Concept: Future Earth – Belmont Forum Collaborative Research Action – Oceans

Background and rationale

Oceans provide vital ecosystem services to humans, and these services are currently under multiple stresses that are both increasing and changing, creating complex, often unpredictable feedbacks. Defining acceptable targets for ocean health and sustainability, establishing the knowledge base needed to maintain and improve the health of ocean systems, and developing systems to predict and respond to shocks or disasters to and from ocean systems all represent critical research needs. Our capacity to chart a course from knowledge of ocean systems to changes in policies, practices, governance, and behaviors that will assist in sustaining those systems will depend on our ability to develop scalable, integrated and systems-approaches to these issues.

Developing these systems approaches will require integrated transdisciplinary ocean research that can speak to decision-makers around the world. In September 2015, the United Nations adopted the Sustainable Development Goals (SDGs). SDG-14 specifically identifies 10 targets that are relevant to the oceans. Ocean health research is relevant to other SDGs as well, such as SDG-13 (climate change) and SDG-2 (food security). In addition to the SDGs, healthy and sustainable ocean systems are also the focus of several other global policy processes, including the Convention on Biological Diversity, the Intergovernmental Platform on Biodiversity and Ecosystem Services, the Intergovernmental Panel on Climate Change, the United Nations Convention on the Law of the Sea, the Port State Measures Agreement, and others. All of these policy processes require integrated knowledge to manage the tradeoffs inherent in decision-making.

Because the threats to ocean ecosystems are complex, the research community must take a cooperative and integrated approach to oceans research and prediction, bringing together the natural and social sciences and economics, as well as partnerships with policymakers, resource managers, industries and other societal partners. Future Earth has a great deal of knowledge to address these challenges, however external partners (e.g. the World Climate Research Program, the Global Ocean Observing System, the Scientific Committee on Oceanic Research, the Intergovernmental Oceanographic Commission, the International Ocean Carbon Coordination Project, and various Regional Fisheries Management Organizations) will also be vital. The research community will need to integrate models, observation systems, analytics and experiments to create the knowledge required to map pathways and identify tradeoffs in conserving ocean health. The research community must also be open to new ideas and theories. There is a pressing need to develop a systems approach in which interactions between multiple domains (the oceans, atmosphere, cryosphere and land) and multiple complex systems (physical, chemical, ecological, evolutionary, economic, governance, and social systems) are integrated to inform projections.

Because of the volume of data and the complexity of the modelling and data assimilation needed, the research community will require new capabilities, skills and infrastructure. These may include big data analytics, visualizations, informatics, quantum computing, artificial intelligence, and more. Finally, these projections must also take into account the value of the

oceans to human societies around the world, and the need to translate and communicate the scientific results to non-scientists. Such an approach is illusive because value cannot always be calculated in monetary terms and can also involve many tradeoffs between competing interests. Finally, effective research programs must also consider scale, integration and delivery; while many of the major threats to the oceans are global, their impacts are often manifested at regional and local scales.

Call topics/work packages

1. **Building pathways toward the sustainable and equitable use of oceans**
   Research proposals in this work package should focus on the environmental, social and economic impacts of living (e.g. fisheries) and non-living (e.g. energy and minerals) resource extraction on ecosystems and human societies and economies, and / or the impacts of other non-extractive industries related to the oceans, such as shipping, transportation, tourism and coastal development. Proposals may use a range of approaches, but are expected to incorporate or address models, scenarios and pathways that can directly support the sustainable use of marine resources. Such models, scenarios and pathways should carefully consider scale dependence and research teams should be prepared to integrate their methods and results with related research efforts.

2. **Modifying pathways to account for and minimize the negative impacts of global change on the oceans**
   Our capacity to sustainability extract resources and derive services from the oceans depends on our understanding of the multi-scale changes in ocean systems, and the additive, antagonistic, and synergistic effects of the multiple drivers and stressors of these changes. Research proposals in this work package should focus on the interactions between stressors, such as ocean acidification, deoxygenation and food scarcity, and ocean dynamics, such as circulation, temperature, sea level, population growth and migration, as well as the changes in goods and services, including wellbeing, that humans derive from oceans. Researchers in this work package should be prepared to integrate their methods and results with related research efforts.

3. **Exploring and minimizing the impact of pollution on pathways to ocean sustainability**
   This work package focuses on understanding the links between pollution and ocean health. Work in this area will require an articulation of the impact of key pollutants on ocean goods and services and a mechanistic understanding of the delivery systems (social, natural and physical) of these pollutants. Only by integrating these links into new and existing ocean sustainability pathways can we develop actionable science that can inform behavior change among individuals, regulators and industries. Pollutants of interest include but are not limited to pollutants from agriculture, manufacturing, industry and shipping and waste, such as sewage, nano-plastics, toxins, radioactive materials, hydrocarbons, and byproducts from new technologies. Researchers in this work package should be prepared to integrate their methods and results with related research efforts.

4. **Predicting, mitigating, and responding to ocean disasters to reduce risk**
   Climate change, rising sea levels, changing storm patterns and the increasing complexity of human use of ocean and sub-ocean resources collectively create a range of risk factors that vary and interact across space and time. Proposals in this work package may focus on the prediction, mitigation, adaptation, valuation and response to ocean disaster risk. The Belmont Forum encourages consideration of interactions between global environmental change and ocean related disaster risks, as well as disaster response strategies that reduce vulnerability and increase resilience in social, natural and physical systems. Researchers in this work package should be prepared to integrate their methods and results with related research efforts.