

# Navigating the Future V European marine research towards the Ocean Decade

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# Navigating the Future V

Kick off meeting – Brussels; 8-9 November 2017



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**Denis Lacroix**, Ifremer, France;

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**Jan Mees**, FWO, Belgium;  
**Luis Menezes Pinheiro**, University Aveiro, Portugal;  
**David Paterson**, MASTS, United Kingdom;  
**Catherina Philippart**, NIOZ, the Netherlands;  
**Ralph Schneider**, KDM, Germany;  
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**Sybille van den Hove**, Bridging 4 Sustain., Belgium;  
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# Navigating the Future V



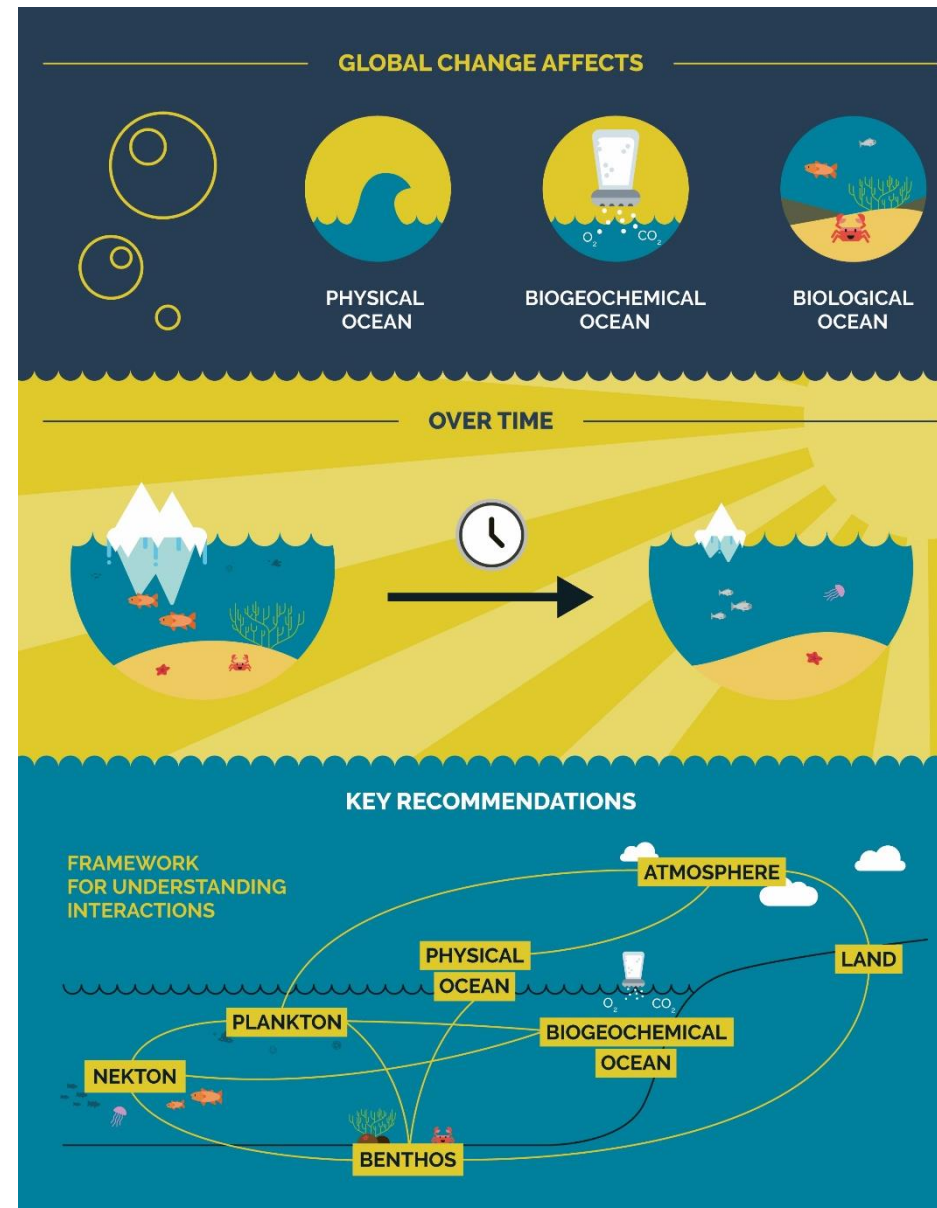
## Key scientific questions:

- **4-Dimensional Ocean** (3D plus time);
- **Impacts of multiple** and cumulative human **stressors**;
- How to predict **extreme events**, natural hazards & climate;
- Advances in **ocean technologies**, modelling & Artificial Intelligence; and
- Foster **sustainability science**.

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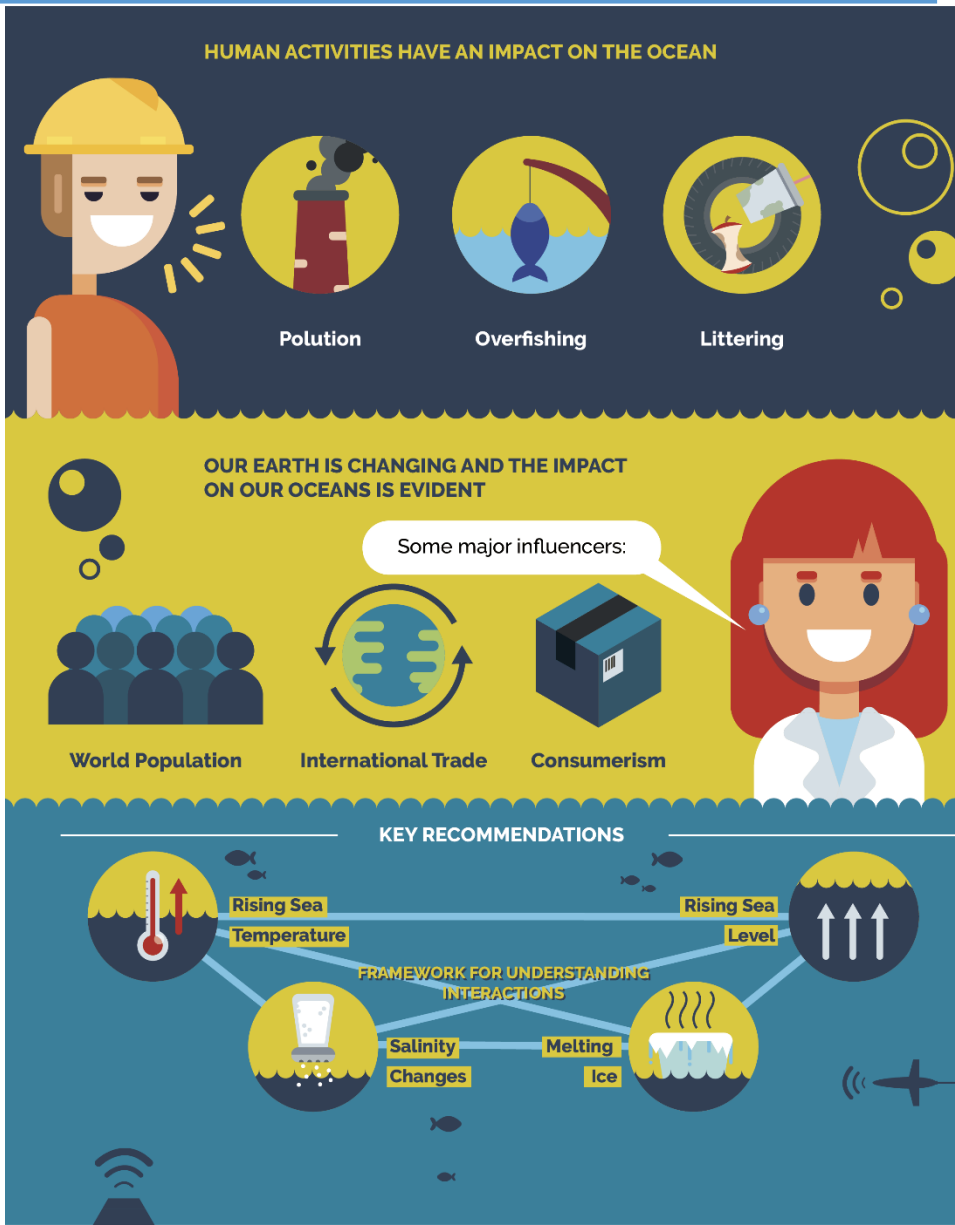
# 4-Dimensional Ocean

- 3D ocean changes over time – 4D;
- Changes physics -> biogeochemistry -> biology -> impacts biodiversity and ecosystem function (BEF)
- Role in the earth and climate system;
- **Priorities:**
- Identify **functional links** in ecosystems;
- Provide **spatial frame** for biodiversity and ecosystem function (BEF);
- **Enhance observing** systems for BEF; and
- Have a **holistic approach**.



# Multiple, cumulative stressors

- By 2050 human population ~ 9 billion;
- Increase need for food, CO<sub>2</sub> and sea level;
- Decrease in pH and ocean O<sub>2</sub>;
- Non-linear impacts, non-additive responses.
- **Priorities:**
- **Identify** local, regional, global **drivers** and **consequences** of current practices on these;
- **Global drivers vs. local studies** – questions need to be framed to provide evidence at the appropriate scale;
- **Conflicting policy drivers** – need science to assess, prioritize and identify plausible actions;
- **Trans-disciplinarity** needed with common management principles; and
- More **strategic integrated approach** including social and economic sciences.



# Science of surprises



- Understanding, forecasting **extreme events**:
- Floods, storms, heat waves, geohazards and tsunamis

## Priorities:

- What **observation strategy** is needed?
- What are the **drivers** of these events and how do they interact?
- Need **improved** physical, biogeochemical and ecological **models** to predict;
- **Unravelling causality** and understanding **tipping points**.



# Novel technologies, modelling, AI

Ecosystem parameters needed to provide advice on cumulative impacts, ecosystem structure and function and sustainability;

## Priorities:

- **Autonomous observation platforms** need to be developed;
- **All data openly available** to everyone in **real time**;
- Open standards and **layers of applications** to exploit raw data;
- **Forecast models** of the full ecosystem;
- Communication tools, and **Ocean Internet Of Things (OIOT)**;
- **Business models** - to make observations sustainable; and
- **Digital ocean twin – virtual reality** showing the impact of human interactions as it happens.

## NOVEL TECHNOLOGIES



NEW SENSORS



ARTIFICIAL INTELLIGENCE



DRONES

## FUTURE TRENDS



### REAL TIME DATA

All data to be openly available to everyone in real time.



MOBILE



COMPUTER

## KEY RECOMMENDATIONS

### OCEAN INTERNET OF THINGS



### TOWARDS A DIGITAL OCEAN

In the future virtual reality software for diving into the sea would allow humans to explore the ocean.

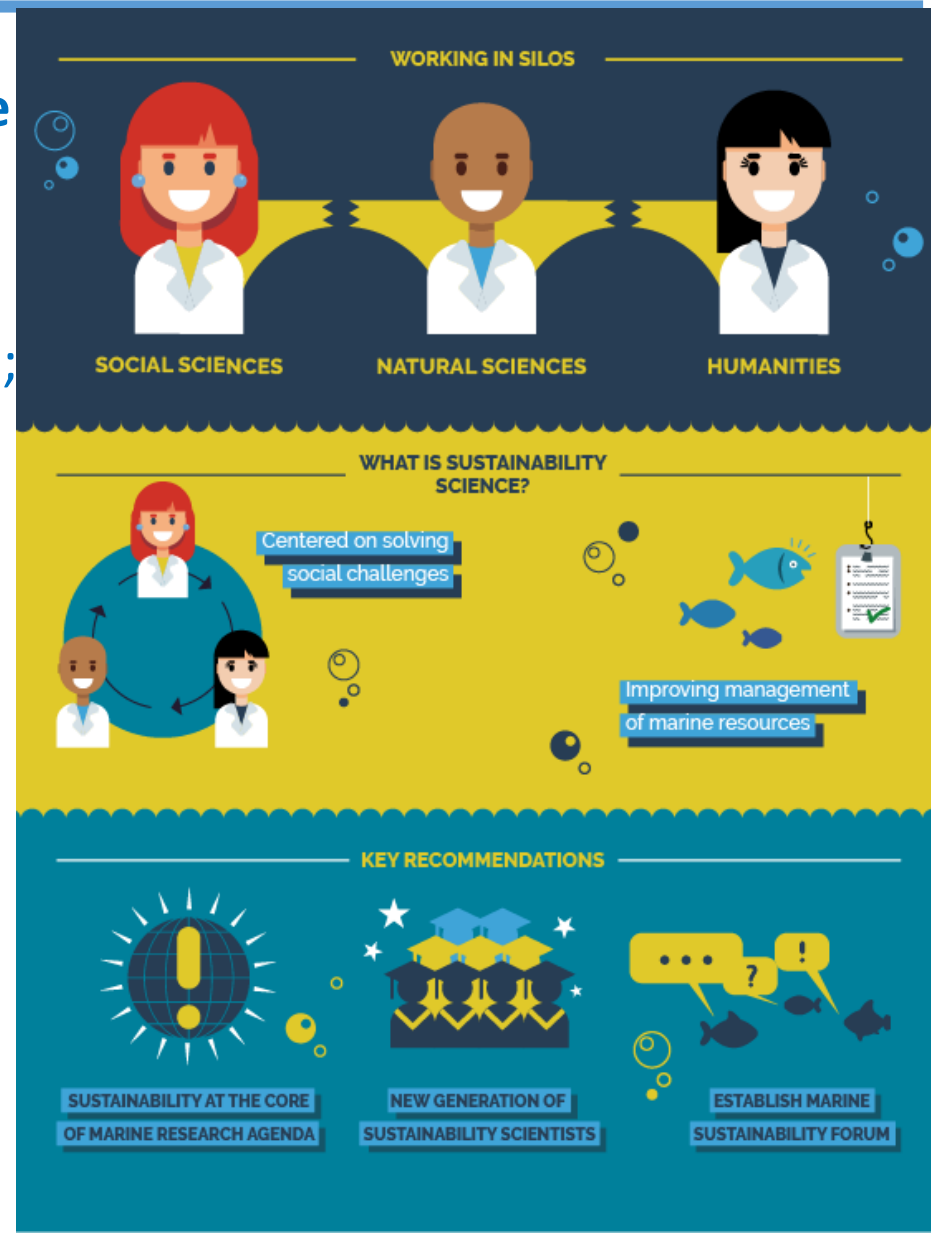


# Sustainability science

- Need to **re-orientate scientific practice** to meet the SDGs;
- Sustainability science - **interface** of natural, social sciences and humanities;

## Priorities:

- Put **governance** of sustainability at the core of marine research agenda;
- Adopt **core principles** of sustainability science;
- Develop a **new generation** of sustainability scientists; and
- Establish a **marine sustainability science forum**, including industry and civil society partners.





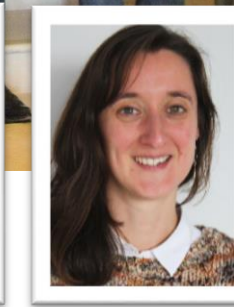
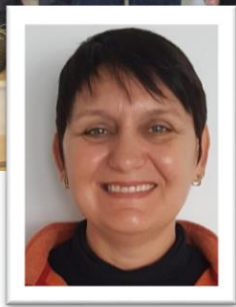
# Recommendations:



- Integrate the **4D structure & function** of marine ecosystems **into management practices**;
- Establish an **early-response system** to gain a better understanding of the short- and long-term impacts of events;
- Develop a **business model** for the long-term sustainability of ocean observations **co-designed with stakeholders**. Including biological observations, geological events, adaptive sampling and access to data in real-time;
- Create an **ensemble of validated** quantitative physical, biogeochemical, biological, bio-economic and socioecological **models** to **quantify uncertainties** and give **early-warning** indicators for multiple stressors or approaching tipping points;
- Develop the **OIOT** : new technologies; real time observation transfer to satellites/other communication networks;
- Develop a **virtual reality ocean platform** where all information is uploaded and visible to the public in real time;
- Promote **dialogue across disciplines**. Train **holistic scientists and sustainability scientists**;
- Enhance **marine citizen science** to understand the ocean as a common good whose health is crucial for humanity; and
- Set up a **sustainability science forum**, including industry and civil society partners.



# Thank you

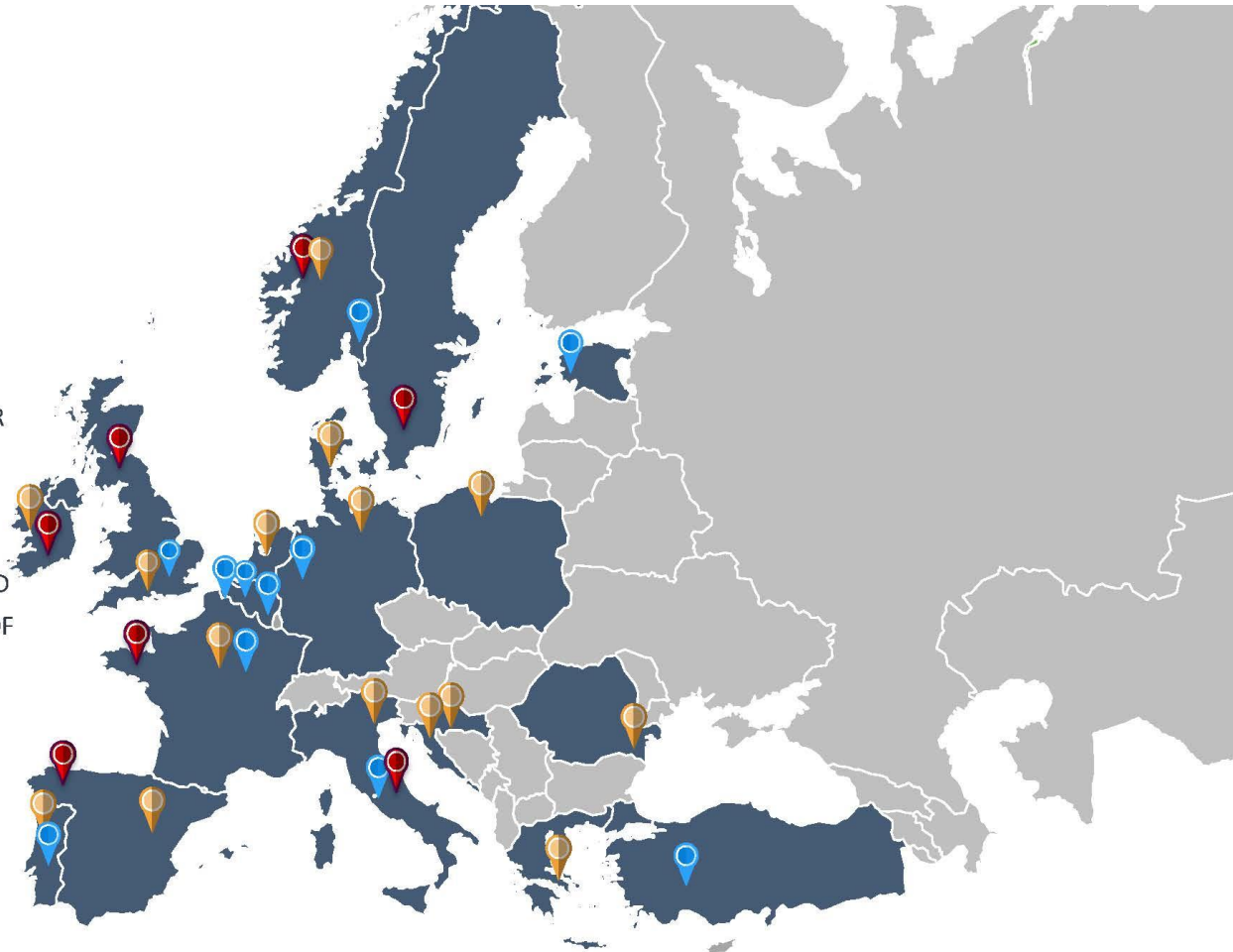


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# Who we are?



A UNIQUE EUROPEAN  
PARTNERSHIP OF MAJOR  
MARINE AND  
OCEANOGRAPHIC  
INSTITUTES, RESEARCH  
FUNDING AGENCIES AND  
NATIONAL NETWORKS OF  
UNIVERSITIES



RESEARCH PERFORMING  
INSTITUTES



RESEARCH FUNDING  
ORGANIZATIONS



NETWORKS AND  
UNIVERSITY CONSORTIA

**33** MEMBERS FROM

**18** COUNTRIES



# Research needs:



- The **influence of climate change** on the physico-chemical characteristics of the ocean including the interaction between the ocean and ice sheet melting and future long-term sea-level rise;
- The **4D ocean** (spatial and temporal framework) and **functional links** between the components of the marine system, i.e. physics, chemistry, biology, ecology and humans;
- The **impact, interactions and evolution** of single and **cumulative stressors** (e.g. climate change, pollution, over-fishing) on ecosystem **function, adaptation** over time, and ecosystem **services**;
- The **characteristics, probability and impacts** of climate-related **extreme events and geohazards** (e.g. marine heat waves, meteotsunamis and submarine earthquakes, landslides, volcanic eruptions and their associated tsunamis) and their **evolution under climate change**; and
- Ocean **technologies, modelling, data and artificial intelligence** for sustainable ocean observations.

