



OCEAN FRONTIERS FOR SUSTAINABLE DEVELOPMENT

CONTRIBUTING TO THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS & THE UNITED NATIONS DECADE OF OCEAN SCIENCE INITIATIVES



FRONTIERS IN OCEAN RESEARCH

The Ocean is the cradle of life and the central component making our planet habitable. Being the largest ecosystem supporting life on Earth, it is paramount we maintain and restore its health in a global context. Thus, the Ocean needs to be present on every agenda for the sustainable development of the world's population, societies and economies. This manifesto advocates for the increased understanding, protection and management of the Ocean to support the health and wellbeing of present and future generations.



MANAGE OCEAN COMPLEXITY

The Ocean is by far the largest reservoir of heat in the global climate system and exerts a fundamental contribution in regulating global warming over short (decades) and long (millennia) time scales. Human population growth and climate change are major drivers acting on all ecosystems, with the Ocean being no exception. Increasing temperatures at all depths, acidification, sea level rise, loss of biodiversity, migration of species and habitat destruction and degradation are all consequences of these drivers. Hence, it is necessary that cumulative human pressures (e.g. pollution, plastics, maritime traffic, overfishing, aquaculture, eutrophication, seabed mining, introduced species), the interactions of stressors, and their combined effects on Ocean ecosystem composition and function are understood, assessed and sustainably managed to allow the same opportunities from the Ocean for our future generations. A systemic approach for the integrated assessment of the state of marine ecosystems and the resilience to cumulative pressures is key to promoting the responsible use of marine resources without compromising the future of our Ocean and consequently the future of humankind.

We need to understand and assess the complex interactions of marine systems, anthropogenic drivers and the role of global cumulative impacts with regard to the provision of goods and services in a changing environment. A safe and resilient Ocean will provide more food and other societal benefits, including increased employment, without compromising our future.



SECURE COASTAL AREAS

Global mean sea level is expected to rise by the end of this century and will have a direct impact on coastal areas which currently accommodate over 40% of the world's populations. This coastal population is increasing disproportionately and it is expected that the majority of future megacities will be located on the coast. These are also areas that sustain keystone breeding and nursery habitats for commercial seafood stocks, have important carbon sequestration functions and constitute the major focus for commercial, aesthetic and touristic activities. The future will thus pose several challenges for the management of coastal areas, from the huge increase in anthropogenic pressures to the need for reconversion and adaptation of present day urban infrastructures. Today, we have the opportunity to develop and demonstrate new nature-based and smart eco-engineering solutions for the sustainable development of our marine urban areas, thereby safeguarding our future wellbeing.

We must create innovative and coordinated solutions for safe, inclusive, smart, resilient and sustainable marine urban spaces. New monitoring, conservation and restoration measures of marine urban spaces should expand the “Blue” component of present day “Grey” cities, to benefit local populations and global Ocean health.



TARGET OCEAN AND HUMAN HEALTH

Oceans can affect human health in many ways through ingestion of pathogenic microbes or algal toxins, or exposure to toxic chemicals such as mercury, lead and pesticides that can cause severe illness. Oceans can also provide enormous human and industrial benefits, through the provision of protein, pharmaceuticals, biofuels and more which in turn support jobs and national economies. A healthier Ocean that is better managed could ensure that the benefits from the exploitation of Ocean resources are sustainably and equitably shared. However, we still face significant gaps in our knowledge of the Ocean. We still have not determined how to balance its opportunities while nurturing the health of its ecosystems. Many species in marine ecosystems are not yet described, and their ecological role and associated services not identified. Just as the study of the human microbiome has revolutionized the field of human health, the study of the Ocean microbiome opens up a new field of discoveries and knowledge. Ocean microbiomes and connectivity between ocean regions are major drivers of biogeochemical processes and play an essential but still poorly understood role in the functioning of marine ecosystems. A better understanding of the complex interactions between oceans and human well-being could allow for the better management of marine resources while preserving all the Ocean ecosystem services provided to our societies.

There is a need to achieve global healthy oceans by characterizing major ecosystems and understanding the functioning and connectivity of local marine ecosystems to: (a) preserve and enhance associated Ocean services such as increased provision of food, discovering new pharmaceutical products, developing renewable sources of energy, improving recreation and transport; (b) maintain and increase all the cultural and aesthetic services provided to future societies.



PROTECT OCEAN COMMONS

Societies and individuals across the globe benefit from the natural and cultural benefits and services provided by the Ocean. The distribution of these “Ocean commons” is changing. The melting Arctic ice cap, reduction of wild seafood provision, emergence of harmful pathogens and parasites, and previously inaccessible Ocean spaces (e.g. the deep sea) now increasingly within human reach, are challenges that need to be addressed by responsible Ocean governance to reduce the potential for conflict at all levels and ensure human well-being. Current knowledge on how to relate and govern Ocean dynamics and associated societal changes is fragmented, and observations of resource distribution and dynamics are scant and insufficiently accessible. We need to advance theory, observations and modelling of the complex global Ocean to forecast, manage and mitigate these changes. New platforms, sensors, methods, holistic approaches (e.g., systems biology, meta-omics, and ecosystem approaches) and novel theoretical frameworks linking evolutionary theory and oceanography as well as marine social sciences and humanities can provide an integrated framework to inform decision making on the governance of the Ocean commons. Empowering Ocean observations (e.g., citizen science framework, robotics, artificial intelligence) and robust science-based thinking at national and international levels will promote diplomacy and wider societal actions to support responsible and sustainability-enhancing Ocean governance.

Better predictions, observations and theory are needed to manage and share the “Ocean commons” in a fair and responsible way under the present global challenges. These will also ensure that the benefits from the exploitation of Ocean resources can be sustainably managed and equitably shared.

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