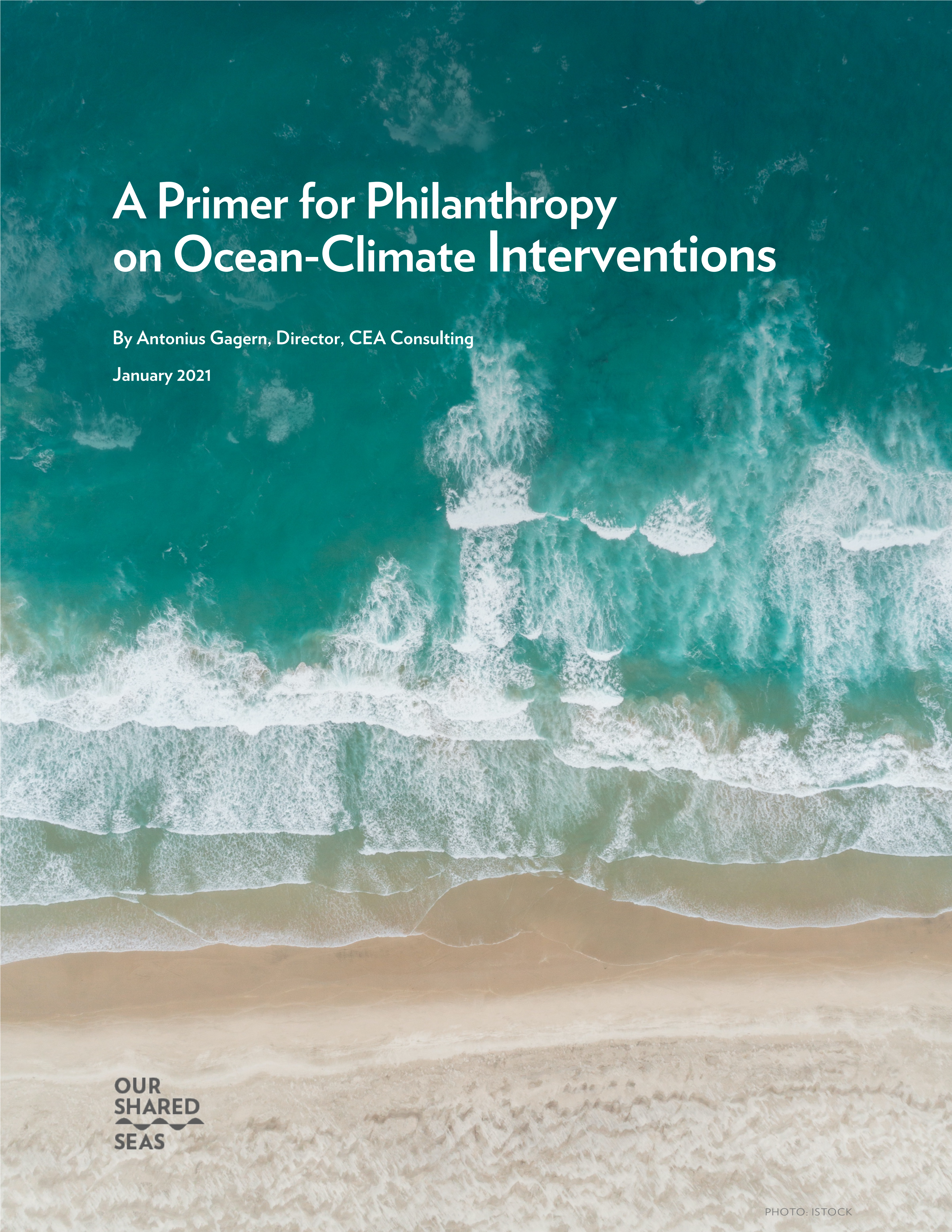

A Primer for Philanthropy on Ocean-Climate Interventions

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Rationale for Increased Coordination between Ocean and Climate Efforts

Human prosperity and marine biodiversity rely on a healthy ocean. The ocean is an indispensable ally for human health and prosperity as it buffers and controls the global climate and has long been an important source of income, protein, cultural value, and recreation. The ocean is also home to millions of plant and animal species that have evolved to survive in delicately balanced ecosystems. Many of the services that the ocean provides to humans rely on a healthy and productive ocean, including its biology, chemistry, and physical attributes.

Climate change has become the largest and fastest-growing threat to the ocean as we know it. The marine environment is now experiencing rapid changes in temperature, acidity, and oxygen levels, which in turn have profound effects on biodiversity, productivity, and ocean circulation. The effects of climate change threaten to dwarf other stressors such as overfishing and pollution, while eroding species' resilience to recover from these pressures as well.[1]

Over the past decades, the philanthropic community has mounted significant responses to both ocean conservation and climate change. The marine conservation community has focused on curbing overfishing, expanding marine protected areas, and slowing the destruction of coastal ecosystems. The climate community has elevated climate change as a societal priority of the 21st century on a global level and championed renewable energy pathways, adaptation, and mitigation efforts.

Ocean funders increasingly recognize that marine conservation priorities and past victories may be overtaken by climate change impacts. Many prominent efforts to safeguard biodiversity, sustainably manage fisheries and alleviate poverty in coastal communities around the world are at risk. The marine conservation community can work locally and nationally to reduce the detrimental effects of pollution, overfishing, or habitat destruction, but ocean acidification, rising temperatures, sea level rise, and hypoxia are largely outside of our direct control.

Ocean funders have an important role to play in shaping a robust response to climate change. Ocean funders have traditionally deferred to the climate and energy funding communities to address and avert the worst effects of climate change. However, there is compelling rationale to believe that ocean funders should increase their efforts to climate-proof existing work, contribute to the global effort to decrease sector-specific emissions, and explore scalable pathways to permanently sequester greenhouse gases. These reasons include:

- Climate change has already altered the physical and biogeochemical state of the ocean and will continue to do so for centuries to come.
- To avert the worst consequences of climate change, every sector in the global economy must aggressively decrease current emissions. In addition, society needs to remove and sequester 100-1000 billion tons of carbon dioxide (CO_2) from the atmosphere by 2100.[2]
- The ocean conservation community is an important stakeholder in many important mitigation and sequestration "wedges." These includes the conservation of carbon-rich coastal ecosystems, direct engagement with ocean-related industries (e.g., shipping), and exploration of ocean-based carbon dioxide removal (CDR) opportunities.

- The marine community has increasing desire to engage in the broader climate dialogue to ensure that the ocean is not inadvertently sacrificed in our search for solutions (e.g., Solar Radiation Management).

Model for Ocean-Climate Interventions

One useful categorization of ocean-climate efforts divides interventions into three areas: the mitigation of future greenhouse gas emissions, the accelerated sequestration of atmospheric CO_2, and adaptation efforts to help vulnerable habitats and communities adapt to the stresses of climate change.

1. **Mitigation**: Ocean stakeholders are important advocates in several global industries with significant CO_2 footprints, including shipping and offshore oil and gas. Research by the High Level Panel for a Sustainable Ocean Economy found that under aggressive scenario assumptions, ocean-based approaches (through five key mitigation wedges) could reduce the global emissions gap by 21 percent to limit warming to 1.5 degrees Celsius, and by about 25 percent on a 2-degrees Celsius pathway by 2050.[3]
2. **Sequestration**: Ocean-based sequestration includes efforts that protect or enhance the ocean's ability to sequester atmospheric CO_2. The ocean plays an important role in the global carbon cycle and has contributed to the stabilization of the global climate for millions of years. Primary producers such as phytoplankton, mangroves, and seaweed turn CO_2 into organic carbon, some of which escapes the food web and is permanently sequestered in coastal soils and seabeds. Over geologic timescales, the weathering of rock washes alkaline molecules into the ocean and converts dissolved CO_2 into carbonates and bicarbonates, which stores carbon for tens to hundreds of thousands of years in sediments.
3. **Adaptation**: Many of the conservation community's existing priorities (e.g., fisheries, MPAs, coastal habitats, and livelihoods of coastal communities) are threatened by climate impacts. Climate-proofing this work and making past gains more durable over time is critical. This includes prioritizing ocean solutions that continue to be effective despite climate impacts and exploring efforts to increase the resilience of both ecosystems and coastal communities.

Mitigation Interventions

In the context of climate change, mitigation refers to all actions that limit emissions of greenhouse gases including CO_2. As such, ocean-based mitigation includes interventions that reduce emissions from ocean-based industries (e.g., shipping, offshore oil & gas, and fishing), interventions that reduce emissions related to ecosystem degradation from blue carbon (i.e., mangroves, salt marshes, seagrasses, and kelp forests), as well as activities that avoid emissions from other sources that would have otherwise occurred. The latter includes accelerating the growth of marine renewable energy (offshore wind), and producing low-carbon foods (i.e., farmed fish) or biofuels (e.g., seaweed-based biofuels) at sea. Figure 1 below shows the mitigation potential of major ocean-related interventions by 2050; the following sections provide brief descriptions of key mitigation opportunities.

Offshore wind is among the most carbon-efficient energy source available.[i] Offshore wind is a relatively new industry. At 0.13 USD/KWh levelized cost of electricity (LCOE), offshore electricity remains almost twice as expensive as electricity generated from fossil fuels and onshore wind, and only adds up to 1 percent of global energy generation.[4] Despite high LCOE, installed capacity of offshore wind has increased by an average of 30 percent per year between 2009 and 2019, twice as fast as onshore wind in the same period.[5] One reason for this fast growth is that LCOE is expected to drop by 77 percent to 0.13 USD/KWh by 2050. Hoegh-Guldberg et al. (2019) estimate that offshore wind might generate up to 3,500 Terawatt hours per year by 2050 (which represents approximately 7 percent of projected global electricity generation), thereby avoiding up to 3.5 Gt of CO_2 emissions per year. Similarly, other marine renewables might mitigate up to 1.9 Gt of CO_2 emissions per year.

The decarbonization of shipping and marine transport could mitigate more than 1 Gt of CO_2 emissions per year if regulations force a transition to increased energy efficiency and zero-carbon fuels. Shipping represents 90 percent of global transport and emits more than 2 percent of global greenhouse gas emissions.[6] By 2050, shipping may double its emissions, reaching up to 1.5 Gt of CO_2 per year.[7] It is plausible that a combination of efficient new ships and practices, zero-carbon fuels, wind assistance, larger capacity ships and avoided shipping of fossil fuels could limit annual shipping emissions to 0.7 Gt per year. Approximately 450 million tons of emission cuts could be profitable for shipping industries in the medium- to long-term (such as through efficiency gains), while the other half will likely come at a cost of at least USD 100 per ton of avoided CO_2 on average.[8,9] A combination of advocacy (through the International Maritime Organization and member countries), CO_2 taxes, corporate engagement, and pressure through financial institutions are potential tools for philanthropy.[10]

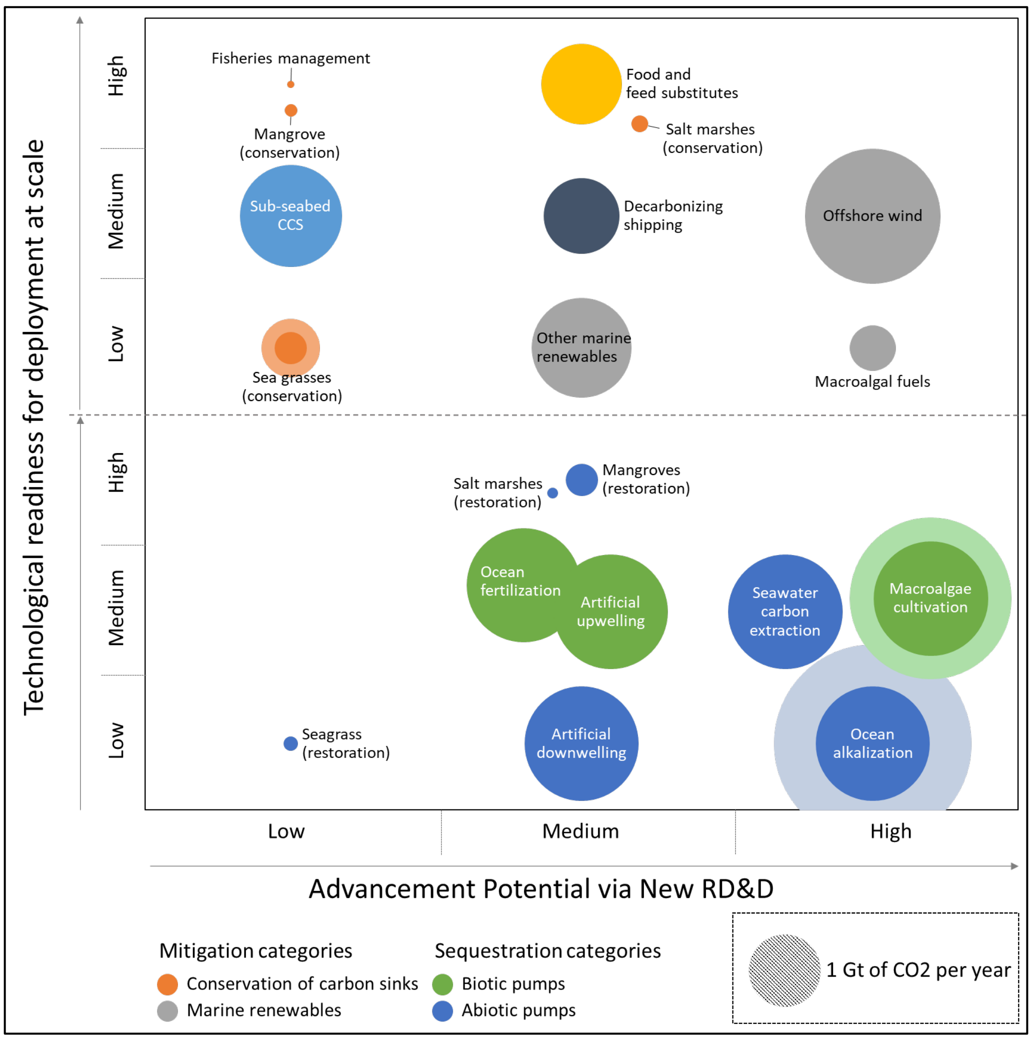
Offshore oil and gas currently account for 25 percent of total global oil and gas production. Offshore deposits account for 15 percent of global oil reserves and close to 45 percent of global gas reserves. Stopping and delaying new offshore oil and gas projects is a significant source of ocean-based mitigation and is part of the broader effort to transition off of fossil fuels. Currently, the top producing offshore areas are the Middle East, North Sea, Brazil, Gulf of Mexico, and the Caspian Sea. Australia, Guyana, and parts of Africa (Mozambique, South Africa, Algeria) are expected to become more significant offshore producers over the next decade. At the same time, there is growing momentum to limit and phase out offshore oil and gas extraction. The fossil fuel industry is facing growing shareholder and investor concerns, as well as mounting public concern about climate change. Frontline communities are fighting back against plans to expand fossil fuel infrastructure, and a growing number of regions and countries have adopted policies to prevent oil and gas expansion. Marine conservation stakeholders have played effective roles in limiting expansion efforts, including in the US, EU, and Belize.

Sub-seabed carbon capture and storage (CCS) is a proven technology to mitigate point source emissions. CCS involves capturing CO_2 from power plants or other point sources and injecting the gas into stable geologic formations under the ground. In the case of sub-seabed CCS, those formations are in the earth

[i] The lifecycle carbon footprint of electricity is measured as Kg of CO_{2eq} emitted per KWh of electricity generated. Wind, both onshore and offshore, has a footprint of 0.012 compared to nuclear (0.016), natural gas (0.47), coal (1.0), and the current energy mix (0.46). Other marine renewables have a footprint as low as 0.008 but have hardly been tested at scale. These include floating wind turbines, tidal range energy, tidal stream energy, wave energy, ocean thermal energy conversion, salinity gradients, and floating solar PV systems.

beneath the sea. CCS costs can be as low as USD 50 per ton of CO_2 when the flue gas is pure and storage sites are nearby. For most stationary emissions, mitigation comes at a cost of more than USD 150 per ton of CO_2 captured, transported, and stored underground.[11] Nonetheless, CCS is one of the only viable options for some industries (e.g., cement, steel, glass) and a prerequisite for key negative emission technologies such as bioenergy with CCS and Direct Air Capture. CCS deployment will therefore likely increase as climate policies cap industry emissions and increase markets and subsidies for mitigation pathways. Offshore or sub-seabed CCS will likely scale where permitting and social acceptance makes offshore storage more attractive, as is currently the case in Europe.[12] Hoegh-Guldberg et al. (2019) estimate that by 2050, sub-seabed CCS has the potential to scale to 2 Gt of CO_2 captured and stored.[13]

Figure 1: Ocean-related mitigation opportunities (top) and sequestration pathways (bottom) that utilize or imitate natural ocean carbon pumps



Bubble size indicates the upper bound annual potential by 2050, based on biophysical constraints, technical readiness, and some basic economic considerations. Where upper bound potential by 2050 is highly uncertain, a halo indicates the scale of uncertainty. Source: Author. This illustrative figure is informed by recent synthesis documents,[14–18] *as well as over 100 expert interviews.*

Sequestration Interventions

The ocean naturally removes CO_2 from the atmosphere, but not fast enough to avert climate change impacts. When CO_2 is more abundant in the air than in the ocean, it diffuses into the surface ocean. Several natural processes, called carbon pumps, contribute to the long-term sequestration of carbon emissions in the ocean:

- **Ocean currents** move CO_2-saturated surface waters poleward, where they cool and sink, pulling emissions into the deep ocean where they can remain isolated for thousands of years.
- Over geologic time scales, **weathering of rock** washes alkaline molecules into the ocean, thereby increasing seawater pH and converting dissolved CO_2 into bicarbonate and carbonate forms.
- On much shorter timescales, **primary producers**, such as phytoplankton, use sunlight and nutrients to turn dissolved CO_2 into organic carbon via photosynthesis.

These natural processes are too slow to remove CO_2 from the atmosphere at a rate necessary to stabilize atmospheric CO_2. However, there are several ways to boost these natural carbon pumps and sequester gigatons of CO_2 from the atmosphere per year.

Marine and coastal sediments contain billions of tons of carbon that will be released into the atmosphere if disturbed. Marine food webs are highly efficient recycling mechanisms that pass carbon from one trophic level to the next, hardly wasting a single gram of valuable carbon in the process. Every year, up to 36 Gt of CO_2 (roughly equivalent to annual global emissions) is fixated by phytoplankton and other primary producers, fueling a food web that consists of millions of species. Most of this carbon is respired back into the atmosphere and only 0.7 Gt of carbon is permanently sequestered in the deep sea and ultimately buried in sediments.[19] Still, over time, thick layers of anaerobic soil carbon have accumulated, containing approximately 150 billion tons of carbon (i.e., 550 Gt of CO_2). This carbon is safely stored unless erosion and physical disturbance (such as trawling, dredging, or coastal infrastructure development) resuspends soil carbon and makes it available to microbes.[20]

Blue carbon ecosystems represent the ocean's most efficient sequestration measure and guard the thickest layers of carbon soil. Mangroves, salt marshes, and sea grass meadows are commonly referred to as "blue carbon," each sequestering more carbon per hectare per year than most terrestrial ecosystems.[21] Mangroves, salt marshes, and sea grasses trap leaf material and carbon-rich sediments in riverine deltas, which are then slowly buried below the ground, creating anaerobic, carbon-rich soils, sometimes several meters thick. Kelp forests and seaweed, by contrast, typically grow on rocky sediments in areas of strong ocean currents; as leaves fall off, a portion is washed away and buried in the seabed elsewhere.[22] Importantly, all blue carbon ecosystems (with the exception of kelp forests and seaweeds) guard thick layers of sequestered carbon that has been sequestered over hundreds or thousands of years. When mangroves, salt marshes, or seagrasses are destroyed, these carbon-rich layers eventually erode, thereby releasing CO_2 back into the atmosphere, sometimes within years, unless quickly reforested. The conservation or restoration of coastal blue carbon ecosystems serves two purposes. First, to prevent the release of soil carbon into the atmosphere, and second, to continue the annual sequestration of carbon.

The theoretical annual mitigation and sequestration potential of blue carbon is estimated at 0.5-1.1 Gt per year by 2050.[23] Estimates are based on current rates of loss, the theoretical restorable area, annual carbon sequestration rates and the carbon stock stored above- and below-ground in each ecosystem. Much of the estimated potential of blue carbon sequestration is driven by seagrass conservation. Unfortunately, data on areal extent and loss rates is scarce and of comparatively poor quality, thereby introducing high uncertainties. Data is more reliable for mangroves, by contrast, which allows for a more detailed look at the sequestration and mitigation potential of mangrove conservation and restoration (see Box 1).[24,25,26,27] Even if their mitigation potential is modest, blue carbon systems play important ecological and economic roles in coastal areas and should urgently be protected. One important mechanism for doing so is by linking conservation and restoration to global carbon markets and policies, including nationally determined contributions (NDCs).

Box 1: Mitigation and sequestration potential of Mangroves

Conservation potential: Every year, 0.15 percent of the standing mangrove stock is lost. Given the global extent of mangroves of 14 million hectares, this translates into approximately 20,000 hectares lost per year. On average, the loss of a hectare of mangrove leads to the one-time emission of up to ~400 tons of carbon per hectare. This means that, as a result of mangrove degradation, 8 million tons of carbon are emitted per year (30 million tons of CO_2). In addition, mangroves sequester ~1.75 tons per hectare per year. Avoided deforestation would therefore mean an additional 37,000 tons of carbon per year.

Restoration potential: Globally, there is approximately 666,500 hectares of highly restorable mangrove area. Restoring and reforesting this entire area would translate into 1.2 million tons of carbon sequestered per year and avoid the emission of 365 tons of soil carbon per ha that is still contained in restorable mangrove area. Assuming a 25 year timeline, the annual sequestration and mitigation potential of mangrove restoration adds up to 11 million tons of carbon per year (40 million tons of CO_2).

Macroalgae could fixate billions of tons of CO_2 in their fast-growing leaves but the scale of net sequestration will depend on the end use of this carbon-rich plant material. Macroalgae, also known as seaweed, is a highly versatile group of plants that can be used in industries as diverse as cosmetics, food, animal feed, fertilizer, biofuels, or biochar. Global production exceeds 20 million tons of wet weight per year and there are no immediate constraints to significantly increase production. Since one ton of seaweed includes approximately one ton of CO_2, expanding seaweed farming has been proposed as a nature-based approach to large-scale carbon sequestration. However, some important considerations for seaweed's potential as a carbon sequestration approach include:

- **Nutrient availability**: While nearshore waters often suffer from nutrient overload, seaweed expansion will soon require a move into offshore waters, where nutrients might become a limiting factor for increased growth.
- **Pre-harvest carbon sequestration**. During growth, some of the cultivated seaweed buds off and sinks to the seafloor, where a portion of it is sequestered in sediments.[ii]
- **Product pathway**: Carbon stored in plants might be permanently sequestered if seaweed is sunk to the ocean floor or used in bioenergy, carbon capture and storage (BECCS) processes. If used for food and feed substitutes, biofuels, fertilizers etc., seaweed's carbon is respired back into the air, but its use might replace more carbon-intensive product alternatives.[iii]
- **Environmental impact**: Beyond nutrient depletion, seaweed can potentially interfere with local fauna (via entanglement) and flora (through shading effects), and impact local biogeochemistry (e.g., hypoxic conditions on the seabed). These environmental impacts will have to be carefully considered when evaluating seaweed cultivation as a large-scale carbon sequestration mechanism.

Ocean alkalinization via enhanced weathering of rock could considerably speed up the geologic carbon pump, but environmental impacts remain uncertain. When seawater is alkalized, dissolved CO_2 is converted into bicarbonate, thereby sequestering carbon for tens to hundreds of thousands of years. In the geologic carbon cycle, 0.5 Gt CO_2 per year is sequestered naturally, suggesting that anthropogenic ocean alkalization could accelerate this process.[28] Billions of tons of alkaline minerals such as olivine, basalt, and carbonate are readily available to be mined and applied to beaches or the open ocean. This "enhanced weathering" could theoretically increase ocean current geologic CO_2 sequestration in the ocean from 0.5 Gt CO_2 per year (naturally occurring), to well more than 10 Gt per year.[29] While rock is not a limiting factor, there are several unanswered questions about this approach which are currently being explored in laboratory, mesocosm (outdoor experiments), and in-situ settings by a dozen oceanographic and climatological research institutes around the world. Outstanding questions include:[30]

- **The environmental benefits and risks**. Generally speaking, the dissolution of alkaline rock will lead to increased pH (beneficial for corals, some phytoplankton species, shellfish, sea urchins), and increased concentrations of trace metals, which vary depending on alkaline rock used. Strong pH swings and high concentrations of trace metals might be detrimental to some organisms or favor some species types over others.
- **The cost of adding alkalinity to the ocean**. This includes logistical challenges of mining, crushing, and distributing rock but also the rate at which alkaline rock dissolves in the ocean, which depends on the rock and the grain size used.
- **The efficacy of drawdown**. In theory, increased ocean alkalinity leads to increased storage of CO_2 as bicarbonates, but in-situ experiments are only emerging now and it will take several years to understand if and under what circumstances permanent sequestration of CO_2 can be achieved through alkalization, and at what rate.

Electrochemical ocean CDR provides a scalable and potentially environmentally safe means of removing CO_2. Electrochemical treatment of seawater is the use of electricity to rearrange water (H_2O) and salt (NaCl)

[ii] 11 percent of total production, as estimated from wild macroalgae.

[iii] Such products and markets would still need to be developed.

molecules into an acidic (HCl) and basic (NaOH) solution. Discharging the basic (alkaline) solution back into the ocean increases seawater pH and converts dissolved CO_2 to bicarbonate, thereby pulling more CO_2 into the ocean while simultaneously counteracting ocean acidification. Costs of electrochemical ocean CDR currently exceed USD 100 per net ton of CO_2 removed, but several approaches are being explored that could significantly reduce the cost of drawdown. These include approaches that minimize costs of water pumping (a major cost driver) and the creation of side-products such as hydrogen and oxygen gas, as well as silica, or nickel and iron hydroxides, which can be sold for a profit.[31,32]

Ocean fertilization and artificial upwelling boost primary productivity but it is unclear if this translates into net sequestration of CO_2. The biological carbon pump is a major contributor to the natural sequestration of atmospheric carbon in the ocean. Every year, up to 36 Gt of atmospheric CO_2 (approximately equivalent to global emissions) is fixated by phytoplankton through photosynthesis. This carbon fuels the marine food web. Most of this carbon is respired back into the atmosphere, while a fraction (approximately 0.7 Gt) slips through the food web and is permanently sequestered in the deep sea and seabed.[33] Since phytoplankton growth is limited by the availability of some few nutrients (such as iron) it has been hypothesized that artificial nutrient addition could boost phytoplankton growth by orders of magnitude, thereby massively increasing the net sequestration of CO_2 in the deep sea. Ocean fertilization (addition of new nutrients) and artificial upwelling (redistribution of deeper nutrient-rich water to the surface) have been proposed as possible approaches. However, after two decades of large-scale research in the field, it remains unclear if and under what conditions artificial fertilization can contribute to large-scale carbon drawdown, given the highly complex nature of biological and physical oceanography.[34]

Adaptation Interventions

Defining Adaptation: Adaptation here refers to two somewhat distinct but related questions.

- First, how can current conservation priorities be adapted to a changing and dynamic future that is characterized by increased biophysical stressors, quickly changing baselines and a high degree of uncertainty? We treat this question under the term “Climate Proofing” below.
- Second, what interventions should be prioritized to help coastal communities predict, prevent, prepare for, and cope with climate hazards? We treat this question under the term “Resilient Coastal Communities” below.

Climate Proofing

Globally, climate change has become the largest and fastest-growing threat to marine biodiversity. Biodiversity in the ocean has evolved in the absence of human-induced stressors such as overfishing, pollution, shipping, habitat destruction and fragmentation, and invasion of new species. Even without climate change, this ‘cumulative human impact’ (CHI) on the ocean has considerably diminished marine biodiversity. Unfortunately, the effects of climate change have now become the biggest and fastest-growing contributors to CHI.[35] A recent report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that approximately one million plant and animal species are threatened by extinction, many within decades, and that human activities have significantly altered two-thirds of the ocean.[36] As a general pattern, tropical regions often experience a loss of species due to elevated heat stress, whereas temperate regions increase in net diversity, as species migrate poleward.[37]

Fisheries yields and profitability will likely decline due to climate change, putting food security and fisheries-related employment at risk. Recent modeling efforts suggest that maximum catch and revenue potentials will decrease by 8 and 10 percent respectively, by 2050 relative to 2000.[38] The main reasons for these changes include shifts in the distribution range of marine species, changes in primary and secondary productivity, shifts in timing of biological events, and differences in species composition. Tropical marine habitats and fish stocks are particularly vulnerable to the physical and biogeochemical oceanic changes associated with climate change; fisheries yields might decrease by 40 percent in tropical exclusive economic zones (EEZ) by 2050.[39]

In theory, fully adaptive fisheries management could offset the negative effects of climate change but would require dynamic multi-sectoral and international collaboration. The dynamic nature of climate change makes static tools of fisheries management increasingly obsolete and calls for approaches that are quickly adjustable to climate implications. Gaines et al. (2018) suggest that adopting proactive and adaptive fishery management approaches today would lead to substantially higher global profits (154 percent), harvest (34 percent), and biomass (60 percent) in the future compared to a business-as-usual approach to fisheries management (i.e., under the RCP 6.0 scenario).[40] Theoretically, a well-implemented and fully adaptive suite of management approaches is projected to result in higher biomass, catch, and profit by 2100 compared to what the ocean currently provides, assuming RCP 2.6, 4.5 and 6.0, not for RCP 8.5.[41] Many in the NGO, funding, and science communities have begun to work on pilot projects and to develop better definitions for what climate-smart fisheries management looks like in practice, though important work remains in application.

Similarly, the conservation and restoration of key coastal and marine habitats is an important element of an adaptation strategy. Coral reefs, blue carbon ecosystems, and other marine ecosystems provide critical services to local and global fisheries and coastal communities. As climate change increases the stress that these habitats experience, civil society has doubled down on the protection and restoration of blue carbon ecosystems. Efforts to increase the scale of protected areas (such as through the 30x30 campaign to protect 30 percent of the ocean by 2030) represent a pathway for increasing the resilience of the marine environment. More proactive interventions have focused on coral reef ecosystems, including the exploration of new tools to promote adaptation (e.g., heat resistant genomes). Similarly, some attention has focused on maintaining polar ecosystems (e.g., Arctic Ice Project).

Resilient Coastal Communities

Coastal communities are both susceptible to, and already experiencing the impacts of a changing climate – being hit "first and worst." Globally, nearly a billion people are estimated to be living in 100-year coastal floodplains by 2030, predominantly in low-income countries.[42] At the same time, at least 775 million people depend directly on coastal and marine ecosystems for food security, economic well-being, and coastal protection.[43] These communities are already experiencing the impacts of climate change through sea level rise, storm surge flooding, erosion, saltwater intrusion into coastal aquifers, runoff, increased water and air temperatures, and ocean acidification. Collectively, these impacts are threatening infrastructure; resulting in physical damage, health and mental health impacts; and leading to declining fisheries and lost tourism opportunities.[44] These impacts can be disproportionate on those living in poverty, women and girls, and structurally marginalized and oppressed groups who rarely have a voice in policy decisions that affect their lives, including climate policy.[45]

Increasing resilience to climate change means reducing vulnerability to climate disruptions and boosting readiness for adaptive actions.[46] *Vulnerability* includes the exposure to biophysical threats, the economic susceptibility to climate change hazards and the availability of social resources for sector-specific adaptation. *Readiness* includes the institutional, social, and economic ability to leverage investments and convert them to adaptation actions. Coastal communities, particularly in the tropics, often score low on both dimensions. On the one hand, effects of climate change are most severe in coastal areas (through exposure to floods, storms and sea level rise, dependence on coastal and marine resources). On the other hand, coastal communities are often among the least ready for adaptive action, given high rates of poverty, struggling economies, and weak institutions. Coastal communities in Small Developing Island States (SDIS) and in low-lying coastal states (such as Bangladesh) are among the most vulnerable to climate change, given their dependence on the ocean for food security, jobs, and coastal protection, their low elevation, and the sheer size of the challenge in adapting to sea level rise.

Strengthening resilience to climate change should be closely linked to efforts of the Climate Justice Movement, with particular focus on structurally oppressed groups. The Climate Justice Movement is an effort to "link human rights and development to achieve a human-centered approach, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly."[47] It will be critical to respect the basic human rights of structurally oppressed and marginalized groups, and proactively involve them in the design of adaption strategies. In recent years, some of the most influential global development agencies and efforts have started focusing on coastal resilience through an adaptation lens and with a focus on cities.[iv] Importantly, solutions have prioritized human well-being and livelihoods – primarily through coastal protection, disaster preparedness, green infrastructure, smallholder agriculture and aquaculture support, as well as financial tools like insurance. There is increasing recognition that policies or interventions that do not have the support of constituencies or a broader movement behind them are unlikely to be successful.

Solutions to improve coastal resilience can have important co-benefits for the ocean. Natural infrastructure, disaster risk management, insurance and other efforts to de-risk financial flows, and community mobilization efforts are some of the kinds of coastal adaptation solutions being promoted.[v] These solutions can help to protect and restore habitat, reduce pollution, create jobs, support tourism and recreation, build constituencies concerned about conservation, and provide financial resources to support conservation and climate action. For example, coastal wetlands in the U.S. provide an estimated $23.2 billion in storm protection services by reducing wave heights, controlling coastal erosion, stopping storm surges, and stabilizing sediments.[48] Additional work is being carried out to estimate and communicate the cost-benefit ratio of ocean-based solutions: at the global level, the High Level Panel for a Sustainable Ocean Economy found that for every dollar invested in ocean sustainability, five dollars are generated in benefits for the planet.[49]

[iv] Among others, this includes the Global Commission on Adaptation, The Asian Cities Climate Change Resilience Network, the Urban Climate Change Resilience Trust Fund at the Asian Development Bank, the Global Resilient Cities Network, C40, and Rebuild By Design.

[v] See the Global Commission on Adaptation's Action Tracks.

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