Research and Innovation for a Competitive and Sustainable Europe

Policy considerations by the Helmholtz Research Field Earth and Environment

This paper complements the Helmholtz Policy Considerations on the proposals for a Framework Programme for Research and Innovation and the European Competitiveness Fund with dedicated priorities from the Helmholtz Research Field Earth and Environment. We see essential prerequisites in fundamental collaborative research, partnerships as cornerstones and clear linking of activities to funding of missions and moonshots. We urge consideration of key priorities in polar and cryosphere research, Earth Observation by satellites in tandem with in-situ monitoring, safeguarding biodiversity and ecosystem services, urban climate adaptation, natural hazards beyond 'civil security', and European space weather predictive capability.

Setting the Stage

The European Competitiveness Fund (ECF) aims to boost Europe's competitiveness by delivering technological, economic, and environmental impact. Achieving this requires a forward-looking approach that fully integrates research, innovation, and the green transition. We advocate and recognise an inherent link between the ECF's objectives and the ambitions of the Clean Industrial Deal and the European Green Deal, which aim to transform the European Union into a modern, resource-efficient, and globally competitive economy. By aligning these three (policy) frameworks in a synergistic manner, Europe can build resilience against global challenges while simultaneously leading the way in innovation and sustainable competitiveness.

A crucial foundation for this endeavour is a deep and fundamental understanding of the Earth System in all its complexity. Climate change, biodiversity loss, anthropogenic pollution, resource scarcity and geopolitical instabilities pose significant risks to European economies and societies. Earth and environmental research, as conducted by Helmholtz Earth and Environment, fosters resilience against global shocks and empowers Europe with the knowledge necessary for adaptation, risk mitigation, and the design of robust infrastructures. We thereby ensure continuity of production and supply chains and strengthen competitiveness and sustainability in uncertain times. Our research includes insights into climate dynamics, the drivers and impact of natural hazards, biodiversity, ocean and atmospheric processes, land use, and georesources. Such knowledge forms the bedrock for launching "investment journeys" that support green technologies, sustainable infrastructure, and long-term climate solutions. Helmholtz Earth and Environment converts world-class Earth System science and data into deployable solutions (e.g. climate services, hazard and risk analytics, coastal and water resilience, geoenergy and sustainable bioeconomy) that raise productivity and strategic autonomy (ECF) while advancing climate neutrality and adaptation targets (Green Deal).

Essential Prerequisites

Though the European Green Deal has almost vanished from the political landscape, the consequences of climate change become increasingly tangible - even more so as Europe is currently the fastest-warming continent, with temperatures rising at roughly twice the global average rate since the 1980s. Consequently, climate change and the resulting increase in natural disasters will profoundly impact our European way of life, affecting business and society alike. We must react and adapt to avoid detrimental economic and societal effects. The European Commission's draft of the Multiannual Financial Framework stipulates an overall climate and environment spending target of at least 35% of the total 2028-34 budget, and this should clearly be reflected in the ECF and Horizon Europe, the Framework Programme for Research and Innovation for the period 2028-2034 (FP10) activities.

The "investment journey" starts with fundamental collaborative research

The majority of challenges addressed in Earth and environmental research has a global dimension, making European collaboration essential to address these challenges. The ECF's 'investment journey' should therefore anchor fundamental collaborative research as its starting point and provide appropriate, sustained support across the ECF and FP10. If Europe lacks a strong, integrated pipeline supporting research across all TRL stages, its innovation ecosystem may become dependent on short-term technological gains and ultimately lose its long-term vitality. A bottom-up approach will maximise innovative potential of fundamental research and benefit EU competitiveness. In parallel, it is essential that applied research is demonstrated and validated towards higher TRLs, so that solutions can be upscaled together with the private sector. The governance of collaborative funding in Pillar 2 via the ECF must ensure minimal political steering in the early stages of fundamental research, in order to safeguard the autonomy of FP10 and enable creativity and breakthrough ideas. Funds allocated to FP10 must be ring-fenced for research and innovation activities, and be managed with full transparency and accountability. This approach strengthens Europe's capacity to generate knowledge, translate it into innovation, and sustain competitiveness.

Partnerships should remain a cornerstone of the R&I framework

European partnerships have been among the most effective long-term, thematically focused instruments for fostering cooperation, alignment and impact in research and innovation. Combining strategic direction with operational flexibility, they enable Europe to address major challenges while maintaining excellence and competitiveness. Partnerships already now demonstrate how structured cooperation can translate cutting-edge science into evidence-based policy support and practical implementation. The continuation of these partnerships, particularly the co-funded ones in FP10, is essential, whereas the administrative burden should be minimised and the management of the partnerships streamlined.

Funding of missions and moonshots should be clearly linked to corresponding activities

The missions have received mixed assessments. However, the Earth and environment-related missions are valuable as they provide dedicated funding streams for urgent challenges. We welcome the clear statement in the draft FP10 regulation that the Framework Programme should fund the research and innovation activities within the missions, while implementation and deployment activities should be carried out using other EU programmes and national funds. Given the scale of the missions, the challenges they aim to tackle will not be solved by 2030 and require funding beyond this date.

A proposed new feature in the Explanatory Memorandum part of the FP10 draft is the possibility of developing so-called 'moonshot projects'. As with missions, only research activities should be funded by FP10, while deployment should be supported by complementary mechanisms. Furthermore, moonshots would need to be part of the FP10 regulation with a dedicated budget. We particularly support the moonshot projects on *Zero Water Pollution* and *Ocean Observation*, which address critical environmental challenges. Additionally, data sovereignty is of central importance for various fields ranging from science to AI applications, making the moonshot topic *Achieving critical research data sovereignty in Europe* highly relevant and timely. The principle of data sovereignty should also be mainstreamed throughout the implementation of FP10.

Key Priorities

The Specific Objectives of the four ECF policy windows cover broad aspects of environmental sustainability research. FP10 and ECF will also need to support the implementation of important European strategies, such as the Ocean Pact, the EU Water Resilience Strategy and the EU Chemicals Strategy for Sustainability towards a toxic-free environment. In our view, the following key priorities sare currently not sufficiently considered:

- Polar, high-altitude and cryosphere research, including glaciers, permafrost, and ice dynamics: The *Clean Transition and Industrial Decarbonisation* policy window highlights climate and water resilience, yet omits the cryosphere and polar regions. Europe is a global leader in polar and cryosphere research and possesses world-class infrastructure for exploring these regions. To maintain this leading position, sustained support is required. Ongoing climate change will profoundly transform the Arctic. Robust adaptation measures are needed to address these transformations and safeguard assets, communities, and ecosystems. Polar research provides the knowledge foundation to steer adaptation. At the same time, seasonal-to-subseasonal sea-ice forecasts and improved coupled prediction systems can enhance shipping, fishing, and offshore planning, thereby fostering the economic development of the region.

- Earth Observation by satellites in tandem with in-situ monitoring: *Article 60* on space-based Earth Observation underscores the importance of Copernicus monitoring services, reinforced by the proposed 'moonshot project' on *Ocean Observation*. A holistic observation of the Earth System requires the combination of satellite data with data from terrestrial, marine, and atmospheric *in-situ* networks, including long-term stations and ecosystem transects. Such an ecosystem for Earth Observation data must capture relevant spatial and temporal evolutions to ensure the necessary accuracy and reliability, enabling both daily forecasts and the detection of decadal climate change signals. Complementary opportunities arise in subsea observations using fibre-optic sensing methodologies embedded in telecommunication cables, which at the same time offer the opportunity to bolster the resilience of communication infrastructure and security aspects. We propose that this is addressed in the ECF. The evolution of Earth Observation networks must be tightly linked with innovative data systems to train AI models and assimilate sensor data into digital twins while ensuring European data sovereignty. Sustained investment in these integrated systems will consolidate Europe's leadership in Earth Observation and strengthen its ability to deliver competitive, science-based climate and environmental solutions.

- Safeguarding ecosystem services that provide the goods and resources essential for society and the economy is essential for Europe's future competitiveness. Agricultural and forestry chains are explicitly mentioned in the policy window *Health, Biotechnology, Agriculture and Bioeconomy*, but ecosystems and their services require a wider perspective. We need a profound system understanding and sustainable management in order to become more resilient to climate and human pressures and enable a competitive bioeconomy. Halting biodiversity loss and its impacts on ecosystem services is still an unsolved challenge with tremendous economic implications. Research into ecosystems undergoing critical transitions and socio-ecologic innovations need to be given greater weight, ensuring that Europe contributes to international efforts in conservation, restoration, and sustainable management of natural resources. The development of multifunctional landscapes can provide multiple benefits for economy, human health and biodiversity. This necessitates a research axis on soil functions. In addition, restoration of land outside direct economic utilization, such as inland renaturation and ecosystem and peatland recovery are aspects vital for sustaining ecosystem services, climate regulation, and long-term resilience.

- Urban environmental and climate adaptation should be explicitly included in the *Clean Transition and Industrial Decarbonisation* window. Resilience and pollution are mentioned, but the development of a dedicated urban transformation agenda is lacking. Priorities should include heat management, water and flooding, mobility, and nature-based solutions, with strong urban-rural linkages as well as attention to societal drivers and impacts. Research must be solution-oriented and co-designed with stakeholders, such as affected citizens, local authorities, and businesses to strengthen infrastructure and build societal and community resilience for long-term sustainability. Addressing these challenges directly supports public health, reduces environmental risks, and safeguards Europe's economic potential.

- Natural hazards & processes of the solid Earth System beyond 'civil security': The policy window *Resilience, Security, Defence Industry and Space* mentions Copernicus/EOGS and Space Weather and refers to disaster prevention. What is lacking is a technical agenda on geological processes and early warning systems. Earthquakes, landslides, volcanoes, floods, droughts and tsunamis cause significant damage every year. The path towards reduction of this damage requires innovations to monitor, analyse and simulate the forecasting of hazards, risks and their causes. There is an urgent need for innovative impact-based forecasting tools. Standardised and homogenised data integration, analysis, and actionable decision support systems must be implemented. Resilience requires that a research-driven approach to attributing extreme events and cascade risks across sectors is included. This also applies to research on subsurface resource management, underground storage (CO_2/H_2) and groundwater recharge and protection as a resource issue.

- Advancing European space weather predictive capability through integrated modelling and AI innovation: Advancing long-term space weather prediction is vital to Europe's strategic autonomy and technological competitiveness and is pursued under the ECF's *Resilience, Security, Defence Industry and Space* window. Reliable forecasting of solar wind and geomagnetic activity requires coupling solar wind, magnetospheric, and ground-based models, enhanced through data assimilation, artificial intelligence, and machine learning. These integrated methods will improve Europe's ability to anticipate and mitigate space weather impacts on critical infrastructures such as energy grids, satellites, and communications. Further progress in ensemble simulations is needed to achieve dependable 1-2-day forecasts before major events. Such innovation-driven capabilities will enable stakeholders to risk-based decision-making, reinforcing the Union's competitiveness, preparedness, and strategic independence in the space and digital domains.

The use of digital twins should be supported across all environmental and societal systems as they enable data-driven innovation and link fundamental science with real-world applications across sectors. They strengthen Europe's technological sovereignty, accelerate the green and digital transitions, and enhance resilience through predictive, collaborative modelling.

About Helmholtz:

Helmholtz is Germany's largest research organization. At Helmholtz, more than 47 000 people work together to develop solutions and technologies for the world of tomorrow. With an annual budget of six billion euros and long-term, interdisciplinary research programs we address global challenges. The research field Earth & Environment comprises the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), GFZ Helmholtz Centre for Geosciences, GEOMAR Helmholtz Centre for Ocean Research Kiel, Helmholtz-Zentrum hereon GmbH, Forschungszentrum Jülich GmbH, Karlsruhe Institute of Technology and Helmholtz Centre for Environmental Research – UFZ.

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