

# Global Ocean and Human Health Program

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## Abstract

*A healthy ocean is foundational for a healthy planet.*

*A healthy planet is foundational for healthy people.*

This *Ocean Shot* addresses the need for an international program to meet the challenges at the intersection of ocean health and human health. We propose creation of a Global Ocean and Human Health (GOHH) Program, to build a transformative network encompassing essential research and engineering, policy, and economic concerns relevant to ocean and human health in the U.S. and globally. The GOHH would involve new research, linking biology, chemistry, toxicology, oceanography, engineering, epidemiology, economics, and public policy. Communities would participate in developing questions and solutions for ocean risks in their locales. Development of novel sensor technology to map global movement of ocean pollutants and natural hazards, enabling mappng to health outcomes, and mitigation of adverse impacts. Collaborators would integrate economic impacts and policy options. Global partners will leverage research and participate in assessment, education, communication and policy, shifting the balance from risk to benefit.

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## Justification

Human impacts on the ocean have accelerated for decades, and the severity of these impacts is expected to grow with increase of coastal populations, expansion of ocean use, and changing climate. These combine to increase the risks to both ocean and human health. Among the risks are chemical and biological risks: pollution, pathogens, harmful algal blooms, and plastics. These risks to the ocean and humans can diminish the benefits the ocean provides, adversely affecting global efforts to achieve Sustainable Development Goals.

There has been rising concern about the risks to ocean health from the global Ocean community, but only recently have studies begun to show the degree to which pollution may affect ocean and human health. Globally, interest in the ocean and recognition of its role in planetary health are surging. Many governments, agencies, NGOs and institutions are calling for action to address what adversely affects the health of the oceans, and subsequently humans.

There is desperate need for a coherent program to catalyze and coordinate the science, policy, and community linkages to address these problems on a global scale, and to positively impact ocean health, and human health and well-being of current and future generations,



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## Background

The impact of pollution on health is of major importance. The Lancet Commission on Pollution and Health implicated air pollution in millions of premature deaths per year (Landrigan *et al*, 2018). High levels of ocean pollution also are linked to adverse health outcomes (Landrigan *et al*, 2020). Background levels of exposure now are being linked to neuro-cognitive deficits, cardiovascular disease, immune suppression, and other effects, with most exposure occurring through seafood (Landrigan *et al*, 2020). Health threats from human pathogens (Stewart *et al.*, 2008) and algal toxins (Anderson *et al.* 2021) are increasing. The levels of such risks are still poorly known in many areas of the Global South and some in the Global North. The **GOHH Program** will pursue assessment of risks globally, and innovative research on detection methods including ocean sensor technology that can lead to early warning and improved forecasts of threats from harmful algal blooms, chemicals, and pathogens. The global assessment will inform linkage of ocean pollution to health and economic impacts, and be balanced against benefits from the oceans, assessed in collaborative programs. Community involvement will help guide assessments, and focus on inclusion and diversity.

**For more, essential background, see Consortium of Universities for Global Health videos on oceans and health:**  
<https://www.cugh.org/human-health-and-ocean-pollution-addressing-the-urgent-crisis-to-save-the-planets-oceans-and-save-ourselves/>  
**And the Monaco Declaration on Pollution:** [https://www.centrescientifique.mc/uploads/documents/fr\\_Declaration%20de%20Monaco.pdf](https://www.centrescientifique.mc/uploads/documents/fr_Declaration%20de%20Monaco.pdf)

## Challenges addressed

The proposed Global Ocean and Human Health Program addresses multiple Ocean Decade Challenges, and provides a unifying theme for addressing nearly all of the challenges in the Ocean Decade goals.

- Human activities have a wide array of impacts on the ocean, particularly in coastal environments. The severity of these impacts is expected to grow with the projected increase of coastal populations and expansion of the ocean economy. Minimizing these potential impacts is crucial to ensuring the sustainable long-term use of the ocean to feed and economically sustain populations and nations worldwide (**Challenges 3 and 4**).
- The essence of the concept is on understanding and characterizing sources, magnitude, and distribution of contaminants and natural hazards, and their impacts on human & ocean health (**Challenge 1**).
- This also involves understanding and mitigating the impacts of climate change on these risks (**Challenge 5**),
- Climate impacts can combine with contaminants and hazards to produce multiple stressors on ocean ecosystems (**Challenge 2**).
- The Ocean and Human Health concept also shall seek to enhance infrastructure, through developing new capabilities for detecting chemical and biological threats, to provide multi-hazard early warning of contaminant and natural hazards (**Challenge 6**)
- New capabilities will contribute to a sustainable ocean observing system (**Challenge 7**).
- The concept address foundational challenges in providing equitable access to information and technology (**Challenge 9**), and
- Broadens the understanding of the ocean globally (**Challenge 10**).



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## Vision: The Global OHH Program Hub and Networks

**Global Ocean and Human Health Program**

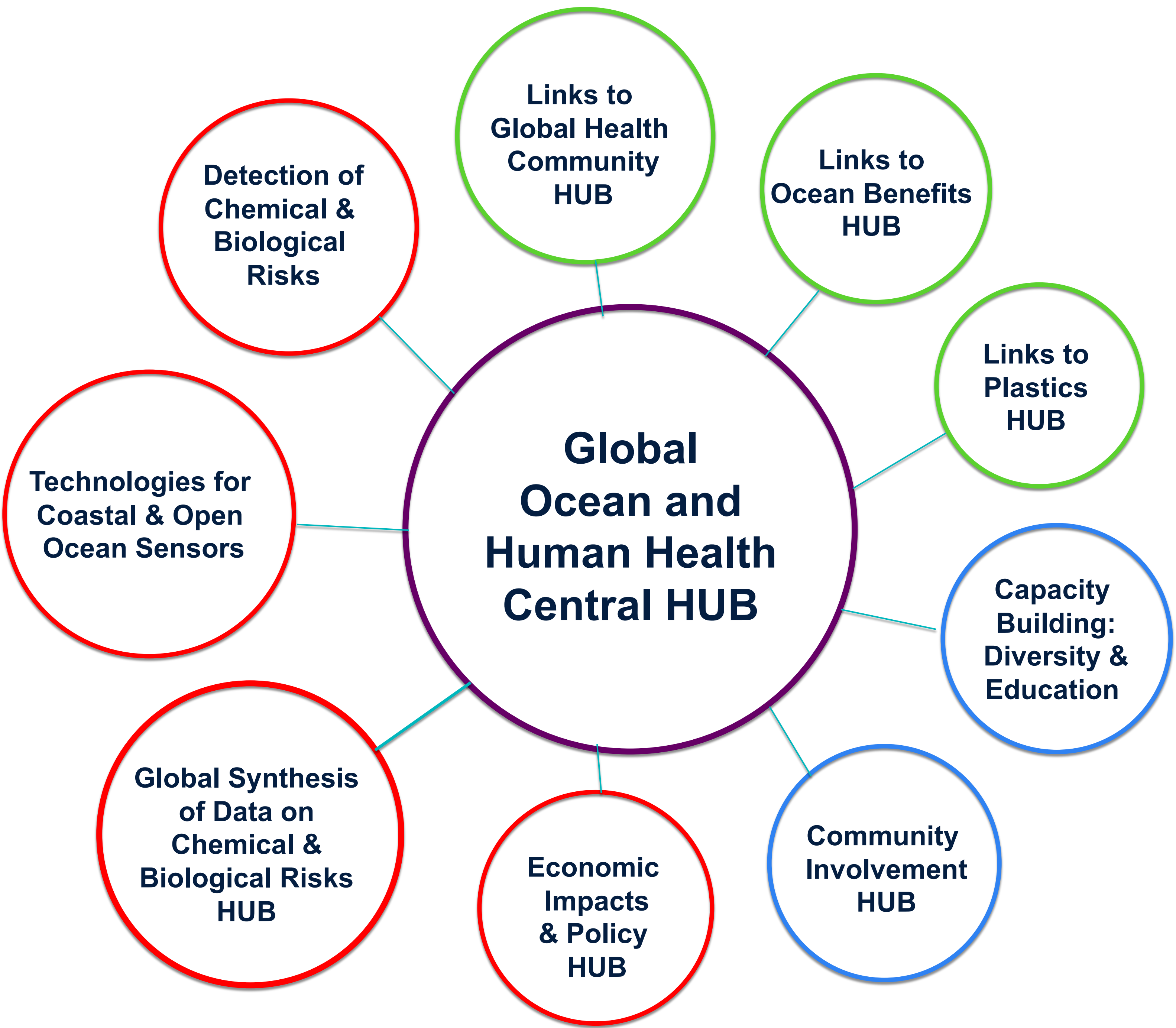
The Vision is to create a central “Hub” that connects data syntheses, research and sensors that can link risk to health outcomes and economic impacts, thereby guiding capacity building, inclusion, and education of researchers and the public, with active involvement of coastal communities globally.

The vision for the Global Ocean and Health Program mirrors the vision for the UN Decade overall.

The Program will meet broad objectives by:

- 1) Establishing new research on key aspects related to risks to oceans and humans.
- 2) Engaging research units worldwide to create a global synthesis of chemical and biological risks.
- 3) Involving communities in identifying areas where risks are not adequately addressed.
- 4) Involving partners and collaborators in the peripheral Hubs to identify new connections and build out to other platforms focused on education and research on ocean and human health in developing areas of the globe.
- 5) Link with major programs of others, focused on various aspects of ocean research, to form a coherent and comprehensive network of programs to balance both risks and benefits from the ocean.

The Global Ocean and Human Health Program will inform policymakers and the general public, on local and global scales with its findings to assist policy formulation.



Red, research; blue. Community activities,; green, links to others' programs

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## Connections to existing infrastructure, technology, and partnerships

### Overall

The GOHH Program leverages and builds on existing scientific infrastructure and partnerships. The U.S. Oceans and Human Health programs (partnerships between NSF, NIH, and academic research institutions, and NOAA) launched in 2004 have been advancing understanding and building research capacity in the U.S. and have already coordinated extensively with European OHH programs. The U.S. National Office for Harmful Algal Blooms facilitates coordinated research and response to HAB events domestically and has extensive global connections, including in developing countries. Integration with ocean observing infrastructure (Ocean Observatory programs – OOI, IOOS, GOOS) has the potential to provide early-warning and global monitoring of contaminants, harmful algae and their toxins, and pathogens that impact human health, particularly in at-risk communities. Data management will be modeled on the US National Biological and Chemical Oceanography Data Management Office (BCO-DMO), essential to sharing data.

### Research directions

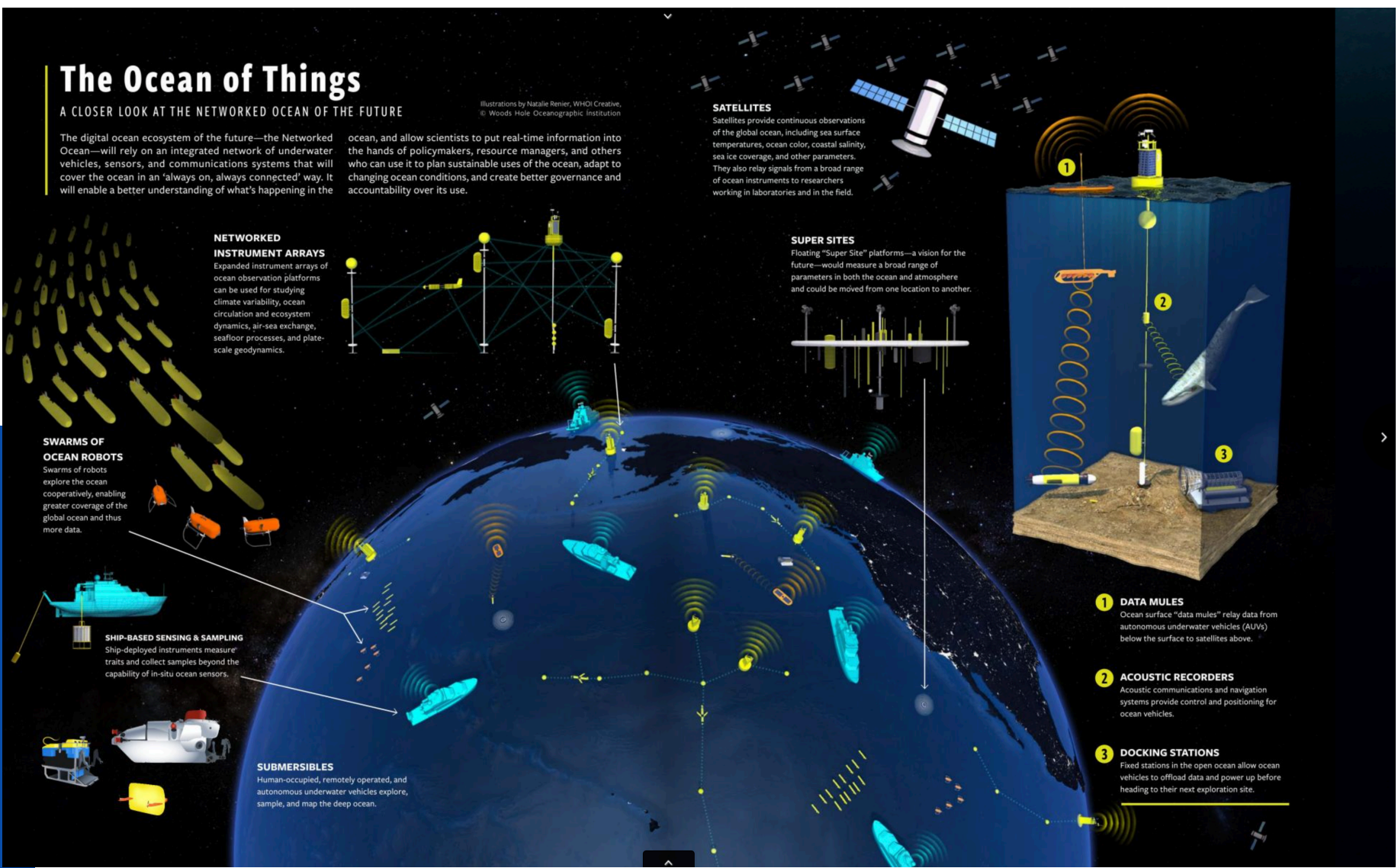
Innovative research will form a key part of the GOHH Program. The research on new detection methods for legacy pollutants and emerging pollutants will build on work done at WHOI to develop Mass Spectrometry methods that can used *in situ* in the ocean. Likewise, genomic methods and eDNA for detecting pathogens and HAB species will be extended to additional species and strains.

Critical research will target expanding the capabilities of remote, autonomous sensors to detect pollutant chemicals or biological agents, providing a high-frequency, in situ ocean observing capability akin to meteorological sensors and data used for early warning and forecast of weather events. The goal is to have the capability to detect meaningful levels of human health risk in coastal and open ocean waters on a real-time basis as part of a globally networked ocean.

**Long term goal: Chemical and biological hazard measurements as part of globally networked ocean, linked to health of ocean and people.**

### GOHH Partnerships

The GOHH Program will partner with existing programs that have compatible objectives. These will include the U.S. Centers for Oceans and Human Health. These are located at the Woods Hole Oceanographic Institution, the Bowling Green State University, the University of S. Carolina, and Florida Gulf Coast University. In addition, we would partner with international programs including the Blue Climate Initiative (Tetiaroa), The European Centre for Environment and Human Health (Exeter UK), the Minderoo Foundation (Australia), and others to be added.



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## Opportunities for international collaboration and capacity-building

### International collaboration

International collaboration is essential to the Global Ocean & Human Health Program.

Just as the ocean knows no international boundary, global connections must form an essential part of the effort to accomplish the objectives of the GOHH Program and research concept. The participants and collaborators in the proposed program currently have strong connections to related efforts and programs in Europe, South and Latin America, Asia and Southeast Asia, and to nascent efforts in many developing countries. Collaborators would help identify new partners, and the GOHH could quickly move to engage, catalyze and coordinate innovative efforts globally.

Initial international effort would synthesize existing data on levels of chemical and biological threats globally. An example is the Global HAB Status Report (Hallegraeff et al., 2017), appraising current knowledge of HAB occurrences across the world oceans. The Network Hubs would ensure mutual sharing of data and findings in all relevant areas.

### Capacity building

The GOHH would support research capability and foster strength in science throughout the Networks, helping to improve ocean and human health research on a global scale.

The GOHH would serve as an information portal for communities at greater risk from pollutants and natural hazards, especially in vulnerable areas, indigenous communities and the Global South to address questions of environmental justice. Connections would enable sharing of new approaches and identify opportunities for research training and education in trans-disciplinary approaches to broaden participation in the ocean sciences.

Capacity building will include collaboration with other Ocean Shot efforts, and GOHH Hubs to enhance the training and research capabilities, including in developing countries.

### Education

Training the next generation of scientists will be essential to the continuation of the research, management, and direction of the GOHH activities. Educational activities will include cross-disciplinary training through existing programs in high-income countries, aiding and strengthening of programs of education in developing countries, and ensuring inclusion and diversity in all programs. The GOHH participants and collaborators include members who focus on diversity and inclusion.



**Objective:** Global Research, Assessment, Education and Community involvement, for ocean and human health

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## Core Participants: Co-authors and Collaborators

### Initial Participants

The GOHH Program Concept was developed in the Woods Hole Center for Oceans and Human Health, with participation from others in the Woods Hole science community. Thus, the GOHH would be established initially in Woods Hole, where there are multiple strengths in essential aspects of the program. Individuals or groups have extensive contacts to create and link to the peripheral HUBs in the geographic and thematic areas. Investigators, including students, in the four NIH/NSF Centers for OHH would assist in building networks to contribute to diverse objectives of the GOHH Program.

### Establishing the GOHH Program

An Initial Steering Committee would be convened from the pool of co-authors and collaborators. (See next page.) This committee will identify leaders who would assist in forming and connecting to peripheral Hubs, expanding the networks to address program objectives. The Committee would then be revised, ensuring that geographic and community interests, and diversity, are fully incorporated in the GOHH Program as linkages and activities expand.

### GOHH Co-authors

**John Stegeman, Ph.D.** Molecular toxicologist and Director of the Woods Hole Center for Oceans and Human Health. He will chair the Steering Committee.

**Donald Anderson, Ph.D.** Dr. Anderson is a world leader in HAB research and the application of remote sensors for detection and monitoring.

**Richard Camilli, Ph.D.** Dr. Camilli’s research focuses on autonomous vehicles and he has engineered mass spectrometry methods for chemical detection in situ

**John Farrington, Ph.D.** Dr. Farrington is an organic biogeochemist and Dean Emeritus, at WHOI. He has broad connections in both the biogeochemistry of chemical pollution and in academic communities.

**Mark Hahn, Ph.D.** Dr. Hahn studies molecular mechanisms by which pollutants and natural products (and HAB toxins) affect human and marine animal health. He also leads the marine microplastics initiative at WHOI, and will coordinate that area.

**Katherine Hubbard, Ph.D.** Dr. Hubbard will participate in developing new genomic methods for detecting HABs and other target organisms. She has a deep interest in educating the next generation of OHH scientists and would aid in that as well.

**Ambrose Jearld, Ph.D.** Dr. Jearld is renowned for promoting diversity and inclusion in science, and will act in that Hub. He also brings extensive experience in fisheries and connections to NOAA.

**Di Jin, Ph.D.** Dr. Jin is a marine resource economist involved in research on policy and economic aspects of ecological services, pollution, and mitigation.

### WHOI Collaborators

**Michael Brosnahan, Ph.D.** Dr. Brosnahan’s research is on the control of harmful algal blooms and on the development and application of in situ sensors.

**Ken Buesseler, Ph.D.** Dr. Buesseler is a radiochemist who studies the fate and distribution of radioactive elements in the ocean. He has done major work on the Fukushima accident.

**Julie Huber, Ph.D.** Dr. Huber focuses on microbial impacts on human and planetary health, and has a deep interest in diversity and inclusion in science.

**Dennis McGillicuddy, PhD.** Dr. McGillicuddy is an oceanographic modeler, Chair of the Applied Ocean Physics and Engineering Department (WHOI) and Co-director of the Woods Hole COHH.

**Michael Neubert, Ph.D.** Dr. Neubert is Director of the Marine Policy Center at WHOI. This Center will be a catalyst for the policy Hub, connecting with other policy groups in the US and elsewhere.

**Christopher Reddy, Ph.D.** Dr. Reddy is well known for work on natural products that resemble industrial chemicals, and on the chemistry of oil spills.

**Mak Saito, Ph.D.** Dr. Saito’s research includes world-leading proteomic analysis of the oceans, which may be important in assessing conditions where pollutant chemicals occur at high levels. He also is involved in data management.

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## National and International Network Collaborators

### Collaborator roles in GOHH

Individuals or groups in the peripheral “HUBs” bring strengths in all geographic and thematic aspects of OHH to the Program. They will be conduits to others, expanding the networks involved in assessment, research, technology, community involvement, education, and communication. All have enthusiastically agreed to participate in the GOHH Program.

This list of collaborators is just the beginning; there are others who will be enlisted at the outset, who would bring similar qualifications.

### Collaborator details

**Brian Arbic, Ph.D.** Professor, University of Michigan, directs a Summer School in Oceanography and Environmental Science in Ghana, with Ghanaian and other colleagues. We would collaborate with Dr. Arbic to guide us in aiding the development of similar courses in Africa, South Asia and elsewhere. (Arbic “Ocean Shot”)

**Augustine Arukwe, Ph.D.** Professor at the Norwegian University of Science and Technology, he Chairs of Board of Trustees for the “African Centre for Climate Action and Rural Development Initiative”, a community and research partner. He will facilitate connections to other research and community groups in Africa.

**Blue Climate Initiative:** The BCI, of the Tetiaroa Society, is an incubator of transformative ideas on ocean and climate interactions, including a “healthy blue community network”. Collaboration with the BCI and Network will be important to the community Hub.

**Rita Colwell, Ph.D.** Professor Emerita, University of Maryland, long a leader in study of Vibrios, and a key participant in creating a Pathogens network in the Biological Risks Hub.

**Lora Fleming, M.D., Ph.D.** Director of the European Centre for Environment and Human Health, University of Exeter. Dr. Fleming has spearheaded OHH projects in Europe that focus on the benefits of the ocean. She will link to programs that Identify, and measure healthy ocean benefits to human health.

**Anders Goksøyr, Ph.D.** Professor of Biology, University of Bergen. Dr. Goksøyr leads chemical and effects programs in coastal and Arctic waters, and will be at the center of a Hub for engaging others in the EU.

**Hisato Iwata, Ph.D.** Professor of the Center for Marine Environmental Studies (CMES), Ehime University, Japan. CMES has long studied global distribution of chemicals and their effects. Dr. Iwata leads the Joint Research/Usage Center – Leading Academia in Marine and Environmental Pollution Research (LaMer), forming the core of a HUB for Asian networks.

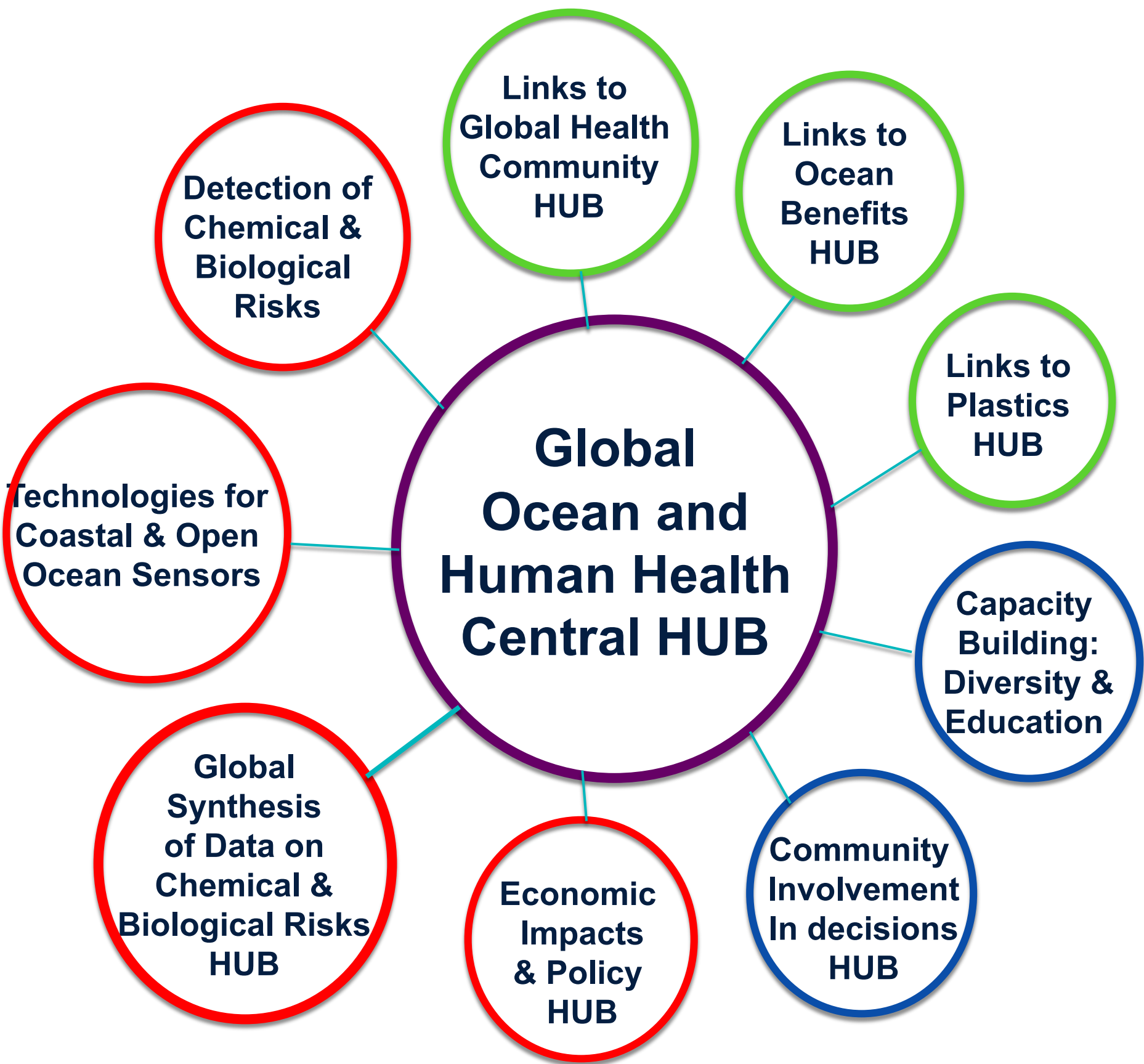
**Philip Landrigan, M.D.** A pediatrician who is Director of the Global Public Health Program and Global Pollution Observatory, at Boston College. Dr. Landrigan brings a vision and deep connection to public health and pollution. He will facilitate links to epidemiology.

**Minderoo Foundation:** This Foundation is focused on finding solutions to plastic pollution of the oceans. Leads: Tony Worby, Ph.D. - Flourishing Oceans; Sarah Dunlop, Ph.D. - Plastics & Human Health, Nakul Saran - No Plastic Waste; They will provide an entrée to global efforts to address the plastics problem.

**Hervé Raps, M.D.** Associate Director of Medical Biology of the Scientific Center of Monaco, and convener of global meeting on ocean pollution and human health, and promoter of the Monaco Declaration. Dr. Raps will facilitate links to global health communities and chemical pollution groups in the EU.

**Paul Sandifer, Ph.D.** Director of the Center for Coastal Environmental and Human Health at the College of Charleston, SC. He has a broad experience in analysis of issues in OHH and will help in discerning how oceans enhance human health and well-being.

**Chris Scholin, Ph.D.** President of the Monterey Bay Aquarium Research Institute. Dr. Scholin is exceptional at engineering remote sensors for detecting microbes and would collaborate in that aspect of the research.



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