Climate risk and adaptation for fisheries in Namibia

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Background

Fisheries are vulnerable to the impacts of climate change, impacting abundance, distributions, and sizes of fish[1], alongside changes in storminess, sea level rise and flooding risks that affect the safety and effectiveness of fishing[2]. Namibia is among the countries where climate change is expected to have substantial impacts on the marine ecosystem, and to the fisheries that depend on them[3-5]. These concerns have been expressed in the National Policy on Climate Change for Namibia[6].

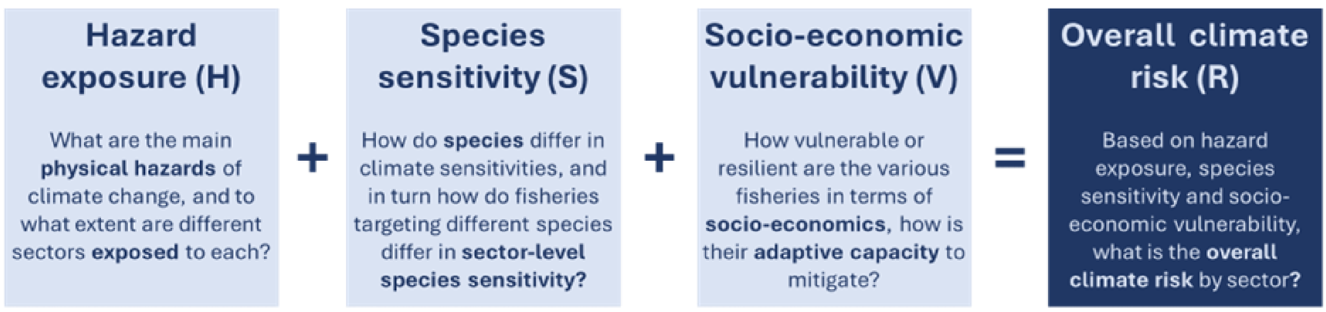
Fisheries in Namibia are important for commerce, income generation and trade, as well as for food security and protein provisioning[7-9]. Namibia's large-scale fisheries are based in Walvis Bay and Lüderitz consisting of eight sectors: 1. hake trawlers; 2. hake liners; 3. midwater trawlers targeting Cape horse mackerel; 4. monkfish trawlers; 5. large pelagic liners; 6. small pelagic purse-seiners; 7. deep sea red crab fishery; and 8. west coast rock lobster fishery[10]. Small-scale (artisanal) fisheries exist along specific areas of the coast that are considered highly marginalised[11]. The recreational sector is an important component of fisheries in Namibia; the country is a well-regarded destination for shore-based (or small boat-based) marine recreational anglers.

Namibia borders the Benguela Current Large Marine Ecosystem (BCLME), which is a productive but highly variable marine environment[12-13]. Climate-driven changes include warming sea temperatures in the north alongside some temperature decreases in the south[14], and increasingly strong offshore winds during summer[15]. Benguela Niños are large-scale intrusions of warm, low-oxygen and nutrient-poor water from the north[15] that occur irregularly. These, on top of climate-driven changes, have impacted on key stocks supporting Namibia's large-scale fisheries[3] and coastal fish populations targeted by recreational and small-scale fisheries[16]. All sectors are affected by changes in weather patterns, storminess, and sea level rise[3].

An initial climate vulnerability assessment of fisheries was done for the BCLME in 2011 that identified vulnerabilities for Namibia, with demersal trawlers, the rock lobster fishery and small pelagic fishery as those with highest risk[3]. Well over a decade has passed since then and more data and information have become available, while fisheries have either responded to climate change and variability or have encountered challenges in doing so. Here, the overall climate risk to each of the Namibian fishery sectors was assessed based on the combination of hazard exposure, species sensitivities, and socio-economic vulnerability. Key climate risks were used to inform a series of stakeholder workshops across Namibia to examine the robustness of the assessment and understand potential for adaptation measures.

Climate risk

Climate risk was assessed for Namibia using the IPCC method[17] for the eight large-scale fishery sectors alongside recreational and small-scale (artisanal) fishery sectors. For each of the ten fishery sectors, we assessed three main risk components: (1) climate hazard exposure; (2) fish species sensitivity; and (3) socio-economic vulnerability. In combination, these three risk components are then used to calculate the overall climate risk for each fishery (Box 1).

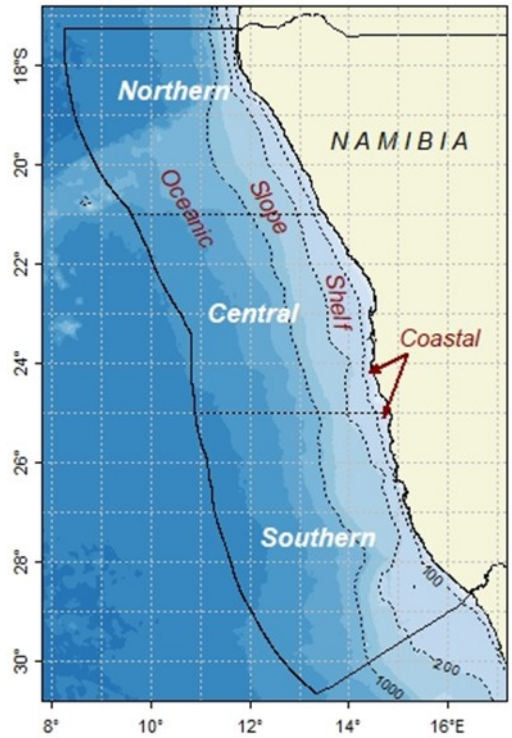


Box 1. Three risk components that together comprise overall climate risk.

Climate hazard exposure

Climate hazard exposure (H) was assessed using the interaction between the spatial distribution of fishing effort and eight key climate hazards within 12 geographic zones that cover the Namibian EEZ (Box 2). Eight 'component hazards' that the various fisheries may be exposed to were assessed: Benguela Niños; temperature rise; elevated CO_2 and ocean acidification; extreme weather and strong offshore winds; jellyfish blooms; low oxygen levels in water (hypoxia); sea level rise (SLR) and storm surges; and harmful algal blooms (HABs).

Climate driven changes have impacts on the Namibian EEZ. Benguela Niños are intrusions of warm, low-oxygen, and nutrient-poor water into the northern and central parts of the Namibian EEZ, most recently in 1995 and 2011. These affect recruitment of fish, cause mass mortality in coastal zones, and facilitate invasion of Angolan fish. General temperature rise is causing high warming rates (0.4°C per decade) north of the Angola-Benguela front, affecting the northern Namibian EEZ due to strengthening of the Angola Current. By contrast, there is evidence of slight cooling in southern Namibia, linked to strengthening of upwelling. Acidification levels off Namibia are among the highest globally, driven by a combination of strong upwelling locally and global atmospheric CO_2 rise affecting the pH of the ocean. This is expected to impact the early life stages of fishes, and particularly crustaceans. An increase in favourable winds linked to a greater heating rate over land relative to the ocean has resulted in an increase in intensity of upwelling. This impacts the entire coast and will affect activities, such as tourism, recreational and rock lobster fisheries. Jellyfish have become far more abundant in the area than they were in the past. Although these may not be climate related, there will be an impact to small pelagic fishes, due to predation and competition for food. In the central region, low oxygen (hypoxic) conditions occur during late austral summer due to the supply of low-oxygen waters from the Angola dome, whereas upwelled water around Lüderitz is oxygen rich yet local hypoxic conditions can be caused by algal blooms. SLR along the Namibian coast was estimated at 1.9 mm per year which may impact on urban areas through increased flooding and storm surges alongside causing habitat loss for intertidal organisms. Finally, there is evidence of HABs affecting Namibian mariculture and are expected to mainly impact coastal or inshore areas.



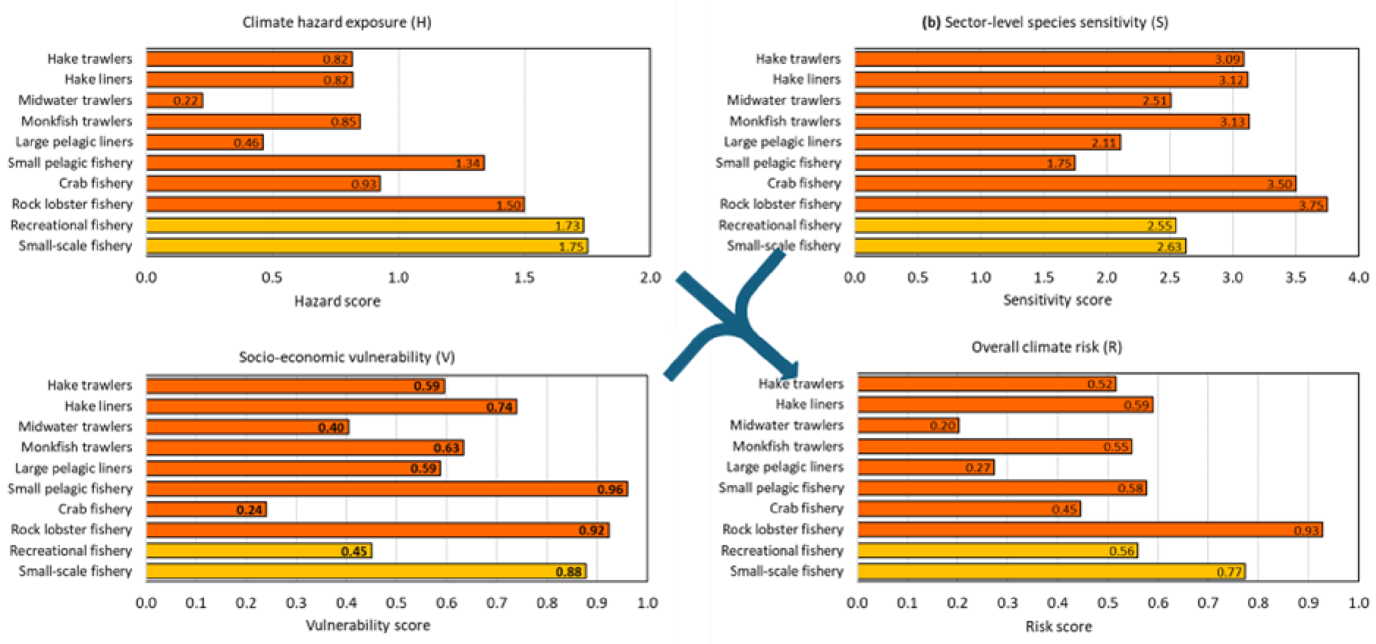
Box 2. The Namibian Exclusive Economic Zone (EEZ, thick black line), and 12 zones delineated by thin dotted lines, used here to assess climate hazard exposure by fisheries sector.

The climate vulnerability for each fishery was based on combining geographical zones and hazards. Climate hazard exposure was found to be greatest for the small-scale, recreational, and the rock lobster fishery, driven by their coastal or nearshore distribution as hazard impacts are generally higher nearshore than offshore (Box 3).

Fish species sensitivity

Fish species sensitivity (S) was assessed for 30 fish and shellfish species that comprise over 99.9% of Namibia's large-scale fisheries catches, as well as eight further species that are important for recreational and small-scale fisheries. To assess each species' sensitivity to climate change, information on their biology was compiled and linked to four traits: tolerance of high temperatures; temperature specificity; habitat specificity; and population resilience.

Box 3. Fisheries sectors climate hazard, species sensitivity, and socio-economic vulnerability that combine to produce overall climate risk.



The species assessed as having highest sensitivity for the large-scale fishery were rock lobster and West Coast sole, followed by deep-sea red crab and kingklip, then shallow-water hake, monkfish, deep-water hake, and Panga seabream. Among the recreational/small-scale fisheries species, the most sensitive were West coast steenbras and spotted gully shark. Overall species scores were combined with the relative importance of the species to generate sector level species sensitivity. Sector-level species sensitivity was highest for the rock lobster fishery, crab fishery, monkfish trawlers, hake liners, and hake trawlers, as these fisheries are dependent on a single or small number of species with high climate sensitivity (Box 3).

Socio-economic vulnerability

Socio-economic vulnerability (V) was quantified based on socio-economic data linked with affluency and infrastructure. For the eight large-scale fisheries, four measures were generated based on Ministry of Fisheries and Marine Resources (MFMR) and FAO data that included: total landed value index; per-capita revenue index; percentage permanent positions index; and annual employment change index. The four measures were combined to generate the overall 'socio-economic vulnerability' (V) for each sector. No information existed for recreational and small-scale fisheries, so it was assumed to be lower and upper quartile of the large-scale fisheries, respectively, to reflect knowledge of the participants in these fisheries. Socio-economic vulnerability was highest for the small pelagic and rock lobster fisheries, which was related low total landings value, low value per employee, employment losses, and few permanent positions (Box 3).

Climate risk

Hazard exposure, species sensitivities, and socio-economic vulnerability were combined to calculate the overall climate risk for each fishery. The overall climate risk was highest for the rock lobster and small-scale fishery, with moderate risk for the hake trawlers and liners, monkfish trawlers, small pelagic, crab, and recreational fisheries. Midwater trawls and large pelagic liners were least at risk from climate change (Box 3).

Climate adaptation

Four workshops were held in the coastal towns of Henties Bay, Swakopmund, Walvis Bay and Lüderitz that were attended by representatives of large-scale, small-scale, and recreational fisheries, with a final workshop held in Windhoek for policy representatives. The aim was to understand experiences of climate change alongside potential options for adaptation to climate change.

Namibian fishers have experienced significant impacts in terms of access to fishing due to changes in weather, alongside distribution and catches of non-desirable species. These have resulted in changed behaviours to maintain catches of target species, although the ability to adapt varies between sectors with, large-scale much more able than small-scale fisheries. Whilst many of these changes could be ascribed by scientists to climate, fishers were unsure if climate was driving these changes or this was simply natural variation. However, it was clear that fishers have knowledge and understanding that needs to be included in decision making. In addition, climate change needs to be addressed in the context of the many other pressures on the marine systems of Namibia.

Potential adaptation approaches were discussed for each sector, concluding that some sectors are able to adapt well, whereas other require more financial support to adapt effectively. For the rock lobster fishery, adaptations included temporarily switching to other species such as snoek and hake, and importing lobsters for local processing when stocks are low. For small-scale fisheries (SSF), adaptation approaches included promoting inclusion and securing the livelihoods of small-scale fishing communities to counter marginalisation, by recognising small-scale fisheries as a sector and allocating exclusive fishing areas to reduce competition with the recreational sector. The small pelagic fishery has collapsed, and the processing sector is dependent on imports. Unless the sardines return, there is limited potential for adaptation beyond finding alternative fishing opportunities or employment for those working in the sector. Hake liners, hake trawlers, and monkfish trawlers have similar offshore distributions, but are experiencing changes in the distribution of fish. Given the financial position of the sector and high efficiency of the vessels, they have been able to adapt their behaviour to maintain catches. However, due attention should be given to potential climate change impacts, based on the enormous commercial value of the hakes for Namibia, the high species sensitivity, and with it being a transboundary stock shared between nations – so that sound, internationally coordinated management is required for sustainability.

Namibia’s marine recreational fishery generates considerable income for local communities, but anglers report they are experiencing stronger winds and gusts, and range shifts in many coastal fish species, including ‘deepening’ distributions. Those who

are most reliant on the fishery (guides, guest house owners and employees, etc.) may have challenges to adapt, especially at remote locations such as Henties Bay where alternative opportunities are limited. One key recommendation towards building climate resilience, is the inclusion in decision-making of anglers' knowledge, who experience climate impacts first hand, to supplement the science as an inclusive, bottom-up management approach, ensuring angler buy-in.

Deep-sea red crab is a small fishery but doing well economically and so far found to have lower climate risk, however it has received limited research focus and development. A potential threat is further warming and acidification in northern Namibian waters negatively affecting the stock, therefore further research on potential climate impacts on deep-sea red crab is recommended. The midwater trawlers were likewise found to have lower climate risk and stakeholders generally agreed that horse mackerel are a more resilient stock, but also expressed concern about the recent decline; with protection of important nursery areas being seen as key for successful management. Finally, the large pelagic liners are affected by climate change due to distribution changes in species such as tuna and billfishes, but the fleet itself is also highly mobile covering more distance than all other sectors. However, high fuel costs and potential further distribution shifts of the target species may well challenge this fishery more in the future, and support is likely also needed given the transboundary nature of the stocks targeted.

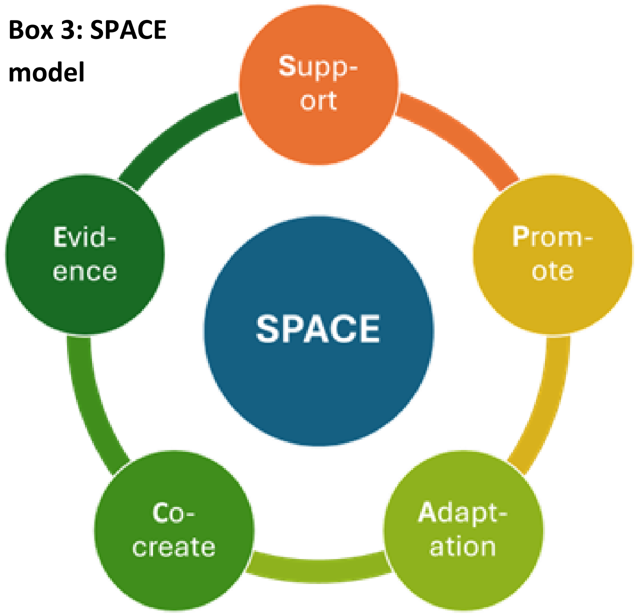
Recommendations

Several clear recommendations emerged from the study that are needed to support adaptation of Namibian fisheries to climate change. These are best captured in the SPACE model: **S**upport change; **Pr**omote understanding; **A**daptation mainstreamed; **C**o-create solutions; **E**vidence generated (Box 3). Recommendations associated with the SPACE model are described below.

Support change financially:

1. Financial support is needed from government to enable adaptation as many fishers do not have the funds. A policy mechanism is needed to grant funding for fishers to adapt in a way that prioritises those fleets identified as most socio-economically vulnerable.

Box 3: SPACE model



Promote understanding of the impact of climate change on Namibian fisheries:

2. Improve knowledge of potential climate adaptation that resonates with fishers and communities, transcends issues with literacy, and works with local champions within the community to facilitate implementation.
3. Support schools in educating children about the impacts of climate change and how Namibia may adapt to ensure a secure future.
4. With most people in Namibia living far away from the ocean, promote awareness of the crucial role the ocean plays for food security and jobs, and how climate change will impact on this.

Adaptation mainstreamed:

5. Develop climate smart policies to mainstream adaptation approaches, so that it becomes part of business as usual.

Co-create solutions:

6. Create inclusive groups that include fishers, scientists, and policy makers to co-create practical solutions that utilise fisher knowledge.
7. Holistic approaches are needed that account

for climate in the context of all pressures on the marine environment and marine spatial planning.

Evidence generated from all sources to underpin decisions:

8. Generate the evidence required for climate smart fisheries management through scientific study and integrate fisher knowledge.

Acknowledgements

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