

ANNEX 6 - CLUSTER 6: FOOD, BIOECONOMY, NATURAL RESOURCES, AGRICULTURE AND ENVIRONMENT

1. Global Challenges and their Drivers

Human activities – driven by rapidly growing global population, 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 transformative changes in the current, linear modes of production and consumption, the demand for natural resources is projected to double between 2015 and 2050^{131,132}.

Natural resources, including soil and biodiversity, are further degraded in terms of quantity and quality because of the impacts of climate change. If current trends continue, global average temperature increase could reach 2°C and considerably more in some regions soon after 2060 and continue to rise afterwards, leading to major adverse impacts on primary production systems¹³³, natural systems and societies in rural, coastal and urban areas^{134,135}.

The continuous, accelerating decline in biodiversity is of particular concern since biodiversity provides the fabric of life with a range of ecosystems services, which provide the food we eat, the water we drink, and the environment we live in¹³⁶. 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 governance¹³⁷. Currently, 27% of assessed species in the EU and 66% of habitat types are threatened – pollinators¹³⁸ are of specific concern. 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 scenario¹³⁹. At the same time, transformative changes could bend the curve of biodiversity loss, but they are currently not happening quick, up-scaled or integrated enough¹⁴⁰.

The way we currently use land and soil – vital and finite resources in Europe – is not sustainable. On the one hand, the pressures on land and soils are expected to continue growing because of the competing demands for the production of food, energy and biomaterials or land use changes for urbanisation, industry and infrastructures. In the EU, one-fourth of our productive land is under the threat of erosion. Globally, more than 75 % of Earth’s land areas are substantially degraded. If this trend continues, more than 90 % of the Earth’s land areas could become degraded by 2050¹⁴¹. 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.

Water is a precondition for human, animal and plant life as well as an indispensable resource for the economy. Around the world, communities, farmers, industries, energy suppliers and ecosystems are increasingly competing for their daily water. Access to adequate water has become

¹³¹ European Commission, Raw Materials Scoreboard 2018

¹³² <http://www.resourcepanel.org/reports/global-resources-outlook>

¹³³ Primary production systems include agriculture, forestry, aquaculture and fisheries

¹³⁴ <https://www.ipcc.ch/sr15/>

¹³⁵ IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (2019), <https://www.ipcc.ch/srocc/home/>

¹³⁶ <https://www.ipbes.net/assessment-reports/eca>

¹³⁷ https://www.ipbes.net/system/tdf/spm_global_unedited_advance.pdf?file=1&type=node&id=35245

¹³⁸ EU Pollinators initiative COM/2018/395 final

¹³⁹ <https://www.ipbes.net/assessment-reports/eca>; <https://www.ipbes.net/assessment-reports/eca>

¹⁴⁰ https://www.ipbes.net/system/tdf/spm_global_unedited_advance.pdf?file=1&type=node&id=35245

¹⁴¹ https://reporterre.net/IMG/pdf/sols-ipbes_re_sume_pour_les_de_cideurs-mars_2018.pdf

a highly contested issue and water resources management had to face continuous changes in values and structural transformations in society and the environment. The overuse and mismanagement of natural resources in the last century has placed a great pressure on freshwater ecosystems¹⁴². Major emerging challenges are to secure water for all, to achieve a good status for all of Europe's waters, to manage water with social equity, economic efficiency with a circular economy posture and environmental integrity, as well as to implement the EU water policy framework.

Oceans, seas, lakes and rivers are key 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, overexploitation, ocean acidification, deoxygenation, excess nutrients, chemical pollutants and plastics. The patterns of biodiversity loss and ecosystem degradation seen across all EU regional seas indicate that many species and habitats are in a poor state¹⁴³. Marine litter is accumulating in European seas, with plastics being the dominant litter in all European regional seas. A major challenge is to tackle marine and freshwater ecosystem degradation and to create a sustainable, circular, and blue economy that is based on sufficient quantities of water as well as on healthy and functioning freshwater and marine ecosystems for the benefit of the current and future generations.

All in all, the global ecological footprint of human activities has increased from requiring less than one Earth in 1961 to more than 1.7 Earths today, and is expected to require two planet Earths around 2030¹⁴². 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 integrity¹⁴³. Accordingly, concerns over environment-related risks for the economy and society are mounting¹⁴⁴.

These concerns are particularly justified for the EU economy, which is largely dependent on fossil resources and many raw materials sourced from international markets¹⁴⁵. This when, as a 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 processes¹⁴⁶. Access to raw materials is a strategic European issue. Sustainable use of raw materials are a key to the ecological transition and digital revolution. A genuine European circular economy could be a way to combat the climate change and biodiversity loss, as well as to reignite the European industrial competitiveness. 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 today¹⁴⁷. More than 70% of the diseases caused by pollution are non-communicable diseases (NCDs)¹⁴⁸.

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

¹⁴² <https://www.footprintnetwork.org/our-work/ecological-footprint/>

¹⁴³ <https://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html>;

¹⁴⁴ In the last three years, the environmental-risks have dominated in the Global Risk Perception Survey; and in 2019 accounting for three of the top five risks for the economy by likelihood and four by impact. <https://www.weforum.org/reports/the-global-risks-report-2019><https://www.weforum.org/reports/the-global-risks-report-2019>

¹⁴⁵ <https://ec.europa.eu/eurostat/data/database> <https://ec.europa.eu/eurostat/data/database>

¹⁴⁶ Final Report of the High-Level Panel of the European Decarbonisation Pathways Initiative (EC, 2018) <https://publications.europa.eu/en/publication-detail/-/publication/226dea40-04d3-11e9-adde-01aa75ed71a1>

¹⁴⁷ <https://www.thelancet.com/commissions/pollution-and-health> <https://www.thelancet.com/commissions/pollution-and-health>

¹⁴⁸ [https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(17\)32345-0.pdf](https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(17)32345-0.pdf);

obesity rates in the last several decades¹⁴⁹ and, at present, more than half of the EU's adult population is overweight or obese¹⁵⁰. The transformation to healthy and sustainable diets requires substantial dietary shift from the consumers and a change in the food production, especially from animal to plant proteins^{151,152}. 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. Such a shift provides simultaneous benefits for climate, biodiversity, global food security, human health and a long-term sustainable food system.

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^{153,154}. Although the food supply in the EU was never so safe as today, the World Health Organisation estimates that food-borne bacteria, parasites, toxins and allergens cause about 23 million cases of illnesses and 5 000 deaths in Europe every year¹⁵⁵ and the European citizen is not fully confident or trusting the food supply systems^{156,157}. Fostering regulatory science to support risk assessment and risk management 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 higher¹⁵⁸. If left unaddressed, the effects of climate change combined with the degradation of our natural capital risk undermining public health and many economic sectors, which depend on the health of ecosystems and on the quality of natural resources such as water, soil, and air. 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, agroecology and the food system provide an opportunity to balance environmental, social, and economic goals and set human activities on a path to sustainability¹⁵⁹. To implement these concepts and address sustainability challenges, new knowledge (including a better access to data), diversity of technological, methodological and social innovations as well as thriving place-based innovation ecosystems are instrumental. In addition, transition to sustainability requires societal engagement 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, coastal and urban territories in the Member States, across the EU and globally.

¹⁴⁹<https://www.sciencedirect.com/science/article/pii/S0140673614604608>;

¹⁵⁰ <http://www.euro.who.int/en/health-topics/noncommunicable-diseases/obesity/data-and-statistics>;

¹⁵¹ <https://euagenda.eu/upload/publications/untitled-74063-ea.pdf>

¹⁵² <https://www.thelancet.com/commissions/EAT>

¹⁵³ <http://www.fao.org/3/a-i6583e.pdf>

¹⁵⁴ http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/Key_Documents/ANIMAL-HEALTH-EN-FINAL.pdf

¹⁵⁵ WHO (2015) Estimates of the global burden of foodborne diseases, p. 255;

https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf;jsessionid=8B2AC517A05A7B81BE04E3AF4FC2EAA0?sequence=1255;

¹⁵⁶ <https://www.sciencedirect.com/science/article/pii/S0924224418305557>;

¹⁵⁷ https://ec.europa.eu/info/consultations/public-consultation-transparency-and-sustainability-eu-risk-assessment-food-chain_en

¹⁵⁸ <https://hbr.org/2017/06/if-you-think-fighting-climate-change-will-be-expensive-calculate-the-cost-of-letting-it-happen>

¹⁵⁹ The transition to a circular economy, including to a circular bioeconomy, is a huge opportunity to create competitive advantages on a sustainable basis. Applying circular economy principles in all sectors and industries will benefit Europe environmentally and socially and in addition have the potential to generate a net economic benefit of EUR 1.8 trillion by 2030(38), result in over 1 million new jobs across the EU by 2030. European Commission COM(2019)22 Reflection Paper "Towards a Sustainable Europe by 2030" https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf

2. EU Policy Objectives

The **Green Deal**¹⁶⁰ puts the transition towards more sustainable and socially just ways of producing, consuming and trading, while preserving and restoring our ecosystems, at the heart of EU actions. These guidelines build on a long-term EU ambition to lead the transition to a sustainable, climate-neutral, circular, environment-friendly and inclusive economy in full compliance with the United Nations 2030 Agenda, the Paris Climate Agreement and the Convention on Biological Diversity, reiterated in recent communications, notably “Clean Planet for All”¹⁶¹ and “Towards a Sustainable Europe by 2030”¹⁶².

Research and innovation under Cluster 6 will support the Green Deal by improving the scientific knowledge on the underlying drivers of sustainability challenges as well as by providing a range of diverse options and solutions to address them. It needs to be matched with investment in technologies, digitalisation, new business and governance models as well as social and environmental innovation to overcome lock-ins and set humanity on more sustainable pathways.

Cluster 6 will therefore be instrumental in supporting the design, implementation and evaluation of initiatives of the Green Deal, as part of the Commission 2019-2024 political guidelines, related to, *inter alia*:

- Climate change,
- Biodiversity Strategy for 2030,
- “Farm to Fork Strategy” for sustainable food along the whole value chain,
- Cherishing and protecting rural areas and investing in their future,
- Zero-pollution ambition; cross-cutting strategy to protect citizens’ health from environmental degradation and pollution, addressing air and water quality, hazardous chemicals, industrial emissions, nitrogen emissions, pesticides and endocrine disruptors (in cooperation with Cluster 1),
- New Circular Economy Action Plan, especially in resource-intensive and high-impact sectors, such as construction and textiles, feeding into overall Industrial Strategy and addressing the issues of micro-plastics on the way towards plastic-free oceans.
- A comprehensive strategy on Africa and trade agreements with sustainable-development chapter.

The forthcoming Just Transition Fund and the Sustainable Europe Investment Plan, notably under the strategy for green financing, will also benefit from and bring benefits to the results research and innovation activities under Cluster 6.

In addition, a number of EU policies and strategies related to the European Green Deal, some of which now being revised, will benefit from the results of research and innovation in Cluster 6, notably the Common Agricultural Policy, the Common Fisheries Policy, the Maritime Policy, EU Arctic Policy, the EU General Food Law, the EU Bioeconomy Strategy, the Blue Growth Strategy, as well as EU environmental legislation and policies targeting biodiversity, water, soil and air. Synergies will be sought with EU structural and investment funds and with LIFE.

Finally, Cluster 6 in cooperation with other Clusters will also contribute to other priorities reiterated in the Commission 2019-2023 political guidelines, i.e.,: an economy that works for people, a Europe fit for the digital age, protecting our European way of life, a stronger Europe in the world and a new push for European democracy.

¹⁶⁰ https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

¹⁶¹ COM(2018) 773 final, A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy;

¹⁶² Reflection Paper “Towards a Sustainable Europe by 2030” https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf;

3. Targeted Impacts

Investments in research and innovation concerning **food, bio-economy, natural resources, agriculture and environment** (Cluster 6) will advance knowledge, build capacities as well as develop and demonstrate innovative solutions to accelerate the transition to a sustainable and circular management and use of natural resources from land and sea, ensuring ecosystem integrity as well as territorially balanced and sustainable development and human well-being, including water, food and nutrition security, in the EU and globally. This will involve user-driven exploitation of environmental big data sources (in particular from the Group on Earth Observations (GEO), Copernicus and Galileo). Cluster 6 will target and contribute to the following impacts:

- Improved knowledge and innovations build the foundations for **climate neutrality** by reducing GHG emission and enhancing the sink and storage functions in production systems¹⁶³ and ecosystems, and foster **adaptation** of ecosystems, water management and production systems as well as of rural, coastal and urban areas to **climate change**.

The climate mitigation and adaptation potential of terrestrial ecosystems, including soils, and of ecosystems in seas, oceans and inland waters as well as in primary production, food and bio-based systems will be better understood and seized. In particular, innovative 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 with innovative approaches. Actions under this Cluster in cooperation with Clusters 4 and 5 will lead to achieve European climate targets. In the longer term this will enhance economic, environmental and social resilience as well as territorial cohesion.

- **Halt of biodiversity decline and restoration of ecosystems** enabled through improved knowledge and innovative solutions towards reaching the global vision for biodiversity 2050.¹⁶⁴

Biodiversity and ecosystem services in natural systems and in primary production will be better understood, monitored, valued and managed. As a result, innovative solutions will be designed, up-scaled and implemented, reversing the decline of biodiversity, including of pollinators, and enhancing ecosystem integrity and resilience in land and aquatic environments.

- Better understanding of planetary boundaries facilitates innovative solutions for **sustainable and circular management and use of natural resources** as well as **prevention and removal of pollution**, guaranteeing healthy soils and clean water and air for all as well as boosting competitiveness, value creation and attractive jobs.

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 innovative solutions for a minimised and more circular use of resources and the mainstreaming of circular systems, including at local and regional levels. As a result, resource efficiency will be increased, and pollution will be reduced all along value chains, from production to consumption and disposal. The efficient management and sustainable use of biological resources will result also in increased and fairly distributed added-value along the whole value chains and their competitiveness as well as more attractive jobs in rural, coastal, peri-urban and urban areas, with a priority on areas which are more socially disadvantaged. Innovative approaches will enable also sustainable management of water resources to better cope with the impacts of floods and droughts (in cooperation with Cluster 3), and reduce the high economic costs related to water pollution control and removal.

¹⁶³ Production systems related to sectors covered by Cluster 6

¹⁶⁴ “By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people.” CBD decision X/2. (Comment MF: This overarching vision will stay valid also if or the Biodiversity Strategy up to 2030, which targets will however only be adopted in autumn 2020)

- Improved knowledge and innovations enhance **sustainable primary production¹⁶⁵, food and bio-based systems, which are inclusive, safe and healthy and** ensure food and nutrition security for all within planetary boundaries.

Thanks to improved knowledge and innovative solutions, 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. The agricultural sector will use water, other natural resources more efficiently. Safe and cost-competitive use of bio-resources from land and sea will be ensured for all. Sustainable, safe and healthy diets will be available and accessible for all and a major shift to healthy diets from sustainable food production systems "from farm to fork" will be achieved.

- Better understanding of the **behavioural, socio-economic and demographic changes** leads to innovative approaches that **drive sustainability and a balanced development of vibrant rural, coastal, peri-urban and urban areas.**

Behaviour, motivation, lifestyle and choices of producers, consumers, industry and retailers, will be better understood including on gender aspects. People, as consumers, as producers, as dwellers, as entrepreneurs and as innovators will have equitable access to knowledge and skills required for making informed choices and being actively engaged in sustainable management of natural resources, from production to consumption and disposal. Healthy, biodiversity-friendly and responsible production and consumption will become the norm. Rural communities will see their quality of life and access to opportunities and services improved and will become drivers of innovations. Mobilising the forces of digital transformation and social innovation will facilitate those changes, help to decouple human well-being from resource overexploitation and environmental impacts, and foster a balanced and interlinked development of rural, coastal, peri-urban and urban areas.

- Environmental observations, strengthened evidence base and tools are delivered and used for the **establishment and monitoring of governance models enabling sustainability.**

Policy design, implementation and monitoring needed for achieving the necessary ecological, economic and social transition will be supported by strong evidence-based knowledge and tools. Knowledge and Innovation systems will be in place and encourage multi-actor, participatory, risk-aware, place-based and community-led innovations. This will accelerate the development and adoption of sustainable practices or solutions, and the removal of harmful practices, in particular in relation to scarce natural resources and in the context of the climate and biodiversity crisis. Solid and reliable information will be derived from Environmental Observations to support better understanding of impacts of global changes and enable sound decision making and adaptation measures 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 Research and Innovation Orientations

The present section describes the most important short to medium-term impacts that are expected from research and innovation orientations under each intervention area. The short and medium-term impacts of research and innovation 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 research and innovation orientations.

¹⁶⁵ **Primary production** should be understood throughout the annex 6 as agriculture, fisheries, aquaculture and forestry

4.1 Environmental Observation

This research and innovation 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 intervention area 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, e.g. ESA and EUMETSAT), 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 research and innovation 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) and research infrastructures.

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 intervention area 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 conservation and water availability 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 intervention area is related to most of the mission areas and many of the proposed European Partnerships, in particular, but not exclusively to the partnership 'Agriculture of data' (Environmental Observation for a Sustainable EU Agriculture). The scope of the partnership is so ambitious that it requires the engagement of the MS in a pro-active way, in order to identify the end-users and reach a critical mass of resources enabling to cope with the challenge at hand.

4.2 Biodiversity and Natural Capital

This research and innovation orientation will support research, innovation and investment activities to guide the development of new methodologies, technologies and solutions, appropriate policy design, and behavioural and economic change to enable the protection, restoration and sustainable management of ecosystems and natural capital.

Biodiversity and natural capital are essential for mitigating and adapting to climate change. To enhance this potential, inter-relations between biodiversity, ecosystem services and climate change mitigation and adaptation, including carbon sequestration dynamics from land and sea, must be better understood (in collaboration with IA4). EU research and innovation will contribute to accelerate the uptake of ecosystem-based approaches and nature-based solutions to climate mitigation and adaptation, to restore fully functional ecosystems so that they can play their role as carbon sinks contributing to the aims of the Paris Agreement, and explore complementary action in digital, regulatory framework and standards, education, market, investment, insurance, behavioural and socio-economic areas.

A better understanding of biodiversity and ecosystem services, and impacts of their decline, will mobilise capacities and investments for their conservation, restoration and sustainable management, also through in-situ research across multiple ecosystem types (including in global biodiversity hotspots), and thus facilitate the continued provision of all ecosystem services, including for water quality, which underpin our economy and society.

This includes better understanding and addressing the drivers of biodiversity loss and their interactions - changes in land and sea use overexploitation (through intensive agriculture, water use, forestry and fishing practices), climate change, pollution (air, soil and water) and invasive species, and their underlying causes (production and consumption patterns, human population dynamics, trade, technological innovations, harmful economic incentives and governance) – their temporal, sectoral and spatial effects, the development of replicable and resilient solutions to mitigate their impacts and the promotion of practices that enhance biodiversity (together with IA3 and 4). Essential tools that will be developed and improved are projections/forecasts, integrated models, scenarios and pathways that integrate socio-economic and cultural values, behavioural and bio-physical factors for biodiversity conservation and restoration, including tipping points and planetary boundaries (links with cluster 5).

Assessing and valuing biodiversity, ecosystem and their services and the multi-benefits of nature-based solutions, along with supporting the development and adoption of natural capital accounting frameworks and metrics, will support their mainstreaming in public and private decision-making. A necessary pre-condition for efficient biodiversity action is investment into long-term integrated monitoring (of species, habitats and cumulative threats) frameworks and associated tools, including new technologies and approaches (together with IA1), to monitor trends and dynamics of drivers of change and of biodiversity and ecosystem services. Intra-specific diversity will also be taken into account, as well as the open integration of knowledge and data from multiple origins such as molecular, phylogenetic, socio-historical, sensors, satellites, etc., to support private and public decision-making.

The crash of insect populations calls for a better understanding of its causes and to look for solutions to mitigate its effects on ecosystem functioning -including its cascading effect on migratory insectivorous species¹⁶⁶- and their impact on citizens' life. EU research and innovation will in particular focus on the role of pollinators in the integrity of ecosystems and the availability of their services, which should help to prioritise and better integrate pollinators into habitat conservation plans and strategies, as called by the EU Pollinators initiative (together with IA3).

Biodiversity and nature-based solutions interlink with other research and innovation areas, notably health (infectious diseases, microbiome), bioeconomy, agriculture and food systems, especially in a climate change context. Synergies and trade-offs among these must be investigated. Better understanding of the links between pollutants and human health, well-being and ecosystems are needed to develop systemic approaches tackling them (with IA3, IA4, IA5, IA7 and Cluster 1).

166 Convention on Migratory species. Insect decline and its threat to migratory insectivorous animal populations.

Innovative nature-based solutions will be developed, tested and scale up to reduce pollution, including diffuse water pollution originated from agricultural and urban sources and revitalise degraded ecosystems and reverse biodiversity decline, notably man-made ones as well as human health, understanding systemic and long-term risks and opportunities.. There are still significant gaps in the knowledge of environmental behaviour and eco-toxicological features of chemical compounds and mixtures. Their characterisation could be related to questions on human toxicology and exposure (Cluster 1). Innovative models harvesting the positive role biodiversity on human health should be developed together with the health sector.

Assessing how extraction, production, consumption, trade, and behaviour patterns, especially primary production and food systems, affect biodiversity loss and ecosystem services, and how ecological transitions can be socially fair is a priority. Better understanding on how measuring and valuing natural capital changes the public and private decision making at all levels is needed, including for business and investors, and for exploring solutions to improve the biodiversity impact of retailers in global value chains. Impacts of digital transformation, new emerging technologies and social innovation on biodiversity need to be addressed. This includes maintaining materials in the economy for as long as possible and comprehensive assessment methodologies for nature-based solutions in business and for social justice (performance indicators, standards, reference models, risk analysis, life cycle assessment). A robust science and evidence base will in turn contribute to EU coordinated action on the sustainable finance action plan, so as to shift investment towards more biodiversity-friendly activities.

Development of innovative and transformative governance models, participatory approaches and integrated decision-support tools are expected to enable systemic approaches and a swift implementation of policy mixes for meeting sustainability, biodiversity and climate challenges set towards 2030. Successful transition to sustainability requires an agreement in the communities on the preferred options for development, beyond the identification of feasible options to address an acute problem. Multi-stakeholder living labs that allow co-creation of systemic solutions and create space for testing them are innovative governance solutions that implement the 'innovation principle' not restricted to biodiversity and natural capital in the strict sense but address transition processes more broadly. Related activities aim at understanding how behavioural, socio-economic and demographic change could be drivers of sustainability and catalysts for a balanced development of vibrant rural, coastal, peri-urban and urban areas. Science-based tracking mechanisms and methods would enable transparent assessment of their effectiveness. Activities will engage communities of innovators, public authorities, research community, business and public in all parts of the science-policy cycle, including through education and citizen science, for facilitating co-creation of actions on natural capital and biodiversity.

Another targeted impact is the improved science and knowledge base, science-policy mechanisms and tools to support the workings and outcomes of IPBES and IPCC and multilateral environmental agreements (see international cooperation).

Biodiversity and nature-based solutions will play a supporting role in several mission areas and European Partnerships, especially the ones related to climate change adaptation and agroecology. In particular, the proposed partnership "Rescuing biodiversity to safeguard life on Earth" will align and integrate pan-European research and innovation efforts in developing and upscaling solutions to stop biodiversity loss and guide actions to protect, restore and sustainably manage ecosystems and natural capital. It will help mainstreaming of biodiversity and will support policy-makers, notably on improving the evaluation and monitoring of the efficiency of biodiversity-relevant policies, developing the science basis and science-policy interface to guide policy implementation, at global, EU and national levels.

Effective communication and dissemination is critical to raise societal awareness of biodiversity and ecosystems. This requires the development of simple and clear messages from science that can resonate with the public and policy-makers and inspire action

4.3 Agriculture, forestry and rural areas

Sustainable, climate-friendly and resilient farming and forestry systems provide a number of economic, environmental and social benefits. In addition to contributing to food and nutrition security, feeding into dynamic value chains, providing millions of jobs and securing well-being of people, EU's farmers and foresters are important stewards of the natural environment, and thus have significant potential to shape and maintain rural landscapes, promote healthy ecosystems, mitigate the effects of climate change and halt the loss of biodiversity. Vibrant rural areas are

essential for farmers, foresters and other rural dwellers to keep managing EU's land and resources for the rest of society and to achieve the EU's objectives for territorial cohesion ¹⁶⁷. EU research and innovation activities under this intervention area will advance knowledge, build capacities and develop solutions to use land in more sustainable ways and to move to climate-friendly, resilient and socially inclusive agriculture and forestry systems. This transition will be supported by applying principles of agro- and forest ecology and making better use of ecosystem services. Research and innovation will contribute to providing consumers with healthy and nutritious food and to developing new value chains (including urban farming) in rural and urban areas. It will further contribute to a more balanced development of rural areas, based on implementation of effective, evidence-based policies. Overall, research and innovation activities under this intervention area will be instrumental for the European Green Deal, in particular with regard to the "farm to fork" strategy for sustainable food as well as for climate, circular economy and zero-pollution objectives.

Fostering climate change mitigation, and achieving sustainable management and efficient use of natural resources implies for agriculture and forestry that there is a right balance between productivity, climate and environmental goals. Research and innovation activities will speed up action for sustainable soil and land management, enhancing the various functions of soils such as their capacity to capture carbon, reduce greenhouse gas (GHG) emissions (CO₂, CH₄ and NO₂) and buffer the impacts of climate change. Solutions for climate- and environmentally-friendly practices will be developed to effectively reduce emissions of major greenhouse gases and the environmental footprint of agricultural activities. New technologies and business models will further halt land degradation and enable a "de-fossilisation" of land-based primary production (in cooperation with Cluster 4 and 5, and IA2). Research and innovation will unlock the full potential of LULUCF¹⁶⁸ activities in the mitigation of climate change. Results of funded activities will benefit forest management and the delivery of multiple forest services such as the provision of goods, the protection of soils, water and biodiversity or their contribution to climate change adaptation and mitigation. Contribution of wood products from forests and agroforestry to carbon storage will be enhanced (in cooperation with Cluster 4 and 5).

A range of approaches will be developed to enhance resource use efficiency in agriculture, forestry to find alternatives to scarce resources such as water and soils and to decrease the dependency on critical raw materials (together with IA5 and Clusters 4 and 5). A better understanding of nutrient flows—a more effective integration of legume crops in farming systems and the deployment of mixed production systems (e.g. agroforestry, agro-aqua farms) will allow to optimise resource flows and reduce the use of pesticides and fertilizers on-farms and across landscapes. Decreasing pollution of water, soil and air from primary production will contribute to the zero-pollution ambition of the Green Deal. By better linking rural, peri-urban and urban resource flows it will be possible to gain value from local residues and by-products, unlock the potential of the circular economy, and hence create attractive jobs in rural communities. These impacts will be enabled, *inter alia*, by promoting small-scale, bio-based solutions (in cooperation with IA6) and innovations in farming at the interface between agriculture, aquaculture, forestry and energy (in cooperation with IA4 and Cluster 5).

Agriculture and forestry are severely affected by more variable and extreme weather events or water scarcity. Accordingly, there is an urgent need to foster adaptation of primary production to climate change. Research and innovation impacts will increase the resilience of plants and animals to biotic and abiotic stresses by bringing more diversity into farming and forestry systems and provide farmers and other actors in value chains with better-adapted crop varieties and animal breeds. Attention will be directed also to forest resilience in the context of climate change. Moreover, research and innovation outcomes will provide solutions for rural communities and operators to mitigate and adapt to changing climatic conditions, in particular by introducing innovations in the areas of renewable energy, mobility and natural disaster prevention (together with Cluster 3 and 5).

¹⁶⁷ [Treaty on the Functioning of the European Union - Article 174](#)

¹⁶⁸ Land Use, Land-Use Change and Forestry (LULUCF), for more information see: https://ec.europa.eu/clima/policies/forests/lulucf_en:

Biodiversity and ecosystem services underpin productivity and resilience of agriculture and forestry; their preservation and restoration at farm, forest and landscape level is therefore essential. Increased knowledge on the benefits of biodiversity-rich and pollinator friendly practices will serve to develop farming and forestry systems that protect, restore and enhance agrobiodiversity, wild biodiversity and ecosystem services across a range of scales. The planned partnership "Accelerating farming systems transition: agro-ecology living labs and research infrastructures" will support implementation and upscaling of agro-ecological approaches in primary production, including organic and mixed farming or agroforestry. Research and innovation impacts will also improve conservation, management and use of plant and animal genetic resources, thereby preserving and enhancing agrobiodiversity. Furthermore, results delivered by research and innovation will allow to better assess the impacts of primary production on biodiversity, and deploy nature-based solutions to enhance biodiversity (in cooperation with IA2).

Health and safety in agriculture and forestry, and of their produce, as well as animal welfare are important societal concerns. Addressing these concerns will require a systemic, multidisciplinary approach. Results of research and innovation under this intervention area are expected to enhance capacities to prevent, monitor and control animal and plant pests and diseases including emerging risks, and to address antimicrobial resistance. This will result in the development of prevention measures as well as safe and environmentally friendly methods for plant protection and weed control that substantially reduce the use of contentious pesticides, and thus also enhance the health and well-being of workers in agriculture and forestry, of consumers and of ecosystems (in cooperation with Cluster 1). With regard to improving animal health and welfare, activities will result in a better understanding of environmental and socio-economic drivers of diseases and promote innovative integrated approaches to animal production. The proposed European Partnership "Animal health: fighting infectious diseases" will tackle transboundary animal diseases, anti-microbial resistance and will allow to advance in the implementation of the One-Health concept (in cooperation in Cluster 1).

Improved knowledge on structure and performance of food and non-food value chains will support their redesign and orientated towards sustainability principles. It will allow to better connect producers, consumers and nature, and to capture the value of environmental, health and socio-economic impacts originating from food and bio-based value chains. Results from research and innovation will contribute to the development and strengthening of value chains of eco-innovative products that respond to new opportunities such as the growing consumer demand for healthier and sustainable diets and at the same time improve the income of producers, and minimize the impact of value chains on climate and environment (together with IA5). Particular attention will be given to promoting diverse and healthy products (fruits and vegetables), EU-grown plant proteins¹⁶⁹ and the organic sector¹⁷⁰. Research and innovation will stimulate mutually beneficial collaboration between farmers, producer organisations, citizens and other actors. This will support the design of sustainable, competitive, resilient, circular and socially responsible food and non-food value chains with a fair distribution of the value added and better balanced power relations (in cooperation with IA5 and IA6). Activities will support the uptake of urban farming to deliver food alongside social and environmental benefits (in cooperation with IA5). New insights, tools and business models will also contribute to improved communication, certification, authentication, traceability and transparency from farm to fork, thereby reconnecting consumers, producers and nature, enhancing consumer trust, empowering rural communities and better reflecting the true value of products (in cooperation with IA5).

The climate, socio-economic and demographic changes in rural areas jeopardise the cohesion of the EU territory. Results of research and innovation will feed into strategies and policies to close the divide between rural and urban areas and benefit rural dwellers and workers (in line with Cork 2.0 Declaration) and generational renewal in farming and rural communities. Vulnerable groups and gender aspects, including women and migrants will receive special attention (in cooperation with Cluster 2). The development of digital services and skills, co-created with and for rural people, will enhance connectivity and service provision in often remote rural areas (including mountain areas) and support smart, green and inclusive rural communities and businesses (in

¹⁶⁹ Report from the Commission to the Council and the European Parliament on the development of plant proteins in the European Union (COM(2018) 757 final).

¹⁷⁰ <https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/future-organics>

cooperation with Smart Villages and POSEI, and Cluster 4). This will be done through a better understanding and further development of social networks, social capital and social innovation processes and allow for innovations in rural communities that support the sustainability agenda locally, create and retain value from local and regional assets and improve the well-being of people living in rural areas (in synergy with the LEADER programme).

To support governance models for sustainability, research and innovation will deliver data, knowledge and impact measurements that will allow improving the monitoring and evaluation of EU policies addressing agriculture, forestry, related value chains and rural areas in the period 2021-2027 and beyond. Activities will deliver foresights and tools for multidisciplinary assessment of sustainability and circularity, lock-ins, transition pathways and coherence of EU policies. Moreover, they will help to create observation networks of European forests and harmonise data related to forests.

Due attention will be given to ICT as an enabler, allowing to build an open digital environment and supporting bottom-up innovation in agriculture, forestry, related value chains and rural areas (together with IA1 and Cluster 4). This is in line with the recent declaration of EU Member States on "Smart and sustainable digital future for European agriculture and rural areas"¹⁷¹.

Agricultural knowledge and innovation systems (AKIS) as well as social innovation will be key drivers to speed up the take-up of results (in synergy with the CAP). This will include promoting place-based innovations, strengthening synergies with other EU Funds in particular smart specialisation strategies, reinforcing the multi-actor approach and establishing a network of living-labs on agro-ecology and leaving space for new approaches such as partnerships and missions.

The proposed European Partnership "Animal health: fighting infectious disease" will provide a cross sectoral research platform bringing together research funding/performing organisations as well relevant industries, notably the pharmaceutical and diagnostics ones, and related stakeholders. It aims to foster large-scale coordination of basic and applied research activities on priority infectious diseases of livestock and zoonoses and related issues. It will hasten the delivery of improved tools, products and services to better predict, prevent, diagnose and manage diseases more efficiently, thus reducing their impact on livestock production (including animal welfare) and on public health, contributing to the fight against anti-drug resistance. The partnership will build on pre-existing public-public partnerships and will connect to industry. A link will be made with the relevant European partnerships under Cluster 1.

The proposed partnership "Accelerating farming systems transition: agro-ecology living labs and research infrastructures" aims at accelerating the transition of farming systems towards more ecological practices by supporting a network of longer-term experimentation spaces embedded in the national and regional knowledge and innovation ecosystems. This network will promote coordinated approaches and ensure knowledge exchange at EU level by fostering place-based open innovation in co-creative environments such as living labs. Involving national and regional authorities in the partnership will facilitate embedment of the research and innovation activities the EC aims to conduct through this partnership in the local and regional innovation ecosystems, while the need to connect these activities, ensure knowledge exchange and Member States ownership of the process justifies EU's involvement and the proposed partnership approach.

The European Partnership "Agriculture of data" (Environmental Observation for a Sustainable EU Agriculture) will be developed together with IA1 and by pursuing synergies with activities in other intervention areas of Cluster 6 and across clusters. It will aim to support sustainable agriculture, especially by maximising the use of the possibilities offered by the digital / data technologies in the field of Earth observations. In order to achieve lasting impact and European outreach, the partnership will imply the involvement of a large community, including Member State authorities.

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,

¹⁷¹ <https://ec.europa.eu/digital-single-market/en/news/eu-member-states-join-forces-digitalisation-european-agriculture-and-rural-areas>

seas and inland waters can deliver food with lower carbon and freshwater footprints than land-based production, while boosting profitability in the sector. Sustainable fisheries and mariculture are set to play an increasing role on food and nutrition security and be part of the forthcoming sustainable food from farm to fork Strategy (in cooperation with IA5).

The health of the ocean and fresh water ecosystems, its conservation and protection are a prerequisite to benefit from their services. By the year 2100, without significant changes, more than half of the world's marine species may stand on the brink of extinction¹⁷². Activities will underpin EU's leading position to advance restoration of biodiversity and ecosystems and its commitment in halting the decline of marine and freshwater species (in cooperation with IA2). The IPCC report on the Oceans and the Cryosphere (2019) provides solid evidence on ominous developments ahead calling for urgent action.

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. The Arctic and Antarctic are among the most sensitive and fragile regions of the globe to human induced climate change and other stressors. Sustained Polar research and observations are increasingly important and necessary to understand the rapid changes taking place in these Regions and to predict their regional and global impacts. Research is also needed for assessing vulnerabilities and building resilience in polar ecosystems and societies.

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.

Marine biodiversity remains largely unexplored, offering a huge potential for seemingly endless discoveries of new species and applications in the fields such as food value chain, pharmaceutical bioactive marine-derived compounds, cosmetics, chemicals, materials, etc. Marine biotechnology offers great potential for the exploration of marine organisms, and their communities, and for the development of new products, processes and services (in cooperation with Cluster 1). Ocean exploration, including the deep sea as the least known frontier of the planet, will also enhance the understanding of ecosystems function and the chemical, physical, biological geological earth's cycles (through also IA1 for ocean observation).

Designing and deploying an integrated approach (looking at the interlinkages of ocean-climate (also in cooperation with Cluster 5), ocean-food (in cooperation with IA5), ocean-land, ocean-society, renewable energy from marine sources (also in Cluster 5), 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 level¹⁷³.

In light of recent IPCC projections, there is a need to adapt to extreme sea level events and coastal hazards and not in a distant future. Climate change mitigation and adaptation, especially through nature-based solutions (together with IA2 and Cluster 3), 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 sectors¹⁷⁴ 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

¹⁷² <http://www.unesco.org/new/en/natural-sciences/ioc-oceans/focus-areas/rio-20-ocean/blueprint-for-the-future-we-want/marine-biodiversity/facts-and-figures-on-marine-biodiversity/>

¹⁷³ EU policies such as the Common Fisheries Policy, the revised EU Bioeconomy Strategy, the Integrated Maritime Policy (including the Marine Strategy Framework Directive), Maritime Spatial Planning and International Ocean Governance as well as the 2050 Clean Planet vision.

¹⁷⁴ Investigate the impacts of climate change on marine and coastal ecosystems, examining effects in terms of ocean acidification, sea level rise, temperature and currents changes, extreme events, deoxygenation, eutrophication, abundance of marine resources and food, and other effects on marine sectors;

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 areas¹⁷⁵ (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 mitigate and adapt to climate change impact and reduce stressors and human induced pressures - from overfishing to pollution, on freshwater and marine ecosystems. It includes to enhancing the means to fight illegal, unreported and unregulated fisheries. The shared use of maritime space with other activities, particularly in the coastal zone, and its socio-economic impact will be addressed through the development of optimal maritime spatial planning. It will result in better human, algal and animal health, facilitating the development and market uptake of sustainable circular bio-based processes and blue bioeconomy products (in cooperation with IA6).

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 research and innovation, improving capacities and skills to reap the benefits of digital transformation and socio-economic 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 observations¹⁷⁶ (together with IA1), interconnected with relevant research infrastructures¹⁷⁷, to serve the needs of decision and policy making.

Prevention and removal of pollution (chemical, physical, bacteriological, nutrients) will deliver on the EU ambition of zero pollution and will be supported by and required behavioural and socio-economic changes. Research and innovation will lead to solutions to limit pollution in inland, coastal and marine waters, including from maritime infrastructures and transport, energy infrastructures and tourism. Special attention will be given to identifying approaches to reduce pollution in river catchment areas at the scale needed to ensure all fresh and coastal water reach environmental standards defined in the relevant EU water and marine policies, and the quality of the cleaned waste water entering coastal waters. It embraces the adoption of circular economy products to prevent and mitigate littering and pollution, very importantly plastic pollution (together with IA7)

Cost-effective solutions for mitigation of morphological alterations of water bodies (e.g. barriers, dams, and 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

¹⁷⁵ This includes research needs from the ongoing negotiations on Biodiversity in Areas Beyond National Jurisdiction (BBNJ)

¹⁷⁶ Technologies for the digital ocean (seafloor, water column and water surface) connecting services and communities, and promoted through the Blue Cloud as part of the European Open Science Cloud.

¹⁷⁷ Such as those identified by the European Strategy Forum for Research Infrastructures (ESFRI) and those established under the European Research Infrastructures Consortium (ERIC) regulation

and new emerging pollutants (such as micro-pollutants, micro-plastics, pharmaceuticals, endocrine disrupters, antimicrobial resistant bacteria) will also help improve the chemical status of freshwater and prevent further pollution, both in inland water bodies and coastal waters (in cooperation with Cluster 1 and IA2,IA7).

An overarching partnership “A climate neutral, sustainable and productive Blue Economy” would cut across several of the above impact areas and it would 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 research and innovation programme in the European seas, coastal and inland waters. In order to maximise efforts and achieve efficiency gains the partnership would deliver the highest impact by joining efforts and to align certain research priorities/activities in all seas and oceans around Europe - and beyond - and to pool existing and new funding streams from national public and private sources together with EU funding.

The partnership - covering the Atlantic, Arctic, Baltic, Mediterranean, North Sea and Black Sea - would be based on previous work, notably the sea basin specific Strategic Research and Innovation Agendas (SRIAs); Ministerial Declarations; international commitments and already ongoing work and sea basin initiatives developed and facilitated by the Commission, together with the EU Member States, funders and stakeholders over the last 10 years. The objectives would be to support the resilience of marine ecosystems and a transition to a strong, climate neutral and sustainable Blue Economy by 2050; to ensure food security and safety for citizens; to foster the alignment of existing EU and Member State research and innovation priorities; to pool EU and Member State (private and public partners) resources; to support a Europe wide fit-for-purpose marine observation framework by 2030; to increase international cooperation in science, research and innovation as well as science diplomacy; to address Climate mainstreaming’. The partnership would focus on establishing a coherent SRIA which will be implemented with co-programmed and co-funded actions. Multi-lateral cooperation with international partners will be pursued to achieve the goals mentioned above, notably in the Atlantic, the Mediterranean, the Black Sea, the Baltic Sea and the Arctic. It builds on Member States (e.g. Belém Statement, Galway Statement), and international commitments. It will assist in overcoming the challenges related to oceans, seas and inland waters and shaping up global governance by strengthening international research, data sharing and scientific exchanges. Furthermore, the EU is well-placed to demonstrate leadership in relation to the implementation of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030).

Understanding the human dimensions is fundamental to decision-making across marine policy realms. Research and innovation actions will help raising awareness and education to empower European - as ‘Ocean Literate’ citizens - to take direct and sustainable action towards healthy seas, oceans and inland water, healthy communities and ultimately - a healthy planet. Social innovation will be supported to as a trigger of environmental, social and economic transformations. Synergies between local citizens’ ideas and scientific development can create huge added-value for sustainable coastal and marine development.

4.5 Food Systems

The global food system is facing a range of challenges including the triple burden of malnutrition (undernutrition, over-nutrition and micronutrient deficiencies), climate change, resource scarcity, biodiversity loss, including in soils, growing and ageing population, urbanization, food waste and food poverty. Food systems are also an important part of the bio-economy in terms of turnover and employment, and because of their common ecosystems. This creates synergies, but limits have to be respected. A food systems’ transformation is thus required which shifts towards more sustainable and healthy diets and aims to ensure food and nutrition security for all, thus contributing to the “farm to fork” strategy for sustainable food. The Food 2030 initiative is a useful model to follow with its four priority areas of nutrition and health, climate and sustainability, circularity and resource efficiency and innovative communities. Its goal is to use systemic approach to transition and future-proof our food systems.

This requires a better understanding of the interactions between the different components of current food systems, such as the interactions between food, biodiversity and water systems, to maximise co-benefits and accelerate transition. More specifically, the goal is to arrive at a sustainable, climate-neutral, resource-efficient, trusted and inclusive global food system from land and sea that respects planetary boundaries and delivers safe, healthy and affordable food to all. Innovative solutions and strategies that tackle systemic issues and have positive social, environmental and economic impacts will play an essential role.

Research and innovation solutions will be developed to build climate smart and environmentally sustainable food systems adaptive to climate change, which conserve natural resources, and implement resource-efficient circular economy principles, while reducing environmental footprint. A range of approaches to enhance diversity, sustainability and food quality, and facilitate production, processing and consumption (e.g. plant-based proteins, algae, seafood with a special focus on low trophic species and insects based proteins) will be investigated (in cooperation with IA3 and IA4). Diversity in food systems (including production, processing, distribution and logistics) will be identified to improve biodiversity, resource efficiency and circularity, prevent and reduce food losses and waste, enhance valorisation of inedible (urban) food waste through the production of bio-based products, rethink packaging, and address the environmental pressures affecting our food systems (in cooperation with IA2, IA3, IA4 and IA6). Placed based food systems innovation will be supported and research and innovation solutions applied to ensure the transformation of urban and peri-urban food systems along with a better understanding of the rural urban divide (in cooperation with IA3). Transformation of EU's food system will require focusing on the potential lying in aquatic production, where e.g. seaweeds, fish and mussel production is highly energy efficient. In addition, the application of microbiome-based knowledge will open new avenues to improve human health with higher quality and safer food products, increase the biodiversity of food resources, tackle waste management, enhance productivity and sustainability, and address climate resilience across food systems (in cooperation with Cluster 1, IA2, IA3 and IA4).

Research and innovation solutions will be developed to ensure safe and nutritious food is available, accessible and affordable for all. Helping citizens to adopt sustainable and healthy diets for good health and well-being will help reduce non-communicable diseases (NCDs), hunger, and malnutrition. Innovative personalized nutrition solutions from smart products, new technologies, business tools and models will reduce the incidence of diet related NCDs. They will arise from a better understanding of the needs and predispositions to develop tailored solutions for different targeted groups taking into account gender related issues, in particular for people in a vulnerable stage of life (in cooperation with Cluster 1). Addressing health and nutritional inequalities is crucial to reduce hunger and malnutrition and to support the transition towards greater sustainability. To ensure that nutritious, sustainable and safe food is available, accessible, and affordable for all, and at any time, will involve innovative solutions and strategies tackling the causes of food and nutrition insecurity, identifying food crises and delivering emergency responses (in cooperation with Cluster 1, Cluster 2, IA3 and IA4). This will occur at different levels (e.g. cities, and regions) and for different communities (developing countries, and vulnerable groups such as the elderly, migrants, and low-income groups).

Innovation in the food chain will be addressed while fostering regulatory science. This will lead to improved risk assessment methodologies and new evidence to support robust food safety regulatory frameworks, including those addressing new and emerging food safety risks. Research and innovation will foster solutions for acceptability, trust, transparency, and innovation uptake by citizens. The development of digital innovation and the improved management and sharing of data will optimize the sustainable use of natural resources along the food system, monitoring its potential impacts on natural resources and contribute to foster food safety and authenticity, crisis management, traceability, transparency, and system resilience, to respond to the trend for more personalized, sustainable and healthy food for consumers' benefits, and to increase the competitiveness and sustainability of the European food industries and related food services sectors. Research and innovation solutions for food products, services and process will improve nutritional, structural and functional food properties, food systems sustainability and resources efficiency, reuse, reduction and recycling of water and packaging, reduction of food losses and waste, and of plastic based food packaging and contact materials.

Advances in systems science, behavioral, socio-economic sciences and decision support tools will help drive policies and food system governance at all levels. Research and innovation solutions to better understand the factors (such as urban planning, obesogenic food environments, cultural and socio economic trends) influencing consumer food choice, lifestyle, motivation and decision-making with a special attention to vulnerable people and gender will facilitate and accelerate the transition towards sustainable and healthy food production and consumption. Safe and healthy diets will

increase well-being, reduce the risk factors of diet-related NCDs, help reach climate targets,¹⁷⁸ and support more environmental friendly production and production systems. European food industries and food services will be engaged for their essential role in facilitating dietary change through the provision of good quality, safe, affordable and convenient food with good nutritional and sensorial qualities.

Citizen's empowerment and involvement in informal and formal governance systems with a gender equality will be crucial to shift consumer preferences and consumption pattern towards more sustainable and healthy diets. Interfaces between informal and formal governance systems need to be developed and tested to accelerate innovations uptake in society. To develop and establish governance models enabling sustainability, will produce knowledge and innovative solutions and strategies in support of evidence-based policy-making, implementation and monitoring and strengthened EU and international science-policy interfaces for improved governance. By addressing political and socio-economic lock-ins starting from the local level of governance, these solutions will ensure policy coherence and societal engagement in developing and applying science-based innovative solutions that also cover awareness raising, education and skills building. Elements of citizen engagement would be implemented within the partnership and related missions.

An overarching partnership on "Safe and sustainable food systems for people, planet and climate" will provide a platform to co-create the healthy, sustainable and inclusive food systems of tomorrow that accelerate the transition towards a carbon neutral Europe by 2050 and contribute to the new "Farm to Fork vision" and action plan under the European Green Deal. This partnership will focus on developing the needed systemic and cross-sectoral EU research and innovation governance relevant to different geographical scales, to foster collective understanding, align research and innovation programmes and leverage investments, develop capacities and skills to address high impact research and innovation transition pathways such as supporting the food safety system of the future to boost consumer trust, foster food safety and food quality; supporting the shift to sustainable and healthy diets and alternative proteins; cutting food system-related waste, in particular food waste and food packaging; and supporting multi-objective urban and place-based food systems transformation in Europe and beyond. It will mobilise diverse partners (e.g. Member States, public and private sector, research organisations, education establishment, foundations and civil society) and resources within and beyond Horizon Europe to implement the European Commission's (EC) FOOD 2030 research and innovation policy framework to future-proof our food systems by delivering co-benefits on nutrition, climate, circularity and place-based innovation, also with view to addressing both land and sea dimensions. This partnership will build on previous work of the Standing Committee for Agricultural Research (SCAR), three Joint Programming Initiatives (FACCE, HDHL, OCEANS), multiple ERA-NETS and the EIT Food and a number of relevant European Technology Platforms, foundations and NGOs that over the last years have confirmed the need to implement a new, systemic and participatory approach to research and innovation policy that is multi and trans-disciplinary and that prioritises the experiences and expertise of all stakeholders within the food system. The partnership will develop a joined-up and policy coherent Strategic Research, Innovation and Investments plan to be implemented by all partners, that will contain a mix of co-programmed and co-funded actions, depending on the pathways. The partnership will also be aligned with other relevant partnerships working in this area to seek synergies and avoid unnecessary duplication (*"in collaboration with Cluster 1 in particular partnership on "Chemical Risk Assessment"*).

4.6 Bio-based Innovation Systems

Bio-based innovation has a major role to play in the sustainable and just transition to a "green" economy that is climate neutral and circular and operates within planetary boundaries. Building on the use of biological renewable resources, as a substitute for fossil- and mineral-based ones, it fosters climate neutrality in very significant parts of European industrial and economic sectors (e.g. construction, packaging, textiles, chemicals, cosmetics, pharma ingredients and consumer goods). It contributes to achieving the resource-efficiency goals of the circular economy – for instance through the development of our capacity to turn organic waste and CO₂ from bio-based

¹⁷⁸ COM(2018) 773 final, A Clean Planet for all and SWD: Dietary changes can by 2050 reduce EU GHG emissions equal to 5% of 1990 levels

processing into valuable products. At the same time, it capitalises on the enormous advances of biosciences and biotechnology to deliver greener and innovative products, processes and services. The transformative potential of bio-based innovation will also be directed towards economic competitiveness (in cooperation with Cluster 1 for the health aspects of bio-based innovation and Cluster 4 for industrial symbiosis and sustainable manufacturing), delivering new value chains, technologies and processes, economic activities and employment, thus revitalising regional economies and local areas.

The contribution of bio-based innovation to fostering climate change mitigation and adaptation strongly relies on the provision of sustainable biomass, grown in a way that contributes to climate and biodiversity goals and sustains ecosystems integrity, and on its conversion into bio-based products and crop nutrients as a substitute of fossil and mineral-based products.

Research and innovation is expected to deliver on two main outcomes. First and foremost, it will result in resilience and sustainable biomass production systems for high-value bio-based products while ensuring the functions of balanced ecosystems (terrestrial, aquatic) with greater carbon sequestration and biodiversity conservation. A number of agroecological approaches and blue biomass can be considered such as multi-cropping strategies, agroforestry, multipurpose biomass, the use of perennials and marginal lands, residues mobilisation and use (in cooperation with Cluster 3 for environmental risk prevention and mitigation) as well as climate-resilient crops (e.g. drought, pathogen resistant) (in cooperation with IA3 for varieties' breeding options, and with IA7 for water use) and sustainable aquatic biomasses with potential for scaling up (IA4). Secondly, it will pursue the establishment of new bio-based value chains through the development of a toolbox of solutions to process diverse biomass into bio-based products, including in advanced sustainable biorefineries, including small-scale decentralised models in rural settings (in cooperation with IA3). A key approach will be the combination of sustainability and functionality of the developed products. Bio-based products can be suitable for various (longer-term) uses (as harvested wood products also replacing fossil-based materials and products), and new end-of-life requirements (such as recyclability, compostability), should show lower environmental toxicity (e.g. bio-based surfactants, pesticides, insecticides) or present new functionalities (e.g. drugs based on chemical composition or structure) or performances (biodegradability in specific environments) meeting societal needs.

Coupled with its potential to reduce greenhouse gas emissions, bio-based innovation can accelerate the transition from a linear fossil-based economy, which leads to overuse and depletion of natural resources, into a resource-efficient and circular bio-based economy operating under safe planetary boundaries. Social innovation will contribute to reducing resource consumption and will result in an increased innovation capacity of all actors. This will also help to decouple human well-being from resource overexploitation and environmental impacts.

Research and innovation is expected to result in solutions to keeping the value of biological resources in the economy for longer through the optimisation of product design, production processes, performance and end of life, replacing fossil-based materials and products in line with the long-term climate strategy 2050. This also includes reuse, repair, remanufacturing and recycling patterns as well as related governance and financing models. Effective approaches will be devised to the increase of the value generated per unit of biological resources. They could range from the optimisation of the chemical (complex molecules), materials and energy potential of the feedstock to the implementation of the principle of cascading use of biomass. Greater value will also be generated from unavoidable biological wastes and residues, including urban bio-waste and residues from agriculture, food processing, forest sector, fisheries and aquaculture. Also the recovery of nutrients from waste streams to produce bio-based fertilisers will allow to reduce impacts associated to the production and use of synthetic fertilisers (in cooperation with IA7). As bio-based products and processing can decrease the presence of hazardous substances, they could improve safety and facilitate circularity. Industrial symbiosis will enable the creation of new value chains and networks where wastes or by-products of an industry or industrial process become the raw materials for another one. This includes the capture and use of CO₂ from emissions from bio-based processing into valuable chemicals, materials and products. The flows of biological resources will be better integrated into models of the circular economy, in particular on the circular use of natural resources that account for its ecological boundaries and enhance biodiversity and the delivery of ecosystem services. Metrics and data on the value generated per unit of biological resources will be developed.

With a view to addressing the previous research and innovation priorities (in cooperation with IAs 3, 4, 5 and 7), the suitability of the establishment of a potential European Partnership in the area

of sustainable, inclusive and circular bio-based solutions, i.e. European Partnership for a circular bio-based Europe, will be assessed. This will take into account the lessons learned from the partnership on Bio-based Industries under Horizon 2020. Synergies will be created with regional and national public funds and other instruments. The partnership supports sustainability-driven innovation for new local value-creation from waste and biomass, driving sustainable, resource-efficient and climate-neutral solutions towards a healthier planet, replacing non-renewable fossil and mineral resources by biomass and waste for renewable products and soil nutrients.

Bio-based innovation is not only driven by the need to address pressing societal challenges (such as climate change, resource depletion, biodiversity loss, environmental pollution), but also by the disruptive potential of the unprecedented advances in life sciences and biotechnology. This goes far beyond biomass processing towards allowing the use of nature's "biological assets", i.e. its functions and principles. Research and innovation is expected to deliver competitive, sustainable and novel industrial processes, environmental services (e.g. bioremediation for restoring ecosystems, water resources, soil) and consumer products through the application of biotechnologies across bio-based value chains (e.g. chemistry, construction). When coupled with the digital revolution, new tools will be put in place for prospecting, understanding and sustainably using the biological resources (in cooperation with IA2).

Maximising the impact of bio-based innovation involves the elaboration and establishment of governance models enabling sustainable and inclusive bioeconomy patterns, including consumption patterns, market measures and financial models (in cooperation with the EIC). This key targeted impact cuts across all key research and innovation priorities identified above. Participatory research and innovation is expected to deliver behavioural and socio-economic change resulting in (i) the revitalisation of local communities through e.g. new (small-scale) business models and innovative market-oriented contractual arrangements in value chains, (ii) effective and inclusive public / civil society engagement, mobilisation and mutual learning, trust building and awareness raising, to avoid 'leaving people behind' (e.g. enhanced transparency in environmental and social sustainability assessment of value chains and their final products and services and communication to stakeholders, labelling etc.); (iii) training and skills development as well as recruitment strategies and education.

Research and innovation is expected to result in a deep understanding of multiple boundaries of the bioeconomy and its bio-based component. This includes knowledge for evidence-based policy making on (i) bioeconomy impacts, synergies and trade-offs with a healthy environment, enabling their comparison with concurrent and alternative economies (fossil-, CO₂-based), involving all actors and including life cycle assessment approaches; (ii) international biomass sustainability criteria and certification schemes, and global sustainability-driven bio-based innovations; and; (iii) hierarchy of use of biological and fossil resources (e.g. trade-offs and synergies with food production or other land use, e.g. recreation). Technological, as well as systemic, territorial, social and environmental innovation will be supported.

4.7 Circular Systems

The recent EC report on the implementation of the Circular Economy Action Plan, the EU Strategy for Plastics in Circular Economy, the updated EU Bioeconomy Strategy, the reflection paper towards a Sustainable Europe by 2030 and the Clean planet for all strategic vision acknowledged the need for further progress in scaling up circular economy, reducing pressure on the environment and consolidating the competitive advantage it brings to EU businesses. There is need to: (i) continue supporting research, innovation and investments to develop and demonstrate innovative systemic solutions in various sectors (e.g. plastics, food, textiles, electronics, construction, mobility and built environment) and reap their full benefits to circularity and cut greenhouse emissions and other forms of pollution; (ii) address the challenges related to the circular use of natural resources, including recycling, energy and material efficiency; (iii) support new circular business models, and consumption and production patterns; (iv) enhance circularity and sustainable water use and circular nutrient and manure management; (v) develop appropriate indicators and governance systems to monitor and measure the progress and accelerate the transition to the circular economy, and tools that could allow consumers/citizens to make better informed choices (vi) integrate circular approaches in all phases of a product life cycle, from design to re-use, recycling and final disposal.

Improved knowledge about the potential and the overall environmental impact of circular economy will contribute to reducing GHG emissions along value chains and to fostering mitigation and adaptation to climate change (in cooperation with Cluster 5). Investing in systemic solutions for circular economy at regional and local scale (in urban, peri-urban, coastal and rural regions)

including new business models, products and services stimulating resource efficiency along the whole value chain, while exploring the potential of digitalisation, will contribute to reducing the environmental footprint of production and consumption and its impact on biodiversity, preventing pollution and achieving sustainable management and circular use of natural resources. A holistic approach will help avoid possible conflicts between different sectors and value chains and safeguard the availability of raw materials for the important societal transitions in the fields of energy and mobility (in cooperation with Cluster 5). The development of a holistic view of a working after-use system in particular for plastic based products, incorporating reuse, collection, sorting, mechanical, chemical and organic recycling will also provide insights on how to coordinate strategically the transition towards a circular economy for plastics and other key material flows and support the implementation of relevant EU policies (in cooperation with Cluster 4, IA 4.9 Circular Industries).

Robust approaches to promote active engagement of citizens and to bring consumers and producers together, to explore the consumer-related aspects of circular economy and identify instruments that can trigger changes in consumer behaviour (notably, increasing transparency about life-cycle footprints of products and services) and make circular economy socially acceptable and inclusive, will be essential to accelerate the transition to circular systems for the sustainable management and use of natural resources. Research and innovation solutions will improve knowledge and develop metrics and indicators for measuring material flows, the circular economy and life cycle performance, governance systems to accelerate expansion of circular economy, including models for multi-stakeholder and cross-value chain collaboration, incentives and financing instruments.

Climate change and biodiversity loss will require adapting water resources and infrastructure management to increased scarcity and flooding, as a result of more frequent and intense extreme weather events and decreased ecosystem services (in cooperation with Clusters 3 and 5). Improved knowledge about the status of waterbodies and about long-term change in resources are essential for adaptation. Innovative solutions for halting pollution and restoring degraded water bodies contribute to maintaining natural capital (together with IA2). Advanced circular urban water systems and deployment of alternative waters sources, including water reuse, and transparent water allocation systems to satisfy all needs are essential for sustainable resource use. New governance solutions that build on better spatial planning, based on environmental observation, better modelling and inclusion of citizen and economic actors, like the insurance sector, will be essential to support EU water and climate adaptation related policies (in cooperation with cluster 5 and IA2, IA3, IA4)).

The ecological consequences of imbalances in the nutrient cycles are visible as eutrophication of surface waters and as contamination of sub-surface waters with increasing costs for drinking water provisions. Forest areas are also affected and get lost for agricultural production. Nutrient emissions cause also impact on air, biodiversity, climate and soil. A comprehensive EU policy to balance nutrient cycles is not yet well developed. Research and innovation is needed to look at how the EU could move to living within the planetary boundaries, with regards to nutrient flows. Research and innovation activities related to the nutrient cycle shall include inter alia sustainable sourcing of nutrients for example from wastes, alternative soil management, and livestock emissions and recovery of recycling of nutrients for different industrial sectors. Analysis of emissions from relevant sectors, nutrient budgets, and key actions to be taken to close nutrient cycles across all environmental media will be developed. Innovation activities may develop and test better governance arrangements through stakeholder involvement for the realisation of a nutrient policy on local and regional levels. Actions to develop and demonstrate systemic solutions for a sustainable management of nutrients flow in Europe will enhance sustainable, inclusive, safe and healthy primary production and food systems (together with Clusters 1, 4, 5 and IA3, IA4, IA6).

The high diversity of challenges we are now facing to address the widespread and cross-sectoral impacts of the risks related to water and to secure water for all, and the relevance of water to several intervention areas of Cluster 6 and other clusters of Horizon Europe (Clusters 1, 3, 4 and 5), require a European and global partnership bringing together a broad spectrum of public and private stakeholders. It also requires the alignment and/or integration of different research and innovation agendas, coordination of funding agencies and commitments to implement a long-term strategy that would deliver major changes and impacts. It also requires the implementation of a wide range of research and innovation activities, including networking, training, demonstration and dissemination of innovative solutions. Finally, it requires more synergies between various EU funding mechanisms and investments funds. This is not possible through regular calls for proposals

and traditional collaborative projects. The proposed Water4All partnership will be goal oriented, providing measurable targets at different levels, such as, decentralised solutions, living labs, increased uptake of innovations and shared research infrastructures and data sets. Beyond scientific progress, it will support policymaking, citizens' engagement and business opportunities.

5. International Cooperation

Global challenges require strong global collective engagement. The EU led international developments towards the Paris Agreement and the 2030 Agenda for Sustainable Development. In this context and also as party to the UNFCCC¹⁷⁹, to the UNCCD¹⁸⁰ and to the UNCBD¹⁸¹ ("the Rio Conventions") it has taken ambitious commitments under this framework to limit global warming (lastly under the Paris Agreement), to achieve land degradation neutrality and to halt biodiversity loss on land and the seas. In 2015, the EU committed to the 2030 Agenda for Sustainable Development. Through successive Framework Programmes the EU supports and contributes to the work of the IPCC¹⁸² and to the IPBES¹⁸³, in terms of providing scientific evidence and science-policy-society interfaces.

Progress towards the EU Green Deal entails emphasizing the EU world leadership and renewed opportunities for research and innovation strategic cooperation and partnerships on the global issues of food and nutrition security, integrity of biodiversity or ocean health. Major efforts will continue in strengthening access to environmental observation data and information through the Global Earth Observation System of Systems (GEOSS), with the leadership and support of the European Commission as a co-chair of the Group on Earth Observations (GEO)¹⁸⁴, in order to underpin environmental policies and global commitments such as the SDGs, Sendai Framework for Disaster Risk Reduction 2015-2030, and the Paris Agreement).

International cooperation will be stepped up through strategic alliances in areas, such as food and nutrition security, animal health, soil, climate change, water management, ecosystem restoration or forest management. This will not only involve bilateral cooperation, but also multilateral cooperation, through existing networks, such as the Belmont Forum, the Bio-economy Forum or the establishment of international research consortia¹⁸⁵ (IRCs). The establishment of one IRC is expected in the area of soil and carbon.

The development of an EU-African Union Research and Innovation Partnership will be continued in areas such as food and nutrition security, sustainable agriculture (FNSSA) and climate resilience. The continuation of the partnership FNSSA in Horizon Europe is a response to the level of hunger in Africa, expanding nutritional imbalances, and the need for agriculture and food production systems to sustainably respond to rising demand and the challenge of urbanisation and migration.

Research and innovation Cooperation with China as part of the Food, Agriculture and Biotechnology (FAB) task force will continue on priority themes of mutual interest.

On the basis of the EU-India Water Partnership, and in line with the EU's strategy on India, research and innovation cooperation with India will be pursued on priority areas of mutual interest including water management and treatment, circular economy and nature based solutions for sustainable cities.

International cooperation with Brazil and the wider CELAC region will be encouraged on nature-based solutions, ecosystem restoration and natural capital in order to support relevant EU policies

¹⁷⁹ UN Framework Convention on Climate Change <https://unfccc.int/resource/docs/convkp/conveng.pdf>

¹⁸⁰ UN Convention to Combat Desertification <https://www.unccd.int/>

¹⁸¹ UN Convention on Biological Diversity <https://www.cbd.int/>

¹⁸² Intergovernmental Panel on Climate Change <https://www.ipcc.ch/>

¹⁸³ Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services <https://www.ipbes.net/>

¹⁸⁴ [GEO Mexico City Declaration: GEO Strategic Plan 2016 - 2025](#)

¹⁸⁵ IRCs are flexible platforms that allow coordination of global efforts in a specific area. The IRC Star-Idaz, supported by Horizon 2020 focuses on animal health.

and partnerships, notably addressing the objectives of the UNFCCC, the CBD, the Sendai Framework, Habitat III and the new Urban Agenda.

Leading international cooperation activities in the field of water will be also promoted with a view of supporting relevant EU policies and partnerships and water and science diplomacy. Also cooperation for all European sea basins will be key to achieve the strategic objectives for seas and oceans, particularly through the All-Atlantic cooperation and the cooperation for the Mediterranean.

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.

In the Mediterranean, marine research and innovation cooperation with a significant number of members of the Union for the Mediterranean will continue through the BLUEMED initiative. At the same time, a Strategic Research and Innovation Agenda for the Black Sea will be implemented, as part of the Common Maritime Strategy for the Black Sea.

The EU (both European Commission and several of the EU Member States) are actively cooperating with international partners within the Organisation for Economic Co-operation and Development (OECD), especially in the context of the Committee for Scientific and Technological Policy (CSTP) and its Working Parties. Among the areas of future cooperation are the bio-based economy solutions, circular urban bioeconomy and sustainability assessment methodologies of bio-based products.

6. 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 research and innovation 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

In addition to the support to the abovementioned European Partnerships, the Cluster 6 will collaborate with relevant EIT 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. A candidate European Partnership on a Geological Service for Europe would contribute to this cluster by providing expertise and data services on sustainable subsurface management.

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 research and innovation 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.

7. Missions

Depending on the scope of future specific Missions, activities within the Cluster Food, Bioeconomy, Natural Resources, Agriculture and Environment are expected to be particularly relevant to the Mission(s) identified within the "Soil Health and Food", the "Climate Adaptation including Societal Transformation" and the "Healthy Oceans, Seas, Coastal and Inland Waters" mission areas, as well as other mission areas.