OCEANS

This summary has gathered the most relevant paragraphs about oceans from the EU document *"Orientations towards the first Strategic Plan implementing the research and innovation framework programme Horizon Europe".* Oceans is a topic that is mainly discussed in Cluster 6. Besides, relevant specific missions and Partnership Candidates from Annex 7 are included at the very end of this document.

1. Global Challenges and Their Drivers

Human activities – driven by rapidly growing global population, unsustainable economic growth, production practices and consumption patterns – are creating mounting pressures on ecosystems (on land and sea) and on natural resources such as soils, water, air and biodiversity. Since 1970, the global demand for natural resources has more than tripled and is now exceeding "planetary boundaries". Without radical changes in the current, linear modes of production and consumption, the demand for natural resources is projected to double between 2015 and 2050.

The continuous, accelerating decline in biodiversity is of particular concern as biodiversity provides the fabric of life with a range of ecosystems services which are crucial for human well-being. Main direct drivers of biodiversity loss, in order of their importance, are land use change, overexploitation (through intensive agriculture, forestry and fishing practices), climate change, pollution and invasive species. Underlying causes are production and consumption patterns, human population dynamics, trade, technological innovations, harmful economic incentives and governance. Currently, 27% of assessed species in the EU, in particular pollinators, and 66% of habitat types are threatened. Worldwide, about 1 million animal and plant species are now threatened with extinction, more than ever before in human history. The situation may become worse under the business as usual scenario. At the same time, transformative changes could bend the curve of biodiversity loss, but they are currently not happening quick, up-scaled or integrated enough.

Natural resources, including biodiversity, are further degraded in terms of quantity and quality as a result of the impacts of climate change. If current trends continue, global average temperature increase could reach 2°C soon after 2060 and continue to rise afterwards, leading to major adverse impacts on primary production systems, natural systems and societies in rural, coastal and urban areas. On the other hand, effective management of land and natural resources whilst safeguarding biodiversity can enhance climate change mitigation and adaptation. Agriculture and forestry have a particular role to play in this respect as these sectors manage 80% of the land in the EU.

Oceans, seas, lakes and rivers are the lungs and farms of our planet; they produce half of the oxygen we breathe and 16 % of the animal protein we eat. Yet, the health and productivity of our oceans, seas, lakes and rivers is severely endangered by climate change, ocean acidification, deoxygenation, excess nutrients, chemical pollutants and plastics and microplastics.

All in all, the global ecological footprint of human activities has increased from requiring less than one planet Earth in 1961 to more than 1.7 planet Earths today, and is expected to require two planet Earths around 2030. Already now we are reaching or even crossing "planetary boundaries" of Earth system in a number of areas related to nutrient flows (notably nitrogen pollution and depletion of phosphorus) and biosphere integrity. Accordingly, concerns over environment-related risks for the economy are mounting.

These concerns are particularly justified for the EU economy, which is largely dependent on fossil resources and many raw materials sourced from international markets. This when, as matter of fact, the mass-scale use of fossil resources has significantly contributed to anthropogenic climate change. Industrial operations represent about 20 % of the EU's total GHG emissions, of which about half originates from the use of fossil resources as raw material and from industrial processes. The use of biomass and waste for the production of renewable products (e.g., chemicals, materials) and nutrients has the potential to strongly contribute to breaking-down the dependence on non-renewable and mineral resources and act as an enabler of the overall bioeconomy.

Environmental degradation in conjunction with unsustainable production and consumption patterns pose also serious risks to human health and well-being. Pollution, responsible for 16% of all deaths worldwide, is the largest environmental cause of diseases and premature deaths today. More than 70% of the diseases caused by pollution are non-communicable diseases (NCDs).

Diets inextricably link human health and environmental sustainability. The prevalent unsustainable and unhealthy diets contribute to the global environmental change, and at the same time are the leading risk factor of NCDs and driver of obesity rates. Despite efforts, no EU country has reduced obesity rates in the last several decades, and at present more than half of the EU's adult population is overweight or obese. The transformation to healthy and sustainable diets requires substantial dietary shift from the consumers and a change in the food production. There is a need to make food systems more responsive to the needs and interests of communities, and to empower people with a stronger influence in local food environments.

Moreover, in an ever-changing environment, keeping plants and animals healthy as well as food supply safe are ongoing challenges. Globally, every year pests and diseases cause around 20-40% of crop and animal production losses. Although the food supply in the EU was never so safe as today, the WHO estimates that food-borne bacteria, parasites, toxins and allergens cause about 23 million cases of illnesses and 5 000 deaths in Europe every yearand the European citizen is not fully confident or trusting the food supply systems. Continuous improvement of risk assessment and risk management methods is necessary to make sure that food stays safe at every stage of the food supply systems.

While addressing all these challenges comes at a price, the costs of inaction and related societal implications would be much higher. If left unaddressed, climate change and the degradation of natural capital risk to undermine public health and many economic sectors, which depend on the health of natural systems and resources. In this context, agriculture, forestry, aquaculture and fisheries, food industry, bio-based and other related sectors will be particularly affected, thereby jeopardizing food and nutrition security, millions of jobs, economic growth, and overall well-being of people, in the EU and globally.

The concepts of the circular economy, the bioeconomy, the blue economy and the Food 2030 initiative provide an opportunity to balance environmental, social, and economic goals and set human activities on a path to sustainability. In addition to new knowledge, technological, innovation, organisational solutions and industrial transformation, implementation of these concepts requires profound changes in people's choices, lifestyles and behaviours as well as appropriate governance models from the local to the global. A transition to sustainable economic growth and competitiveness can only be successful if it goes hand in hand with increased prosperity and is inclusive. This implies a fair distribution of costs,

benefits and risks along the value chains and balanced development of rural, costal and urban territories in the Member States, across the EU and globally.

2. EU Policy Objectives

The EU has the ambition to lead the transition to a sustainable, climate-neutral, circular and environment-friendly economy in full compliance with the United Nations 2030 Agenda, the Paris Climate Agreement and the Convention on Biological Diversity, as reiterated in recent communications, notably "Clean Planet for All" and "Towards a Sustainable Europe by 2030".

Many EU policies and strategies have been developed or reformed to foster the transition to an environmentally, economically and socially balanced future. This includes in particular: EU environmental legislation and policies targeting biodiversity, water, soil and air, the Common Agricultural Policy, the Common Fisheries Policy, the Maritime Policy, EU Arctic Policy, the EU General Food Law, the Circular Economy Package, the Circular Plastics Strategy, the EU Bioeconomy Strategy, the Blue Growth Strategy, the Food 2030 initiative, the new Industrial Strategy Policy and the 2030 Climate and Energy Framework.

Research and innovation (R&I) is crucial to better understand the underlying drivers of the sustainability challenges as well as to devise options and a range of solutions to address them. It needs to be matched with investment in technologies, new business and governance models as well as social and environmental innovation to overcome lock-ins and set humanity on more sustainable pathways. Accordingly, R&I can play a key role in achieving objectives set in relevant EU policies and global commitments. These include: meeting the goals of sustainable development, mitigating and adapting to climate change, guaranteeing the production and consumption of safe and healthy food and bio-based products, promoting sustainable practices in agriculture, aquaculture, fisheries and forestry, ensuring access to clean water, soil and air for all, achieving the good environmental status of the seas and oceans, preserving and restoring the planet's vital natural ecosystems and environment.

This is expected to foster an innovative, responsible and competitive European economy generating sustainable jobs and growth.

3. Targeted impacts

R&I in the Cluster 6 aims to advance knowledge, build capacities as well as develop and demonstrate innovative solutions that will accelerate the transition to: a sustainable and circular management and use of natural resources ensuring ecosystem integrity as well as sustainable development and human well-being, including food and nutrition security, in the EU and globally. This will involve user-driven exploitation of environmental big data sources (in particular from Copernicus and Galileo). R&I activities under this Cluster shall create the following interlinked, long-term impacts:

- Reduction of greenhouse gas emissions and successful adaptation of ecosystems and production systems as well as rural, coastal and urban areas to climate change

The climate mitigation and adaptation potential of terrestrial, seas, oceans and inland waters ecosystems as well as primary production, food and bio-based systems will be seized. In particular, GHG neutral and climate-proof production and consumption will be enabled. Negative GHG emissions through sink and storage functions provided by ecosystems and sustainable bio-based resources, materials and products will be actively enhanced. As a result of actions under this Cluster in cooperation with Cluster 4 and 5, European climate targets will be achieved, notably a cut of at least 40% in greenhouse gas emissions (from 1990 levels). In the longer term this will enhance economic, environmental and social resilience.

- Halt of biodiversity decline and restoration of ecosystems

Biodiversity and ecosystem services in natural systems and in primary production will be better understood, monitored, valued and managed. As a result, the decline of biodiversity, including of pollinators, will be reversed and ecosystem integrity and resilience in land and aquatic environments enhanced.

- Sustainable and circular management and use of natural resources; prevention and removal of pollution; healthy soils and clean water and air for all; attractive jobs, enhanced value creation and competitiveness

The physical and biological planetary boundaries in relation to the use and management of biodiversity and natural resources on land and sea will be better understood and defined. This will provide the basis for a more circular use of resources and the mainstreaming of circular systems. As a result, resource efficiency will be increased and pollution will be reduced all along value chains, from production to consumption and disposal. The resource-efficient management and sustainable use of biological resources will result also in increased added-value along the whole value chains and their competitiveness as well as more attractive jobs in rural, coastal, peri-urban and urban areas. Sustainable management of water resources will help to better cope with the impacts of floods and droughts and reduce the high economic costs related to water pollution control and removal.

- Establishment of primary production, food and bio-based systems based on sustainability, inclusiveness, health and safety; food and nutrition security for all

Sustainable, low emission, resilient, competitive and equitable primary production and food systems will become the norm. The potential of aquatic production systems and aquaculture to produce sustainably high quality food and biomass will be unlocked. Imbalances in our food value chains will be corrected, from agriculture and fishing, to the food and drink industry, transportation, distribution, and consumption. Safe use of bio-resources from land and sea will be ensured. Sustainable, safe and healthy diets will be available and accessible for all and a major shift to healthy diets from sustainable food production systems will be achieved.

- Behavioural, socio-economic and demographic change are well understood and drive sustainability; a balanced development of vibrant rural, coastal, peri-urban and urban areas
- Establishment of governance models enabling sustainability

Policy design, implementation and monitoring will be supported by strong evidence-based knowledge and tools. Innovation systems will be in place and encourage multi-actor, participatory, risk-aware, place-based innovations which in turn will accelerate the development and adoption of sustainable practices. Solid and reliable information from Environmental Observations will allow better understanding of impacts of global changes and enable sound decision making by public authorities. The EU's and international science-policy interfaces will be strengthened to achieve a global impact on the transition to sustainability.

4. Key R&I Orientations

The present section describes the most important short to medium-term impacts that are expected from R&I orientations under each area of intervention. The short and medium-term impacts of R&I orientations will be key for achieving the long-term impacts outlined in the previous section. As the challenges and impacts under this Cluster are highly interconnected, systems-based approaches will be

encouraged. This implies encouragement of multi-actor involvement as well as interdisciplinary or even transdisciplinary approaches in the R&I orientations.

4.1 Environmental Observation

This R&I orientation will support the Commission and the European Union with Environmental Observation-based information and data in the domains of the global science challenges.

The disruptive technologies emerging in the digital economy offer many opportunities in the field of Environmental Observation to deliver information for EU strategy and policies in bio-economy, food, agriculture, natural resources, and the environment.

The main challenge in this area of intervention is to deliver more reliable and standardised information, building on the FAIR (findability, accessibility, interoperability, and reuse) principle, to better understand the impact of global changes and to feed into sound decision making on the big challenges our society faces (links with all the Clusters and AI's in Cluster 6).

The objectives will be reached through facilitating the sharing and integration of environmental data and information collected from the large array of observing systems contributed by countries and organisations within the Group on Earth Observations (GEO). This includes space-based (Copernicus and other space missions), airborne, in-situ and citizens' observations, e.g. through EU platforms such as the European Open Science Cloud (EOSC), the Copernicus DIAS and the European Marine Observation and Data Network (EMODnet) (links with Cluster 4 (Space) and AI4). The approach will also include developing algorithms, using big data and AI (machine learning) to detect and analyse Earth System-relevant information (e.g. in the biosphere), as well as by empowering citizens to contribute to environmental observation and achieve a broader citizens' engagement.

This R&I orientation of work will aim to fill in situ observational gaps and deliver effective solutions for the sustainable use and monitoring of food and natural resources through Environmental Observation, contributing to the Agenda 2030 on sustainable development.

Impacts on the short term consist of better facilitated access to existing ground environmental information through European and global repositories. Furthermore, these efforts will lead to improved time series and geographical coverage of ground environmental observations for e.g. the ocean, Polar regions, and urban and peri-urban areas. It will deliver strengthened partnerships connecting environmental observation with application development groups in the field of food and natural resources, to provide integration knowledge for decision making and resource management. It should lead to upgraded planetary observation systems integrating European systems and benefiting to European users (links with Cluster 4 (Space)). And this should end up in improved European Big Environmental Observation Data Processing/storage facilities connected to the European Open Science Cloud (EOSC).

This area will support Earth system science activities in relevant domains in the context of climate change and biodiversity, such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). This includes monitoring to support the implementation of EU nature, climate and agricultural legislation and the EU biodiversity strategy as well as contributions to the delivery of a more sustainable agriculture under the Common Agricultural Policy (CAP) (links with Cluster 5 and AI2, AI3 and AI5).

This area of intervention will support models and data assimilation for the development of indicators, scenarios, service capacity, and innovation. This will be done for many topical fields including biodiversity, species and ecosystem health, climate mitigation and adaptation (including GHG flux

monitoring), food security and food safety, agriculture and forestry, land use and land use change, marine and water conservation and use, urban and peri-urban development, renewable energy and natural resources management. It will furthermore support risk assessment and evidence-based policy for ensuring resilient, secure and safe environment-based systems, including farming. It will look into areas of ecosystem resilience, including tipping points, risk prone areas and disaster risk reduction (links with Cluster 3, Cluster 5 and AI2, AI3, AI4 and AI5).

This area of intervention is related to most of the missions and many of the proposed partnerships, in particular, but not exclusively to the partnership 'Agriculture of data' (Environmental Observation for a Sustainable EU Agriculture).

4.4 Seas, Oceans and Inland Waters

Seas, oceans and inland waters have a central role in climate processes and in the provision of food, biodiversity, critical ecosystem services, renewable energy and other resources. Oceans, seas and inland waters can deliver more food with lower carbon and freshwater footprints than land-based production, while boosting profitability in the sector. Crucially, the ocean economy needs to prepare for and adapt to alterations in the marine ecosystem – notably from climate change and ocean acidification – requiring integrated management frameworks leading towards win-win outcomes for the ocean economy and the ocean environment from Antarctica to the Arctic. Furthermore, the health of the ocean, its conservation and protection are a prerequisite to benefit from the ecosystem services.

Contributing to the above, science, technology and innovation are key to the development of a sustainable ocean economy, along with skills and education, ensuring that by 2030 the potential of oceans, seas and inland waters, their ecosystems and bioeconomies to drive a healthy planet is fully understood, unlocked and harnessed.

Designing and deploying an integrated approach (looking at the interlinkages of oceanclimate, ocean-food, ocean-land, ocean-society, renewable energy from marine sources, marine biodiversity, etc.) will lead to systemic solutions that by design respect the health of seas and oceans and planetary boundaries. Knowledge and innovative solutions will support evidence-based policy making and implementation through engagement and dissemination actions and assessment at EU and global level.

Climate change mitigation and adaptation will be enhanced through the improved scientific knowledge and innovations that will allow to better understand, forecast, monitor the ocean and its changes (including sea level), the climate-ocean interface and the impact of stressors and global changes on ecosystems and maritime sectors as well as on inland waters and related economic activities and human settlements. The development and demonstration of Greenhouse gas "neutral" and climate-proof production and exploitation innovations will contribute to climate neutrality and support the adaptation of fisheries, aquaculture and sustainable exploitation of ecosystem services and other resources in the context of climate change and other global changes (in cooperation with Clusters 3, 4 and 5).

Preservation and restoration of biodiversity and ecosystem services will benefit from increased understanding of marine biodiversity and other biological resources, marine ecosystems, planetary boundaries and ecosystem services at sea and in coastal areas (together with IA2), including fisheries for the sustainable use and management of natural resources at sea, environmental protection, coastal management, food security and food sovereignty. The development and demonstration of the use of ecosystem-based approaches and other systemic solutions will allow to protect and sustainably use and

manage marine biological resources and to enhance ecosystem integrity and resilience in marine and coastal environments.

Sustainable management of inland water, coastal and marine resources will be achieved through innovative solutions (including circular economy business models and social innovations – together with IA7) to reduce stressors and human induced pressures on freshwater and marine ecosystems and human, algal and animal health, facilitating the development and market uptake of sustainable circular bio-based processes and blue bioeconomy products.

Contributing to global food and nutrition security, will be realised through developed and demonstrated solutions to produce more, safe, healthier and better quality food, and by exploiting new food sources from the seas, oceans and inland waters, whilst conserving biodiversity, thus alleviating pressure on land and fresh water resources and boosting profitability in the sector. This will go hand in hand with sustainable and resilient aquatic food production systems that minimise the use of chemical inputs, nutrients and antimicrobials, and guarantee the transparency and traceability of aquatic food products (together with IA5).

Establishment of governance models enabling sustainability will benefit from the results of R&I, improving capacities and skills to reap the benefits of digital transformation and socioeconomic innovations for more resilient, prosperous, sustainable and dynamic inland water, coastal and maritime economies, also by developing management frameworks aligned to policy objectives and ensuring fit for purpose ocean observations (together with IA1), interconnected with relevant research infrastructures, to serve the needs of decision and policy making.

Prevention of pollution (chemical, physical, bacteriological, nutrients) and required behavioural and socio-economic changes will be addressed through R&I leading to solutions to limit pollution in inland, coastal and marine waters from maritime infrastructures and transport, energy infrastructures and tourism and by demonstrating adoption of circular economy products to prevent and mitigate littering and polluting. Special attention will be given to the river catchment areas and the quality of the cleaned waste-water entering coastal waters.

Cost-effective solutions for mitigation of morphological alterations of water bodies (e.g. barriers, dams, canalisation) and for restoration and management of heavily modified water bodies will help to preserve and restore biodiversity and ecosystems. Innovative solutions, improved analytical tools and monitoring methods to address the negative effects of past chemical stressors and new emerging pollutants (such as micro-pollutants, micro-plastics, pharmaceuticals) will also help improve the chemical status of freshwater and prevent further pollution, both in inland water bodies and coastal waters (in cooperation with IA7).

A planned overarching partnership “A climate neutral, sustainable and productive Blue Economy” will cut across several of the above impact areas and it will have a key role in achieving the desired impact on a sustainable Blue Economy, creative value added, blue growth and jobs in Europe through a jointly supported R&I programme in the European seas, coastal and inland waters.

Multi-lateral cooperation with international partners will be pursued to achieve the goals mentioned above, notably in the Atlantic, the Mediterranean,the Black Sea and the Arctics.

5. European Partnerships

In the area of Cluster 6 the landscape of Horizon 2020 partnerships is characterised by a high share of public – public partnerships. Among those partnerships, two are institutionalised ones (Bio-Based Industries and PRIMA). With a view to rationalise the landscape, the following eight areas for future

partnerships have been identified, The specific nature of some of the identified challenges make partnerships a useful means for implementation. This is notably the case if a structured cooperation with already existing broad stakeholder networks is required to create impact from a strategic research and innovation agenda; or if partnerships with a network of public R&I funding agencies can create synergies. The following areas for partnerships with centre of gravity in this Cluster are proposed:

- Towards more sustainable farming: agro-ecology living labs and research infrastructures
- European Partnership on Animals and Health
- Environmental Observations for a sustainable EU agriculture (Agriculture of data)
- Rescuing biodiversity to safeguard life on Earth
- A climate neutral, sustainable and productive Blue Economy
- Safe and Sustainable Food Systems for People, Planet & Climate
- European Partnership for a Circular bio-based Europe: sustainable innovation for new local value from waste and biomass
- Water4All: Water security for the planet

EIT Knowledge and Innovation Communities (KICs). In addition to the support to the abovementioned European Partnerships, the Cluster 6 will collaborate with relevant EIT Knowledge and Innovation Communities (KICs). Thanks to their societal challenge-driven approach and their portfolio of activities, ranging from entrepreneurial education and training, to innovation projects, business creation activities and support services for start-ups, scale-ups and SMEs, the EIT KICs, in particular, EIT Climate-KIC and EIT Food, are well equipped to develop synergies and complementarities with Cluster 6 activities. 'Water and maritime' has been proposed a potential theme for a future EIT-KIC and EIT might support in future the KIC in coordinated cross-KIC actions in challenges, like the circular economy, that are so far addresses at the margins of several KICs.

The Standing Committee on Agricultural Research (SCAR) is an established advisory committee for the coordination of research and innovation addressing large parts of this Cluster and has played a key role in identifying R&I orientations in this field for many years. The continued use of the SCAR advisory committee is key to achieving the targeted impacts of Cluster 6.

6. Missions

One of the main novelties of Horizon Europe is the introduction of missions; high-ambition, high-profile initiatives which will put forward concrete solutions to challenges facing European citizens and societies. Missions are currently in the process of being defined within five areas;

- adaptation to climate change including societal transformation
- cancer
- healthy oceans, seas, coastal and inland waters
- climate-neutral and smart cities
- soil health and food

Accomplishing missions will require a cross-cutting approach, drawing on research and innovation activities defined not only through individual Clusters, but across Horizon Europe and beyond. Research and innovation activities within this Cluster thus have the potential to support missions in all of the above-mentioned areas. The synergies between each mission and cluster will be further explored as possible missions take shape.

7. International Cooperation

The EU will continue to work with international partners to step up science, research and innovation in all European sea basins to underpin international ocean governance, ensure food supply from the seas and oceans, advance polar science and knowledge on climate variability and predictive capabilities for changes such as sea level rise, and complete sea floor mapping, including habitats. This will include the further implementation of the Galway and Belém Statements, respectively signed with the US and Canada, and Brazil and South Africa with a vision of building an all Atlantic Ocean Community and by also implementing the bilateral Administrative Arrangements on Marine Research and Innovation Cooperation with Argentina and the Republic of Cabo Verde.

ANNEX 7: – MISSION AREAS AND PARTNERSHIP CANDIDATES

Mission Area for Healthy Oceans, Seas, Coastal and Inland Waters

Addressing sectors, policies and systemic, transformative solutions (governance, technological, non-technological, services, behaviour changes, investments), in fields including notably: systemic solutions for the prevention, reduction, mitigation and removal of marine pollution including plastics; transition to a circular and blue economy; public awareness raising; users affected by the need to adapt to and mitigate pollution and climate change in the ocean; sustainable use and management of ocean resources; development of new materials including biodegradable plastic substitutes, new feed and food; urban, coastal and maritime spatial planning; ocean governance; ocean economics applied to maritime activities.

Partnership Candidates

	31. A climate neutral, sustainable and productive Blue Economy The objective is to sustainably unlock, demonstrate and harvest the full potential of Europe's Oceans and Seas through a well-structured, sustained and simplified joint effort in this borderless domain with the aim to support the transition to a strong, climate neutral and sustainable blue economy by 2050.	Co-programmed or Co-funded	BONUS, MARTERA, JPI Oceans, BlueBio	MS/AC (RFOs, nat./reg. authorities), EU Agencies	Cl.1,2 4,5,6
	34. Water4All: Water security for the planet Secure all water demands in terms of quality and quantity, protect both economic and natural systems, as well as people from water-related hazards. Support the transition to a healthy planet and to ensure a resilient Energy Union, EU climate neutral policy and respect of planetary boundaries.	Co-programmed or Co-funded	Water JPI	MS/AC (RFOs, nat./reg. authorities)	Cl.1,2 ,4,5,6