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The Global Transboundary Climate Risk Report



2023



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Chapter 2.2

Managing transboundary ocean resources under a changing climate

Alexandre K. Magnan,^{1,2,5} Jean-Pierre Gattuso^{1,3,4}

There are now serious concerns about the growing risk of shortfalls in open-ocean fish stocks, and the effects on economic imperatives to access the remaining stocks, global-scale inflation and resulting inequalities in access to marine proteins for the most deprived people in society, as well as fractured regional and international relationships beyond the fishery sector itself.

- There is growing evidence on the cascading impacts of climate change on ocean and coastal ecosystems, from the surface to the deep ocean. In particular, climate-driven geographical shifts are affecting fish stocks, exacerbating economic and geopolitical tensions.
- The risk of overfishing in exclusive economic zones (EEZs) results in the loss of fish stocks driven by an incentive to “catch fish before they go away”, which will accelerate with climate change and trigger cascading risks on global supplies.
- Current global frameworks are not equipped to deal with the permanent loss of fish stocks within national jurisdictions, while regional arrangements to compensate for shifting ocean resources have serious limitations. This illustrates a broader gap in policy and governance arrangements addressing transboundary climate risks in ocean and coastal shared resources, covering large regions, and allowing to adapt to and manage, for example, the movement of fish stocks to the high seas under climate change.
- There is therefore an emerging need to design international compensation mechanisms to support countries’ coping capacities to adapt to transboundary climate risks for ocean resources.

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Overview

Climate change is now causing major geographical shifts of natural ocean resources, particularly fish stocks. The climate-driven transboundary shifts of these resources between EEZs have implications for fisheries management and for global markets. When these shifts combine with other challenges, such as overfishing, there is a risk that the ways in which countries address the threats to their fisheries will disrupt markets and create or exacerbate bilateral and multilateral geopolitical tensions. This highlights the need for agreements to manage migratory fisheries and ocean resources that include international mechanisms to counteract the limitations of regional governance.

Introduction

Ocean and coastal resources play an essential role in feeding humanity, through both small-scale coastal fisheries that take between one-quarter and one-third of the total fish catch from the sea, and the industrial fishing operations found across more than half of the world’s oceans. Marine fisheries are, however, increasingly affected by climate change (IPCC, 2019): ocean warming forces species to move to waters more suitable for their feeding and growth; ocean acidification damages fish habitats; changes in extreme sea levels and long-term sea-level rise affect fishing infrastructure, such as harbours; and ocean deoxygenation increases “dead zones” (areas of water where low oxygen levels limit aquatic life).

There is growing evidence on the cascading impacts of climate change on ocean and coastal ecosystems, from the surface to the deep ocean. Significant and widespread impacts on warm-water coral reefs are already detectable and possibly irreversible (Hoegh-Guldberg et al., 2018), and there are high risks to the abundance and distribution of other marine fauna and flora, for example krill and sea snails and slugs at high latitudes, seagrasses at mid-latitudes, and finfish fisheries at low latitudes. Bivalves and their fisheries, aquaculture, mangrove forests, estuarine

ecosystems, salt marshes, sandy and rocky shores, and deep-sea ecosystems are all considered to be vulnerable to continued climate change in the coming decades.

A synthesis of risk assessments developed under the IPCC Special Reports of the Sixth Assessment Cycle published in 2018 and 2019 suggests that every additional 0.5°C of global warming will increase the risks to ocean and coastal systems by 30–40% globally (Magnan et al., 2021).

These predictions raise serious concerns for three reasons. First, about 11% of humankind lives in low-lying coastal areas (a percentage expected to increase by 2050), and food from the sea currently represents 17% of the global availability of edible animal protein, possibly increasing to 25% by 2050 (Costello et al., 2020). Second, some coastal ecosystems, such as coral reefs, mangroves and seagrasses, provide important nursery areas for species caught offshore, and any impacts on coastal ecosystems will, inevitably, have knock-on effects beyond the area that is initially impacted. Third, some open-ocean fish species respond to climate stress through geographical shifts, moving towards the poles and into deeper waters in response to warming seas, which challenges the bases for sustainable development (Pecl et al., 2017) and for established fishing practices and agreements. This last point, in particular, illustrates the transboundary risks to ocean resources from climate change and from adaptation responses.

On a longer-term perspective, it is estimated that about half of transboundary fish stocks (i.e., stocks currently crossing neighbouring EEZs) will have shifted by 2100, and about 80% of the world's EEZs will include at least one shifting stock (Palacios-Abrantes et al., 2022). Any change in the geographical distribution of fish stocks leads to a decrease or increase of catches and revenues for the countries that lose or receive fish, respectively.

In addition to national and local economic impacts, shifts in the distribution of fish species have the potential to generate political tensions, as illustrated by the “cod wars” from the 1950s to the 1970s between Great Britain and Iceland over rights to cod fishing or the tensions that occurred in the 1990s between the US and Canada as a result of the shift of Pacific salmon towards the poles (Pinsky et al., 2018). While these two examples were not attributed to climate change, it is likely that climate-driven geographical shifts will exacerbate such bilateral and even multilateral economic and geopolitical tensions (see, for example, “mackerel wars” in Pinsky et al., 2018).

Scientists also warn against the risk of overfishing in EEZs that are expected to lose fish stocks in the coming decades, driven by an incentive to “catch fish before they go away” (Oremus et al., 2020). There are now serious concerns about the growing risk of losing open-ocean fish stocks, economic imperatives to access the remaining stocks, global-scale inflation and resulting inequalities in access to marine proteins for the most deprived people in society, as well as fractured regional and international relationships beyond the fishery sector itself (Lam et al., 2020).

“The transboundary risks associated with geographical shifts of high-value fish species are very likely to increase in the coming decades.”

Characterization of the transboundary climate risk

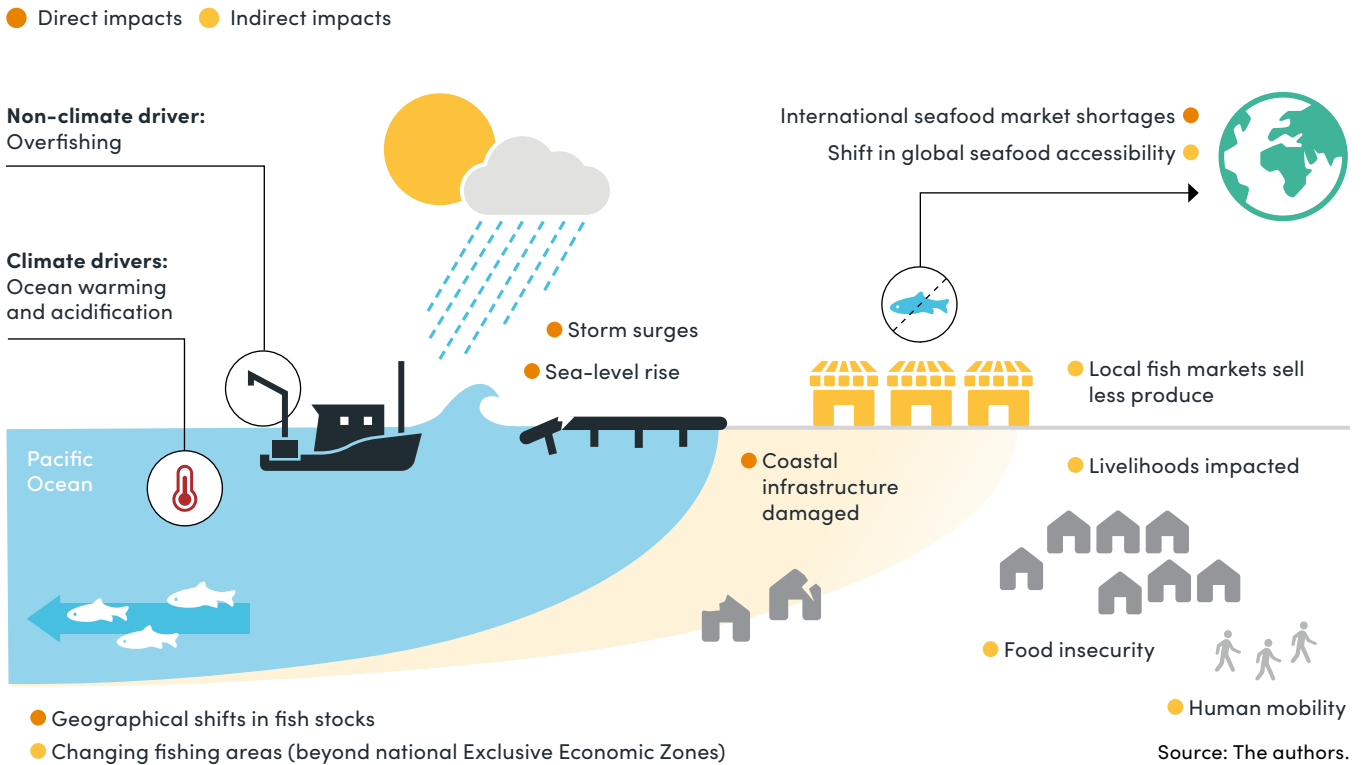
This section explores shifting fish stocks in the open ocean to highlight the key characteristics of the transboundary implications of climate change. These are the likelihood of detrimental consequences, transboundary propagation modes, timing, risk pathways and possible responses.

In terms of likelihood of detrimental consequences, the transboundary risks associated with geographical shifts of high-value fish species are very likely to increase in the coming decades as a result of a combination of three factors. First, the global consumption of marine products is expected to continue to increase (Lam et al., 2020). Second, the maximum fish-catch potential of global fisheries could be reduced by 20% to 25% by the end of the 21st century under a high greenhouse gas emission scenario (Representative Concentration Pathway RCP8.5) because of a net decline of fish stocks driven by changing climate conditions (Bindoff et al., 2019). Third, climate change will lead to fish redistribution among EEZs as well as between EEZs and the high seas: the areas beyond national jurisdictions that represent two-thirds of the global ocean surface (Kroodsma et al., 2018). By the end of this century, most coastal states, especially in some temperate regions and in shared Antarctic fishing grounds, are expected to receive up to 30% of their fish catch potential from newly redistributed stocks, while the tropics are likely to see a decline in fish stocks (Pinsky et al., 2018).

The chain of impact illustrates two propagation modes of transboundary climate risks across borders (including across sectors and systems in different countries at different spatial distances) (Carter et al., 2021). First, between neighbouring countries, with subsequent cascading effects on local markets, jobs and industries. Second, between distant countries through cascading impacts of changing fish catches on the international seafood market, including on supply chains and financial markets (Lam et al., 2020). As a result, the spatial dynamics of ocean transboundary risks from climate change will run from small-scale regions (e.g., affecting the boundary between two EEZs) to wider regions (e.g., at ocean scale, involving more than two countries), and through distributional impacts on trade and markets at the global scale [Figure 5].

These climate-induced cascading impacts remain understudied, but there are some initial thoughts on the potential

Figure 5. Transboundary impacts of shifting fish stocks



timing of impacts, response implementation, response outcomes, and the autonomous adaptation of species. First, impacts are likely to be substantial well before the end of this century, in particular, if the world continues on its path towards a high emissions scenario. By 2050, for example, the total biomass of three species of tuna is projected to decline by an average of 13% in the combined EEZs of 10 Small Island Developing States (SIDS) in the Western Pacific region as the fish move out to the high seas (Bell et al., 2021). And as soon as 2030, an estimated 20% of transboundary stocks will have shifted across EEZs (Palacios-Abrantes et al., 2022).

Second, the timing of human response remains largely unknown, making it hard to assess how much time it takes for a policy to deliver results or reveal its collateral effects, and whether these positive or negative outcomes will be short-lived or permanent. However, it can be argued that the more complex the cascade of impacts, the deeper the outcomes and the higher the probability that societies are affected for generations (e.g., in the case of radical economic shifts).

Third, the recovery time of marine species depends on natural parameters as well as exogenous stressors (climate, pollution, etc.) and potential climate change adaptation policies. There is general agreement that the time needed to design and implement adaptation policies and, therefore, to benefit from them, is longer than the timeframe over which the abundance and distribution of natural resources will be affected under accelerating climate change (IPCC, 2022; Palacios-Abrantes et al.,

2022). Recovery times for species ranges from sometimes 10 years or less for some oyster and coral reefs, to 10–30 years for exploited fish stocks (including tuna species), and up to 40–100 years for whales and sea turtles. Overall, however, marine species and fish stocks have recovery times that could be supported by active interventions, particularly if their loss has been triggered primarily by mismanagement (Duarte et al., 2020; Fromentin & Rouyer, 2018).

The combination of several transboundary risk pathways includes a “biophysical pathway” that encompasses changing flows of ecosystem services and resources, a “trade pathway” involving changing flows of goods and services in international supply chains and global markets [Chapter 2.4] and, to a lesser extent, a “people pathway” through the movements of people and human activities across EEZs and the related issue of remittances from fishermen [Chapter 2.8] (Hedlund et al., 2018).

Two types of influence shape the connections with other transboundary climate risks. On the one hand, the increased risk of overfishing associated with the climate-induced geographical shifts of fish stocks has implications not only for biodiversity, but also for livelihoods and living standards in fish-dependent communities and countries, such as in the Pacific Ocean, across the whole fishing industry and among the most deprived people in distant fish-consuming countries [Chapter 2.9]. This, in turn, presents threats to food security (e.g., in terms of food availability) and poses indirect risks to human health (e.g., through increased poverty and difficulties in accessing

affordable food) and possibly mobility (e.g., through loss of jobs) [Chapters 2.3, 2.7, 2.8, 2.9]. Indeed, there is a general view that non-voluntary (inter)national migration is influenced increasingly by the transformational consequences of climate change on livelihoods (increased precariousness, gender inequities, etc.) and social capital (i.e., the erosion of community networks as a result of exacerbated tensions within and between communities and countries) (Loiseleur et al., 2021) [Chapters 2.8, 2.9].

On the other hand, cascading transboundary risks related to fisheries will themselves be exacerbated by external factors. Sea-level rise, for example, will affect coastal infrastructure for transportation (e.g. harbours and airports), and possibly energy production (e.g. power plants) and the supply of commodities (e.g. waste management and freshwater supply), with ramifications for economic development and, in turn, the ability of countries to respond to a shift in fish stocks beyond EEZs.

Box 3. Case study:

Geographic shifts in tuna stocks in the Pacific and transboundary governance responses

The projected redistribution of tuna in the Pacific Ocean is an opportunity for a deeper assessment of ocean transboundary risks from both climate- and adaptation-related responses. Tuna fishing in the Pacific makes a substantial contribution to global fish catches and to the island economies of the region. In particular, the 10 Pacific SIDS where most tuna fishing occurs – Cook Islands, Federal States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands, Tokelau and Tuvalu – receive an average of 37% of their non-grant government revenue from tuna fish access fees (Bell et al., 2021). However, as ocean warming drives tuna further to the east, the purse-seine catch of tuna from their combined EEZs is expected to decline by 20% by 2050, reducing government revenue by up to 13% per year for individual SIDS (Bell et al., 2021). The redistribution of tuna biomass will, however, increase the catch from the surrounding high seas, which currently play a negligible role in global seafood production (Schiller et al., 2018).

In all, 9 of the 10 tuna-dependent Pacific SIDS participate in a regional fisheries management arrangement that enables them to deal with the geographic shifts of tuna within their EEZs as a result of climate variability. This arrangement, known as the Vessel Day Scheme (VDS), was established in the 2000s by the Parties to the Nauru Agreement (PNA) (Aqorau et al., 2018). The VDS has been designed as a cross-border tool to achieve sustainable tuna harvests and optimal outcomes for island economies from their shared tuna resources in response to the profound influence of El Niño and La Niña events on fish distribution (Aqorau et al., 2018; Clark et al., 2020).

El Niño and La Niña are characterized by temperature anomalies at the scale of the entire Pacific basin, resulting in conditions for purse-seine fishing in the Western and Central Pacific Ocean (WCPO) that are more favourable in the eastern part of the WCPO during El Niño episodes and in the western part during La Niña events. This climate variability does not affect the total purse-seine catch from the combined EEZs, but it does have important consequences for the distribution of catches and, therefore, for the revenues received by Pacific SIDS which they depend on for health, education and infrastructure programmes, etc.

The VDS sustains annual purse-seine catches by limiting total fishing effort to ~45 000 days per year and allocates those days among the nine Pacific SIDS that participate in the scheme based on the catch history from their EEZs over the past 7 to 10 years (Clark et al., 2020). In essence, the VDS is a “cap and trade” scheme that allows participants to respond to the profound effects of the El Niño on the prime fishing grounds for tuna.

During La Niña events, countries in the west buy days from members in the east to enable fleets to keep fishing in their EEZs, with this arrangement reversed during El Niño episodes. Therefore, regardless of where the tuna are caught, all PNA members receive revenue each year as long as the fish remain within their combined EEZs.

The VDS is also designed to govern fisheries in a non-confrontational way (Bell et al., 2021) as the tuna are redistributed to the east as a result of climate change. Over time, PNA members in the east are expected to accumulate a greater catch history and receive more days. However, the “pooling” and “roaming” provisions of the VDS (Clark et al., 2020) provide practical ways for PNA members in the western area of the WCPO to maintain much of their catch history, thereby minimizing the risks to their economies by movement of the fish to other EEZs.

One important limitation of the VDS, however, is that it is restricted to the management of tuna within the combined EEZs of the participating Pacific SIDS. As tuna are redistributed to the east and progressively into the high seas by climate-related changes, lower catches from the EEZs will undermine the socioeconomic benefits that the Pacific SIDS derive from tuna fishing, and weaken the strong existing management arrangements for tuna resources. This has been raised as a climate justice issue, given that Pacific SIDS contribute very little to global greenhouse gas emissions. A solution needs to be found that enables Pacific SIDS to retain the benefits they currently enjoy from tuna fishing, regardless of the redistribution of the fish (Bell et al., 2021).



Regional-level agreements can help address climate-related shifts in fish stocks. © Francisco Blaha

Critical reflections on existing policy tools and their limitations

As demonstrated by the example of the Vessel Day Scheme (VDS) for the Pacific SIDS in the case study, regional arrangements have limitations, even though they are essential for effective governance of transboundary ocean resources under a changing climate. Both the general ethos of the VDS (i.e., a cross-border tool to promote the use of migratory fisheries resources in a collectively beneficial and non-confrontational way), and the specific management arrangements (e.g., equitable distribution of fishing days) are important foundations for the strengthening or design of regional-scale mechanisms to address transboundary risks triggered by the effects of climatic variability. However, rapid climate change under continued high greenhouse gas emissions will present profound challenges to the foundations of existing regional arrangements as the fish move eastwards in the high seas.

Beyond the VDS example, there is a widespread need for governance tools that cover larger regions to address climate-driven redistribution of transboundary fish stocks at large spatial scales. The development of such tools could be supported by the international community, for example, by the United Nations Framework Convention on Climate Change (UNFCCC) encouraging governments to include transboundary climate risks in their official adaptation documents (National Adaptation Plans, Adaptation Communications), and even calling for the development of Regional Adaptation Plans dedicated specifically to the collective management of transboundary climate risks. Other frameworks and conventions, such as the UN Convention on the Law of the Sea and the Water Convention also offer binding mechanisms through which some maritime transboundary climate risks could be managed.

Nevertheless, mechanisms are needed to overcome weaknesses in international policy on the movement of fish stocks to the high seas. Unfortunately, global frameworks are not equipped to deal with transboundary risks such as the permanent exit of fish stocks from national jurisdictions (Oremus et al., 2020; Pinsky et al., 2018). The 1995 United Nations Fish Stock Agreement, for example, recognizes the need to manage highly-migratory stocks but operates “at a high level and do[es] not mandate specific management mechanisms” (Oremus et al., 2020, p. 1).

This raises a critical question: how can the international community define clear and adjustable regulatory policies that can account for new knowledge on transboundary climate impacts in areas beyond national jurisdictions? Likewise, there are continued constraints to monitoring, control and surveillance measures in the high seas (Cremers et al., 2021). These issues, in turn, call for improvements in the scientific collection and sharing of data (e.g., on the spatial structure of fish stocks and fish catches), the harmonization of national legislations and deterrent sanctions, and greater investment in the capacity of coastal states to implement monitoring, control and surveillance measures and adjust their fishing policies and practices over time.

Finally, scientists warn that even the combination of highly aggressive greenhouse gas mitigation and ambitious adaptation efforts will not fully eliminate risk (IPCC, 2022; Magnan et al., 2021), so that residual risks will remain. This highlights the need for international compensation mechanisms to help countries face the unavoidable consequences of transboundary climate risks. At present, however, the UNFCCC Warsaw International Mechanism for Loss and Damage, which focuses on residual climate risks within national boundaries, does not address transboundary dimensions (Oremus et al., 2020). ●

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