# The contribution of coastal Small-scale Fisheries towards the Sustainable Development Goals: A Kenyan case study

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# Abstract

Small-scale fisheries (SSF) have a significant contribution to economies of coastal countries, offering employment and healthy and affordable food for communities. Despite an increasing focus on SSFs worldwide, data and knowledge gaps still exist. Furthermore, SSF contribution to SDGs is neither known nor accounted for. Through the Fish2Sustainability (F2S) Project a case study was conducted in Kenya to assess interactions between SSF and SDGs using a Rapid Appraisal Tool and summarize interactions between SFF attributes and SDG targets for selected fishery. A participatory approach was used to collect information from SSF actors' and experts in each fishery. Data was analyzed using Pycharm software in the Anaconda Package (Anaconda3 version 2023.03-1) to provide polar charts showing the contribution of each SSF towards the SDGs. Results showed variable contributions for different fisheries and that the contribution of Kenya's SSF towards the SDGs is at a medium level.


Introduction

# Introduction

Small-scale fisheries (SSF), which mainly include artisanal, inshore, traditional and subsistence fisheries, have a significant contribution to the economies of coastal countries, supporting livelihoods specifically in the least developed countries (FAO 2022). Small-scale fisheries offer key development solutions and are pivotal for hunger and poverty eradication. They promote Economic growth through job creation and provide sustainable jobs. In addition, they provide healthy and affordable food for communities.

Fishing is a major source of livelihood for communities along the Kenya coast supporting small-scale fishers, traders and processors including women who play a key role in the value chain of landed fish and fishery products (Kimani et al 2018). Kenya's marine small-scale fisheries generate approximately $7.95 million per year (Obura et al. 2017) and produce 90% of the total annual marine landings of 24 000 tons (Kimani et al 2018). About 14,451 fishers are involved and the fishing capacity is constituted of about 3,174 small-scale fishing crafts operating from 213 landing sites (Government of Kenya, 2022). The sector provides income and animal protein for up to 80% of rural coastal households (McClanahan et al. 2013).

In Kenya, approximately 80% of marine production is by small-scale artisanal fishers (Kimani et al., 2018). Majority of the small-scale fishing activities in Kenya occur in the inshore waters around coral reefs, mangrove creeks and seagrass beds (Mangi et al. 2007). Fishing is concentrated in these nearshore areas mainly because the local fishers lack the capacity in terms of suitable fishing vessels and gears to venture offshore to the deep waters. The catches fluctuate significantly between months, with the highest catches each year occurring between January to March when fishing for deeper water stocks takes place (Ndegwa and Geehan, 2017). Total monthly catches range from 1,200 to 3,400 mt, with an average catch of 2,000 mt per month (Ndegwa and Geehan, 2017).

Suitable and salient information on SSF is considered key for the sustainability of these fisheries. However, information about SSF remains poor due to their diversity and complex social-spatial structures (Islam and Chuenpagdee, 2022). These characteristics challenge evaluating their activities that could give significant contributions to inform policies, as is done for large-scale/industrial fisheries (LSF). Consequently, there is a poor representation of SSF in policies and implementing agencies thus receiving minimum support (Kolding et al., 2014).

The Sustainable Development Goals (SDGs) that were agreed in 2015 by all 193 member states of the United Nations were set to be achieved by 2030. According to the Sustainable Development report 2023, none of the goals and only around 18 per cent of the SDG targets are on track to be achieved globally by 2030 (Sachs et al, 2023). It is estimated that at the global and regional levels, less than 20 per cent of the SDG targets are on track (United Nations, 2023). There is significant variation in progress by regions and income groups. Most countries of the sub-Saharan region have achieved or are on track to achieving SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

Currently, Kenya is ranked at 123 out of the 166 countries (Sachs et al, 2023). The country has achieved SDG 12 (Responsible Consumption and Production) and SDG13 (Climate Action) and is on track on implementation of SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure) and SDG 13 (Climate Action). The country is stagnating on implementation of SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 6 (Clean Water and Sanitation), SDG 8 (Decent Work and Economic Growth), SDG 14 (Life Below Water), SDG 16 (Peace, Justice and Strong Institutions) and SDG 17 (Partnerships) and decreasing on SDG 11 (Sustainable Cities and Communities) and SDG 15 (Life on Land) (Sachs et al, 2023).

Small-scale fisheries are explicitly addressed by Sustainable Development Goal (SDG) Target 14. b (Provide access of small-scale fishers to marine resources and markets) to account for global change in marine resources, technology, and fishery value chains, which have been jeopardizing the sustainability of SSF around the world, threatening the livelihood of many coastal communities. Often related to problems in resource utilization, the SDGs and other factors determine the viability of SSF.

Marine SSF being practiced in many coastal communities worldwide could potentially play a bigger role in achieving the UN SDGs than LSF. Evidence shows that SSF contributes to food security, provides income, employs more women, and does less harm to the environment (Short et al., 2021). Small-scale coastal fisheries provide valuable food security and livelihoods for about 20 million coastal people living in eastern Africa (Bell et al. 2017). Given this context, the space for SSFs in the discussion about SDGs should be obvious. Unfortunately, SSFs are often wrongly considered a sustainability problem, rather than an asset. As we approach 2030, understanding the interactions between SSFs and environmental and social SDGs is crucial for recommending approaches for sustainable SSFs. The interactions may vary depending on fishery patterns, the general social-ecological context, and the spatial and temporal scale.

Despite an increasing focus on SSFs worldwide and a growing amount of data, huge data and knowledge gaps exist in most countries. Better information sharing and collaboration amongst the different actors of SSFs (e.g., fishers, non-governmental organizations, scientists, fishery administration, and policymakers) is a key challenge that needs to be addressed.

Scaling-up locally collected data will be required to inform national policies and interventions, e.g. for a better understanding of the contribution of SSFs to sustainable development, including inherent trade-offs between SDGs. In this context, recent studies have highlighted the diverse benefits transdisciplinary (TD) research provides in the context of SSFs (Chuenpagdee and Jentoft, 2018; Said et al., 2019), offering tools and methods to look at problems and to inform policies through a more holistic lens (Polk, 2014). Such an approach allows scientists, practitioners, fishers, and many other stakeholders to identify the problems and opportunities through an interactive and iterative process, helping align actors' perspectives across scales, from local management to national policy levels.

The Fish2Sustainability (F2S) Project was a project aimed at Enhancing the Contribution of Small-Scale Fisheries to the Sustainable Development Goals. The project aimed to assess the relationships and contribution of SSFs towards the United Nations SDGs for 2030. The project was part of the Belmont Forum call for Collaborative Research Actions (CRA) towards Pathways to Sustainability. The case study aimed to gather and analyze existing knowledge about the interactions between SSF and SDGs in Kenya through small-scale fisheries networks. The F2S case study in Kenya focused on the marine SSF which included Estuarine cat fish, Basket trap, Octopus, Gill net, Lobster, Hand line, Ring net, Prawn, Sea cucumber and Small pelagic fisheries.

## Results

The results presented here give a brief description of the selected SSF and the output from the Pycharm analysis which give a snapshot of the contribution of each SSF case study towards the SDGs.

# Estuarine catfish fishery

Estuarine fishery targeting catfishes (marine catfishes and freshwater catfishes) fished using longline hooks and gillnets in the lower Tana River Delta, oxbow lakes, Tana estuary and Ungwana Bay. The main ecosystems include the Tana River mouth and the river channel, delta, estuary, and mangrove areas. About 200 fishers operate in this fishery. The fishing gears include set gillnet (multi and monofilament), longline, *mgono* traps (conical fish-trap used mostly in rivers and creeks), and use bait e.g., octopus. Setting is done in the morning (from 4 pm to 6 am) and retrieval after 2–4 hours. Fishers use dugout canoes with a crew of two per canoe. Products include salted, sun-dried, smoked, and fried fish. Governance mode is Co-management, following the regulations in the Fisheries Management and Development Act 2016 and fisheries Beach Management Unit Regulations 2021. Threats: Environmental degradation, pollution and climate change.

Results for estuarine catfish fishery show that catfish fishery contribution is high for SDG 12 on responsible production & consumption, followed by SDG 2 on zero hunger (Fig. 1a). Contributions to SDGs 1, 3 and 10 on eradicating poverty, good health & well-being and reduced inequalities was medium high; while SDGs 11, 14 and 16 were medium. Contribution to SDGs 5 and 8 on gender equality and decent work & economic growth are at medium low. There were no data available for SDGs 9 and 12. These results indicate that catfish fishery has the potential of achieving SDGs related to production and consumption, eradicating poverty, and supporting food security, good health and well-being. More efforts need to be placed on gender equality and decent work. The products from this fishery are mainly for domestic consumption, thus is reflected in its contribution towards consumption, food security and health.

Figure 1: Polar charts showing the contribution of small scale (a) estuarine catfish fishery (b) octopus fishery (c) sea cucumber fishery and (d) prawn fishery towards SDGs

# Octopus fishery

Octopus fishery occurs mainly in Kwale and Kilifi Counties, in coral areas, rocky bottoms and lagoons. The two main species caught are *Octopus vulgaris* and *Octopus cyanea*. Fishing gear are spear gun; hook and sticks. Octopus fishing can be through diving or walking searching for the target and capturing using hooks and sticks. Women also take part in this fishery.

Results for Octopus fishery (Fig. 1b) show that the contribution was highest towards SDG 16 on peace and strong institutions. Contribution to most of the SDGs was at or below medium. Contributions to SDGs 9, 10 and 17 were at medium low, indicating more efforts need to be placed in the areas of industry and infrastructure, reduced inequalities, and partnerships. The fishery can potentially contribute towards SDGs 16, 1,2,5,8 and 11.

# Sea cucumber fishery

Occurs in the entire coastline, concentrated in Lamu and Kwale Counties, in seagrass, sandy areas, hard rocks, coral areas, with the highest diversity reported in reef lagoons and the lowest in seagrass beds. The main species are Holothuria spp., *Thelenota ananas*, *Actinopyga mauritiana* etc. Fishing gears are scoop nets, hand picking, involving foot fishers and divers.

Results of the sea cucumber fishery demonstrate that the fishery has a medium-high contribution in SDGs 1, 10, 11, and 12 (Fig. 1c) on eradicating poverty, reducing inequalities, sustainable communities and responsible production and consumption. At the medium level are SDGs 2, 3 and 8 on no hunger, good health and well-being, decent work and economic growth. More efforts need to be placed on contributing towards SDGs 9 and 17 which are at medium-low level.

# Prawn fishery

The fishery occurs in Kwale, Mombasa, Kilifi, Tana River & Lamu Counties, in river estuaries and mangrove creeks, sandy and muddy bottoms. Main species include *Penaeus monodon*, *Metapenaeus*

*monoceros*, *P. indicus*, *P. semisulcatus* and *P. japonicus*. Fishing gears are prawn seine (1.5" to 2.25 prawn seine nets), monofilament net, conical traps. Fishing takes place during the rainy season and is also commercial.

Results of prawn fishery (Fig. 1d) show that the fishery has the highest contribution on SDG 3 (Good health & well-being), and is high on SDGs 1, 10, 12 and 16 on poverty eradication, reduced inequalities, responsible production and consumption, and peace and strong institutions. Contribution is medium to medium high on SDGs 2, 8 and 14 on zero hunger, decent work and economic growth and life below water. Contribution to SDG 17 is low and more efforts need to be placed on partnerships and gender equality.

Figure 2: Polar charts showing the contribution of small scale (a) handline fishery (b) basket trap fishery (c) small pelagic fishery and (d) lobster fishery towards SDGs

# Hand line fishery

The hand line fishery occurs along the entire coastline, mostly in nearshore areas, at the reef ecosystem seagrass meadows, and mangroves. The main species include *Lutjanus argentimaculatus*, *L. fulviflamma*, *L. bengalensis*, *L. bohar*, *L. gibbus*, Serranidae, Trevallies, Barracuda, Tuna, Wahoo and Sailfish. Fishing gears are handlines, trolling lines, long lines and droplines. Fishers use either motorised or unmotorised boats to get to the fishing grounds, with ice and cool boxes and stay out at sea for up to 3 days. Fishing takes place both at night and daytime and use artificial baits (Rapala).

Handline fishery contribution to SDGs is highest for SDGs 16 and 1 on peace and strong institutions, and eradicating poverty at the medium high level (Fig. 2a). For the rest of the SDGs contribution is at or below medium level. The fishery has the potential to contribute towards peace and strong institutions and poverty eradication. However, more efforts need to be placed on SDG 2, 5 and 9, i.e. reducing hunger, gender equality and industry and infrastructure.

# Basket trap fishery

The basket trap fishery operates along the entire Kenya coastline, at national scale in seagrass beds, sand bottom, off coral reefs and rocky shores. The main species caught include *Siganus sutor*, *Leptoscarus vaigiensis*, *Scarus ghobban*, *Lutjanus fulviflamma*, *Lethrinus lentijan* etc. The fishing gear is a basket trap. Fishers use non-motorized canoes (dugout canoes) propelled by sail power or paddles. Deployment of traps is done during the day. The traps are left overnight and the catch is removed the next day. A combination of algae, crushed sea urchins, brittle stars, molluscs, even cabbage etc. are used as bait.

Results of basket trap fishery are presented in Fig. 2b. The fishery contributes to SDGs 12, 1, 3 and 9 at high to medium high level. The fishery also contributes at above medium level to SDGs 14, 16, 5 and 8. The fishery has the potential to contribute towards SDGs 12, 1, 3 and 9 on responsible production and consumption, poverty eradication, good health and well-being and industry and infrastructure. However,

more efforts need to be placed on achieving SDGs 17, 2 and 11 on partnerships, reducing hunger and sustainable cities and communities.

# Small pelagic fishery

The small pelagic fishery operates at a local scale in South Coast of Kenya- Kwale County in Vanga, Jimbo, Gazi and Shimoni, within seagrass beds, open waters and off coral reefs. The species caught in this fishery include anchovy (*Engraulis* sp., *Stolephorus* sp.), round herring (*Etrumeus teres*), spotted herring (*Herklotsichthys* sp.), *Sardinella* spp etc. Fishing gear is surrounding nets (Ring net). Fishing is mostly done during the night. The vessels used in the fishery are *Mashua* (locally made) and lamps to provide light attracting the fish. The fishery is highly seasonal.

The results of the small pelagic fishery are presented in Fig. 2c. The fishery contributes well to SDGs 1, 5 and 10 on eradicating poverty, gender equality and reducing inequalities. This fishery involves a lot of women (about 80%) in the post-harvest processing. The contribution was at medium high level for SDGs 2, 11 and 12. However, more efforts need to be placed on achieving SDG 17 on partnerships.

# Lobster fishery

This is a national fishery occurring in Kwale, Mombasa, Kilifi, Tana River and Lamu Counties. The main fishing grounds include the waters off Kiunga, Kizingitini, Kipini, Ngomeni, Msambweni and Shimoni. About 70% of catches come from the Lamu archipelago, specifically Kizingitini, Kiunga & Kiwayu (Kimani et al., 2018). The fishery operates in inshore areas located near shallow reefs and lagoons with the main habitats being coral reefs, rocky bottoms and seagrass beds. The Five species caught (*Panulirus ornatus*, *P. homarus*, *P. longipes*, *P. versicolor* and *P. penicillatus*. *Panulirus ornatus* comprises the bulk (70%) of the catch. The main fishing method used by artisanal fishers is skin diving and using snorkeling gears. Other legal methods of lobster fishing include multifilament gill nets and traps. Prohibited fishing methods include monofilament gillnets, spear guns and SCUBA gear.

The results of lobster fishery's contribution to SDGs are presented in Fig. 2d. The fishery has the highest contribution to SDG 10 on reduction of inequalities. The fishery also has a high impact on SDG 12 and 8 on responsible production and consumption, and decent work. More efforts need to be placed on achieving SDG 5, 11 and 17 on gender equality, sustainable cities and communities and partnerships.

Figure 3: Polar charts showing the contribution of small scale (a) gill net fishery and (b) ring net fishery towards SDGs

# Gill net fishery

The gill net fishery occurs along the Kenya coastline, at National scale in areas off coral reefs, open waters, mangroves, seagrass and lagoons. Various species are caught including *Istiophorus* spp, *Thunnus* spp, *Scarus* spp, *Lutjanus* spp, *Lethrinus* spp, *Caranx* spp, *Siganus* spp. Main fishing gears are

Gillnet and Monofilament gillnet. Drifting gillnet is mostly done at night, and set gillnet are done both day and night. Some fishers use multi-filament gillnets while others monofilament gillnets.

The results of gill net fishery contribution to SDGs are presented in Fig. 3a. The fishery has the highest contribution to SDG 3 and 16 good health and well-being and peace and strong institutions. The fishery also has high levels on SDGs 1, 5 and 12 on poverty eradication, gender equality, and responsible production and consumption. More efforts need to be placed on achieving SDGs 11, 14 and 17 on sustainable cities and communities, life below water and partnerships for the goals, which are below medium level.

# Ring net fishery

The ring net fishery occurs especially in Kwale and Kilifi Counties, within seagrass, bare sand, patchy areas, beyond the reefs, at 15 m to 20 m depth. Various species are caught including *Sardinella* spp, *Thunnus* spp, *Selar crumnepholus*, *Rastelliger kanagurta*, and *Sphyraena* spp. The gear is surrounding ring (small purse seine) net. Ring net was introduced into Kenyan waters from Pemba, Tanzania in the late 1990s, and there has been conflict on mesh sizes. The fishery mainly operates 30–40 km from landing sites. The fishing operation includes the use of SCUBA divers to locate schooling fish and guide them towards the ring net. They use motorized boats, with each fisher having a responsibility during the fishing operation. Ring net fishing is done during the day.

Ring net fishery contributes highest to SDGs 1, 5 and 16 on poverty eradication, gender equality, and peace, justice and strong institutions (Fig. 3b); followed by SDGs 3, 10 and 12 on good health and well-being, reduced inequalities, and responsible production and consumption. More efforts need to be placed at contributing towards SDGs 17, 11 and 14, on partnerships for the goals, sustainable communities and life below water, which are below medium level.

# Overall small-scale fishery contribution to SDGs

The results of average scores at target level for the SDGs of all the 10 fisheries assessed are presented in Table 1. On average small pelagic fishery performed well at targets level, while handline fishery had a low performance.

Table 1
Average scores at target level for the ten small scale fisheries

| SSF | Average score |
|---|---|
| Small pelagic fishery | 3.61 |
| Shrimp fishery | 3.42 |
| Basket trap fishery | 3.32 |
| Lobster fishery | 3.24 |
| Sea cucumber | 3.24 |
| Gillnet fishery | 3.23 |
| Ring net fishery | 3.16 |
| Catfish fishery | 3.12 |
| Octopus fishery | 3.05 |
| Handline fishery | 2.81 |

The scores of all the assessed fisheries show that the overall contribution of Kenya's coastal SSFs towards the SDGs is at medium level. There is medium-high contribution on six of the seventeen, i.e. SDGs 1, 3, 8, 10, 12 and 16. Contributions to SDGs 2, 5, 11 and 14 are at medium level. More efforts need to be placed on contributions towards SDGs 17 and 9, on partnerships for the goals and industry, innovation and infrastructure. In general, Kenya’s coastal SSFs contribution towards SDGs is yet to reach a high level, it is still at medium level.

Figure 4: Kenya’s coastal small-scale fisheries contribution to SDGs

# Discussion

Small-scale artisanal coastal fisheries are characterized as being multi-gear, multi-species and landed at multiple landing sites (Kaunda-Arara et al., 2003, McClanahan and Mangi, 2004). Due to their multifaceted nature, small-scale fisheries are complex to understand and manage, thus they are poorly quantified, and their contribution to national income and livelihoods is poorly acknowledged (Obura 2001; Ochiewo, 2004; Cinner et al., 2009). Furthermore, their contributions to global commitments to sustainability such as the SDGs often go unrecognized or under-valued.

Studies have shown that many of the artisanal or small-scale coastal fishing communities are dependent on fisheries resources for food security and their livelihood (Omukoto et al., 2018; Wabnitz et al., 2018). Small-scale fisheries play an important role in food security, income and economies of many developing countries, and thus are pivotal in contributing towards the SDGs.

In this study, we applied a rapid appraisal framework to measure the contributions of selected SSFs to multiple SDGs. Variability in the contributions of SSF towards the different SDGs was evident, and this may be attributed to, and a reflection of the complex nature of these fisheries.

Overall small pelagic, prawn, basket trap and lobster fishery performed better than all the other fisheries, having higher contributions for a higher number of SDGs. Conversely, handline, octopus and catfish fishery contribution towards most of the SDGs was lower. Small pelagic fishery which had a higher contribution in six of the SDGs (1, 2, 5, 10, 11 and 16) performed well in eradicating poverty and providing food security. These two goals are closely linked. Small pelagic fishery also contributed to SDGs 5 and 10, on gender equality and reduced inequalities is reflected by the involvement of women in the fishery, particularly in the post-harvest activities. From this study, it was revealed that Women form about 80% of the value chain in post-harvest activities (boiling, drying and selling). Further, the contribution of small pelagic fishery to these SDGs has had positive effects that support contribution to SDG 11 and 16, sustainable communities and peace. Prawn fishery performed well at SDG 3, having the highest contribution to this goal among all the studied fisheries. The high contribution to good health and well-being of prawn fishery is also reflected in SDG 1, on eradicating poverty which was also high. The fishery also performed well on SDG 12 on responsible production and consumption which may be linked to wellbeing and no poverty. On the other hand, handline fisheries did not perform well and this may be partly attributed to lack of information. Indeed, there was no data or information for SDG 17 in this fishery. The highest contribution for this fishery was for SDG 16 on peace and strong institutions which scored at medium high level.

In the prawn fishery stakeholders indicated that the stock is rapidly declining partly attributed to increased fishing activities due to increased populations. In prawn fisheries, women play a key role in the market where they buy prawns from the fishers, process them, and then sell them locally or regionally. However, fishing activities are dominated by men who are assumed to have the technical know-how and muscles to handle boats and fishing nets. The fishery capitalizes on the local and regional markets as accessing the international market has not been harnessed due high market standards, low catch and low technology. Prawn catches are purely for commercial purposes; prawns are consumed by the local community during peak season when there is more than enough for market supply.

Basket trap fishery dominates the Kenyan coastal fishery. Fishers have experienced a decline in catches over the years which they attribute to the degradation of marine and coastal ecosystems and overfishing (Thoya et al., 2022). The small-scale coastal fishing communities are characterized by low mean annual income and low levels of education (Dzoga et al., 2019). Apart from small-scale trading, women's involvement in basket trap fishery is in the collection of bait (some use cabbage/seaweed) and gathering the weaving materials for the traps, owning the basket traps and fishing vessels.

Small-scale fisheries are most often associated with SDG 14.b. In this study we show that SSFs directly contribute to multiple social, economic, and environmental dimensions of sustainability and other SDGs. The SDGs assessed can be grouped into three clusters following the traditional sustainability pillars:

‘Economy’ (SDGs 8, 9, 10, 12 and 17), ‘Society’ (SDGs 1, 2, 3, 5, 11, and 16), and ‘Biosphere’ (SDG 14). Small pelagic fishery showed a good balance across these pillars, with more substantial contributions to societal SDGs. The overall contribution of the assessed SSF to SDG 14 was at medium level, which was linked to changes in market demand, declining catch rates, and an increasing fishing effort for fishers to sustain their income, leading to resource depletion and aggravating food insecurity concerns for coastal populations.

The Results highlighted some of the complex challenges faced by these SSFs, identified areas where they performed well or lagged, and highlighted some causal mechanisms between SDGs. Several studies have noted several challenges faced by small-scale fishers which include poor transport and market infrastructure, unfair and fluctuating market demand and prices, fishing vessels, gears and equipment incapacitation and limited access to capital (Wamukota 2015; Kimani et al., 2020).

It is very rare to find waste in small-scale fisheries and all catch including bycatch is either marketed or consumed (Mangi et al, 2007). Overall, the Fishers’ income was beyond minimum wage both for the national and international market; living above the poverty line in many cases. This is an indication of gradual economic growth along the Kenyan coast and also translates to national benefits. The majority of the fishers live in inadequate housing, semi-permanent houses in some areas while others live in low levels of housing; but most have access to health services.

Several factors like weak monitoring and enforcement capacity, few alternative livelihood sources, limited scientific data and lack of good political will limit effective management and governance of small-scale fisheries (Okemwa et al., 2017). The men on the other hand have always dominated in the fishery where they act as fishers, weavers of the basket traps, boat owners and fish dealers. The fishers in the surveyed sites complained about over-exploitation by the gear and vessel owners (tajiri’s) where the tajiri’s manipulated the fish prices and the time taken to give payments to the fishers. Previous studies have recommended that the fishers be financially capacitated to own their gears and vessels and this will help in reducing the over exploitation (Fulanda et al., 2009).

In Kenya, increased fishing efforts driven by a growing population, unemployment and limited alternative or complementary livelihoods, coupled with open access to fisheries and the use of destructive fishing gear (e.g., beach seines), have caused the degradation of critical marine habitats and affect the country’s fish stocks. Weak governance has affected coastal fisheries and has contributed to the over exploitation and degradation. Several NGOs are also important stakeholders. They advocate for the sustainability of the fisheries of the region.

There were some limitations in the study that may have influenced the findings. The framework provided a partial image of the SSF-SDG dynamics as only directly influenced targets were selected. The technical terms used in the surveys may have been difficult to explain to stakeholders or for them to understand, hence affecting the scoring. Other variables, especially those concerning household welfare (i.e., housing conditions, the health of household members, the prevalence of some diseases in the fishing communities, and education level), are sensitive and remain challenging to acquire in some contexts. In

addition, the assessment was focused on the global standards set in the goals and targets, which may be biased or exclude certain local situations that could be assessed as contributions towards the SDGs e.g. it is assumed that small-scale fisheries actors are employed, yet in our local situation many actors particularly women are self-employed. There is a need to refine the assessment tool further to use in future studies.

Existing small-scale fisheries assessment tools like stock assessments provide a limiting picture and the tool used in this study could help other actors recognize the valuable contribution SSFs provide, as well as opportunities to improve SSF sustainability and acknowledge trade-offs. This study was the first attempt to assess the contribution of SSFs towards the SDGs. Only a small fraction of the fisheries was captured and the findings may be biased. More case studies should be conducted to give a comprehensive account of Kenya's SSFs towards the SDGs.

The contribution of SSFs towards the SDGs is not accounted for due to their multiple dimensions that make their assessment complex. In this study, SSFs were assessed using a simple tool that involved the SSF actors. The contribution of Kenya's SSF towards the SDGs is at a medium level. The tool served as a diagnostic tool for identifying strengths and gaps in the contribution of SSFs to achieving the SDGs. With only a few years to the 2030 deadline for SDGs achievement, many of the SSFs actors are not aware of them and a lot of capacity building will be required to bring SDG awareness to this group. More such case studies will be required to give a comprehensive account of SSFs contribution towards the SDGs.

## Methodology

# Case study selection

Selection of the SSF to be assessed for the study was done based on commercial importance; dominant fisheries and location with guidance from the Frame survey (Government of Kenya, 2016). The selected SSFs were either gear or species-based. The following SSFs were selected:

1. Estuarine catfish fishery
2. Octopus fishery
3. Sea cucumber fishery
4. Prawn fishery
5. Hand line fishery
6. Basket trap fishery
7. Small pelagic fishery
8. Lobster fishery
9. Gill net fishery
10. Ring net fishery

# Approach

We used an expert-based rapid appraisal framework to identify and characterize the relationships between SSFs and the SDGs. The framework was developed for the Fish2Sustainability Project and the details of the methodology can be found in Bitoun et al., (2024). The framework included 32 of the 169 SDG targets belonging to 12 of the 17 SDGs that are related to SSF. The 12 SDGs are SDGs 1(No poverty), 2 (Zero Hunger), 3 (Good health & well-being), 5 (Gender equality), 8 (Decent work & economic growth), 9 (10 (Reduced inequalities), 11 (Sustainable cities & Communities), 12 (Responsible production & Consumption), 13 (Climate action), 14 (Life below water), 16 (Peace, justice & strong institutions) and 17 (Partnerships for the Goals). Forty-four variables were used to measure fisheries' contributions to the 32 SDG targets corresponding to 12 SDGs evaluated by the framework. Variable scoring was performed using empirical evidence and expert knowledge.

A participatory approach was used to collect information from SSF actors' experts in each case study. These actors (stakeholders) included: i) SSF participants (e.g., fishers, community representatives, actors within the value chains, local organizations) and ii) other stakeholders of the fishery sector (e.g., fishery administration agencies, research institutions, international NGOs, fishing consultants).

The scoring exercise was flexible allowing group (score by consensus) or individual (scores averaged per SSF) scoring. The activity applies to any SSF scale: community, province/state, or region.

Scoring the SSF Attributes - involved assessing the different SSF variables related to SDG targets (Table 2). The scores ranged from H (Highest), MH (Medium high), M (Medium), ML (Medium low), L (Low), ND (No data) and NA (Not applicable). The attributes and the score values are phrased so that they are in the same direction, with the first value being the best one (or score = High), respectively. Table 1 presents the SSF attributes analyzed in the project.

Table 2
The categories and their SSF attributes were used in the scoring

| Category | SSF Attributes |
|---|---|
| 1. **Environmental condition** | 1.1. Ecosystem health |
| | 1.2. Fish stock health |
| 2. **Practices** | 2.1. Stewardship practices |
| | 2.2. Management effectiveness |
| | 2.3. Rule compliance (formal and informal) |
| | 2.4. Fishing effort |
| | 2.5. Gear impact |
| | 2.6. Innovation and Technology |
| 3. **Access** | 3.1. Involvement in the SSF (women, men, and youth) |
| | 3.2. Access to resources (men and women) |
| | 3.3. Access to markets |
| 4. **Food** | 4.1. Food dependency |
| | 4.2. Food security |
| | 4.3. Food losses and waste |
| 5. **Income** | 5.1. Share from fisheries-related activities |
| | 5.2. Income compared to local standards |
| | 5.3. Income compared to international poverty |
| | 5.4. Income growth |
| 6. **Well-being** | 6.1. Housing |
| | 6.2. Epidemics |
| | 6.3. Global health |
| | 6.4. Social cohesion |
| | 6.5. Participation in decision-making |
| | 6.6. Education and literacy |
| | 6.7. Geographic and economic mobility |
| | 6.8. Working conditions |
| 7. **Economy** | 7.1. Economic growth |
| | 7.2. Tourism growth |

| Category | SSF Attributes |
| --- | --- |
| | 7.3. Cooperation with other economic sectors |
| 8. **Global exchanges and Finance** | 8.1. Subsidies<br>8.2. Global resource mobilization<br>8.3. Global exports (share and growth) |

# Stakeholders Involvement

Several stakeholders were involved in the case studies. These included Government representatives from Research, Management, National and County, several National and International Non-Governmental Organizations (NGOs) operating within the Coast region of Kenya and several Beach Management Units along the Kenyan Coast. All the Government representatives provide support for the project and play an important role as decision-makers. However, capacity will be required for effective management and resources for enforcement. The NGOs involved had an interest in the project and a number can support in terms of networking or supporting community projects. The Beach Management Units which comprise of local fishers, dealers, fishmongers and all those related to fishing or coastal activities, are the key stakeholders and the main actors. However, they lack information on SDGs; many are not aware of them and a lot of capacity building will be required to bring SDG awareness to this group, and information on how they contribute to the SDGs is crucial.

# Data collection

A workshop was held with 50 stakeholders from research, academia, government and non-government organizations, representatives of the fisher community (Beach Management Unit) and graduate students. In the workshop, there were group and plenary discussions for the selected fisheries.

Interviews were held with Beach Management Unit representatives (BMU) and Fisheries Managers in field visits. Interviews were done in 16 BMUs along the Kenyan coast from Tana River, Kilifi, Mombasa, and Kwale Counties. The BMUs were in Kipini, Malindi, Watamu, Kilifi, Takaungu, Mtwapa, Nyali, Timbwani, Mwaepe, Gazi, Mkunguni, Shimoni, Kibuyuni, Majoreni, Jimbo, and Vanga. Interviews were conducted with 3 to 5 BMU officials/members (with at least one female) for one or more of the selected SSF. The questions asked during the interviews are in Supplementary Information 1. Secondary data was sourced from published and grey literature.

# Declarations

### Ethics Review

This research involved participation of stakeholders and was approved by the Technical University of Mombasa Scientific Ethics Review Committee (TUM-SERC) with the approval number TUM SERC EXT/001/2023. Informed consent to participate in the study was obtained from participants as part of the requirements of the Ethics Review.

## Data analysis

Scores from the stakeholders' workshop and BMUs were compiled for each of the 10 SSF and averaged to obtain the average score for the attributes. The results were uploaded into the Kobo Toolbox and further analyzed using Pycharm software in the Anaconda Package (Anaconda3 version 2023.03-1) to provide polar charts showing the contribution of each SSF towards the SDGs.

## Code availability

The code used to run the analysis is available in the Supplementary Information 2 and was used in Pycharm software in the Anaconda Package (Anaconda3 version 2023.03-1).

## Data availability statement

The raw data for this study is available in Supplementary Information 3.

## Author Contributions

E.N.F conceptualization, wrote and edited the manuscript, data collection, curation and analysis

E.N. K conceptualization, edited the manuscript, data collection and analysis

C.N.M edited the manuscript, data collection and analysis.

N.W edited the manuscript, data collection and analysis

N.I. edited the manuscript, data collection and analysis

D.M. edited the manuscript, data collection and analysis

B.B. edited the manuscript, data collection and analysis

S.A. edited the manuscript, data collection and analysis

M.O. edited the manuscript, data collection and analysis

G.M. edited the manuscript, data collection and analysis

R.E.B conceptualization, edited the manuscript, developed the code, data curation and analysis

All authors have read and approved the manuscript.

### Competing Interests

The authors declare no competing interests.

# References


1. Bell JD, Watson RA, Ye Y. 2017. Global fishing capacity and fishing effort from 1950 to 2012. Fish and Fisheries 3: 489–505.
2. Bitoun, R.E., Léopold, M., Razanakoto, T., Randrianandrasana, R., Akintola, S.L., Bach, P., Fondo, E.N., Franz, N., Gaibor, N., Massey, Y. and Saavedra-Díaz, L.M., 2024. A methodological framework for capturing marine small-scale fisheries' contributions to the sustainable development goals. Sustainability Science, pp.1–19.
3. Chuenpagdee, R., & Jentoft, S. (2018). Transdisciplinarity for small-scale fisheries governance. Analysis and practice. Cham: Springer Nature. Cham: Springer Nature
4. Cinner, J.E., Daw, T.M., McClanahan, T.R., (2009). Socioeconomic factors that affect artisanal fishers' readiness to exit a declining fishery. Conserv. Biol. 23 (1), 124–130
5. Dzoga, M., Simatele, D. M., & Munga, C. (2019). Climate variability and small-scale fisheries in Kenya: Characterization of current socio-economic conditions of artisanal fishing communities in Ungwana Bay and the Lower Tana Delta. International Journal of Environmental Sciences & Natural Resources, 17(5), 147–153.
6. FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. https://doi.org/10.4060/cc0461en
7. Fulanda, B., Munga, C., Ohtomi, J., Osore, M., Mugo, R., & Hossain, M. Y. (2009). The structure and evolution of the coastal migrant fishery of Kenya. Ocean & Coastal Management, 52(9), 459–466.
8. Government of Kenya, 2022 - Government of Kenya, Marine Frame Survey Report – 2022. 129 pp
9. Islam, M.M. and Chuenpagdee, R., 2022. Towards a classification of vulnerability of small-scale fisheries. Environmental Science & Policy, 134, pp.1–12.
10. Kaunda-Arara, B., Rose, A.G., Muchiri, M.S., Kaka, R. (2003) Long-term trends in coral reef fish yields and exploitation rates of commercial species from coastal Kenya. Indian Ocean Journal of Marine Science 2: 105–116
11. Kimani, E.N., Aura, M.C., Okemwa, G.M. (eds.) (2018) The Status of Kenya Fisheries: Towards the sustainable exploitation of fisheries resources for food security and economic development. Kenya Marine and Fisheries Research Institute (KMFRI), Mombasa. 135 pp
12. Kimani, P., Wamukota, A., Manyala, J. O., & Mlewa, C. M. (2020). Analysis of constraints and opportunities in marine small-scale fisheries value chain: A multi-criteria decision approach. Ocean & Coastal Management, 189, 105151.
13. Kolding, J., Bené, C. and Bavinck, M., 2014. Small-scale fisheries: Importance, vulnerability and deficient knowledge. Governance of marine fisheries and biodiversity conservation: Interaction and coevolution, pp.317–331.

14. Mangi, S.C., Roberts, C.M., Rodwell, L.D. (2007). Financial comparisons of fishing gear used in Kenya's coral reef lagoons. AMBIO: A Journal of the Human Environment 36: 671–677.
15. McClanahan TR, Mangi SC. 2004. Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. Fisheries Management and Ecology 11: 51–60
16. McClanahan TR, Allison EH, Cinner JE. 2013. Managing marine resources for food and human security. Food Security and Sociopolitical Stability 26: 142–168
17. Ndegwa, S., Geehan, J. (2017) Evaluation of the Kenyan Catch Assessment Survey. IOTC2017-WPDCS13-36 Rev1. 11 p
18. Obura, D.O., 2001. Participatory monitoring of shallow tropical marine fisheries by artisanal fishers in Diani, Kenya. Bull. Mar. Sci. 69, 777–792.
19. Obura, D., Smits, M., Chaudhry, T., McPhillips, J., Beal, D., Astier, C. 2017. Reviving the Western Indian Ocean economy: actions for a sustainable future. Gland, Switzerland: World Wide Fund for Nature.
20. Ochiewo, J., 2004. Changing fisheries practices and their socioeconomic implications in South Coast Kenya. Ocean Coast. Manag. 47 (7–8), 389–408.
21. Okemwa, G. M., Maina, G. W., Munga, C. N., Mueni, E., Barabara, M. S., Ndegwa, S., Thoya, P., & Ntheketha, N. (2017). Managing coastal pelagic fisheries: A case study of the small-scale purse seine fishery in Kenya. Ocean & Coastal Management, 144, 31–39.
22. Omukoto, J.O., Owiti, H., Mwakha, V.A., Munga, C.N., & Wamukota, A.W. (2018). Participatory assessment of priority fishery profiles in an overfished urban inshore seascape in Kenya WIO Journal of Marine Science, 17 (2), 79–92.
23. Polk, M. (2014). Achieving the promise of transdisciplinarity: a critical exploration of the relationship between transdisciplinary research and societal problem solving. Sustainable Science 9: 439–451.
24. Sachs, J.D., Lafortune, G., Fuller, G., Drumm, E. (2023). Implementing the SDG Stimulus. Sustainable Development Report 2023. Paris: SDSN, Dublin: Dublin University Press, 2023. 10.25546/102924
25. Said, A., Chuenpagdee, R., Aguilar-Perera, A., Arce-Ibarra, M., Gurung, T. B., Bishop, B., Léopold, M., Márquez Pérez, A.I., de Mattos, S.M.G., Pierce, G.J. and Nayak, P.K. (2019). The principles of transdisciplinary research in small-scale fisheries. In Transdisciplinarity for Small-Scale Fisheries Governance (pp. 411–431). Springer, Cham.
26. Short, R.E., Gelcich, S., Little, D.C., Micheli, F., Allison, E.H., Basurto, X., Belton, B., Brugere, C., Bush, S.R., Cao, L. and Crona, B., 2021. Harnessing the diversity of small-scale actors is key to the future of aquatic food systems. Nature Food, 2(9), pp.733–741.
27. Thoya, P., Horigue, V., Mollmann, C., Maina, J., & Schiole, K.S. (2022). Policy gaps in the East African Blue economy: Perspectives of small-scale fishers on port development in Kenya and Tanzania.
28. United Nations. 2023. Progress towards the Sustainable Development Goals: Towards a Rescue Plan for People and Planet. UN Economic and Social Council. Report of the Secretary-General (Special Edition).

29. Wabnitz, Colette C.C., Omukoto, Johnstone O., Daw, Tim, Cheung, William W. L. (2018) Ecosystem modelling to support fisheries management efforts in the Nyali-Mombasa area, coastal Kenya. Fisheries Centre Research Report 28 (1): 76 pp.
30. Wamukota, A. W., Crona, B., Osuka, K., & Daw, T. M. (2015). The importance of selected individual characteristics in determining market prices for fishers and traders in Kenyan small-scale fisheries. Society & Natural Resources, 28(9), 959–974.

# Figures

**Figure 1**

Polar charts showing the contribution of small scale (a) estuarine catfish fishery (b) octopus fishery (c) sea cucumber fishery and (d) prawn fishery towards SDGs

**Figure 2**

Polar charts showing the contribution of small scale (a) handline fishery (b) basket trap fishery (c) small pelagic fishery and (d) lobster fishery towards SDGs

**Figure 3**

Polar charts showing the contribution of small scale (a) gill net fishery and (b) ring net fishery towards SDGs

**Figure 4**

Kenya’s coastal small-scale fisheries contribution to SDGs

# Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryInformation1.docx
- SupplementaryInformation2.txt

- SupplementaryInformation3.xlsx