



# TRANSFORMATIONAL OPPORTUNITIES

FOR  
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WELL-BEING**





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# The Blue Climate Initiative Healthy Blue Communities Network – Safeguarding Human Health & Well-Being Against Climate Change: An Ocean-Based, Community-Centered Proposal

Philip Landrigan\* (Schiller Institute for Integrated Science and Society, Boston College, USA), Samantha Fisher (Schiller Institute for Integrated Science and Society, Boston College, USA), Michael Depledge CBE\* (European Centre for Environment and Human Health, University of Exeter, UK), Lora E Fleming\* (European Centre for Environment and Human Health, University of Exeter, UK), John Stegeman\* (Woods Hole Oceanographic Institution, USA), David Kamp (Center for Design and Health at the University of Virginia, USA), Timothy A. Bouley (Emergent Ocean and BioFeyn Biotechnology, France), Cinnamon Carlarne (Wadham College, Oxford, UK), Ursula Scharler (University of Kwazulu Natal South Africa and Global Oceans GSAP Initiative, South Africa) Lilian Corra (School of Medicine at University of Buenos Aires, Argentina), Bruce Maycock (European Centre for Environment and Human Health, University of Exeter, UK; Asia Pacific Academic Consortium of Public Health (APACPH), Pacific Region; Curtin University, Australia), Patrick Rampal (Scientific Center of Monaco), Pál Weihe (University of the Faroe Islands, Denmark)

\*denotes lead

## Abstract

Climate change is the existential challenge of our time. Its consequences are already causing widespread disease and death and threaten the sustainability of modern societies. In the absence of thoughtful, courageous, equitable, science-based intervention, climate change will result in even more severe harm to human health and well-being in coming decades. All humans will suffer these effects, but vulnerable populations - the poor, the elderly, indigenous populations, coastal communities, the people of small island nations, and the world's youth - will suffer the most.

However, these impacts are not inevitable. The Blue Climate Initiative (BCI) Working Group on Human Health & Well-Being is of the firm opinion that there is still time to safeguard human health and well-being and protect societies against the consequences of climate change. Coastal and island communities are engaged already in urgent efforts to counter climate change and are uniquely well positioned to spearhead this work.

The BCI Working Group on Health and Well-Being proposes to leverage the dynamism, the resources and the leadership of the world's coastal and island communities to form **The BCI Healthy Blue Communities Network** - an interconnected global web of climate-resilient coastal and island communities, research and educational institutions, NGOs and sustainable businesses – large and small, in both the Global North and the Global South. Communities in this global network will work singly and together to promote health and well-being, advance social justice, and sustainably grow the global economy, while developing ocean-based solutions to mitigate and adapt to climate change.

At the local level, each member community of The BCI Healthy Blue Communities Network will undertake place-based work in partnership with its local universities, research institutions, businesses, policymakers and diverse other partners to identify and co-create unique ocean-based solutions and commercial opportunities to address climate challenges. We anticipate that individual communities will be especially effective in developing place-based approaches to both climate mitigation and climate adaptation that will enable them to meet their local challenges.

At the regional and global levels, communities in The BCI Healthy Blue Communities Network will work together to devise ocean-based solutions to both climate mitigation and climate adaptation. They will form **Living Blue Platforms for Innovation**, Research and Action. These platforms will extend and amplify the work of individual communities. Four key functions of these Living Blue Platforms will be:

- Generating and Sharing Knowledge through the **Forum Oceanum**, a new venue for sharing information and ideas across sectors and for taking on the “wicked problems” of today’s rapidly changing world.
- Advancing New Technologies by providing **community-based test-beds**, collaborative spaces, infrastructure, expertise, training and evaluation capacity - places where innovative solutions that emerge from the BCI Working Groups can be developed, refined and, if successful and appropriate, brought to scale and deployed.
- **Collaborative Education and Outreach**. Education of policy makers and the public is of critical importance to building political will for climate change mitigation and adaptation.
- **Joint Interventions**. Communities in The BCI Healthy Blue Communities Network will collaborate in transnational efforts to improve human health and well-being.

The BCI Healthy Blue Communities Network will be a key resource for the Blue Climate Initiative. It will work with the BCI to identify opportunities for investment in specific communities and projects. It will create incentives, rewards and recognition for transformative work undertaken throughout the BCI to limit climate change and adapt to its consequences. It is unique among all the activities proposed by the BCI in that it is human-centered, community-based, outward-facing and inherently political; and thus provides the BCI with a platform for turning excellent ideas into real-world, scaleable and transferable solutions.

## Executive Summary

Climate change is the existential challenge of our time. Its consequences – pollution, violent storms, sea level rise, coastal flooding, wildfires, drought, and famine - are already causing widespread disease, and death, and they threaten the sustainability of modern societies. In the absence of thoughtful, courageous, equitable, science-based intervention, climate change will result in even more severe harm to human health and well-being in coming decades. All of us will suffer these effects, but vulnerable populations - the poor, the elderly, indigenous populations, coastal communities, the people of small island nations, and the world’s youth - will suffer the most.

But these impacts are not inevitable. The BCI Working Group on Human Health & Well-Being believes that there is still time to safeguard human health and well-being and to protect societies against the worst consequences of climate change.

The key to mitigating climate change and adapting to its consequences will be to use our collective intelligence, our technology, and our proven capacity for collaborative action in the face of great peril to grasp smart, new, sustainable lifestyles that allow us to live healthy, happy and productive lives, advance social and economic justice, and protect our planet.

The coasts, seas and global ocean offer extraordinary resources for accomplishing these goals. Coastal and island communities - the vibrant, polyglot, open societies that have thrived for millennia in the complex and ever-changing environment at the interface of land and sea - are center-stage in confronting climate change and in creating ocean-based solutions to its challenges.

Coastal and island communities hold 37% of the world’s population, a fraction that is growing rapidly. They include 13 of the world’s 20 most populous cities. They are hubs of innovation, economic activity, creativity, and culture. They are home to a disproportionate number of the world’s great universities and research institutions. They are leaders in climate and ocean policy. They are accustomed to working together, across national boundaries and over great distances. They have the knowledge, the ability, the will and

the political power to take action – and to take action quickly - even when national governments cannot or will not act. And because they are among the places on the planet most gravely threatened by climate change, coastal and island communities have enormous incentive to come together to develop and deploy bold, innovative, ocean-based solutions.

The BCI Working Group on Health and Well-Being proposes to leverage the dynamism and the urgency of the world’s coastal and island communities to form **The BCI Healthy Blue Communities Network** - an interconnected global web of climate-resilient coastal and island communities, research and educational institutions, NGOs and sustainable businesses – large and small, in both the Global North and the Global South. Communities in this global network will work singly and together to promote health and well-being, advance social justice, and sustainably grow the global economy, while developing ocean-based solutions to mitigate and adapt to climate change.

At the local level, each member community of **The BCI Healthy Blue Communities Network** will undertake place-based work in partnership with its local universities, research institutions, businesses, policymakers and diverse other partners to identify and co-create unique ocean-based solutions and commercial opportunities to address climate challenges. We anticipate that individual communities will be especially effective in developing place-based approaches to both climate mitigation and climate adaptation that will enable them to meet their local challenges.

In developing equitable, ocean-based solutions to climate change, communities within the Network will place high priority on addressing the social determinants of health and disease - the macro-level social, economic and environmental factors that shape patterns of health, and disease within societies - economic injustice, disproportionate exposures to pollution, sub-standard flood-prone housing, inadequate food, degraded ecosystems, and lack of access to decent health care and essential medicines. These disparities must be reduced if community-based responses to climate change are to be effective.

Each community within the Network will work to design and develop climate-resistant infrastructure: roads, bridges, tunnels, buildings, electrical grids, water supplies, sewage systems and ports that can withstand rising seas, coastal flooding and violent storms. To reduce disparities in health and enhance social justice, communities will extend this infrastructure to all members of their societies. Each community will share these solutions across the Network.

At the regional and global levels, communities in The BCI Healthy Blue Communities Network will work together to devise ocean-based solutions to both climate mitigation and climate adaptation. They will form **Living Blue Platforms for Innovation**, Research and Action. These platforms will extend and amplify the work of individual communities. Four key functions of these Living Blue Platforms will be:

1. Generating and Sharing Knowledge through the **Forum Oceanum**, a new venue for sharing information and ideas across sectors and for taking on the “wicked problems” of today’s rapidly changing world. Through the Forum Oceanum, communities in the Network will pool knowledge and resources, share best practices, and work together to study and devise solutions to problems that extend beyond individual communities. Collaborative activities undertaken through the Forum Oceanum could include policy studies, marine genetic research, studies of the impacts of ocean pollution on health, studies of fish stocks and migrations, ocean mapping, economic and social research, innovative design of adaptive architecture, and the development of metrics to quantify the benefits to both human health and well-being and ecosystem health with a global economy of ocean-based solutions to climate change.
2. Advancing New Technologies by providing community-based test-beds, collaborative spaces, infrastructure, expertise, training and evaluation capacity - places where innovative solutions that emerge from the BCI Working Groups can be developed, refined and, if successful and appropriate, brought to scale and deployed. These could include ocean-based as well as land-based solutions for re-

ducing greenhouse gas emissions, especially in the building and transport sectors; new strategies for capturing carbon; the design and construction of responsive, adaptive, climate-resilient coastal infrastructure with health co-benefits; and the adoption of low-carbon, locally tailored approaches to sustainable mariculture.

3. Collaborative Education and Outreach. Education of policy makers and the public is of critical importance to building political will for climate change mitigation and adaptation. Communities in The BCI Healthy Blue Communities Network will therefore work together to build environmental literacy and to develop sophisticated, state-of-the-art strategies for disseminating information and training about the health and economic benefits of ocean-based solutions to climate change.
4. Joint Interventions. Communities in The BCI Healthy Blue Communities Network will collaborate in transnational efforts to improve human health and well-being. These could include:
  - Developing and sharing model laws and policies;
  - Extending current treaties and international agreements on pollution control and ocean protection to all countries of the world;
  - Extending monitoring programs for chemical pollutants, algal toxins, microplastics, and microbial pathogens in seawater and seafood products to all countries of the world;
  - Building research and education capacity in low-income and middle-income countries; and
  - Creating large new Marine Protected Areas (MPAs).

At the heart of the BCI Healthy Blue Communities Network will be the **Blue Communities Network Coordinating Center**. This Center will provide the 'glue' and the connective tissue that holds the network together. It will certify communities for membership in the Network, facilitate exchange of information through the Forum Oceanum, and catalyze collaborations in

research, education and intervention. The Center will have responsibility to ensure that the individual efforts that are undertaken in particular communities will contribute to a coherent, joined-up overall response to the common challenges we face.

**The BCI Healthy Blue Communities Network** will be a key resource for the Blue Climate Initiative. It will work with the BCI to identify opportunities for investment in specific communities and projects. It will create incentives, rewards and recognition for transformative work undertaken throughout the BCI to limit climate change and adapt to its consequences. It is unique among all the activities proposed by the BCI in that it is human-centered, community-based, outward-facing and inherently political; and thus it provides the BCI with a platform for turning excellent ideas into real-world, scaleable and transferable solutions.

## Problem Statement

*The "health" of the environment and human health are inextricably linked. The greatest challenge confronting humanity today and in the future is to sustain the health of both the planet and all people.*

Climate change and other large-scale changes in the global environment such as ocean pollution, biodiversity loss and deforestation are already causing enormous harm to human health and well-being (Table 1). Heat waves kill children and the elderly. Hurricanes, coastal flooding and other extreme weather events cause disease, disability, and death in millions; destroy livelihoods; and with increasing frequency drive entire populations from their homes - most recently in Bangladesh and two years ago in Puerto Rico. Global warming and changes in rainfall have extended the geographic ranges and lengthened the infective seasons of vector-borne diseases - malaria, dengue, Zika virus, West Nile Virus, Lyme disease, and chikungunya. Wildfires have made areas of Australia and the western United States seasonally uninhabitable. Sea surface warming is extending the geographic ranges of toxin-producing Harmful Algal Blooms and of dangerous

microorganisms such as *Vibrio* species – the bacteria that cause ‘flesh-eating’ wound infections and cholera. The emergence of antimicrobial resistance in bacteria and viruses in warming, highly polluted coastal waters is a growing cause for concern. Climate-driven redistribution of marine species is causing profound reductions in the availability of food from the sea and impacting adversely on biodiversity.

Continued use of fossil fuels is exacerbating all these problems. For example, mercury released to the oceans by the combustion of coal accumulates in fish and marine mammals and causes brain damage with loss of IQ and lifelong disruption of behavior in the children of women who unwittingly eat mercury-contaminated seafood while pregnant. Pollution, the inevitable concomitant of fossil fuel combustion and climate change, contributes to the destruction of marine habitats, declines in fish stocks, biodiversity loss and reductions in food security. Pollution is responsible for an estimated 9 million premature deaths each year.

Climate change is responsible also for catastrophic economic losses (Stern et al., 2006). The losses associated with extreme weather events run to hundreds of billions of dollars (CBO. 2019). The annual losses resulting from climate-related pollution are conservatively estimated to be US\$4.6 trillion per year, more than 6% of global economic output.

**Table 1. Negative impacts of climate change on human health and well-being**

<i>Direct Effects</i>	<i>Indirect Effects</i>
<ul style="list-style-type: none"> <li>• Extreme heat and heat waves</li> <li>• Severe weather events</li> <li>• Floods – riverine and coastal</li> <li>• Drought</li> <li>• Wildfires</li> <li>• Pollution – chemical, and microbial contamination of air, water, land</li> <li>• Expanded geographic ranges of microbial diseases, including cholera</li> <li>• Increased frequency of harmful algal blooms</li> <li>• Loss of habitat-building biota and habitats - coral reefs, estuaries, and mangroves</li> </ul>	<ul style="list-style-type: none"> <li>• Crop loss leading to terrestrial food insecurity and famine</li> <li>• Declines in fish stocks leading to marine food insecurity</li> <li>• Economic insecurity, inequalities, and poverty</li> <li>• Mental health impacts</li> <li>• Civil unrest</li> <li>• Migration</li> <li>• War</li> </ul>

All of the adverse health and economic impacts of climate change fall most heavily on the poor, the vulnerable and the voiceless – women and children, the poor and the disenfranchised, minorities and the marginalized, and indigenous communities – people who generate only miniscule amounts of the greenhouse gases that drive global climate change, yet suffer disproportionately from its consequences. Coastal communities and small island nations are at especially grave risk. This is environmental injustice on a global scale.

## Ocean-Based Solutions

Severe as they are, the increasing impacts of climate change on human health and well-being are not inevitable. The BCI Working Group on Human Health & Well-Being is of the strong opinion that with intelligent, courageous, science-driven interventions, there is still time to safeguard human health and well-being against the worst consequences of climate change.

The key to mitigating climate change and adapting to its consequences will be to use our intelligence, our technology, and our proven capacity for collective action in the face of great peril to grasp smart, new, sustainable lifestyles that allow us to live long, healthy, happy and productive lives, advance social and economic justice, and protect our planet.

The vast resources of the oceans offer extraordinary resources for safeguarding human health and preserving human societies against the negative consequences of climate change. (Table 2) The oceans safeguard humanity and the planet today by absorbing more than 90% of the excess heat released into the climate system and taking up nearly one-third of carbon dioxide emissions, thus greatly slowing the pace of global climate change. Microscopic organisms in the oceans are a



source of atmospheric oxygen. The extraordinarily diverse ecosystems of the seas provide food to billions, livelihoods for millions and support the economies of countries around the world. The oceans are the source of essential nutrients that reduce risk of stunting, malnutrition including undernutrition and obesity, cardiovascular disease, stroke, diabetes, dementia and goiter, and are the source also of multiple essential medicines.

The world’s coasts, seas and oceans have traditional cultural value and are places of joy, beauty, peace, and recreation. There is increasing evidence that interactions with coasts and seas can promote and sustain the physical and mental health and well-being of all people, especially those of lower socio-economic status.

## The Unique Strengths of Coastal and Island Communities

Coastal and island communities are uniquely well positioned to develop innovative ocean-based solutions to climate change. These communities are growing globally in numbers, population and importance. They encompass 37% of the world’s population (and continue to grow) and include 13 – two-thirds - of the world’s 20 most populous cities. Because of their location at the edge of the sea, coastal and inland cities, towns, and villages (and their ecosystems and human populations) are uniquely vulnerable to climate and other environmental change, including sea level rise, extreme weather events, ocean acidification, invasive species and both chemical and microbial pollution.

Coastal and island communities have a millennial long tradition of openness. They are ports open to the world, unbound by terrestrial borders, hubs of innovation, economic activity, creativity, and culture, and incubators of new ideas. Coastal and island cities are home to a disproportionate number of the world’s great universities and research institutions. They are leaders in climate and ocean policy. They are accustomed to networking with one another across national boundaries and across great distances, and they have the knowledge, the ability, the will and the political power to take action – and to take action quickly - even when national governments cannot or will not act.

## Transformational Opportunity

To create an innovative, effective, flexible, geographically distributed and resilient platform for countering the existential threat of climate change - a platform that harnesses the energy, creativity and leadership of the world’s coastal and island communities, the BCI Working Group on Health and Well-Being proposes a single overarching Transformational Opportunity – **The BCI Healthy Blue Communities Network**.

**The BCI Healthy Blue Communities Network** will be an interconnected global web of coastal and island communities, research and educational institutions, businesses, NGOs and citizens. This unique network will build upon and amplify the enormous potential of coastal communities for innovation, entrepreneurship, collaboration and collective action. Communities in **The BCI Healthy Blue Communities Network**

**Table 2. Benefits of healthy oceans for human health and well-being**

<b>Current Benefits</b>	<b>Potential Future Benefits</b>
<ul style="list-style-type: none"> <li>• Major source of food, dietary protein, and essential nutrients (e.g., omega-3 fatty acids, iodine)</li> <li>• Source of medicines and other natural products</li> <li>• Promotion of physical health</li> <li>• Promotion of mental well-being</li> <li>• Trade, commerce, and cultural exchanges</li> <li>• Blue tourism and recreation</li> <li>• Connections with culture and history</li> <li>• Opportunities for citizen science and community participation</li> </ul>	<ul style="list-style-type: none"> <li>• Potential to produce renewable (“blue”) energy</li> <li>• New cities – floating metropoli</li> <li>• Future diverse sources of food – advanced mariculture</li> <li>• New medicines, foods and other products</li> <li>• Innovations based on marine biotechnology</li> <li>• Marine models of human disease</li> <li>• Ocean-based strategies for monitoring and preventing the impacts of extreme weather events</li> </ul>



will work singly and together in a mosaic of collaborative efforts to safeguard human health and promote well-being against the dangers of global climate change.

**The primary near-term aim of the BCI Healthy Blue Communities Network** will be to use the resources of the world's oceans to more equitably protect and enhance the health and well-being of all coastal and island people in the face of climate change.

Key to achieving this goal will be education of policy-makers and the global public of the grave dangers we face while at the same time increasing awareness that climate change can be mitigated and its worst consequences avoided. Scientific data will be essential to this effort, but data alone will not catalyze change. There must also be stories, champions and successes. Conversation and concern about climate change and its solutions must become as much a part of everyday life as is discussion about the weather.

**The BCI Healthy Blue Communities Network** provides a unique platform for harnessing human intellect, creativity, energy, reason, and story-telling to confront the complex and highly interconnected web of global threats we face today. In particular, it provides an opportunity to frame the range of difficulties we face in a new way. There is precedence for this. In the 5th century BCE the Greek philosopher, Anaximander, transformed the way in which we understand natural phenomena by using observation and reason, rather than relying on supernatural and religious explanations to explain the world around us, thereby laying the foundations for Science. Now we have a new opportunity to use transdisciplinary approaches to tackle what have previously been intractable, interwoven environmental, social and economic challenges - so-called "wicked problems" (Rittel et al.,1973).

"Wicked problems" have ten key characteristics:

1. They do not have a definitive formulation.
2. They do not have a "stopping rule." In other words, these problems lack an inherent logic that signals when they are solved.
3. Their solutions are not true or false, only good or bad.

4. There is no way to test the solution to a wicked problem.
5. They cannot be studied through trial and error. Their solutions are irreversible so, as Rittel and Webber put it, "every trial counts."
6. There is no end to the number of solutions or approaches to a wicked problem.
7. All wicked problems are essentially unique.
8. Wicked problems can always be described as the symptom of other problems.
9. The way a wicked problem is described determines its possible solutions.
10. Planners, (i.e. those who present solutions to these problems), have no right to be wrong. Unlike mathematicians, "planners are liable for the consequences of the solutions they generate; the effects can matter a great deal to the people who are touched by those actions.

Framing climate change, biodiversity loss and pollution threats together with socio-economic and well-being issues as wicked problems, and using transdisciplinary approaches co-created with affected communities to address them will not lead to simple solutions, but will help us make genuine progress in moving towards more favourable circumstances.

## Governance Frame

**The BCI Healthy Blue Communities Network** will encompass a wide diversity of coastal and island communities ranging from megacities to rural fishing villages and indigenous communities in both the Global North and the Global South. These communities will work individually and collectively to confront climate change.

This network structure creates a framework for an innovative, flexible governance system that links coastal communities worldwide and enables nimble, responsive, and sustainable climate policymaking. It reflects and responds to the recognition that developing effective climate governance systems in a way that advances equity and human health and well-being will require a

polycentric set of institutions, policies, and networks of public and private actors that can work individually and collectively (Ostrom, 2012; Cole, 2011; Ostrom, 2009). It builds on the example of city governments that have been stepping up boldly in the absence of national leadership on climate change to share best practices and to translate into daily reality the noble agreements of the Paris Climate Accord (Ericsson & Tempest, 2014).

This Network will emulate other networks (See Box 1 and Appendix 1), most notably the C40 Initiative, a group of cities around the world that have come together to take bold action on climate change. C40's Climate Leadership Group consists of a network of mayors and other leaders from 96 of the world's largest cities committed to addressing climate change (mitigation, adaptation, and sustainability) and meeting the goals of the Paris Agreement. C40 provides an open sharing of resources and case studies. It is potentially a source of a source of case studies and a model for the BCI network. The C40 Network helps cities to replicate, improve and accelerate climate action and supports ongoing monitoring, assessment, and evaluation.

Like C40, **the BCI Healthy Blue Communities Network** recognizes that local leaders are in the best position to effect change and have the greatest potential for quick comprehensive action. Both C40 and the BCI Healthy Blue Communities Network build also on the understanding that local governments are uniquely well able to educate their citizens about the improvements in quality of life, job creation and environmental improvement that can be achieved through climate action and thus build political will for necessary actions.

However, unlike the C40 Initiative, whose focus is on large (mega) cities, the BCI Healthy Blue Communi-

**Box 1. Models that demonstrate the innovative power of communities and could inform development of *The BCI Healthy Blue Communities Network* include the following:**

1. [C40 Cities Network](#)
2. [The Roses Ocean and Human Health Chair](#) (Lloret J, et al.2020) (Case study box)
3. [Objectives of the Oceans and Human Health Chair](#)
4. [Coastal communities](#): How government is helping coastal communities flourish as places to live, work and visit.
5. [SOPHIE](#)
6. [CoastAdapt](#)
7. [Sustainable coastal management strategy](#)
8. [Community-Based Population, Health, and Environment Projects](#)
9. [Coastal Communities Alliance](#)
10. [Eco Tourism In Belize](#)

*And see Appendix 1. Examples/case studies of potential BCI Healthy Blue Communities*

ties Network will also include less densely populated areas and smaller coastal communities. An additional distinction is that the BCI Healthy Blue Communities Network will focus specifically on coastal and island communities.

Five key issues that **the BCI Healthy Blue Communities Network** will need to address as it develops are:

1. How should “community” be defined? We understand that “community” is intended to be a place-based concept, but is there a size or type of community that should be targeted or required?
2. What should be the basic criteria for designating a community as a BCI Healthy Blue Community?
3. What evidence of community support should be required to designate a community a BCI Healthy Blue Community? Presumably evidence will be needed of a broad coalition of community support. Should there also be a requirement for government support, e.g. a letter of support from the mayor or another person in a similar capacity?
4. What benefits would communities receive through being included in the network? Pre-

sumably benefits would include better access to knowledge, the opportunity to learn from peers, visibility, creation of added excitement, the opportunity to share experiences and successes and help others, and potential access to funding.

5. What would it take to sustain the network over time? Presumably the **Blue Communities Network Coordinating Center** will need resources to support a governing body and dedicated staff members.

Communities in the Network will be linked and their work coordinated through a **Blue Communities Network Coordinating Center**.

**Legal Underpinnings of The BCI Healthy Blue Communities Network** (Erikson & Tempest, 2014; Ostrom, 2012; Cole, 2011; Ostrom, 2009).

The need for decentralized decision making in climate adaptation is particularly evident in the context of coastal communities, where for millennia, social, cultural, and economic systems have been shaped by complex interactions between humans and the marine environment.

**The Blue Communities Network Coordinating Center** will be the “connective tissue” of the Network - a mechanism that holds the Network together, certifies communities for membership in the Network, serves as a repository for data, facilitates the dissemination of knowledge and best practices, fosters collaborations, provides expertise, and catalyzes action to combat climate change. Additional functions of the Coordinating Center will be to direct investors towards the Network, its member communities and its projects, and to create incentives, rewards and recognition for transformative work undertaken in the Network. The governance of the Center will be delivered through the active involvement of Members of the **BCI Healthy Blue Communities Network**.

Another function of the Coordinating Center will be to conduct an annual global competition for the Healthy Blue Community Challenge Grants. These Grants will recognize and support best ideas to co-create unique approaches and innovative solutions to local climate challenges. Grants would be awarded in different sizes that include initial small exploratory 12-18-month awards for communities to identify a challenge and opportunity as individual or linked communities, as well as opportunities for larger 4-5 year funding to expand to a larger local project and/or to collaborate with other coastal communities. Solutions and best practices identified through this grant competition will be shared across the Network.

Adaptation law and policy is still a fledgling area of law and policy making; there is a tremendous amount of experimentation and an increasing amount of cooperation and transnational learning taking place. There is, however, a dearth of knowledge about the range and effectiveness of governance approaches being employed and the ability to transfer and replicate successful strategies in diverse geographical contexts. The BCI Healthy Blue Communities Network provides a platform to fill these gaps in knowledge and experience by creating new opportunities and incentives for thoughtful and extensive adaptation planning in coastal communities. Additionally, the Blue Communities Network Coordinating Center will provide an infrastructure that will allow subnational and non-state actors in coastal areas not only to develop, but also to share information about climate policies (focusing on both mitigation and adaptation) that are locally sustainable as well as scalable and transferable.

## **The Work of The BCI Healthy Blue Communities Network**

Communities in **the BCI Healthy Blue Communities Network** will identify and co-create unique ocean-based approaches, innovative solutions and commercial opportunities to address their local climate challenges. In this work, member communities will place high priority on devising and deploying climate solutions that improve human health and well-being. Thus, they will devise and deploy strategies that adopt an asset based approach seeking co-benefits from their interventions across the sectors to address the social, economic and environmental determinants that shape patterns of health and disease - factors such as inequity, disproportionate exposures to pollution, substandard flood-prone housing, inadequate food, and

lack of access to health care and essential medicines. These disparities must be ameliorated if community-level responses to climate change are to be effective.

**The BCI Healthy Blue Communities Network** provides opportunities for both mitigating climate change and adapting to its consequences.

## Climate Mitigation in the BCI Healthy Blue Communities Network

The focus of climate mitigation policy has traditionally been top-down. It has emphasized maximizing economies of scale at the regional and national level.

**The BCI Healthy Blue Communities Network** creates avenues and opportunities for this type of high-level thinking and coordination.

**The BCI Healthy Blue Communities Network** adds a new dimension to this paradigm and creates opportunity for smaller scale climate mitigation strategies at the local level. In particular, it opens up opportunities for leveraging the capacity of cities and their partners in business and academia to address climate change. This is very important because cities and other smaller communities are often nimbler than their state and federal counterparts, allowing them to act more quickly and creatively than at the national and international levels. Consequently, cities and other smaller communities are important sites of climate governance innovation, particularly in the coastal context, and have already demonstrated a willingness and ability to step up boldly in the absence of global national leadership on climate change.

Given their growing scale, nimbleness, and heavy carbon footprints, climate action at the city level is not just possible, but vital. In fact, one study suggests that city-level actions could reduce greenhouse gas emissions associated with urban buildings, transport and waste disposal by nearly half (47%) by 2050. Cities – both large and small - as well as other smaller communities have ample tools at their disposal to reshape urban consumption and energy patterns, rethink relationships between humans and terrestrial and marine environments, and advance more just and sustainable lifestyles. These include efficiency standards for resi-

dential and commercial “green” building codes, and zoning ordinances that can be used to regulate everything from energy efficiency, water consumption, and choice of materials, to storm water management systems, and coastal management and development. Specific climate mitigation actions that could be undertaken at community level include:

- Sharply reducing greenhouse gas emissions by rapid transition to non-polluting renewable sources of energy, both ocean-based and land-based;
- Reducing greenhouse gas emissions, especially in the buildings and transport sectors through efficient, adaptive design.
- Reducing the generation of waste by imposing bans on most single-use products and developing aggressive, well-funded recycling and reuse programs.

## Climate Adaptation in The BCI Healthy Blue Communities Network

Communities in **The BCI Healthy Blue Communities Network** will also be leaders in climate adaptation. Adaptation challenges are highly varied and differ from place to place. The decentralized structure of the Network is perfectly suited for encompassing this diversity. It reflects Elinor Ostrom’s groundbreaking work on polycentric governance, which demonstrated that, while there is no ‘optimal’ adaptation strategy, the best level for adaptation actions will often be at the local and regional levels (Ostrom, 2012, Ostrom 2009). Adaptation planning requires understanding and responding to the multitude of risks that climate change creates in particular geographic and socio-political contexts. This, in turn, necessitates greater decentralization of decision-making authority and more bottom-up, pluralistic, and inclusive policy making processes. Examples of local, place-based climate adaptation strategies are:

- Design, development and deployment of climate-resistant infrastructure, including roads, bridges, tunnels, buildings, electrical grids, water supplies, sewage systems and ports that can withstand rising seas, coastal flooding and violent



storms. To reduce disparities in health and enhance social justice, communities will extend this infrastructure to all members of their societies;

- Adopting innovative, low-carbon, locally tailored approaches to sustainable mariculture and other marine-based activities.

## Members of the Network Will Collaborate around Broader Challenges

The **BCI Healthy Blue Communities Network** will bring together transdisciplinary teams from the natural and social sciences, medicine, design and engineering, economics and the business community, and the humanities to develop new, integrated approaches to deal with the wicked problems that confront our rapidly changing planet and grasp opportunities to address these problems. Whilst we might not be able to solve every problem we will be able to move coastal and island communities into better, safer and fairer circumstances, through a continuing process far into the future. These collaborations will fall into four main areas:

1. Generating and Disseminating Knowledge
2. Advancing New Technologies
3. Collaborative Education
4. Joint Interventions

**1. Collaborations in Generating and Disseminating Knowledge.** To support collaborations in generating and sharing knowledge about ocean-based solutions to climate change, communities in the Network will form the **Forum Oceanum**, a new venue for sharing information and ideas across sectors. The Forum Oceanum will extend and amplify the work of individual communities. It will enable communities in the Network to share knowledge, research findings, best practices, lessons learned, and educational innovations with each other and with coastal communities around the world.

The Forum Oceanum will provide a platform for

collaborative research. Examples of issues that could be examined collaboratively through the Forum Oceanum include: include creative law and policy making; marine genetic research; studies of the health impacts of ocean pollution; ocean mapping; economic research; transformative mariculture; renewable energy; and development of metrics to quantify the benefits to human health and well-being of ocean-based solutions to climate change. These will demonstrate the diversity and sustainability of the Blue Climate Health Initiative!

All collaborations supported through the Forum Oceanum will follow:

- [FAIR](#) Principle
- [CARE](#) Principle
- [TRUST](#) Principle

## 2. Collaborations in Advancing New Technologies.

To advance collaborations in technology development, the BCI Healthy Blue Communities Network will form **Living Blue Platforms for Innovation, Research and Action**. These will be test-beds where innovative solutions to climate change, pollution and other aspects of environmental degradation can be co-created, developed, piloted, shared, and, if successful, brought to scale and deployed. These platforms will provide collaborative spaces, infrastructure, expertise and pre-existing evaluative capacity that can assess, refine and accelerate development of the best of the Transformative Opportunities in health, energy, transport, nutrition, materials and tourism that emerge from the BCI Working Groups.

Equally important, these platforms will provide launch pads - collaborative spaces, infrastructure, expertise and pre-existing evaluative capacity - where new opportunities for improving health and well-being can be brought to scale. Through providing collaborative spaces, infrastructure, expertise and pre-existing evaluative capacity, the platforms will permit the assessment, refinement and accelerated development of the best of the Transformative Opportunities in health, energy, trans-

port, nutrition, materials and tourism that emerge from the BCI Working Groups.

Using the Platforms in co-creation, Communities in the Network will test and share new ideas and approaches to assess what works, what does not, why, how to make better, how to adapt to different conditions/scenarios within a network of shared data/training/and lessons learned. This will include pilot testing of potentially transformative solutions that emerge from all of the BCI Working Groups. An example is intelligent continuous monitoring using novel sensors and Big Data analysis augmented by Artificial Intelligence.

- 3. Collaborative Education and Outreach.** Communities in the Network will work together to develop sophisticated, state-of-the-art strategies for dissemination of information about the health and economic benefits of ocean-based solutions to climate change and to build environmental literacy.

To develop narratives that describe the benefits to human health of ocean-based solutions to climate change, we will create novel locations in coastal settings that will attract and engage both local people and visitors to discover why the oceans are so important, and to explain how diverse cultures around the World share common hopes and fears of how climate change will affect their lives.

These places will provide the opportunity to use innovative technologies such as 5G and will host other, newly emerging, state-of-the-art digital communication methods to bring to life the stories of the solutions to health and well-being issues being implemented successfully in coastal communities worldwide. Locally practiced traditional cultural interactions with the ocean such as storytelling, theatre, music and cultural and religious rituals can be shared via **the BCI Healthy Blue Communities Network**. These stories can be incorporated into school curricula to capture the imagination of people and communities living both close to and far from the ocean, building a culture of empowerment and hope about the future. Globally, much of the energy, innovation, and impetus for action on climate change is coming from local leaders - from

women, children, indigenous peoples, and traditionally marginalized communities. This Forum will give voice to the work and the ideas of these communities, and create a platform for shared learning and innovation.

- 4. Joint Interventions.** Communities in the Network will collaborate on transnational efforts to improve human health and well-being by extending current pollution control strategies to all countries and all regions of the world; extending monitoring programs for chemical pollutants, algal toxins, microplastics, and microbial pathogens in seafood products; building research and education capacity in low-income and middle-income countries; and creating large, new Marine Protected Areas.

#### **Examples of Collaborative BCI Healthy Blue Communities Projects**

In Appendix 2, there are examples of specific **Collaborative BCI Healthy Blue Communities Projects** that could be organized through the Blue Communities Network and that would include partners in coastal communities around the world linked through the BCI Networked Blue Community Platform.

# Appendices

## Appendix 1. Examples/case studies of potential BCI Healthy Blue Communities

### *COLLABORATION IN RESEARCH:*

#### *Implementation Research.*

Transdisciplinary international cooperative implementation research is needed to identify best practices and feasible, cost-effective solutions to prevention and control of ocean pollution. This research will build upon and codify the findings that have emerged from the case studies in success against ocean pollution presented in this report. Continuing research and development into biodegradable polymers will be an important component of this research.

### *COLLABORATION IN INTERVENTION: BCI Healthy Blue Communities Network and the Blue Economy.*

The Blue Economy is an established concept that defines the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ecosystems (The World Bank, 2017). It is inclusive of a range of interlinked and emerging sectors, each of which share the common aim of seeking to improve overall stewardship of marine spaces.

**The BCI Healthy Blue Communities Network** aligns well with this framework in multiple ways. Participants in the blue economy, such as fishermen, tourism operators, scientists, park rangers, ocean sports people, retailers, restaurateurs, and others who work along the coast or at sea are critical redistributors of the wealth of natural capital that exists in the seas. These participants in the blue economy translate the unique value of the ocean - nutrition, recreation, and other natural resources - into tangible economic value and re-distributed it across society (European Union, 2018). As their livelihoods and recreation depend on the ocean, these actors also have other important roles to directly play in blue communities. Their lived experience as stewards of blue space position them to share knowledge and experience, enriching overall community health (Commonwealth, 2020).

Consumers of the blue economy are all people who consume goods that originate in the oceans. In the most basic sense, this is virtually everyone – those who eat fish or seaweed, vacation at a beach, purchase canned pet food, take certain medicines or supplements, and in some parts of the world, use electricity (European Union, 2018). Recognition of the economic value of these ocean-based resources and engagement with professionals who specialize in their extraction, processing, shipping, or maintenance, can build stronger community bonds and lead to the development of potentially very profitable, new blue projects focused on sustainable use of marine resources.

As blue, climate-smart projects emerge from communities in the BCI Healthy Blue Communities Network, they will need funding. One pathway is grant awards, as highlighted in an earlier section, and an important service that could be provided by the Network could be to serve as a clearinghouse for those looking for finance to support their projects, directing them to emerging funding initiatives like [Fundingtheocean.org](http://Fundingtheocean.org), local and national government grant programs, and foundations with ocean-specific agendas. If certain projects are more appropriate for private finance, the Network could direct participants to any number of new ocean-focused start-up incubators, accelerators, angel investors, or venture funds that have an ocean-based or sustainability focus.

For decades, economic approaches have been employed as tools to address climate change, such as cap and trade, penalties, carbon pricing, and green bonds. Increasingly, the blue economy is playing an active role in these solutions, as many new blue projects have been thoughtfully developed to reduce climate impacts. These include initiatives in sustainable energy, coastal infrastructure, carbon sequestration, blue bonds, and others. As BCI Healthy Blue Communities convene, they have many examples from which to develop scalable community projects that can be connected to national and international efforts.

**COLLABORATION IN EDUCATION AND OUTREACH: *The Roses Ocean and Human Health Chair: A New Way to Engage the Public in Oceans and Human Health Challenges* (Lloret J, et al., 2020).**

Involving and engaging stakeholders is crucial for studying and managing the complex interactions between marine ecosystems and human health and well-being. The Oceans and Human Health Chair was founded in the town of Roses (Catalonia, Spain, NW Mediterranean) in 2018, the fruit of a regional partnership between various stakeholders, for the purpose of leading the way to better health and well-being through ocean research and conservation. The Chair is located in an area of the Mediterranean with a significant fishing, tourist, and seafaring tradition close to a marine reserve, providing the opportunity to observe diverse environmental conditions and coastal and maritime activities.

The Chair is a case study demonstrating that local, collaborative, transdisciplinary, trans-sector, and bottom-up approaches offer tremendous opportunities for engaging coastal communities to help support long-lasting solutions that benefit everyone, especially those living by the sea or making their living from the goods and services provided by the sea. Furthermore, the Chair has successfully integrated most of its experts in oceans and human health from the most prestigious institutions in Catalonia.

The Chair focuses on three main topics identified by local stakeholders: Fish and Health; Leisure, Health, and Well-being; and Medicines from the Sea. Led by stakeholder engagement, the Chair can serve as a novel approach within oceans and human health areas to tackle a variety of environmental and public health challenges related to both communicable and non-communicable diseases, within the context of sociocultural issues. Drawing on the example provided by the Chair, four principles are established to encourage improved participatory processes in the oceans and human health field: bottom-up, “think local”, transdisciplinary and trans-sectorial, and “balance the many voices”.

**COLLABORATION IN TECHNOLOGY: *Responsive Coastal Infrastructure. Adapting and refitting coastal infrastructure in response to climate change.***

Developing an adaptive approach to coastal infrastructure is intended to blur the boundaries of the built and marine environment both practically and philosophically. It seeks to meld the physical environment (our communities and support networks such as transportation) and economic systems (such as sustainable food production and tourism) with larger goals: environmental remediation and building economic, societal and personal resiliency for individuals living in complex and often daunting circumstances. It ties together diverse but interrelated perspectives, such as biology, well-being, food security, law, policy, investment and engineering.

Centuries of coastal settlement and urbanization have resulted in a vast accretion of critical infrastructure in low lying and exposed areas. These expansive aging networks undergird coastal communities and commerce, and yet many of these systems were not designed to withstand today’s (or tomorrow’s) environmental stresses. The age of climate crisis has exposed myriad vulnerabilities of these networks to the twin threats of sea level rise and increasing storm severity and frequency. Often the failures of these systems disproportionately impact poor, minority, and disenfranchised groups. Increasingly, these communities are exposed to overlapping and intersecting disasters that exacerbate inequality exponentially.

Building resilient infrastructure does not mean building bigger or stronger. Resilience implies a nimbleness, responsiveness, a capacity to adapt to uncertain futures. At a time of increasing strain on limited resources, emphasis should be placed on projects that advance an imaginative retrofitting of existing infrastructure that strives towards emergence and synergy. This must be flexible to incorporate other infrastructure networks or typologies, with natural systems and habitats, with sustainable commerce, with community health or needs, and with an eye towards identifying and responding to the relationship between infrastructure and structural inequality. Notably, resilient infra-



structure by definition should encompass not only many scales (local to regional) and modes (hard or soft, green or grey), but should also capture both built and natural systems—natural systems provide critical, invaluable services and should be protected, enhanced and emulated. Coastal infrastructure of the 21st century can no longer serve narrow purposes with linear, extractive flows of energy—they must embrace complexity, operate sustainably, and reflect a conception of the coast not as a fixed boundary but a continuous and migrating zone.

To propel responsive infrastructure and emergent outcomes, planning efforts should be informed by and co-created with the communities these systems and networks touch—both in terms of identifying key issues but also in visioning possible futures and desired outcomes. Building community health and resilience, particularly for the historically disenfranchised, begins with community empowerment in the face of increasing hardships brought on by climate change and sea level rise. Infrastructure, the physical, economic and social networks in which they operate, and the stresses they endure may be complex, but the communities that interface with these systems daily have a unique perspective into their operations and hazards. If we are to promote a sense of coherence for individuals living in these complex and often daunting circumstances, it is essential for designers, planners and policymakers to amplify these perspectives and narratives, and to strengthen the threads that tie individual experiences to larger social and environmental needs.

This concept will be most effective not in large comprehensive projects, but in the incremental retrofitting of our coastal fabric. **The BCI Healthy Blue Communities Network** can encourage diverse and shared projects and promote experimentation—trial and error—to best fit a solution to a specific context, one sensitive to local circumstances and able to draw upon local resources. Our solutions should be flexible, simple and equitable. Further, they should be understandable, manageable and meaningful. Design is an expression of values. In it we express our hopes and aspirations through what we build and through what we protect.

Case Studies/Models that demonstrate the multi-faceted and far reaching benefits of an adaptive response to the concept of infrastructure include the following:

1. [Falmouth Climate Change Vulnerability Assessment and Adaptation Planning](#). This study sought to raise public awareness of the risks of sea-level rise and identify strategies for local municipalities to develop a phased response for infrastructure adaptation.
2. [Sihwa Lake Tidal Power Station](#). This project, a total rethinking of a failed infrastructure system, provides renewable energy generation, water quality improvement and the generation of recreational space.
3. “[Room for the River](#).” This project, reflecting the concept of a riverine or coastal edge as a continuous, migrating zone, fundamentally works with, rather than against, the region’s ‘natural’ cycles of flooding.

#### **COLLABORATION IN INTERVENTION:**

##### ***Create New Marine Protected Areas.***

Designation of new Marine Protected Areas (MPAs) around the world will safeguard critical ecosystems, protect vulnerable fish stocks, and enhance human health and well-being. Creation of Marine Protected Areas is an important manifestation of national and international commitment to protecting the health of the seas. Protecting 30% of the World’s Ocean is estimated to protect marine ecosystems in the long-term (O’Leary et al. 2016). However, only about 3.5 % of marine habitats are receiving any form of protection with less than half strongly or fully protected (Lubchenco and Grorud-Colvert 2015). Further, not all habitat types fall under protection (Rogers et al. 2020). **The BCI Healthy Blue Communities Network** will engage in Marine Spatial Planning (MSP) (as well as sustainable land use planning) that allows for the accounting of all uses in an area, and thereby an allocation to human socio-economic uses and the protection of the coastal and marine environment. No-take Marine Protected Areas (MPAs) are highly effective in increasing species richness, organism size, density and biomass by an average of 21, 28, 166 and 446% re-

spectively (Lester et al. 2009). MPAs with zoned usage may show improvements in smaller increments, but importantly they afford legal control over exploitation and exploration. The adjacent use by fisheries of spillover from high biomass in MPAs and earnings and co-benefits from sustainable tourism and recreation can exceed the economic value of the area before it was preserved, and economic returns can already be established within a few years (Sala et al. 2013).

The protection of the high seas, where fishing is currently heavily subsidised (Sala et al. 2018), is beneficial to reducing fishery overcapacity and re-building stocks, while protecting critical habitats in the area. In addition, the critical habitats and their biodiversity in shelf and coastal regions need to be protected in MPAs. For once, this ensures global protection of coastal biodiversity, its genetic resources and potential for evolution. It further ensures that marine migrants and those using different specific habitats throughout their life histories (many marine invertebrates, fish, mammals, birds) can persist through time. The comprehensive protection of habitats as a network can guarantee the continued existence of biodiversity and fisheries resources and therefore continued and improved health benefits, economic activities and heritage for the future human population.

Perhaps more importantly, direct economic benefits in the short-term are exceeded by long-term and indirect benefits of renewable resources protection. Such benefits speak to the Sustainable Development Goals, climate change mitigation, costs that would have been incurred through the loss of such resources, and costs saved in human health and well-being services provided by the environment. For instance, the rebuilding of fisheries resources could prevent around 20% of the global population being threatened by nutrient deficiencies (Golden et al. 2016). Well-functioning coastal and open ocean ecosystems serve as carbon sinks by sequestering carbon and store them in biomass, facilitate burial or sink to deeper parts of the ocean. Mangrove forests, seagrass meadows, saltmarshes, micro- and macroalgae add in the reduction of CO<sub>2</sub> from the atmosphere and thereby play a role in mitigating climate change (e.g. Hoegh-Guldberg et al. 2019). More than 80% of the global carbon cycle involves

the ocean, making it the largest player in the natural mitigation of climate change. The ocean takes up 20-30% of total anthropogenic carbon emissions (Bindoff et al. in press) that has resulted in increased acidification detrimental to calcifying organisms. The ocean has also warmed, with a consequence of reduced O<sub>2</sub> content, changing biogeography of species, reduced fishery catches and changing nutrient cycles. Due to ocean warming, stratification of the ocean has intensified. This prevents mixing of deep cold nutrient rich water with nutrient poor surface water, thereby hindering production and thus lowering the CO<sub>2</sub> content of the atmosphere and ocean. Storms intensify over warm oceans, and sea levels rise affects coastal communities (Roberts et al. 2017).

MPAs can mitigate some of these effects, in conjunction with mitigations across other sectors that includes alternative energy sources, a decarbonisation of the marine shipping and transport sector, and a replacement of ruminant protein with seafood (Hoegh-Guldberg et al. 2019). Protected areas themselves create buffers against uncertain environmental fluctuations, policy or management through several pathways (Roberts et al. 2017). They can be summarized as affording species the space to climate-migrate, the time to use their genetic diversity to adapt, protecting ecosystem components that have stabilising effects on ecosystems (e.g. top predators), or allow for the accumulation of once sequestered carbon in undisturbed sediments.

The establishment of MPAs in parallel to mitigation and development strategies allows for a strategy to 'buy time' while other activities are developing. **The BCI Healthy Blue Communities Network** can assess and implement locally relevant strategies both for protection and development. Investment to allow nations to finance a transition from the status quo to sustainable options of protection and development can be channeled to alternative employment opportunities when fisheries are not subsidised, to a promotion of energies other than fossil fuels, protection enforcement of MPA, biodiversity assessments and that of species' economic potential, and importantly the education of the population on the value of services the ocean and coastal habitats provide.

**COLLABORATION IN INTERVENTION:  
*Seychelles.***

Investing in economic and conservation activities through a debt-for-nature swap

The Seychelles are a chain of 115 islands situated in the Western Indian Ocean off East Africa. The Seychelles' main economic activities are related to tourism and fisheries, which both depend on a healthy marine environment. Fisheries are responsible for more than 90% of the country's export revenue, and it is clear how important well functioning marine ecosystems are to the economy of the island state, and thus to the health and well-being of its population.

Increasing national debt prompted the small island nation to consider alternative routes to channel investment into the pillars of its economy, and a debt-for-nature swap was initiated in 2015 (Nature Conservancy 2016; The World Bank 2018; Saigal et al. 2019, Silver and Campbell 2018, Laing 2020). This comprised a unique concept to relieve the state of debt through active debt relief and raising of funds from private and philanthropic investors. At the same time, the country invests in its economy as a sustainable enterprise and builds on the environment to provide the economic goods – fish for fisheries, and an intact natural environment for tourism.

As a results of this “Debt Restructuring for Marine Conservation and Climate Adaptation Program” (Silver and Campbell 2018) that constitutes the debt-for-nature swap, 30% of Seychelles' exclusive economic zone (EEZ) was placed under protection, half of which as no-take zones (Silver and Campbell 2018). This proclamation is accompanied by Marine Spatial Planning (MSP) efforts that should ensure the division of the marine space for various economic activities and conservation. Concurrently, the country is building its Blue Economy through Blue Bonds, and through its Seychelles Conservation and Climate Adaptation Trust (SeyCCAT) invests into endowment funding and current conservation and adaptation projects (Silver and Campbell 2018).

As one of the first such projects implemented worldwide, it is eyed as an example to apply to other Small

Island Developing States (SIDS), foremost in the Caribbean (Climate Analytics 2020; Silver and Campbell 2018). Barbuda, for instance, has already engaged in comprehensive marine spatial zoning activities to account for use of its marine space (Johnson et al 2020). Such models that build on conserving the basis of marine economic activities, i.e. the natural environment, can ultimately be applied to different ecological, socio-economic and political contexts in various countries bordering oceans and other island states.

**COLLABORATION IN INTERVENTION:  
*Coastal Communities, Intersecting Disasters, &  
Environmental Justice: New Orleans as a Case  
Study in Innovation.***

New Orleans offers a case study in how overlapping and intersecting disasters expose and exacerbate inequality in coastal communities and also prompt creative and effective local responses. The compound effects of natural disasters frequently hit coastal communities such as New Orleans particularly hard. On August 29, 2005, Hurricane Katrina struck New Orleans. The storm and the resulting levee failures inundated the city, displacing the majority of residents, and resulting in almost 1000 deaths. The patterns of destruction following Katrina reproduced existing patterns of racial and economic inequality in the City. Now 15 years on, New Orleans confronts a new crisis. COVID-19 has torn through New Orleans and surrounding parishes. In common with larger national patterns, New Orleans (and Louisiana's) black population has been hit hard (Weinstein, 2020). Early data reveals that black Louisianans are dying by COVID-19 disproportionately high rates (Weinstein, 2020). Even as the acute arc of the pandemic smooths out and the City begins to recover and rebuild, it faces another challenge – climate change. New Orleans is one of the U.S. cities most at risk for climate change. The effects of overlapping disasters in New Orleans are acute, but these patterns can be seen in coastal communities all over the world.

In New Orleans, intersecting crises have prompted creative local responses focused on integrating coastal resiliency, economic growth, and social and environmental justice (Climate Action Equity Project 2019). In addition to award winning city-wide efforts to facilitate

green infrastructure and low-impact coastal development and adaptation led by the New Orleans Redevelopment Authority (NORA), organizations such as The Lower 9th Ward Center for Sustainable Engagement and Development and The Deep South Center for Environmental Justice are finding innovative ways to integrate coastal rehabilitation and the greening of the built environment with complementary efforts to address persistent patterns of food security and environmental injustice (DSCEJ, 2020; CSED, 2020). These efforts focus on creating economically, culturally, and environmentally sustainable coastal communities through a variety of projects. These projects include: generating the first maps showing the correlation between toxic pollution and race in gulf communities; producing data showing racial disparities in environmental health and climate vulnerabilities; developing the nation's first carbon-neutral, affordable housing communities; launching new cooperative initiatives such as the Historically Black College and University Climate Change Consortium, which draws upon the resources and initiative of HBCUs to raise awareness of the disproportionate impact of climate change on marginalized communities. Such locally initiated public and private initiatives are critical sources of information and innovation and demonstrate the ingenuity, experimentation, and cooperation that will be necessary to drive creative solutions to climate change in coastal communities worldwide.



## Appendix 2. Examples of potential future Collaborative BCI Healthy Blue Communities Projects

### *COLLABORATION IN RESEARCH: The Global Marine Genetic Resources Network.*

Several dozen global marine biobanking, gene banking, and taxonomic initiatives are currently working to identify and categorize life in the ocean. Unfortunately, many of these efforts are not coordinated, and consequently, work is redoubled, and information lost. If **The BCI Healthy Blue Community Platform** could link these initiatives through modern data infrastructures, e.g. cloud computing and artificial intelligence, the participating communities (as well as global community) would stand to benefit considerably.

New knowledge that emerges from this collaborative effort will offer tools for conservation (e.g. species restoration, ecosystem modeling, and greater focus for protected areas) as well as benefits for human bioscience and biotechnology.

This project would align well across levels:

- International level, efforts are currently underway within the United Nations to explore regulatory and protective pathways for marine genetic resources;
- Nation-states, who are the primary stewards of biobanks and gene banks;
- Private companies, who are leading the way in sequencing and other genetic technologies;
- Non governmental organisations (NGOs) involved in climate change, ocean, health and well-being;
- The scientific community, who has long been engaged in this space and is leading current research; and
- Local communities, many of whom have been involved in community-level collection efforts that both feed into global initiatives as well as those in their home countries.

This work would require considerable public support. Private sector investment should therefore be seen only as a catalyst to bring together and launch a broader global initiative, that will include governments, communities, scientists, large corporations, and smaller start-ups. This work would not have to start from scratch, given both the multitude of global efforts already working on some dimension of banking and sequencing, as well as a feasibility study for this very project that was conducted in 2019 by a private California foundation. **The BCI Healthy Blue Communities Network** would be able to accommodate small and larger shared Projects to actualise this vision.

### *COLLABORATION IN RESEARCH: The Global Marine Census.*

The links between oceans, climate, and human health here are self-evident. Climate change is affecting marine life in a calamitous way through warming, acidification, and habitat loss.

If we are to safeguard marine life, it would be helpful to have a census of marine life. Such an effort has already started (<http://www.coml.org>); and we are at a point in time when we have yet more sophisticated genetic and technological tools to expand it to yet undiscovered and undescribed species in more detail and from more locations in the world. Doing so would enable sustainable management of ecosystems, while also enabling untold contributions to fostering human health and well-being (e.g. Blue Gym, EU BlueHealth, EU SOPHIE, etc) and treating disease through new biomedicines. It also offers an opportunity to establish a strong public health narrative for protecting this natural bank of living resources and necessarily their habitats, by illustrating our utter dependence on the coasts, seas and ocean for food, oxygen, medicine, and essentially the advancement of contemporary biological science.

### *COLLABORATION IN RESEARCH: Transformative Mariculture.*

Malnutrition (including both obesity and undernutrition) remains one of the grand challenges facing humanity (Dietz 2020; UNICEF 2019). An estimated 1-3 billion people worldwide depend on seafood as their

principal source of dietary protein. With 90% of ocean fish stocks being either fully fished or over fished (FAO 2016), wild fish capture does not have the capacity to provide recommended levels of levels of protein or of essential micronutrients such as Omega-3 fatty acid to the global population (Willett et al 2019).

Climate change is exacerbating inequality, decreasing already exploited fish stocks, and limiting the capacity of people to consume adequate protein and micro-nutrients. Nine countries in the Asia Pacific region account for 87% of the global fish catch (FAO 2018; Huelsenbeck 2012) and fish consumption provides more than 50% of the total animal dietary protein for some populations in Asia, Island States and West Africa (FAO 2014). These same countries face growing seafood insecurity and many are particularly reliant on small fish, an important source of many micronutrients.

Unfortunately, of the 29 million tonnes of forage fish caught each year, approximately 16 million tonnes are converted to fish meal, much of which is used as feed in aquaculture. (Cottrell et al. 2020).

The only way that the global population can receive the recommended level of dietary protein and Omega-3 fatty acid will be through a combination of mariculture and development of an alternative to forage fish for aquaculture feed. Note that vegetable diets are already in use in various mariculture operations in Asia and Scandinavia. Cf. <https://www.skretting.com/>

Aquaculture now supplies more than 50% of all seafood, and further advances will be vital in meeting the food requirements of the growing global population. Yet as fish farming has intensified, so too have the challenges, but also the opportunities.

Recent years have seen astronomical losses across farmed species. The problem is made worse by inefficient delivery of essential compounds and nutrients. Overuse and inappropriate use of these essential materials can be polluting, and can lead also to dangerous accumulations of toxic chemicals such as heavy metals, persistent organic pollutants and antibiotic residues in farmed seafood; thus, erasing the important gains achieved by otherwise environmentally-conscious aquaculture practices.

There is also a need to ensure that farmed fish and shellfish contain all of the essential nutrients found in wild-caught fish, because more than 2 billion people worldwide are nutrient-deficient, leading to a wide range of serious health problems.

Other areas of innovation include intensive seaweed culture to provide food and other innovative materials e.g. <https://www.seaweedeurope.com/> and <http://www.montereybayseaweeds.com/>.

To address these issues and feed their growing populations, communities in **BCI Healthy Blue Communities Network** and their research partners will work together to develop innovative, science-based advances in mariculture such as targeted, modular, delivery mechanisms for compounds and nutrients that are tailored for optimal size, shape, buoyancy and to appeal to shellfish and that can be adapted to meet the most critical needs in the industry. New filtration systems now permit mariculture operations to be set up at many more locations, some inland from the coast, while large offshore open ocean mariculture structures are creating new opportunities to reduce the use of pharmaceuticals used in the treatment of fish diseases and removal of parasites. Ongoing monitoring of the potential positive and negative impacts on local ecology and local populations health and well-being will be essential.

Resources include:

- [Sustainable development of marine aquaculture off-the-coast and offshore – a review of environmental and ecosystem issues and future needs in temperate zones](#)
- [Offshore Fish Farming](#)
- [Can Deepwater Aquaculture Avoid the Pitfalls of Coastal Fish Farms?](#)
- [Eight digital technologies disrupting aquaculture](#)

***COLLABORATION IN RESEARCH: The Ocean Health Map - Improved Mapping of Ocean Pollution and Its Health Impacts.***

A major impediment to estimating the Global Burden of Disease attributable to pollution of the oceans is a lack of comprehensive, geospatially coded measurements that display current information on the types and concentrations of pollution in seas around the world and their impacts on human health and well-being. Absent this information, it is not possible to estimate the sizes of the populations exposed to ocean pollutants or their levels of exposure. Opportunity exists here to apply new technologies such as satellite imaging and ocean sampling by marine sail drones and autonomous underwater vehicles coupled with big data analyses that integrate data from multiple sources.

Monitoring for all of the chemical and biological hazards in the oceans should increase in scope and be coordinated globally. It is possible to monitor for some biological hazards, ocean pH and temperature in sensors that are part of the Global Ocean Observing system (GOOS) within the UN system. Enhancing this capability and adding sensors for chemical hazards and the health status of marine organisms that incorporate new technologies and capabilities is an objective that may be achieved by partnering with programs such as the Partnership for Observation of the Global Ocean (POGO).

Because consumption of contaminated seafood is the major route by which chemical and microbial pollutants in the ocean, as well as HAB toxins, reach humans, better information is needed on concentrations of key pollutants in seafood. High-quality data are available from high-income countries, but much less information is available from the countries of the Global South.

Specific needs are the following:

- Assist countries with the establishment and certification of monitoring programs for chemical pollutants, algal toxins, microplastics, and microbial pathogens in seafood products.
  - Build and sustain strong transdisciplinary teams of scientists and strengthen analytical capabilities

ties at the national level to provide countries with capability to respond to new and unexpected marine pollutants.

- Develop new monitoring capabilities using networks of in situ sensors that can detect toxic chemical pollutants, HAB cells and their toxins, microplastics and pathogenic bacteria.
- Generate new information on concentrations of key pollutants in seafood. High-quality data are available from high-income countries, but much less information is available from the countries of the Global South.
  - Deploy innovative techniques for monitoring the global spread of pathogenic bacteria, such as *Vibrio* species and use data derived from these technologies to expand geographic coverage of marine bacterial sampling - especially into areas important for commercial fishing, shellfish harvesting and aquaculture - coupled with real-time information on sea surface temperature will be important for tracking and predicting the spread of life-threatening bacteria and for mobilizing early responses to new outbreaks of diseases.
  - Enhance communication, literacy and outreach efforts so that the risks of human illness and death from ocean pollutants is recognized and understood throughout all levels of society, including in the medical and public health communities.

(Cf Health of the Oceans Design Plan; IOC/IMO/UNEP)

***COLLABORATION IN RESEARCH: Economic Research towards the Establishment of Natural Capital Accounting, and its Depletion Account.***

Deploy improved analytical capabilities to document health and economic benefits of programs to control and prevent ocean pollution. Economic gains from the natural environment, and the economic losses through its destruction and impaired human health are measures of natural wealth which can guide policy and governance of such resources (Lange et al. 2018).

Human health and well-being depends on pollution levels, disease burden and potential positive as well as negative interactions with the environment. Their economic activity furthermore depends on functioning climate systems and healthy ecosystems. The economic benefits that ecosystems provide are numerous and well known (Constanza and Daly 1992, Lange et al. 2018). They range from water purification through abiotic and biotic processes, to providing renewable harvests of food (fish, invertebrates, algae) and building materials (mangroves, sand), and mental and physical benefits of green spaces and ocean access. Naturally, the depletion and degradation of such resources impacts human well-being and economic structures. Natural wealth is especially important in low income countries where it has a large share of 47% of total wealth. Even in the lower-middle income countries, the share of natural wealth is more than 25% (Lange et al. 2018).

Economic considerations of ocean conservation are not new, and many parallel efforts are currently underway. One such example is the restructuring of national debt into ocean conservation, the so-called debt-for-nature swap in the Seychelles (<https://www.woi.economist.com/seychelles-swaps-debt-for-nature/>). The increase of marine protected areas from 0.04 to 30% of Seychelles' territory has been a notable step towards conservation, re-building fish stocks, protecting habitat, and controlling exploitation. Such action enables the Seychelles to continue fishing and tourism on a sustainable basis, and at the same time provide for income for its population.

Increasingly, economic fora and institutions, and international organizations such as the UN or the Worldbank have recognized the economic potential of functioning ocean ecosystems. It is well known that biodiversity enables ecosystem services (Worm et al. 2006). In Mauritania, fisheries account for nearly 50% of the nation's natural capital (de Fontaubert et al. 2018). However, worldwide fisheries catches have peaked in the mid 1990s with a small decline since, but with a steeper decline in catch per unit effort that has prompted nations to subsidise their fisheries to counteract the economic losses of the fishing industry (de Fontaubert et al. 2018). Currently, nations could save

money by ceasing to subsidise unproductive fisheries (>50% of high-seas fisheries are unprofitable without subsidies (Sala et al. 2018)), re-grow fish stocks, or expand tourism thereby increasing food security and guarantee employment. Subsidies, this and the substantial illegal, unreported and unregulated (IUU) fishing result in further declines in fish stocks (Telesky, 2015). New networks of observation and data storage (Leape et al. 2020) can assist in such efforts.

The decline in wild fishery catches has led to a dramatic increase in aquaculture production over the past few decades (FAO 2020). Aquaculture practices adversely affect natural capital, for instance through habitat destruction by removing mangroves and thereby coastal protection and timber, through water pollution from feed and antibiotics, or genetic mixing of wild and farmed species.

The **BCI Healthy Blue Communities Network** and its partners can provide a platform to assess gains and losses from fishery related activities, and how to transform into sustainable fisheries (re-build stocks, stop subsidies, prevent illegal fishing) and mariculture. The network can further serve as infrastructure for expanding observation networks for illegal, unreported and unregulated (IUU) fishing and mobilisation and enabling governments to build networks of collaboration to address the issue. An assessment of natural wealth, natural capital depletions, and attainable services in the future under various economic, marine protection, human population growth, etc. scenarios can serve as part of a roadmap for policy and development. Education is an important part of this effort, at all levels of the formal education sector, and including the public, policy makers and politicians.



# References

- Aiken, C., Chase, N., Hellendrung, J., & Wormser, J. Designing with Water: Creative Solutions from Around the Globe. Preparing for the Rising Tide Series, 2. 2014
- BBC. Coastal management. Available at: <https://www.bbc.co.uk/bitesize/guides/z8rmw6f/revision/4>
- Belize.com. Eco Tourism In Belize. Available at: <https://belize.com/eco/>
- Bindoff, N.L., W.W.L. Cheung, J.G. Kairo, J. Arístegui, V.A. Guinder, R. Hallberg, et al., Changing Ocean, Marine Ecosystems, and Dependent Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate . 2019. In press
- C40 Cities. Available at: <https://www.c40.org/>. Accessed: September 1, 2020
- CBO. Expected Costs of Damage From Hurricane Winds and Storm-Related Flooding. Available at: <https://www.cbo.gov/system/files/2019-04/55019-ExpectedCostsFromWindStorm.pdf> 2019. Accessed: September 1, 2020
- Census of Marine Life (n. d.). Census of Marine Life: A Decade of Discovery. Available at : <http://www.coml.org> (Accessed 15 January 2020)
- Climate Action Equity Project. Taking Steps Together on Equity and Climate Change: A Report By and For New Orleansians, [https://issuu.com/greaterneworleansfoundation/docs/2019.08.30\\_-\\_climate\\_action\\_equity\\_report\\_-\\_web](https://issuu.com/greaterneworleansfoundation/docs/2019.08.30_-_climate_action_equity_report_-_web). Accessed: September 1, 2020
- Climate Analytics. Available at: <https://climateanalytics.org/>
- CoastAdapt. Case Studies. Available at: <https://coastadapt.com.au/case-studies>
- Coastal Communities Alliance. Case Studies. Available at: <https://www.coastalcommunities.co.uk/arts-opera/ccn/case-studies/>
- Cole, D., From Global to Polycentric Climate Governance, 2 Climate Law 395- 413 (2011)
- Commonwealth. Blue economy. Available at: [thecommonwealth.org](http://thecommonwealth.org). Accessed: September 1, 2020
- Costanza R, Daly HE.. Natural capital and sustainable development. Conservation Biology, 1992. Vol 6(1): 37-46.
- Cottrell, R.S., Blanchard, J.L., Halpern, B.S. et al. Global adoption of novel aquaculture feeds could substantially reduce forage fish demand by 2030. 2020. Nat Food 1, 301–308 . doi: <https://doi.org/10.1038/s43016-020-0078-x>
- CSED. Lower 9th Ward Center for Sustainable Engagement and Development, <http://sustainthenine.org/mission-values/>.
- de Fontaubert C, U. Rashid Sumaila, and Glenn-Marie Lange. Subsidies Reduce Marine Fisheries Wealth. In: Lange, Glenn-Marie, Quentin Wodon, and Kevin Carey, eds. 2018. The Changing Wealth of Nations 2018: Building a Sustainable Future. Washington, DC: World Bank. 2018. doi:10.1596/978-1-4648-1046-6.
- Dietz WH. Climate change and malnutrition: we need to act now. Journal of Clinical Investigation. 2020.130: 556-58
- DSCEJ. The Deep South Center for Environmental Justice, Available at: <https://www.dscej.org/our-story>.
- Erickson, P. & Tempest, K. Advancing Climate Ambition: How City-Scale Actions Can Contribute to Global Climate Goals, Stockholm Environmental Institute, Working Paper 2014-06. 2014. Available at: <https://mediamanager.sei.org/documents/Publications/Climate/SEI-WP-2014-06-C40-Cities-mitigation.pdf>. Accessed 20 Sept. 2020
- European Union. The 2018 annual economic report on EU Blue Economy. 2018
- FAO. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome. 2020. doi:<https://doi.org/10.4060/ca9229en>
- FAO. High Level Panel of Experts on Food Security and Nutrition. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: FAO. 2014.
- FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome FAO. 2018.
- GIDA. CARE Principles. Available at: <https://www.gida-global.org/care#>
- Global Aquaculture Advocate. Eight digital technologies disrupting aquaculture Available at: <https://www.aquaculturealliance.org/advocate/eight-digital-technologies-disrupting-aquaculture/> 2018
- Go Fair. FAIR Principles. Found at: <https://www.go-fair.org/fair-principles/>
- Golden CD, Allison EH, Cheung WW, Dey MM, Halpern BS, McCauley DJ, et al. Nutrition: Fall in fish catch threatens human health. Nature. 2016;534(7607):317-20. doi: 10.1038/534317a.
- Gov.uk. How government is helping coastal communities flourish as places to live, work and visit. Accessed at: <https://www.gov.uk/government/collections/coastal-communities>. Published: 26 February 2018.
- Gunther. M. Can Deepwater Aquaculture Avoid the Pitfalls of Coastal Fish Farms? Available at: <https://e360.yale.edu/features/can-deepwater-aquaculture-avoid-the-pitfalls-of-coastal-fish-farms>. 2018
- Hoegh-Guldberg O, Eliza Northrop, Jane Lubchenco. The ocean is key to achieving climate and societal goals. 2019. Science. VOL 365 ISSUE 6460
- Holmer, M. Sustainable development of marine aquaculture off-the-coast and offshore-a review of environmental and ecosystem issues and future needs in temperate zones. FAO Fisheries and Aquaculture Proceedings, 2013.(24), 135-171
- Huelsenbeck M. Ocean-Based Food Security Threatened in a High CO2 World [https://oceana.org/sites/default/files/reports/Ocean-Based\\_Food\\_Security\\_Threatened\\_in\\_a\\_High\\_CO2\\_World.pdf](https://oceana.org/sites/default/files/reports/Ocean-Based_Food_Security_Threatened_in_a_High_CO2_World.pdf). 2012. accessed 18 May 2020. Washington DC: Oceana

- Johnson AE, McClintock WJ, Burton O, Burton W, Estep A, Mengerink K. et al. Marine spatial planning in Barbuda: A social, ecological, geographic, and legal case study. *Marine Policy* 113 (2020) 10379
- Laing S. 2020. Blue Economy and Blue Bonds: An overview of the concepts and the pioneering case of Seychelles. *Seychelles Research Journal*, Volume 2, Number 1, 155-164.
- Lange, G., Wodon, Q. Carey, K. The Changing Wealth of Nations 2018: Building a Sustainable Future. Washington, DC: World Bank. 2018. doi:10.1596/978-1-4648-1046-6.
- Leape, J., M. Abbott, H. Sakaguchi et al. Technology, Data and New Models for Sustainably Managing Ocean Resources. 2020. Washington, DC: World Resources Institute. Available at: [www.oceanpanel.org/Technology-data-and-new-models-for-sustainably-managing-ocean-resources](http://www.oceanpanel.org/Technology-data-and-new-models-for-sustainably-managing-ocean-resources)
- Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, et al. Biological effects within no-take marine reserves: a global synthesis. *Marine Ecology Progress Series*. 2009. 384: 33–46.
- Lin, D., Crabtree, J., Dillo, I. et al. The TRUST Principles for digital repositories. *Sci Data* 7, 144. 2020. <https://doi.org/10.1038/s41597-020-0486-7>
- Lloret J, et al. The Roses Ocean and Human Health Chair: A New Way to Engage the Public in Oceans and Human Health Challenges. *Int. J. Environ. Res. Public Health* 2020, 17, 5078.
- Lubchenco J, Grorud-Colvert K. OCEAN. Making waves: The science and politics of ocean protection. 2015. *Science* 350:382–383.
- Monterey Bay Seaweeds. Available at: <http://www.montereybayseaweeds.com/>. Accessed: September 1st, 2020
- NORA. Annual Report. 2019. Available at: <https://noraworks.org/images/NORA-YiR2019-web.pdf>
- Oceans and Human Health. Objectives of the Oceans and Human Health Chair. Available at: <http://www.oceanshealth.udg.edu/en/objectives-of-the-oceans-and-human-health-cha.html>
- O’Leary BC, et al. Effective coverage targets for ocean protection. *Conserv Lett*. 2016. 9:398–404.
- Ostrom, E., A Polycentric Approach for Coping with Climate Change, World Bank Policy Research Working Paper No. 5095, 39. 2009
- Ostrom, E., Nested Externalities and Polycentric Institutions: Must we Wait for Global Solutions to Climate Change before Taking Action at Other Scales?, 49(2) *Econ. Theory* 2. 2012
- PRB. Strategies for Sustainable Development: Case Studies of Community-Based Population, Health, and Environment Projects. Available at: <https://www.prb.org/strategiesforsustainabledevelopmentcasestudiesofcommunitybasedpopulationhealthandenvironmentprojects/>
- Rittel, H. W., & Webber, M. M. “Dilemmas in a General Theory of Planning.” *Policy sciences*. 1973. 4(2), 155-169. [https://urban-policy.net/wp-content/uploads/2012/11/Rittel+Webber\\_1973\\_PolicySciences4-2.pdf](https://urban-policy.net/wp-content/uploads/2012/11/Rittel+Webber_1973_PolicySciences4-2.pdf)
- Roberts CM, O’Leary BC, McCauley DJ, Cury PM, Duarte CM, Lubchenco J, et al.,. Marine reserves can mitigate and promote adaptation to climate change. *Proceedings of the National Academy of Sciences*. 2017 Jun 13;114(24):6167-75.
- Rogers, A., O. Aburto-Oropeza, et al. Critical Habitats and Biodiversity: Inventory, Thresholds and Governance. 2020. Washington, DC: World Resources Institute. Available at: [www.oceanpanel.org/blue-papers/critical-habitats-and-biodiversity-inventory-thresholds-and-governance](http://www.oceanpanel.org/blue-papers/critical-habitats-and-biodiversity-inventory-thresholds-and-governance)
- Saigal K. Conservation finance: Seychelles’ troubled waters. *Euromoney*. Accessed at: <https://www.euromoney.com/article/b1hhzxr8z0syh/conservation-finance-seychelles-troubled-waters>
- Sala E, Costello C, Dougherty D, Heal G, Kelleher K, et al. (2013) A General Business Model for Marine Reserves. *PLoS ONE* 8(4): e58799. doi:10.1371/journal.pone.0058799
- Sala, E., Mayorga, J., Costello, C., Kroodsma, D., Palomares, M. L., Pauly, D., ... & Zeller, D. (2018). The economics of fishing the high seas. *Science Advances*, 4(6), eaat2504.
- SalMar. Offshore Fish Farming: A new era of fish farming is on its way. Available at: <https://www.salmar.no/en/offshore-fish-farming-a-new-era/>
- Seaweed for Europe. A Coalition to advance and scale a sustainable and innovative seaweed industry in Europe. Available at: <https://www.seaweedeurope.com/>. Accessed: September 1, 2020
- Silver, J., Campbell, L. Conservation, development and the blue frontier: the Republic of Seychelles’ Debt Restructuring for Marine Conservation and Climate Adaptation Program. *International Social Science Journal*. 2018. DOI: 10.1111/issj.12156
- SOPHIE. Innovative Solutions. Available at: <https://sophie2020.eu/activities/innovative-solutions/>
- Stern, N., S. Peters, V. Bakhshi, A. Bowen, C. Cameron, S. Cato, D. Crane, et al., Stern Review: The Economics of Climate Change, HM Treasury, London. 2006
- Telesetsky, A. Scuttling IUU fishing and rewarding sustainable fishing: enhancing the effectiveness of the port state measures agreement with trade-related measures. *Seattle UL Rev.*, 38, 1237. 2014.
- The Nature Conservancy. SEYCHELLES INVESTING FOR RESILIENCE Available at: <https://www.cbd.int/doc/meetings/mar/soiom-2016-01/other/soiom-2016-01-seychelles-01-en.pdf> 2016
- The World Bank. Seychelles Achieves World First with Sovereign Blue Bond. 2018. Accessed at: <https://www.worldbank.org/en/news/feature/2018/10/29/seychelles-achieves-world-first-with-sovereign-blue-bond>
- The World Bank. “What is the Blue Economy?”. 6 June 2017. Found at: <https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy>
- United Nations Children’s Fund (UNICEF); World Health Organization; International Bank for Reconstruction and Development/The World Bank. Levels and Trends in Child Malnutrition: Key Findings of the 2019 Edition of the Joint Child Malnutrition Estimates; WHO: Geneva, Switzerland, 2019.

Weinstein R, Monitoring the COVID-19 Pandemic in New Orleans and Louisiana, The Data Center (April 20, 2020), <https://www.datacenterresearch.org/covid-19-data-and-information/covid-19-data/>

Wikipedia. Sihwa Lake Tidal Power Station. Available at: [https://en.wikipedia.org/wiki/Sihwa\\_Lake\\_Tidal\\_Power\\_Station](https://en.wikipedia.org/wiki/Sihwa_Lake_Tidal_Power_Station). Accessed: September 15th, 2020

Willett W, Rockstrom J, Loken B, Springmann M, Lang T, et al. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet* 393: 447-92. 2019.

Woods Hole Group, Inc. Falmouth Climate Change Vulnerability Assessment and Adaptation Planning. Available at: [http://www.falmouthmass.us/DocumentCenter/View/7018/FalmouthVA\\_Final\\_Report\\_Draft](http://www.falmouthmass.us/DocumentCenter/View/7018/FalmouthVA_Final_Report_Draft). December 2019

World Resources Institute. Managing Ocean Resources. Washington, DC: Available online at [www.oceanpanel.org/](http://www.oceanpanel.org/)

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, et al., Impacts of biodiversity loss on ocean ecosystem services. *Science*. 2006. Vol 314, 787-790.

# Working Group Co-Leads & Members

## Co-leads

- Dr. Phil Landrigan, MD: Director, Global Public Health Program and Global Pollution Observatory Schiller Institute for Integrated Science and Society, Boston College.
- Dr. Lora Fleming: Director, European Centre for Environment and Human Health; Chair of Oceans, Epidemiology and Human Health at the University of Exeter Medical School.
- Dr. John Stegeman: Director, Woods Hole Center for Oceans and Human Health, Senior Scientist in Biology, Woods Hole Oceanographic Institution.
- Dr. Michael Depledge CBE: Founding member of the European Centre for Environment and Human Health, Emeritus Professor of Environment and Human Health, University of Exeter.

## Members

- Dr. Timothy A. Bouley: Co-founder and CEO of BioFeyn Inc. Previously head of climate and health at World Bank, researcher at World Health Organization, National Academy of Sciences, UCSEF.
- Cinnamon Carlarne: Faculty, Moritz College of Law, The Ohio State University. Previously, University of South Carolina School of Law; Harold Woods Research Fellow in Environmental Law at Wadham College, Oxford.
- Dr. Lilian Corra: Medical doctor; Director, Medical Specialist Program on Health and Environment, School of Medicine, University of Buenos Aires.
- David Kamp: Author, healthcare and landscape design scholar. Loeb Fellow, Harvard University; Fellow, MacDowell Colony; Fellow, American Society of Landscape Architects; Cofounder, Center for Design and Health at the University of Virginia.
- Prof. Bruce Maycock: Secretary General, Asia Pacific Academic Consortium of Public Health (APACPH); Honorary Professor, College of Medicine and Health at the University of Exeter; Head, School of Public Health, Curtin University, Australia.
- Dr. Patrick Rampal: President, Scientific Center of Monaco; Gastroenterology Professor; former President of the French Society of Gastroenterologists.
- Prof. Ursula Scharler: Professor at the School of Life Sciences, University of KwaZulu-Natal, Durban, South Africa.
- Pál Weihe: Head, Department of Occupational Medicine and Public Health, Faroe Islands; former Medical Director of the Faroese Hospital System. Adjunct Professor at the University of the Faroe Islands, Visiting Scientist at Harvard School of Public Health.
- Samantha Fisher: Data Analyst, Global Observatory on Pollution and Health, Boston College.



# WHAT WILL YOU DO?



The Blue Climate Initiative accelerates ocean-related strategies, collaborating across a multidisciplinary global community towards a restored and healthy climate; an understood and protected ocean; and resilient, thriving and equitable communities. The fiscal sponsor for the Blue Climate Initiative is Tetiaroa Society, a US 501(c)(3) nonprofit organization ([tetiaroasociety.org](http://tetiaroasociety.org)).