UNIVERSITY OF BATH

Our oceans: a deep dive

A collection of insights and perspectives from a major IPR public events series

IPR Report

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Contents

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1. Why are the oceans important, and why now?

1.1. Global perspective

In March 2023, the United Nations agreed on a legal framework to protect biodiversity in international waters. Covering almost two-thirds of the ocean that lies outside national boundaries, the treaty will provide a legal framework for establishing vast marine protected areas (MPAs) to protect against the loss of wildlife and share out the genetic resources of the high seas. It will establish a conference of the parties (COP) that will meet periodically and enable member states to be held to account on issues such as governance and biodiversity. The international enthusiasm greeting this treaty, coming from governments, environmental groups and many other organisations, is justified, given the time it took to reach this agreement (almost 20 years of talks), and the fact that it builds on previous international agreements and commitments, from the recent Kunming-Montreal Global Biodiversity Framework (GBF) at COP15, to the long-established UN Convention on the Laws of the Sea (UNCLOS).

Why are the oceans important? They cover 71% of our planet's surface. We rely on them to support human life and our economic, cultural, social, and environmental wellbeing. They host 95% of the biosphere. But our oceans are under threat. With the effects of climate change increasingly evident, sea water temperatures are rising rapidly. Continued ocean warming is projected to lead to marine ecosystems disappearing – systems which are essential for biodiversity, and also provide food and livelihood for millions of people. Around half the world's population relies on fish as a major source of protein, and the fishing industry employs over 56 million people across the globe. Yet the way we fish is unsustainable, boosting carbon emissions, depleting wildlife, and polluting our oceans. We must find new ways to protect fish stock numbers, whilst sustainably feeding populations.

Why now? The environmental and human issues have been steadily building up over the last decades. 2021-2030 is the United Nations (UN) Decade of Ocean Science for Sustainable Development, and yet, Sustainable Development Goal (SDG) 14 'Life Below Water' is one of the most underfunded SDGs by both Official Development Assistance and philanthropic development funding. The complexity of our ocean systems makes it difficult for us humans to comprehend the scale of interventions and investments required to restore them.

This report serves as a summary of the event series *Our oceans: a deep dive*, hosted by The University of Bath Institute for Policy Research (IPR) throughout 2021-2022. This series engaged with experts, advisors, policymakers, and the general public to address the role our oceans can play in our collective action to reach net zero; how we can protect Indigenous communities and our oceans from pollution, overfishing, and fish farming; the role and opportunities of nature-based and geoengineering solutions; and the geopolitics of our oceans.

Now is the time to act for the protection of our oceans for future generations. The following report shows how. It provides a collection of summaries of the public lectures delivered as part of the IPR events series[1]. The perspectives presented here

[1] It is acknowledged that this format presents the work, views, and opinions of the original lecture presenters.

are from a range of diverse stakeholders including social and political scientists, Indigenous activists, and conservation practitioners. The first part of this report looks at the past, providing a historical perspective on ocean governance and demonstrating how economic growth and financialisation were at the heart of maritime matters since pre-modern times. The second part of the report focuses on the latest science of our oceans and how the degradation of the oceans is linked to the climate and ecological crisis. The third part of the report presents current policies and practices aiming at restoring our oceans. The report concludes with a reflection on the politics of our oceans, and in particular, the need for a Blue New Deal to govern and restore our oceans.

1.2. Historical perspective: From a Eurocentric to a transnational perception of our oceans

A summary of the lecture 'World oceans and contemporary challenges: An historical perspective' by Professor Maria Fusaro (Professor of Social and Economic History and Director of the Centre for Maritime Historical Studies, University of Exeter, UK), delivered on 21 April 2022.

Historians of maritime matters have a lot to offer in terms of sustainable socio-economic solutions to ocean governance. As such, we need to learn how matters were handled in the past in order to understand the potential for sustainable solutions. Some interesting solutions are emerging which would never have been thought possible a few years ago. There is something practical to learn with solutions that can sustain economic development and at the same time provide a bit more equitable treatment for all parties.

Over the past ten years, maritime history has moved away from its traditional niche and joined mainstream historical research by becoming more action-oriented, across the planet. New approaches to oceanic histories are now helping us to deal with jurisdictional problems, issues regarding economic exploitation, pollution, and climate change. Such change of perspective has been enabled by a shift away from a traditional narrative centred on the Atlantic experience to a more global, transnational, and network-based type of narrative. Neglected evidence also emerged from the colonised world, as historians who tended to study archives and documentary evidence which survived in the metropolises of the various European empires started to study archives from the colonised world. Together with such new evidence, there has been an active shift from political and normative evidence-centred research to the inclusion of wider socio-economic factors well served by archives across the planet. This has allowed us to move away from a Eurocentric view, with investigations occurring for around 30 years across many different countries, in many different languages, and from many different methodological perspectives.

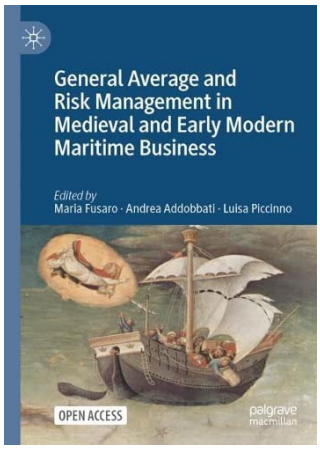
The sea as an engine of economic growth

In the pre-modern period, before the industrial revolution, the sea was the engine of European economic growth, hence the attention of historians has traditionally been focused on technological developments. However, there has been a recent shift towards focusing more on the factors contributing to the reduction of both transaction and production costs, and the cost of labour in particular - with all its social

implications. Credit networks, for example, were supporting maritime expansion and trade, which is an area of research promoted by the path-breaking book of Richard Unger on Shipping and Economic Growth from 1350 to 1850. Here, the focus of economic factors in maritime matters has been crucial to link economic and legal historians, who are now cooperating in trying to understand new ways of discovering and investigating the past. In effect, there is still a very fuzzy perception of how pre-modern economies functioned in practice, for example, how contracts were enforced or what forum of litigation was in place. It was also thought that only Europeans were active in this area across the globe, but we now know that the role of non-European actors was absolutely essential in shaping European activities. Such interdependence based on maritime trade has been at the heart of unprecedented economic growth globally.

Current developments and challenges

A crucial development in recent maritime legal history was triggered by the Evergreen blockage of the Suez Canal in March 2021. The massive cost resulting from the event brought new public interest into the legal instrument of General Average (GA). In fact, it is through this very ancient legal instrument that the costs of that accident are being absorbed. GA in maritime law means that, in the event of an emergency in a sea venture, all stakeholders share all losses proportionately in order to save the whole venture. Professor Fusaro has been running a research project on the historical development of GA in those European countries where substantial data exists: Italy, Spain, England, France and the Low Countries, from 1500 to 1800. Her research has shed new light on GA and notably on the mutual nature of averages. Over the last few decades, there has been a growing interest in insurance across different subfields, and national historiographies owe a lot to the way in which most economic historians have adopted the so-called New Institutionalist Economics approach. Such an approach focuses on how institutions can foster or impede economic growth.



One of the great tools at the basis of the historical success of marine insurance is that it did not only cover risk, but, since its beginning in 14th century Genoa, it also became a tool of capital rising and financial speculation. GA instead remains a strictly mutualistic tool of risk management with no speculative purpose. Is GA pointing to a more sustainable maritime economy? Could it serve as a basis for a future ethical principle to act as a break or legal remedy for unjustified enrichment? If a sustainable economy is based on balancing economic, environmental, and social development, then trying to find new and wider uses of legal instruments from all traditions that have equity as a founding principle is possibly a way forward. In particular, equity-based instruments tracing their roots onto medieval Sharia law are becoming popular ways for sharing profits and losses. Such tools tend not to be biased towards shareholders and against stakeholders, but rather try to find a balance between these two elements. New voices along these lines are particularly active in France, where they are trying to see the entirety of the planet as a community of risk — as defined by GA in which a voluntary and intentional act to save us from a bigger danger needs to be redistributed equitably between all of those who have made the sacrifice.

Finally, a major challenge in terms of managing maritime spaces is the problem of enforcing jurisdiction. Hence, it made perfect sense when Lauren Benton came up with the idea of intersecting jurisdictional lanes because "ships and their captains moved as delegated legal authorities along intersecting paths, extending corridors of control, in turn weakly or strongly associated with jurisdiction, into an inter-imperial sea space that could not be owned but could be dominated" (p. 161)[2]. Domination as a proxy for ownership is enlightening, especially when considering the contemporary challenge of protecting biodiversity in international waters (see part 4 of this report which covers the 'politics of our oceans').

After sketching the history of maritime matters, two main themes are emerging. The first theme is that there seems to be a conceptual shift in human perception of maritime matters away from a colonial and Western-dominated perception to a more global and transnational perception. This brings hope in terms of sustainability, because if equity-based instruments of finance are gaining in popularity, then the community of risk is becoming global and not dominated by one view of our oceans. The second theme is that maritime matters have been dominated by the discourse around economic growth, commercial and financial goals, i.e. for trade, resource exploration and exploitation. This is why we need to amplify neglected voices and perspectives: first, a scientific voice that explores new discoveries and current challenges (covered in the next part of this report); and second, a more holistic voice, that acknowledges how our oceans have been negatively affected by this dominant discourse of economic growth in the Anthropocene which has led to the Great Acceleration.

2. The science of our oceans

2.1. The ocean-climate nexus

A summary of the lecture 'The ocean-climate nexus' by Dr Peter Richardson (Head of Ocean Recovery, Marine Conservation Society), delivered on 14 October 2021.

As this is a very challenging subject, let us try and follow the kind of narrative of some of the most popular superhero movies of essentially 'happy-sad-happy', with a little happy bit at the beginning, quite a big sad bit in the middle, and hopefully a sort of quite happy bit at the end. It is quite appropriate, because it is going to take a superhuman effort to actually meet the challenges of climate change — and the ocean can play a role in that.

Let us start with the story of Trevor the Turtle, whom I met earlier this year while doing some work in Montserrat. Turtles have been on the planet for about 110 million years in their current form. They are a very successful species, and the ocean-climate nexus is very important for them. Their habitat and foraging habitat are likely to be impacted by climate change (e.g. coral reefs and seagrass beds). Turtles depend on a predictable climate in order to breed because the females, once they have mated, will crawl ashore on a beach, lay some eggs in the sand, and then leave them to be incubated by the sun. The issues with the climate are even more compounded because Trevor, some 30

[2] Benton Lauren (2014). A Search for Sovereignty: Law and Geography in European Empires, 1400–1900. New York: Cambridge University Press.

years ago, when he was an embryo developing in his egg, had his sex determined by the temperature at which he was incubated. Below about 29 degrees centigrade, he developed as a male turtle. Nesting beaches in the tropics with surface temperatures at 29 degrees or less are going to become increasingly rare with climate change. We therefore think that if turtles do not adapt fast enough to the climatic changes, the population will become feminised, and Trevor, already an endangered species, will become an increasingly endangered species because he is a male, and males will become very scarce. Hence, while conservation efforts for turtles have been extremely successful in the last few decades, with green turtle populations in the Caribbean going up for example, we do not know what is around the corner for them.

The ocean is important for us for a number of reasons. It covers 70% of the planet and provides us with about 50% of the oxygen we breathe, so every second breath we breathe comes from the ocean. It also provides us with food and energy, it is good for our health and well-being, and of course it regulates our climate by absorbing about 25% of the anthropogenic CO2 that has been released in the atmosphere. Finally, it is thought that the ocean has absorbed about 90% of the excessive heat that has arisen from global warming. Hence, the ocean and the climate are inextricably linked, as shown on the schematic illustration on page 7 of this report by the Intergovernmental Panel on Climate Change (IPCC).

The key thing to take home is that we are getting (1) increased ocean heat content, which – together with the melting polar ice caps – causes sea level rise, (2) ocean acidification, meaning the average pH of the ocean is going down, as a result of increased carbon content, and (3) deoxygenation of our oceans. Often these relationships involve positive (self-reinforcing) feedback loops, for example, the ice caps melting leads to a darker land cover as the snow melts away, which absorbs more heat and accelerates global warming.

A changing ocean with warmer currents also affects fish communities and our fisheries. We are seeing submarine species that prefer cooler waters are heading north, and we are also seeing species that prefer warm waters moving north. Species such as plaice and sole, flat fish that live on the seabed and love cold shallow water, are also slowly moving north. Unfortunately, in the North Sea, the shallow habitat runs out, it gets deeper, and we are therefore probably going to see over the next few decades some sort of local extinctions of certain species such as blackfish. Other species such as sardines will be moving in from the south, which will affect northern fish communities as well as the fisheries that depend on them.

Ocean acidification is often dubbed the ‘evil twin’ of climate change in the sense that the more CO2 is absorbed into the ocean, the more acidic it gets, and the lower the pH drops. All the data today shows that we are seeing accelerating rates of ocean acidification that are unprecedented in the history of the ocean as far as we know. This is a problem, for instance, for species that are dependent on synthesising calcium carbonate for their shells because, in essence, the acidic water dissolves their shells. Some species are just not going to be able to survive in an increasingly acidic ocean.

Apart from these big ecological changes, we are going to see some profound societal impacts; as we are already seeing on the news every day. Around the world, populations have coalesced around the coast, with many cities on the coast. As these cities become less habitable, their populations are going to move away to where there

is still a good quality of life. We are seeing now a trickle of people moving north which is only going to increase over time. There is a need to develop very progressive ways of dealing with this as this flow of migration plays to some of the most dangerous political philosophies. So, we have a nature emergency, we have a climate emergency, and this is going to lead to a social emergency.

The main ways forward are in terms of decarbonising our economy and implementing ocean-based solutions. The UK is seen as a leader in offshore wind with a record £900 million invested in 2021, but I think we need to move faster. As suggested by the IPCC report, we now have about 10 years in order to implement systemic change to respond to the ecological crisis and avoid the most catastrophic effects of climate change. The global community is starting to respond and implement initiatives such as the decade on ecosystem restoration, which hopes to restore millions of hectares of terrestrial marine environment for biodiversity.

In terms of ocean-based solutions, we can invest in more ocean-based renewable energy, and we can work to develop alternative technologies to reduce the shipping emissions. We can develop our aquaculture by cultivating food sources such as bivalves and seaweed that are low impact and low carbon sources of protein. We can change the way we manage our fisheries to provide low carbon protein food security, that will involve some dietary shifts. Then, we have got blue carbon, such as mangroves, salt marshes, and seagrasses that can sequester carbon and store it for us.

Finally, our Marine Conservation Society has released the 30 x 30 report together with Rewilding Britain which is aiming at protecting at least 30% of the ocean by 2030. Our three key asks are 1) to scale up the rewilding of our seas for biodiversity and blue carbon, 2) to integrate blue carbon protection and recovery into climate mitigation and environmental management policies, and 3) to work with the private sector to develop and support sustainable, innovative, and low-carbon commercial fisheries and aquaculture.

Overall, there is no doubt about it. The challenges for us, and for Trevor the Turtle, are almost unfathomable — but they are not insurmountable, as pointed out by the paper by Duarte et al. (2020) published in *Nature* and entitled "Rebuilding marine life". We have the knowledge and the technology to act, we just have to have the will to do so.

2.2. A Caribbean perspective on the ocean-climate nexus

A summary of the lecture 'A Caribbean perspective' by Veta Wade (Montserrat), delivered on 14 October 2021.

The geographical situation of Montserrat, a small island with a very active volcano, makes it an ideal point to study the ocean-climate nexus. Home to a population of 4,500 people, coral reefs, and several endangered species of marine life, it is a focal point for the intersection of economic and societal issues with nature conservation amidst climate change. The speaker started by describing youth club "Fish'n Fins", which teaches children swimming and diving to fully appreciate biodiversity around Montserrat and promotes local culture. This includes the nurturing of a Young Leaders programme, aimed at linking with other communities across the Caribbean and further

afield. The presentation included a description of the links between finance and sustainability initiatives, which are more difficult in economically challenging settings. Climate action includes innovation and adaptation, participating in the Blue Economy. The talk included discussions of the best way to engage local communities to address global challenges wider than the immediate, urgent and personal ones. This is ideally done through Community Champions and other key stakeholders. Another recommendation is to modernise the academic science research model and invest in local science talent. Valuing local expertise should also include monetarisation, rewarding the incorporation of local knowledge into wider initiatives and addressing the ownership of Intellectual Property based on local efforts.

2.3. Physics of the ocean-climate nexus

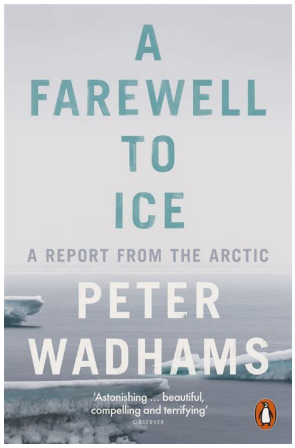
A summary of the lecture 'Physics of the ocean-climate nexus' by Dr Philippe Blondel (University of Bath), delivered on 14 October 2021.

The speaker spoke about the physics underlying the problems explored in the previous talks, for example the fact that the oceans are now warming down to 700 meters in some places, limiting the future amounts of heat they will be able to absorb. Measurements across the oceans show the increase in movements of animal communities to more hospitable waters, for example salmon moving north to colder waters, and how this affects local resources, in particular in Indigenous communities. The speaker highlighted the issues in the Arctic oceans, with melting ice, warmer waters, increased shipping and ultimately pollution. What happens underwater, be it chemical pollution, physical change or sound propagation, is not limited to one country or one jurisdiction, and this is an area where the science base needs to be integrated into a transnational, truly global framework. This is exacerbated by climate feedback loops, where for example climate change in the Arctic influences monsoon patterns at lower latitudes. Local knowledge and local interests are increasingly used in responsible science projects, and the speaker highlighted the book 'Adventures in the Anthropocene' by Gaia Vince, which showcases uplifting examples of adaptation to climate change in local communities.

2.4. A deep dive on geoengineering

A summary of the lecture 'Our oceans: A deep dive on geoengineering' by Professor Peter Wadhams (Professor of Ocean Physics, University of Cambridge, UK), delivered on 24 November 2021.

The use of fossil fuels to emit carbon dioxide started in the early 19th century, when steam engines were developed, and coal became the primary source of fuel. For many years, people had no idea that we were doing anything to the climate by burning coal. In fact, it was only in 1896 that the relationship between carbon dioxide production and climate was found quantitatively by Professor Svante Arrhenius from Sweden, with his classic paper 'On the influence of carbonic acid in the air upon the temperature of the ground'. Hence, from 1896, we had no excuse for ignoring climate change — but we did.



Historically, there is a linear relationship between how much carbon dioxide there is in the atmosphere and global warming. Carbon dioxide content continues to increase exponentially. At the end of the Ice Age, it was 280 parts per million, and it had only risen to 320 by the time the first measurement started in Hawaii. Today, it is beyond 400. There is a high rate of increase over the last century and, of course, this rate of increase is still growing, hence the momentum gathered by carbon dioxide content. None of the Conference of Parties (COP) meetings — the first one being held in Berlin in the early 1990s — had any impact on that rate of acceleration. Carbon dioxide content is not the only issue. Since the 19th century and the burning of fossil fuels, methane also shot up dramatically. The trend shows that it slowed down in the early 2000's, but is now rising again very rapidly, at a greater rate than carbon dioxide.

What can we do?

The IPCC recommendations focus on reducing carbon emissions. The problem here is that carbon stays in the atmosphere for hundreds of years, so even if we reduce carbon emissions today, the carbon dioxide content keeps rising, and so does global warming. We are never going to bring the temperature down to a more moderate climate by reducing our emissions only. We can switch to renewable energy, but it does not actually solve the problem of carbon content in the atmosphere. One solution could be direct air capture to take CO2 out of the atmosphere.

Let us look at the ways involving the ocean that can be used to try to reduce the rate of warming and bring it down to negative warming. The first method I present here is marine cloud brightening. This does not involve directly removing carbon dioxide from the air but rather increasing the amount of long-wave radiation being emitted by the planet so that we do not warm up so fast. This method was developed in 1990 by John Latham in Leeds, and then further by Stephen Salter in Edinburgh, and Alan Gadian in Leeds. The method consists of taking marine stratocumulus clouds, the sort of low-level mythical grey clouds we see a lot in Britain and adding a strain of very tiny droplets of sea water to brighten the clouds, at a certain size, one or two nanometres across. The droplets increase the brightness of the cloud, and the brightened cloud that spreads around the world then increases the average albedo of the planet, which increases the emissions from the surface and cools the planet down.

The inspiration for marine cloud brightening came from the satellite pictures of ship tracks. The ship is leaving an exhaust of water vapor in the atmosphere and, amazingly, this is surviving for a couple of days. The idea then developed by Stephen Salter is to have an unmanned ship injecting the tiny particles — 40 microns in size — into the cloud. Stephen estimated that about 200 of those ships would get enough effect to alter the world's climate. Forty of them would be enough to affect the climate of the Arctic, restoring its cold conditions. However, so far, in the UK, there has not been the support needed to actually get a viable global system, or even national system of marine cloud brightening going.

Another method that has been tried is injecting aerosols into the stratosphere. The principle is to find a means to loft a powdered aerosol into the high stratosphere, then to release it, whether it is from a balloon or from a rocket. The powdered aerosol

spreads out and reflects solar radiation, and gradually settles out. This has been physically tried, but there are a number of problems with it. One is public perception, because covering the upper atmosphere with something which you would regard as a poison would seem dubious to the public, even though it is in tiny quantities. With marine cloud brightening, however, we are dealing with sea water, which is pretty safe. Another problem is that while it is settling out, which can take weeks or months, the aerosol may affect the climate (e.g. monsoon), whereas with marine cloud brightening, it can be stopped immediately by stopping pumping. Personally, I would go for marine cloud brightening here, as would many others.

Now, let us look at different ways to remove carbon dioxide, namely afforestation, bioenergy, enhanced weathering, and direct air capture. Out of these four methods, the first three are not feasible given the scale of the problem. Every year, 42 Gigatons (Gt) of CO2 is released into the air. The area required to remove 8 Gt CO2 per year is however 6,400,000 km^2 for afforestation (large-scale tree plantations), 2,500,000 km^2 for bioenergy in combination with carbon capture and storage, and 220,000 km^2 for enhanced weathering, a method which consists of distributing crushed silicate rocks on large soil surfaces to absorb and bind CO2 chemically.

The most sensible method would be direct capture of CO2 from ambient air through engineered chemical reactions, which collectively capture, purify and compress atmospheric CO2. A few examples exist whether it is in terms of CO2 conversion into limestone (Blue Planet Ltd in California), sequestering CO2 in basalt rock (e.g. Climeworks in Switzerland and CarbFix in Iceland), or CO2 conversion into jet fuel (Carbon Engineering in Canada) whereby CO2 emissions emitted equal the amount of CO2 converted. One of the reasons why direct air capture is not as attractive as it used to be is that it is a very energy intensive business. For example, one plant can be using geothermal power while another one such as the jet fuel plant in Canada is using hydroelectric power in the Rocky Mountains. I think it is part of the answer, but we need to make it more efficient and less expensive.

A methane problem

The problem of methane we have is associated with the Arctic Ocean. About a third of the area of the Arctic Ocean is very shallow shelf seas, which are less than 100 metres deep now, as the ice has been retreating from the centre. The sea ice in the centre in summer may soon be disappearing but around the edges of the Arctic, we have open water in the summer. It is shallow, which means that it warms up quickly—five degrees in summer around the edge of the Siberian seas. It warms up a protective layer of material on the seabed, frozen ground thaws, and reveals something below much nastier: methane in the form of methane hydrates. Methane hydrates are solid but quickly turn into a gas if you release the overpressure. Expeditions going to the East Siberian Sea are seeing more and more of these plumes of methane coming from the seabed, reaching the surface and being emitted into the atmosphere.

Various ideas have been proposed, some of which seem to make sense but have not been tried properly yet. One of them is ‘Buoyant flakes’. Rice being a staple, the waste from it, rice flakes, is gigantic. It turns out that rice flakes are buoyant and if you coat them in some kind of mud that comes from aluminium refining, then they become iron-rich and these iron-rich flakes float around in the ocean and react with methane. Methane reacts with ferric chloride and disappears as methane. Hence, one way to get

rid of methane from the ocean surface is to spread huge amounts of buoyant rice flakes on the surface. It sounds crazy, but it actually makes sense, and so this is something worth trying.

There are a lot of other methods to try to recover the colder climate, but there is lack of political will, and a lack of investment on a large scale. We always have to think about scaling up whenever we think about technology and geoengineering, which is not necessarily the case, and it makes many methods unfeasible.

My personal approach to colder climate would be much more systemic which is why I propose a systematic climate restoration strategy with cooling, sequestrating CO2 and de-acidifying, as well as ecosystem restoration. First, cooling could be implemented using marine cloud brightening which is safe, scalable and controllable. Second, the sequestration of CO2 could be implemented using slow release of ocean nutrients replicating the Mount Pinatubo eruption and Shamal winds. Finally, the restoration of the Arctic ecosystem could be done using ice cap thickening techniques based on existing ice road technologies. But, as I mentioned, at the moment, political will is missing to take it to such a large scale, although it is now a moral obligation to start an immediate climate restoration programme.

2.5. A deep dive on blue carbon

A summary of the lecture 'Our oceans: A deep dive on blue carbon' by Steven Lutz (Senior Programme Officer, Blue Carbon Lead, GRID-Arendal, Norway), delivered on 27 January 2022.

The concept of 'blue carbon' was introduced in late 2009 in the lead up to the Copenhagen international climate change meeting, COP15. It was introduced through two reports published by the UN Environment Programme and the International Union for Conservation of Nature. These reports stimulated and galvanised interest in merging marine conservation with climate action. From 2009, non-government organisations and civil society have been highly efficient at getting national states with large coastal areas interested in climate mitigation via wetland conservation and restoration, as well as raising public awareness on the importance of coasts to our climate.

Blue carbon refers to the carbon stored in the biomass and sediments of coastal and ocean ecosystems. A major focus has been on coastal vegetated habitat, i.e., sea grasses, salt marshes, and mangroves, and their role in blue carbon storage and sequestration. The potential blue carbon values of kelp and seaweed habitats are gaining a lot of traction here in Norway, where, through efforts such as the Norwegian Blue Forest Network, which is looking at how kelp conservation and restoration can potentially help sequester carbon in the oceans. There has also been a lot of recent attention here on macro algae and seaweed, and their potential role in mitigating climate change.

Coastal blue carbon habitats are reported to sequester ten times as much carbon into their soils as terrestrial forests. The phenomenon is similar to terrestrial forests, whereby carbon is absorbed through the photosynthesis in the leaves, and then stored in the peaty sediments through the roots. The carbon here, however, is primarily stored

in the soil, not just in the biomass. A lot of carbon can be stored in peaty blue carbon sediments, and once it is below the water level, it is out of contact with the atmosphere. So, these ecosystems, even though they might exist on the fringes of our coastlines, are very effective as carbon sinks and as potential nature-based solutions to climate change.

Unfortunately, coastal blue carbon ecosystems are among the most threatened ecosystems in the world. Coastal habitats are rapidly degrading at rates ranging from 0.7 to up to 7 of their global coverage each year — to the point that these carbon sinks can rapidly become carbon sources. When these ecosystems are degraded, for example by converting a mangrove area into an agriculture pond, gases that have built up over thousands of years escape into the atmosphere and contribute to climate change. And, when these ecosystems are degraded, many other important ecosystem services are consequently impacted. Blue carbon ecosystems provide food security through protein from fishing, recreational opportunities, and shoreline protection from storms and flooding, but also biodiversity that can be intrinsically connected with the health of fish habitat and coral reefs.

In that context, the Global Environment Facility (GEF) was interested in advancing the science around coastal blue carbon and in understanding how the value of ecosystem benefits could be harnessed to support conservation, climate action, and sustainable livelihoods. From 2015 to 2021, the GEF implemented a programme to explore the value of blue carbon for the planet. I have been privileged to coordinate and manage the project on behalf of the UN Environment Programme with the support of the GEF, and many other key partners. The Blue Forests Project aimed at harnessing the value of blue carbon through local, national, and international incentives for supporting conservation. It also advanced the 'Blue forests' approach, which recognised the multitude of ecosystem services and co-benefits that coastal and marine ecosystems support, not just in sequestering carbon. The project was implemented at a time when the science around coastal blue carbon and ecosystem services contained many gaps, with very few proofs of concepts, and when the international community did not fully recognise the value of these ecosystems for climate change mitigation. The Blue Forests Project has been key in overcoming these hurdles.

Among our impacts, I would like to highlight the important projects that took place in Abu Dhabi, Kenya, and Ecuador. The blue carbon exploration and data collection in Abu Dhabi included on-the-ground field testing to explore how much blue carbon could be worth to the United Arab Emirates (UAE). The project illustrated that the carbon finance or voluntary carbon market harnessing blue carbon in the UAE was not entirely feasible, i.e., the cost of coastal development could not be offset with the blue carbon value of mangrove of local mangroves. However, the UAE was able to meaningfully integrate blue carbon into policy at multiple levels, from municipal, to emirate, to the national level.

In Kenya, payments for blue carbon in the voluntary carbon market are supporting local mangrove conservation and restoration activities. With profit from the carbon revenue, project beneficiaries in five communities have been able to build fresh water wells and buy schoolbooks for local children among other community benefit activities. Though our project sites in Kenya, the Blue Forests Project has shown that blue carbon in the voluntary carbon market (VCM) can work for communities and climate action. Similarly,

in Ecuador, mangrove conservation agreements were explored, between the national government and local communities. The arrangement meant that communities gained exclusive access to the red crab fishery and other fisheries that their local mangrove forests support, which can be quite lucrative, while the government benefited from additional support for the management of these ecosystems. Hence, this is a sort of incentive management scheme that now covers over 40,000 hectares of mangroves in Ecuador. The experiences of the Blue Forests Project, especially at our project sites, are serving as examples that are being replicated nationally, regionally, and internationally.

The Blue Forests Project increased international acceptance of the value of blue carbon, which also led us to produce the world's first inventory and assessment of blue carbon in Nationally Determined Contributions (NDCs). Many developing countries, as we have seen in the recent Glasgow COP26, are recognising this value, and including measurable targets in their national pledges. Now, over 28 countries include reference to coastal wetlands in terms of mitigation, and 59 countries include these ecosystems in terms of adaptation strategies, as more countries recognise these ecosystems for their adaptation value over mitigation.

Finally, there are two blue carbon concerns I would like to emphasise. The first is related to the explosion of demand for nature-based offsets in the VCM and a dramatic increase in the price of carbon. In the past few months, the price per ton went from around $4 a ton to over $14 a ton. However, the supply of blue carbon projects has not met the demand; we simply do not have the projects on the ground right now to implement, and it takes a few years to set them up. We have been approached by many carbon brokers and carbon offset customers looking for projects, so project development is a priority. Second, in terms of implementation, the development of local and regional capacity in blue carbon science in developing countries is urgently needed. Simply flying in white western scientists to do the work will not suffice anymore and is not sustainable. Regional knowledge-exchange and local capacity will be key to successful blue carbon projects.

3. Our oceans in the Anthropocene

3.1. A deep dive on the blue economy

A summary of the lecture '[Our oceans: A deep dive on the Blue Economy]' by Professor Pierre Failler (Professor of Economics and Director of the Centre for Blue Governance, University of Portsmouth), delivered on 13 April 2022.

Definitions and challenges

The concept of the 'blue economy' is not new, but the Third International Conference on Small Island Developing States (SIDS) in 2014 in Samoa was a milestone in the understanding of the scale of the vulnerabilities these countries are facing, given the small size of the islands in comparison to the size of our oceans. For example, our research team found out that, for big Pacific Island countries, 20% of plastic pollution is coming from the sea and 80% from the land, while it is the opposite for small island countries, with 80% of plastic pollution coming from the sea and 20% from the land.

How do we define the 'blue economy'? To start with, the basic principles of the blue economy include (1) the circular economy, including waste management, (2) good governance, (3) environmental and social sustainability, and (4) empowerment and inclusion of previously voiceless actors in decision-making processes. (1) and (2) tend to be included in policymaking but (3) and (4) are not often applied.

(3) The key issue in designing a sustainable blue economy at the national level is about making relevant linkages between the social, environmental, and economic dimensions, but also between the different pillars within the economic dimension, which is quite challenging. The policy handbook on Africa's blue economy from the UN Economic Commission for Africa (2016) provides clues as to how to approach policymaking at the national level. For example, when designing a national policy for the blue economy, it is important to include the regional and continental strategy and explore their synergies with the national level. However, at the same time, it is equally important to include context-specificity such as the context-dependent circular economy (1). In the case of the Seychelles for example, we found that incorporating debt-swaps was a relevant policy move.

(4) Additionally, in order to flesh out the potential linkages across the different dimensions, it is also important to bring the relevant actors and stakeholders of the blue economy together to turn policy into action. Making links across dimensions also means that, within the framework of the SDGs, SDG 14 on Life below Water should be considered in the context of all other SDGs, such as SDG 17 on Partnerships but also SDG 13 on Climate Change. Beyond the SDGs, the whole water system of a country, and continental waters in particular, is important in the way it helps making linkages between the social, economic and environmental dimensions of the blue economy. Taking the example of Lake Victoria, Tanzania and Kenya are taking more fish from the lake than Uganda, but they are also taking fish from the sea. Evidently, there is a clear issue of equity in access to food supply at the national, regional, and continental levels.

In policy terms, a review of policy reports shows that the blue economy is still defined according to its different sectors without implementing a more integrated approach with the social and environmental dimensions. The discourse is slowly changing and the World Bank itself is trying to adopt a more integrated approach to the blue economy. A recent example related to the World Bank's work in Madagascar, as they were trying to find actions that integrate climate change and aquaculture through seaweed farming. However, the mindset of most policymakers and funding agencies is still geared towards a traditional sectoral approach without a broader integration of the social and environmental dimensions, without thinking of continental waters and maritime matters, and without thinking about the synergies across the different sectors of the blue economy.

There is therefore scope for change. And, this change is coming if we look at the recent regional action plan of the Indian Ocean Commission who are adopting such a trans-sectoral approach to the blue economy. The experience of the Bahamas in that respect is quite relevant. As hurricane Dorian hit the Bahamas in September 2019, it caused dramatic damages on the islands, to the point that even the tobacco industry was completely destroyed. Before the hurricane, blue finance was understood there in terms of revenues from tourism and increasing the capacity of cruises. After that, the policy mindset shifted to improve coastal resilience to ecological shocks.

Current trends and issues

The major issue is that, before thinking about the expansion of the blue economy, not many actors are thinking about the current problems that should be fixed first in order to avoid biodiversity loss and ecosystem imbalances.

One problem here relates to trash fish, which are fish species considered as having no food value. In Bangladesh, our team had been working for three years to ban fishing of trash fish, which play a vital role in balancing the underwater ecosystem. It took many years to change and educate people's mindsets to the fact that trash fish are vital for biodiversity. Another problem is related to migratory fisheries which are not being accounted for in national quotas, and yet greatly impact on biodiversity loss and underwater ecosystems. For example, migratory fisheries in West Africa account for 25% of total catches, and 80% of fish exports from the Gulf of Guinea to the EU are from migratory fisheries.

Another issue is that environmental protection is currently missing in the various blue economy frameworks that are being implemented. A lack of coordination and planning between ministries is often the main issue here, which is due to a lack of supra-ministerial coordination to make sure different actors of the blue economy are working together. It could also be due to the fact that the main implementing department is usually based in the ministry related to fisheries (e.g. Mauritius, Seychelles) when the concept of the blue economy actually goes far beyond fisheries, as we have seen above. Such shortcomings in the governmental decision-making structure prevent policymakers and other relevant actors from thinking about the blue economy within broader ecosystem services and the multi-dimensional effects of climate change.

Recently, there has been more emphasis on biodiversity in policymaking. In particular, coastal maritime ecosystems, such as tidal marshes, mangroves, sea grass, and peat lands, are now recognised as invaluable carbon sinks. For example, Cape Verde is the first country to put 'sea grass' into their Nationally Determined Contributions (NDC). The policy problem, however, is that the bulk of currently available finance is going to climate change mitigation and adaptation rather than biodiversity protection. Finance goes towards projects which will, for example, select species that are highly relevant for climate change in terms of carbon sequestration or coastal protection, rather than trying to preserve the biodiversity of species. Nature-based solutions to our current global ecosystem challenges exist and they should be based on the conservation of biodiversity in the long-run.

3.2. The future of seafood in a changed ocean

A summary of the lecture 'The future of seafood in a changed ocean' by Mark J. Spalding (President of The Ocean Foundation), delivered on 9 February 2022.

How do we build resilience of coastal communities in the face of climate change?

Fisheries and aquaculture

With 71% of our planet covered with water, fisheries and aquaculture are the two major ocean-based sources of seafood. Additionally, with half of the global population living near the coast, and one in seven people depending on the ocean for their protein

sources, a large proportion of the world population is affected by ocean warming, ocean acidification, and deoxygenation. The industry is also a contributor to greenhouse gas emissions, which are substantially changing the ocean and threatening our seafood, whether from wild caught fisheries or from aquaculture. Its depletion of biomass has a significant effect on the ocean's own biological carbon pump. To understand the scale of the industry, here are just a few numbers to bring some perspective: marine fisheries contribute US$401 billion (2018) to the global economy, offering livelihood support to 60 million people, who are employed worldwide in fishing (39 million) and fish-farming (20.5 million).

Substantial changes in the weather, temperature, wind, and rainfall patterns are taking place as a result of increased carbon dioxide in the biosphere. Water itself is warmer; sea levels rise; we suffer much more severe storms; extreme rainfall occurs, with the flipside of this being droughts on land. All those changes then proceed to impact coastal erosion. Oceans, however, are acting as our carbon sinks that absorb vast quantities of heat from the sun and make it a liveable planet for us all. So, what are the changes currently taking place that are affecting seafood more specifically?

Heat and ocean warming

Changes in temperature are more extreme in the polar regions than in the tropics; the changes in the oceans are not uniform. As those changes take place in systems such as the current channels in the ocean, that make places such as the UK much more liveable than they normally would be, they will result in significant change. And, if those systems are destabilised as a result of ice melt and other things going into the water, and the actual surface temperature is changing, we could see substantial changes in the comfort zones such as Maine (USA), where I live, or where Bath is in the UK. These temperature changes are going to directly affect the metabolism of fish, their growth rates, reproduction and productivity, and migratory patterns -- which will be particularly difficult for fisheries, but also cause some issues around susceptibility to diseases and toxins that will become more likely to succeed in warmer waters. This will also change where animals are, which could disrupt food chains entirely. Taking the example of coral reefs, fisheries are very dependent on coral reefs. Now, coral reefs cannot migrate, at least certainly not as quickly as other animals can. Therefore, coral reefs are dying very rapidly as a result of heat, more than any other ecosystem that is affected by climate change. As a result, we will lose their role in the food chain and more broadly their contribution to the ocean's own biological carbon pump.

Again here, changes are not uniform and we will see variable outcomes. Some species will flourish, others will fail, and much of it will depend on who can migrate or not. Let me give you an example here of the Dungeness Crab Fishery in North America. In 2015, the fishery failed to open in all three States of California, Oregon and Washington due to unusually warm ocean temperatures which have led to an unprecedented algae bloom, and left high levels of toxic domoic acid (neurotoxin) in the food chain. This, however, meant that the ocean species also eating the crab were significantly harmed as result of toxin consumption (e.g. pinnipeds). On the flip side, warmer water has meant increased catches in lobster fisheries in the northeast of the United States and on the east coast of Canada, jumping 30% in quantity from 2014 (125 million pounds) to 2018 (200 million pounds) -- and still increasing today. Some studies indicate that with warmer water, lobsters remain active far longer into the winter.

Commercial fish species, that we monitor more than other species, are changing their location in the ocean: they are moving deeper into the ocean, moving up north in the northern hemisphere and farther south in the southern hemisphere to go to cooler waters that take them back to their comfort zone. Eventually, they may run out of space, but, for the moment, this trend is continuing. There are thus serious implications for fisheries. Do you have the gear to fish at a lower depth? Do you have the legal right to go further north in the ocean? Can you afford it?

Ocean acidification

Chemistry changes damage the ocean by increasing its acidity; whilst the ocean is not going to become acid, it will become slightly more acidic as a result of the carbon deposition from the atmosphere into the ocean. The term 'acid' here describes the chemistry process that can ionise in water to release hydrogen ions, while the term 'acidic' refers to the ability to release hydrogen ions. Since the industrial revolution, we have seen a 30 percent increase in acidity. Additional contributors to ocean acidification, in addition to our greenhouse gas emissions, are storm water runoff, fertilisers, and so on. The impact of which can be found at the very bottom of the food chain with pteropods, also called 'sea butterflies', who have a very thin shell. They are currently in danger of being unable to form their shell, or even to live to a high standard in a more acidic ocean.

Most of our fisheries are dependent on that food chain starting with those basic plankton-like pteropod creatures. If we take out the bottom of the food chain, what are the smaller animals going to eat? Some of our major whale species also rely on those pteropods for their livelihood, so we are extremely worried about places that are becoming more vulnerable to such impacts. This is also something that can affect shellfish aquaculture. In fact, this was how ocean acidification was identified. Looking at the development of some shellfish, increased levels of acidity in the water resulted in malformation of their development. What happens here is that more and more energy has to be spent trying to grow these thin shells, and therefore less energy is spent on the growing of the actual substance of the animal, which, therefore, ends up with a loss of strength and a loss of capacity for the animal to survive. Another impact of ocean acidification for fish themselves is that they cannot rely on their sense of smell anymore. In effect, the acidity changes the smell of the ocean, which then affects their migration movements over a lifetime, to return to a river for example, but also affects how they can detect potential predators.

Finally, the cost of ocean acidification is estimated to be more than $1 trillion annually by 2100, and this sum solely accounts for the commercial fish and aquaculture that we need to sustain our current levels of consumption. Such cost is of course minimal once we account for the potential synergies and impact of ocean warming and acidification.

What can we do?

Adapting to ocean acidification

Adapting to ocean acidification involves activities like testing the pH of the water and monitoring it carefully. For example, if you have a shellfish hatchery associated with your aquaculture, you can shut off the intakes during an acidification event, you can add buffers to the water. Essentially, you can intervene locally to the larvae stage spat, helping them grow to healthy shellfish before putting them into the ocean.

Ocean deoxygenation: Another challenge

Another chemistry change resulting from greenhouse gas emissions is ocean deoxygenation: a process by which less and less oxygen is present in the ocean, and which has synergy with ocean acidification. Ocean deoxygenation often takes place at the mouth of a river where there are fossil fuel based fertilisers going out and causing large algae blooms. The algae blooms suck up a lot of energy and oxygen while they rapidly grow, feeding on the fertiliser, and then also suck up a lot of oxygen in the system when they die off and run out of the fertiliser. As a consequence, ocean deoxygenation strongly impacts seafood, with high costs related to longer trips and spending less time on the fishing ground. In some cases, fish will be crowded next to shore where they are easier to catch and that will skew things in the other direction. In other words, it increases uncertainty, and makes fishing a lot more unpredictable because fish will move quickly to a place where they do have access to oxygen. However, you can also have rapid events that cause rapid die offs.

Solutions for fisheries

Overall, a main solution is to work, as we do, on protecting coastal communities. Equally, work on supply chains for seafood is needed, particularly through increased international co-management solutions for fisheries (e.g. license-related issues). Importantly, we also need to think about how we can increase marine protected areas: both in terms of how they relate to the blue carbon resources that can take up carbon, store carbon, and create habitats, but also in terms of how we manage fisheries. Fish have a role in the carbon system and Marine Protected Areas (MPAs) play a key part in keeping them in the ocean's carbon pump. Reducing emissions of greenhouse gases and shifting human dietary requirements towards low carbon marine sources are, of course, the two most important issues to be addressed. If we move away from emissions intensive land-based sources of protein, such as beef and pork, towards low carbon marine sources such as sustainably harvested/farmed fish, seaweed, and kelp, it would be a significant improvement. Such changes need to occur quickly and sustainably. In terms of nature-based solutions, the conservation and restoration of blue carbon ecosystems is key. Restoring seagrasses, mangroves, and estuary marshes will absorb carbon, move it into the plant structure, and then bury it in the soil all naturally, and generally without using any generated energy sources.

3.3. Arctic Indigenous Seas

A summary of the lecture 'Arctic Indigenous Seas: Selected highlights from the unknown region', by Dr Tero Mustonen (Head of the village of Selkie in North Karelia, Finland and President of Snowchange Cooperative), delivered on 9 March 2022.

Indigenous groups are all very distinct, with over 40 different linguistic and cultural groups, as diverse as the environment they live in. The fact that Arctic Indigenous peoples can survive on their marine environment is through knowledge alone. By knowing the ocean and its intricate details – how the ecosystems are functioning, how the food chains happen, how the animals migrate, stay, behave, and so on – we have been able to see the continuous survival of human civilisation in this part of the world, which is, in some ways, one of the harshest environments on the planet. The only

perhaps similar unbroken cultural connections to the land can be found in Australia, and some other remote parts of the planet.

How do we know about the North and the ocean?

"Come forth, Mother of the Sea,
Blowing in the Wind,
Swept and Seen in the Gales." (Ancestral Poem)

This beautiful poem conveys how our ancestors thought about the oceans as the 'Mother of the sea.' It also shows how linguistic diversity, cultural knowledge, and the sea are deeply connected.

One of the elders I would like to introduce you to is Elder Stanton Katchatag, from the small village of Unalakleet on the Bering Sea. His life and work focused on the area where the continent of North America and Eurasia meet. I worked with Stanton's knowledge and partnership for many years. We met in 2002 and, unfortunately, he passed away five years later. I wanted to bring you here a sort of dialogue between science and Indigenous knowledge about the oceans. In one of the interviews we had in 2002, he mentioned that he first started to observe and place significance on the fact that the ocean and the weather are changing in the early 1970s. He also qualified that at first the changes were 'slow' in comparison to the time of the interview. He clearly positioned that 1972 is roughly the time when the ocean started warming up. Now, together with my colleagues, we then worked on the weather charts from the 1950s onwards and we were able to find the exact correlation in the early 1970s when the temperatures shot up. It just confirms how Indigenous peoples are at the frontline or early responders to climate change, and they possess a wealth of first-hand knowledge on the oceans.

How do they belong?

"We have an alliance with the Earth. Each one of us does, and some of us as a people have continued to grasp this alliance and have anchored it into our souls…The lifeways of a people cover an entire spectrum, a spectrum so wide and profound that it continues to astound the western mind as non-Inupiat learn more about us."

Herbert O. Anungazuk from Wales and Anchorage

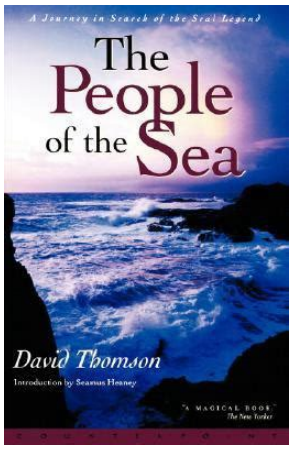
This quote, from Herbert Annungazuk, elegantly conveys the notions of seascape, oceanscape, and the many relations that Indigenous peoples have with the land and the ocean. The word of relevance here is 'alliance'. Indeed, most of the Arctic Indigenous peoples think of themselves as belonging and being in close alliance with the ocean ecosystem they are living in. This means that the Indigenous way of living covers a spectrum so wide and profound that it continues to surprise and trigger novel

ideas, new knowledge, and dialogue, provided there is respectful exchange between Indigenous and western communities.

What are the new challenges?

How does the global modern society and the Indigenous society meet? Here is an example to illustrate how Indigenous knowledge matters in managing our common resources. In 1977, the International Whaling Commission (IWC) deleted the Aboriginal Subsistence exemption for the right to hunt whales, which included the Bering Sea stock of bowhead whales. This action effectively eliminated, without prior notice or due process by the U.S. government, a vital nutritional and cultural food harvest of the Inupiaq peoples, which was practised uninterrupted for thousands of years. This led to a dramatic impact on nutrition, and increased levels of alcoholism in the villages impacted by the policy cut. The IWC's rationale for this devastating decision was based on the Scientific Committee's advice that the Bering Sea stock of bowhead whales wrongly numbered 600 to 2,000 animals. Given the failure of early science efforts to count the whales, the Indigenous whaling captains took it upon themselves to train western researchers about the behaviour of migrating whales and jointly developed better tools for accurately counting them.

What can be done?



Ecological rewilding using Indigenous knowledge of anadromous fish habitats is needed. For example, those fish that come up to the rivers in the north to spawn. If we are able to strengthen, rewild, and restore habitats, we may buy time and possibilities for those species that are interconnected with the Arctic seas -- such as Atlantic salmon, trout, and lamprey. Linkages to land and freshwater systems may be one of the solutions. I also invite you to have a look at our website www.arcticseas.org to see Indigenous engagements and knowledge regarding the Arctic Ocean and coastal areas with over 500 different Indigenous communities marked on the website. There are also links to videos, maps, oral history, photos, and cultural representations.

Finally, closer to Bath and the UK, given the proximity of the UK with the ocean, I was thinking to share with you a book from David Thompson, *People of the Sea*, that he published 20 years ago. In that book, he collected a lot of oral stories, folk tales, and living knowledge from the Okney Islands, Shetlands, Northern Scotland, and many other places where the communities are keeping a lot of interactions with the oceans. He has built a basis of knowledge around the concept of the 'Selkie', which is coincidentally the name of my village. Selkie is a seal that, in your culture, was believed to come to shore on special nights to leave her skin on the shore. She would then transform into a human being, sometimes marrying fishermen, or becoming part of the community only to one day return to the ocean.

The reason I wanted to end in your culture and on your shores is that -- as all Indigenous peoples would know -- we are interconnected. And, the story of the Selkie transforming into a human being and becoming a seal again afterwards strengthens the understanding that we are all related, connected to the mother ocean. Yet never before has she done so poorly. So, the notion of hope I wish to convey is that it is not all over.

We are still in a position to enact what Selkies are able to do; a transformation. But the window is closing rapidly.

4. The politics of our oceans

4.1. A deep dive on geopolitics

A summary of the lecture 'Our Oceans: a deep dive on geopolitics' by Professor John Hannigan (Professor of Sociology, University of Toronto, Canada), delivered on 16 May 2022.

Geopolitics of the deep ocean during the Cold War

Deep sea mining is becoming one of the most important environmental stories as a resource frontier of the next quarter century. Hence, the history of the deep ocean's geopolitics is crucial to understand its current geopolitical landscape. The current geopolitical landscape is an extension of that which existed during the Cold War in the 1950s and 1960s. The international political tensions of that era were placed out in the deep, where US and Soviet submarines incessantly tracked one another across the globe. After 1957, the Cold War arms race escalated when the Soviet Union launched the Sputnik 1, the first artificial Earth satellite. This was seen as a direct challenge to the technological supremacy of the United States. Less than a year later, in August 1958, the USS Nautilus, the world's first nuclear power submarine became the first to reach the geographic North Pole underwater. Then, six months after that, in March, the USS SKATE became the first submarine to surface at the North Pole. The United States was overjoyed at this. The novelist commander William Anderson was awarded the Legion of Merit by President Dwight Eisenhower as a result of that.

In the last few decades, there has been a critical mass of really fascinating historical research from authors such as Naomi Oreskes and others. What these historians have done is to document how oceanographic scientific research during this era was largely funded through defence spending, notably that provided by the US Office of Naval Research.

Changes in geopolitics since the Cold War

China as a major player

The addition of China as a major player in geopolitics is well known through its role in the South China Sea, where it has clashed with neighbour countries, including Vietnam, Indonesia, or the Philippines. A less known, but no less significant role of China, is in the Artic. Chinese oil and gas drilling vessels have become a familiar sight in the Kara Sea. In 2017, a Chinese drilling rig made one of the largest gas discoveries in the Russian Arctic shelf. China has also invested in an icebreaker called the 'Snow Dragon' and is lobbying to become an observer at the Arctic Council, although China has no actual connection with the Arctic geographically. China has also attempted to acquire significant chinks of land in Greenland and other northern areas. Hence, China is here to stay as a major player in the geopolitics of the Arctic.

Proliferation of boundary disputes around claims to an extended continental shelf

The proliferation of boundary disputes is an extremely complex issue more related to maritime law, but it was triggered by a provision under Article 76 of the United Nations Convention on the Law of the Sea, adopted in 1982. According to this provision, a coastal state could assert subsurface rights beyond the existing 200 mile nautical of the Exclusive Economic Zone (EEZ). An EEZ, from the 12 miles of territorial waters up to 200 miles, does not grant a country territorial rights but considerable rights over issues such as oil and gas development and fishing. This provision stated that if a nation could convince the UN Commission on the Limits of the Continental Shelf (CLCS) that a geographic link exists between land mass and adjacent underwater formations, then they could include it as part of their EEZ. Numerous geopolitical conflicts emerged as a result, in the China Sea for example, but also in the Polar Arctic between Canada, Denmark, and Russia. Lodging a claim under article 76 is complex, costly, and lengthy, involving detailed geo-scientific assessments as the claims between nations can easily overlap. The role of the CLCS is to rule on the efficacy of scientific claims which means that ultimatey this will become a matter of geopolitical negotiation potentially requiring a treaty.

Deep-sea mining

The deep-sea floor is presently, along with Antarctic, the only area on Earth where mineral resources are not extracted commercially. This is partly due to a fundamental scientific error as, for most of human history, there was a widely shared perception that there is nothing down there, right up until the mid-20th century. In oceanographic research, the Azoic hypothesis stated that no life exists in the oceans beneath 500 meters. Most scientists assumed that the sea floor was a vast, empty plain, devoid of life. The famous “Challenger expedition” in 1872-1876, which is often credited as laying the foundation for the science of oceanography, brought up in trolls and dredges large surface-dwelling marine animals such as sea cucumbers, sea urchins and molluscs. The rich ecological communities at deeper depths were overlooked. Ironically, the Challenger nets used to haul up black potato shaped particles from the seabed, which today turn out to be the leading commodity in deep-sea mining, but no one knew their value other than being a scientific curiosity.

The environmental threats of deep-sea mining are numerous. Starting with manganese nodules, the vacuuming process of mining the sea floor kicks off a dust storm which takes days to settle. Vast plumes of resuspended sediment potentially could choke biological communities for miles around these nodules, as well as crust and sulphides that act as substrate for a unique fauna. Mining will remove or crush these organisms. Mining nodules could also unleash a cascade effect which impacts ocean currents that circumnavigate the globe. Greenpeace also pointed to the disruption in carbon storage on the ocean floor.

There is, therefore, a need for regulating seafloor mining. The International Seabed Authority or ISA is the chief regulatory mechanism established by the United Nations Convention on the Law of the Sea (UNCLOS), and became operational in 2011, beyond national jurisdiction. In fact, negotiations at UNCLOS were deadlocked for a decade primarily due to disagreement between countries likely to engage in deep-sea mining in the future who wanted to create quotas, and those in developing nations who wanted

to share in the spoils, arguing that the ocean was part of the common heritage of humankind.

Critics identified gaps in the ISA's mandates and powers, arguing that the ISA was tasked with overseeing the commercial development of the seabed, but not the water column above. In effect, the ISA only has jurisdiction over what happens on the seabed, not over bioprospecting, which remains virtually unregulated outside territorial waters. The ISA is trapped in a contradiction where, on the one hand, it is a regulator of a mandate to shape and control deep sea mining by issuing licenses for exploration and exploitation of the seabed. On the other hand, the ISA was handed the responsibility for environmentally protecting the area, this is the seabed on the ocean floor, and subsoil beyond the limits of national jurisdiction. Exploitation versus conservation is the main foundational, and yet contradictory principle of the ISA.

4.2. The need for a Blue New Deal

A summary of the lecture 'A Blue New Deal: Why we need a new politics for the ocean' by Professor Chris Armstrong (Professor in Political Theory, University of Southampton, UK), delivered on 29 June 2022.

A crisis of inequality

In the blue economy, there is a pattern of oligarchy across all sectors that are dominated by just a few privileged actors. Across all key sectors, almost all of the total revenues are monopolised by just ten corporations, which suggests that the spoils of the blue economy are not being widely shared. Strikingly, even though hundreds of millions of people in the Global South are heavily nutritionally dependent on fish, there is a net flow of fish from the Global South to the Global North, which reflects the purchasing power of consumers in the north but also northern corporate interests exploiting southern natural resources.

How did we get here? Pendulum of freedom vs enclosure

The narrative of freedom at sea

The idea of freedom at sea is associated with Dutch legal scholar Hugo Grotius who published an essay called 'Mare Liberum' or the 'Free Sea' in 1609. Grotius argues that humans have a right and perhaps a duty to navigate the great ocean and to engage and trade with other communities, which is why the ocean should remain free and not become the territory of any one state. Another important reason Grotius puts forward is that there is no point to own a ship, or the extension of territorial claims over the sea, because the goods that the ocean gives us are just unlimited, infinite in their bounty. Hence, if a country fishes to its heart's content, it does not prevent another country from doing the same. This narrative of freedom at sea has been hugely influential, certainly right up into the 20th century, and it is the dominant idea of oceanic governance. Yet, the arguments made by Grotius are incorrect. In a critique of Grotius, the English scholar John Selden argued that consuming the resources of the ocean makes things worse because it introduces scarcity. His view feeds into contemporary debates about marine genetic resources, such as who is going to get to patent the genetic code of a jellyfish, are merely about control over scarce resources and the pursuit of this scarce property.

The narrative of enclosure

The second great narrative of 'enclosure' is linked to the process of territorialising the ocean. The UN Convention on the Law of the Sea, coming into force in 1994, lays out the foundation of such process by moving away from Freedom at Sea. The figure here shows the current distinction between territorial sea --up to 12 nautical miles-- and the Exclusive Economic Zone --up to 200 nautical miles --, both of whom are the product of the Convention on the Law of the Sea, and the High Seas which still operate under the narrative of the Freedom at Sea.

Arguments in favour of enclosure point to the risk of a 'tragedy of the commons,' meaning that, unless we turn these extensive sways of the ocean into state territory, over-exploitation of natural resources will take place, such as overfishing. Arguments against enclosure however show that there are major problems. One such problem is that enclosure does not address the issue of inequality. The poorest coastal countries lack the developed state capacity, technologically and financially, to engage in ocean industries. A consequence is that the poorest coastal states sell access to multinational corporations, and those access agreements tend to be highly one-sided. In places like West Africa, the same is true for fishing, where fishing agreements mean that, on average, the coastal state retains about five percent of the net value of any fish that are caught, the rest goes to the fishing state.

Freedom on the High Seas

The story of High Seas (HS) governance is a story of dysfunctional governance. HS fishing represents a tiny proportion of all the fish caught in the world's ocean, and we could probably dispense with HS fishing without making a significant impact on anyone's nutritional needs. Poor people do not really engage in HS fishing because it is expensive. The High Seas fishing industry is economically irrational: to get 200 nautical miles out onto the open ocean requires expensive equipment and high volumes of fuel. Hence, the HS fishing is highly subsidised, with fuel subsidies in particular.

We have here an interesting picture where about half a dozen countries, presumably because of domestic political pressures, are subsidising to a very considerable extent their HS fishing industries, which are often geographically concentrated. The HS fishing industry is also highly destructive of both the seabed and the bycatch. Large numbers of species (e.g. dolphins) who are caught are not the target species, so they are thrown dead into the water. As a whole, the HS fishing industry makes neither economic nor environmental sense. If we did not have HS fishing at all, no one would be worse off, and probably many people would be better off, because fish would have a refuge in which to recover from the onslaught of industrial fishing.

Why do we not have 'marine protected areas' in the High Seas?

Marine protected areas are geographical designations where some economic activities are limited. In the case of the HS, it may be the case that no fishing could take place, as a sort of marine reserve at the strong end, or perhaps there would be serious limits on the kind of equipment that could be used, or catch limits, or seasonal limits. Marine protected areas, when properly policed, can be extremely effective in nursing fish populations back to bountifulness – so why do we not have marine protected areas in the High Seas? Simply because of this narrative of freedom of the seas.

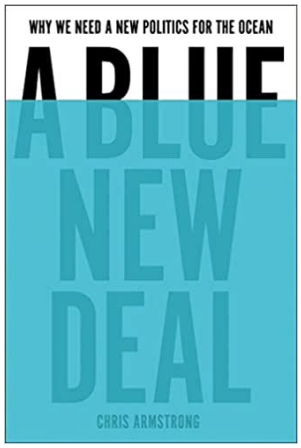
The governing idea on the HS is still that natural fish resources can be caught freely in the HS without any authority stopping it. Some organisations, such as Regional Fisheries Management Organisations (RFMOs), do cover parts of the HS. Others cover particular species, such as tuna. The problem is that many states do not belong to any particular RFMOs, in which case such states are not bound by its rules or catch limits.

Treaty on the High Seas[3]

The HS treaty on Biodiversity Beyond National Jurisdiction (BBNJ) has been in preparation for a couple of decades, with various kinds of intergovernmental panels that have not resulted in an agreement to date. The current draft treaty is still very open-ended, with many decisions still to be made, which I think leaves open too many vital questions. One major question is around benefit sharing and transparency: who gets the benefit of genetic exploitation and where does the money go? So, the draft has not solved this issue yet, and it leaves open whether benefit sharing will be compulsory or optional. It also leaves open whether benefit sharing will, in fact, be financial, sending money in the direction perhaps of poor countries, or whether it might just mean sharing information.

Time for a Blue New Deal

The High Seas Treaty, if it comes to pass, will achieve some progress. However, it pales in relation to the multifaceted, sweeping, and accelerating environmental crisis facing our oceans. Also, the crisis of accelerating inequality in the ocean economy sharing will be impossible to turn around without substantial processes of benefit. I think we need to switch the narrative away from the idea of Freedom at Sea where, rather than the default being that any activities are permitted on the HS, they should be limited or qualified in some ways. The default option should rather be in terms of protecting the HS, and any exploitative extractive activities require permission.



This might be blue sky or rather blue water thinking here, which is why in my book 'A Blue New Deal', I paint a picture in which the international community comes together to create a 'World Ocean Authority' that acts as the custodian for the HS. The existing instruments of international law of the sea, for example the Convention on the Law of the Sea, does say that the areas beyond national jurisdiction, including the HS, are part of our common heritage. However, I want to argue that these areas are not just the common heritage of humankind, as we do not live there, but first and foremost home to an incredibly diverse, complex, beautiful ecosystem with millions of species, many of which are still unknown to science.

Protecting the ocean would require a democratic and inclusive politics of the ocean, as it is currently driven by a technocratic elite. Current political structures exist and I point toward the use of the concept of 'international park', whereby there is free access as long as there are no damages made, or anything is taken away from it. Not protecting our ocean right now is leading to a scale of environmental destruction that will have knock-on effects for our planetary ecosystems. A Blue New Deal is unlikely to be

[3] The 'High Seas Treaty' discussed here has now been finalised. The treaty was agreed on 4 March 2023 and sits underneath the United Nations Convention on the Law of the Sea (UNCLOS).

established tomorrow, but again, history can bring some hope here. In 1959, the Antarctic Treaty froze any territorial claims over Antarctica – a system which is still in place today, and which inspires us to protect the High Seas to restore our oceans and our planet.

5. Conclusion

Interestingly, the Freedom of the Seas is both the starting and ending point of this report. It also represents the current challenge in social sciences for conservation, restoration, and sustainable use of the oceans. In effect, the political economy behind ocean governance seems to be along the following spectrum: (1) *laissez-faire* exploitation of ocean resources and exponential addition of carbon and methane into the atmospheres and the oceans, (2) full intervention to protect our oceans and coastal biodiversity on a global scale, or (3) somewhere in between by implementing more Marine Protected Areas (MPAs) which play a key part in the ocean's carbon pump. Hence, where the UN Ocean Decade will end up in 2030 depends on a sound understanding of the social sciences of ocean governance.

Professor Fusaro attributed the dominant historical perception of the oceans to the ideal of eternal economic growth, which has underpinned much of human activity during the age of the Anthropocene, facilitated by a Westphalian territorial system between freedom and enclosure (Professor Armstrong), where domination is used as a proxy for ownership (Professor Fusaro). Such a perspective of the High Seas is, however, redundant and even problematic given the scale of the territories to be covered, and also given the unequal capabilities countries have to monitor and enforce existing and future international agreements. Professor Fusaro instead called for the acknowledgment of the diversity of risks linked to the ocean-climate nexus; risks that have now become life-threatening and global.

According to Professor Wadhams, intervening and protecting our oceans on a global scale has become a moral issue given the scale of geoengineering and financial challenges we are facing. This is prompting Professor Wadhams to think about geoengineering systemically and to promote a systemic climate restoration strategy. International cooperation and the mammoth finance required are, however, not up-to-speed to implement such systemic strategy, especially in light of the current scientific uncertainties surrounding the effectiveness of these approaches.

From the bottom-up, the increased unpredictability of the ocean-climate nexus and the variable outcomes it has at the local level (Mark Spalding) have led to a rise in community-based interventions. Professor Failler, Dr Richardson, Mark Spalding, Veta Wade and Steven Lutz have shown the importance of such locally based initiatives, whether it concerns coastal blue carbon, or community resilience in the blue economy. Scaling-up such initiatives to cover all coastal areas in the future would however require, again, more finance and greater political will. Dr Blondel showed how the scientific evidence already points in certain directions, from the warming of oceans at depth to the migration of ecosystems to more hospitable waters.

Climate finance is there (Professor Failler) but not always directed to where it is most needed. While interest in voluntary carbon markets – including those that actively

incorporate blue carbon – is on the rise, it takes time to set up effective coastal projects on the ground (Steven Lutz). Without MPAs, growing interest in carbon offsets encourage *laissez faire* approaches in climate finance governance. This will give rise to more and more bluewashing practices to fulfil shareholders' interests while disempowering the voiceless stakeholders that are most directly impacted, especially where poorer countries have lower bargaining power than corporate forces.

Throughout this series, we have seen that the scientific knowledge is ready, that the finance – in principle – is ready, but that political decisions and policy action are not responding fast enough. Beyond a moral obligation, it is a defining moment for humankind to challenge "enclosure" and to free the collective mind to protect biodiversity and avoid extinction in the long run. Hence, bridging the gap between the lack of political action and the existing scientific solutions goes through (1) bottom-up local knowledge to govern and restore coastal habitats - Dr Mustonen has shown, for example, how important the role of Indigenous knowledge is in terms of producing scientific knowledge, (2) protecting the High Seas as the recent UN Treaty shows a way forward to implement the 30x30 pledge of protecting 30% of all oceans by 2030, and (3) channelling finance in line with the priorities set by Nationally Determined Contributions in order to restore the biodiversity of the blue economy and to protect our oceans. Now is the time to take action.

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