Major opportunities in the Research Field Earth and Environment in Europe

Position paper by the Helmholtz Association

a) Introduction

Life on Earth is undergoing profound change. The human population is growing steadily and by mid-century is expected to approach the 10 billion mark – with everyone needing water, food, energy and a sustainable and healthy environmental life support system. At the same time we are witnessing strong changes in the natural realms of our planet, like climate change, land use, industrialisation and urbanisation. Conserving and sustainably developing the structure and functions of the environment, and successfully confronting climate change, loss of biodiversity and habitat represent continuously growing challenges to policy makers, industry and society as a whole. Substantial research and leadership efforts coordinated at the European level are required, to successfully meet these local, regional and global challenges. Scientific knowledge aids people in making the necessary transformations, with Earth system research delivering important insights needed to achieve the 2030 Agenda for Sustainable Development and its goals (SDGs), the Paris Accord and the Sendai framework for Disaster Risk Reduction. All United Nation Agreements highlight the essential role of research and innovation in addressing those challenges and should play a very significant role in FP9 and represented across all thematic clusters.

b) Future Directions

The following four key research topics of the future are related to the Global Challenges such as fighting Climate Change and sustainably managing natural resources along the lines set by the 2030 Agenda for Sustainable Development. These topics should be addressed at the European level:

Regional and global impacts of global change

These impacts are decisive in developing future strategies of mitigation and adaptation but have not yet been sufficiently clarified, are still hardly predictable and may even be more severe than currently expected. Latest model results e.g. predict larger droughts in Central Europe than anticipated ever before. To achieve the better understanding and prediction capabilities, future research must address the quantitative assessment of remaining knowledge gaps and further advance our monitoring and real-time management. This should be supplemented by global and regional Earth system models, dedicated process studies and the development of big data analysis methods for evaluating the trends, probabilities and adaptation measures associated with changes in regional conditions and especially urban systems.

Protection and sustainable use of natural resources

This concerns geological (metals, minerals, rocks, energy), biological (plants, animals, microorganisms) and natural (water, air, soil, nutrients, habitats) resources. Research focuses on sustainably managing and using resources from land and sea, including through their exploration, monitoring, protection, restoration and valuation. In addition, a concept for a sustainable bio-economy expected to support the development of bio-based production systems for food, feed, chemicals, materials and energy that work without the need for fossil resources and incorporate the socio-economic dimension.

Holistic and disaster risk reduction approach to mitigate impacts of natural hazards and extremes

Developing systems to protect against hazards such as earthquakes, volcanic eruptions, tsunamis, hurricanes, storm tides, droughts, forest fires, landslides and flooding requires an improved understanding of their trigger mechanisms. The great challenge in this field of research lies in applying the holistic approach, covering all aspects from the estimation of natural hazards and their probability of occurrence to the real perception and

assessment of risks. The development of protection systems requires the development of mobile observation platforms that can be deployed during hazards and events and that are able to improve our understanding of occurrence of hazards and events and will enable the implementation of early warning management systems and strategies.

Fighting the loss of biodiversity, habitats and ecosystem functions

Research focuses on the analysis of existing and potential future ecosystem services in the marine and terrestrial sectors, including suitable protection and management options. The challenge here is to achieve a sustainable utilisation of the Earth's systems under the conditions of global change. Beyond this, the manifold interrelationships between the ecosystems and their exploitation by humans need to be better analysed and quantified in order to generate cross-system strategies on managing man's use of the Earth system. Research into the natural and man-made dynamics of functional diversity contributes significantly to the management and protection of habitats and their biodiversity.

The Earth system is extremely complex. Therefore we have to consider a large number of subsystems, such as the atmosphere, biosphere, geosphere, hydrosphere, cryosphere and anthroposphere, as well as the interactions between them. Furthermore it is necessary to align the broad variety of different methodological pillars of observation, experimental process simulation, consideration of the whole value chain, modelling and developing course of action. The application of research infrastructure, such as satellites, research vessels, research aircraft, observatories, simulation chambers, is indispensable for obtaining new findings in these scientific fields.

c) Missions for FP9

The Helmholtz Research Field Earth and Environment has identified three proposals for missions in FP9. We are convinced that these missions have the potential to bring important benefits to citizens with regard to environmental issues. These missions have already been sent to the European Commission in 11/2017.

- ***"BlueOCEAN – Providing the Healthy Ocean we need for the Future we want"***
  Sub-Missions: A Plastic Free Ocean, A Sustainably Harvested Ocean, A Well Planned/Governed Ocean, A well Observed Ocean.
- ***Securing Resources, Functions and Services of Future Land and Freshwater Ecosystems***
- ***Sustainable livelihood in a changing climate***

(For further details please see our mission paper, updated March 2018.)

Activities are pursued at 8 Helmholtz Centres: *the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), the Forschungszentrum Jülich (FZJ), the GEOMAR Helmholtz Centre for Ocean Research Kiel, the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the Helmholtz Zentrum München – German Research Center for Environmental Health, the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, the Helmholtz Centre for Environmental Research – UFZ, and the Karlsruhe Institute of Technology (KIT).*

Brief portrait of the Helmholtz Association

The Helmholtz Association contributes to solving major challenges facing society, science and the economy with top scientific achievements in six research fields: Energy; Earth and Environment; Health; Key Technologies; Matter; and Aeronautics, Space and Transport. With some 39,000 employees in 18 research centres and an annual budget of more than €4,5 billion, the Helmholtz Association is Germany's largest scientific organisation. Its work follows in the tradition of the great natural scientist Hermann von Helmholtz (1821-1894).

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