- Landfills

Oil
- Urban exhaust smoke
- Losses and discharges from ships and extraction platforms
- Spills from the subsoil

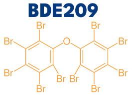
Chemical pollution caused by man is one the main sources of stress affecting the marine environment

Heavy metals
Cr Cu Cd

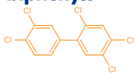


Methylmercury
H_3C-Hg^+

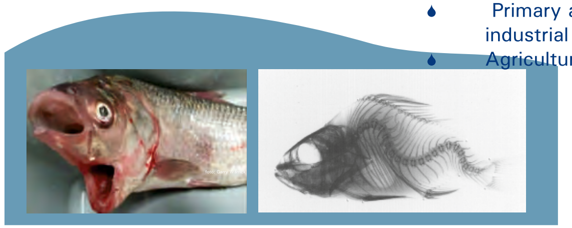
BDE209



Polychlorinated biphenyls



Polycyclic aromatic hydrocarbons



Some pollutants can interact at the cellular level, causing metabolic and genetic alterations.

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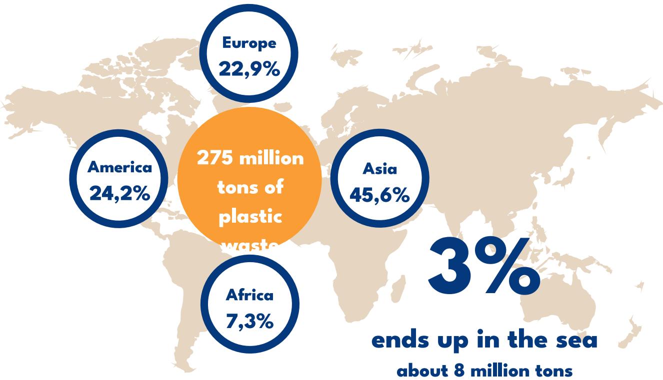
A plastic ocean

The world production of plastic has exponentially grown since the 1950s. Unfortunately, most of this plastic quickly becomes waste which, if not properly managed, is dispersed in the environment. Around 8 million tons of plastic end up in seas all over the world, where they can remain even for a few hundred years before they completely degrade.

How much plastic ends up in the sea every year?



Degradation time of marine waste

Plastic is not pollutant as such, it becomes so when it is abandoned

- **Paper towel** 2-4 weeks
- **Apple core** 2 months
- **Daily newspaper** 6 weeks
- **Cigarette butt** 1-5 years
- **Plastic bag** 10-20 years
- **Floating buoy** 50 years
- **Aluminium can** 200 years
- **Plastic bottle** 450 years
- **Fishing line** 600 years
- **Glass bottle** indefinite

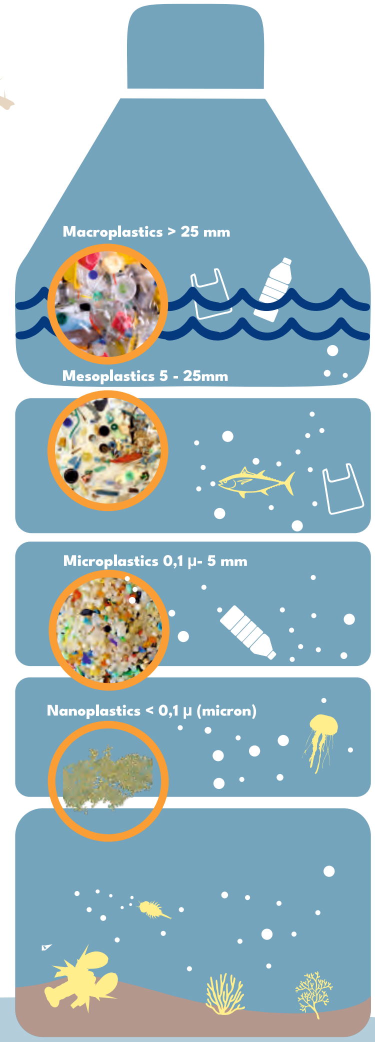
REUSE
REDUCE
RECYCLE

Plastic becomes part of marine litter due to the inaccurate management of waste and the incorrect application of the three «Rs» Reuse, Recycle, Reduce

Macroplastic at sea undergoes physical, chemical and biological degradation processes

- **UV radiation**
- **Interaction with toxic substances**
- **Salinity**
- **Microbial degradation**
- **Temperature**
- **Physical stress**
- **Dispersion**
- **Wave action**

Macro-Micro-Nano plastics



Large marine organisms can be damaged by macroplastics and mesoplastics, if taken for food, because they can be entrapped or suffocated

Plastics, fragmented into microplastics, can be ingested by organisms and enter the marine trophic chain. Microplastics can also interact with existing chemicals at sea and transfer them to the trophic chain

The real ecotoxicological effect of nanoplastics on the trophic chain is still very uncertain, because of their very small size

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The big Vortex

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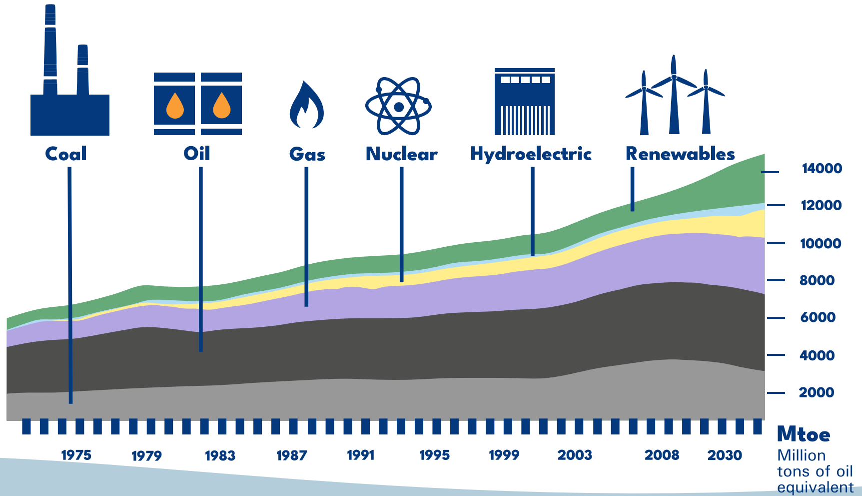
Energy from the sea

The growth of the world population urgently requires to face some crucial social challenges ranging from the growing demand of energy to the scarcity of food and water.

The use of renewable sources taken from the sea is a promising solution for the availability of large spaces, for the variety of marine resources and for the low visual

Energy consumption in the world



The term energy from the sea refers to some particular technologies, sometimes very different from one another, that exploit the energy potential of the oceans.
Many of these technologies are still under study, but their potential development is very encouraging.

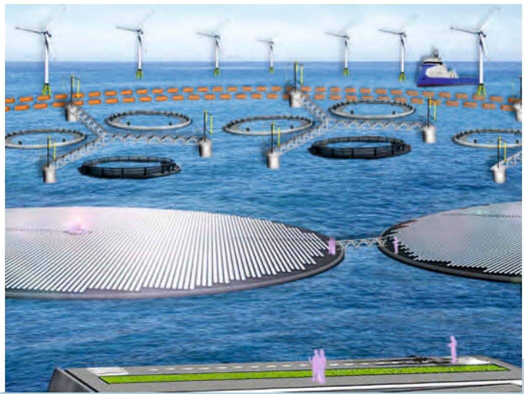
Energy from tides
High tide water is captured in a basin where a dam releases it at low tide and powers turbines coupled with electric generators

Energy from waves
Energy is produced by variously shaped floating devices that turn the movement of waves into the motion of a rotor

Energy from temperature gradients (thalassothermic energy)
The different temperature between the sea surface and ocean depths is used for the production of electricity through a steam cycle (Ocean Thermal Energy Conversion)

Energy from saline gradients (osmotic power)
It exploits osmotic power deriving from the difference in salinity between the oceans and fresh water at the outlets of rivers

Energy from currents
Current moves turbine blades in the sea, in the same way as it happens with wind turbines



The future in a floating Smart City

The Energy Archipelago is an example of a floating smart city, autonomous as far as energy is concerned and able to use the energy produced by renewable marine sources for the production of liquid fuels (methanol and hydrogen), as well as for the expensive desalination processes of sea water and for aquaculture activities.

The archipelago consists of an external array of energy converters from waves, with the dual functionality of:

- extracting energy from waves;
- acting as a dam, favoring a reduction of the wave field in the internal area.

Floating modules ("islands") can be built internally, each with specific functions: from energy production with solar panels, to aquaculture and other productive and recreational activities.
Externally, in sea areas with high wind potential, a floating wind farm will guarantee an important energy supply for the activities inside the archipelago.
The flexibility of the Energy Archipelago allows targeted planning for the exploitation of the energy resources on site, to be integrated with the productive and economic needs of the local communities and to cause the least possible impact on the marine ecosystem.

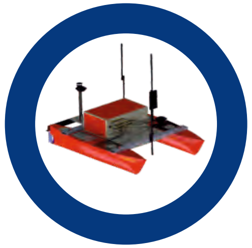
Marine robotics

The oceans hold enormous resources of food and raw materials, but they are still largely unexplored due to the difficulties men face in operating in such an arduous environment.

Marine robotics can help men overcome the difficulties of oceans exploration, making it possible to acquire more information, exploit and protect their enormous resources.

Types of marine robots

ASV - Autonomous Surface Vehicle autonomous boats, work on the surface, for example for port and coast profile survey



Charlie ASV

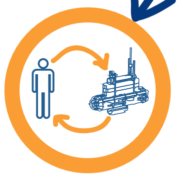
AUV - Autonomous Underwater Vehicle works in the water column, for example for large-scale sampling of bio-chemical-physical water parameters, for bottom profile survey

ROV - Remotely Operated Vehicle wire-guided underwater vehicles, work near natural and/or anthropic structures, allowing physical interaction with them, such as “offshore” installations, underwater pipelines, sample collection

e-URoPe

Robot

A robot can support the diver in his activities and monitor his health conditions



It replaces man in the performance of repetitive tasks such as sampling along predefined paths on the surface or in depth

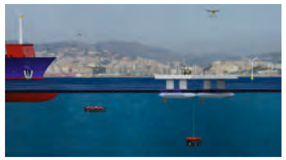
It works as an extension of man being able to intervene, remotely controlled, in inaccessible places like the seabed, under the pack, under the walls of glaciers, in minefields

Il The future of marine robotics

Modular, transformable and portable robots

POP ART

Extended ship with underwater and surface robots



ARES

Autonomous ship

The autonomous ship Yara Birkeland

The robot e-URoPe (electronic - Underwater Robotic Pet)
Cnr - Institute of Marine Engineering

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Marine research in Italy

We regard the ocean as an unlimited vastness and, erroneously, we think that its resources and resilience to human pressure are equally limitless. It is not so. We need to rethink our economy considering that the ocean, with its ecosystems and its circulation, must also be preserved and protected. For two centuries our society has regarded "economic growth" as linear and unlimited. Since this perspective proved to be illusory and unsustainable, we must now become aware of how the oceans have helped us so far in a silent and irreplaceable way. The acidification of ocean waters has kept the dramatic increase of CO_2 in the atmosphere just over 400 ppm instead of over 600 ppm (in the absence of the ocean); global warming would be more drastic if the ocean did not absorb a great amount of heat, leading however to an inevitable increase in the volume of its waters and therefore in the sea level.

We perceive it only when our economy has to fight coastal erosion or the drowning of entire oceanic islands. Finally, the ocean has become a huge "garbage bin" where we throw dissolved chemicals and, over the last 50 years, lots of plastic (on which, luckily, the attention of society is increasing).

We cannot save the ocean ecosystem by maintaining our idea of economic growth unaltered and preserving only some "beautiful" areas to be exploited in a framework of mass industrialized tourism. We must study the ocean, its creatures and its depths but at the same time we must change our economic system by moving to a circular economy that overcomes the production of waste and the "use and throw-away" approach that our Planet can no longer sustain even with the patient aid of the oceans.

In Italy, the marine research system is represented by nine Organisations and Institutes, supervised by three Ministries and by a vast network of Universities supervised by the Ministry of Education, University and Research. Over 2000 researchers and technicians, involved in the various disciplines that characterize marine and maritime research, coordinate and participate in international, European and national projects, dedicated to the study of the main processes that characterize and drive the evolution of the marine and coastal environment and to the development of new technologies for a sustainable and modern use of its resources. An impressive effort that actively supports the development of innovation in the private sector and the "blue economy of the country" and contributes to the correct management and protection policy of the marine ecosystem and to the implementation of the integrated maritime policy.
Research Infrastructures are fundamental for the local research and development activities, together with the widespread network of Institutes and Centres of excellence throughout the national territory. They represent the technological platforms and environment interconnected at European level to enhance growth, knowledge transfer and training in the leading sectors of marine and maritime science.

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The President of the Italian Republic Sergio Mattarella
Opening Rome, Cnr Headquarters 21 november 2018

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Consiglio Nazionale
delle **Ricerche**

The project group with the General Director of Cnr
Opening Rome, Cnr Headquarters 21 november 2018

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