A CRITICAL REVIEW OF THE LIBERIAN FISHERIES SECTOR: A TECHNICAL REPORT

ALVIN SLEWION JUESEAH

PhD. CANDIDATE

DEPARTMENT OF ECONOMICS

SCHOOL OF SOCIAL SCIENCES, UNIVERSITY OF ICELAND

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Edited/Reviewed By:

Dr. Ogmundur Knutsson

Dr. Tumi Tómasson

Prof. Dadi Mar Kristofersson

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EXECUTIVE SUMMARY

Liberia is amongst the poorest countries in the world with an exclusive economic zone (EEZ) of 246,000 km^2 and a 579 km coastline. Fisheries are a source of food and nutrition security, livelihoods for several thousand Liberians, revenues and foreign exchange for government and account for 3% of GDP. Six major exploitable fish stock complexes include small, medium and large pelagics, shallow- and deep-water demersals as well as crustaceans. These stock complexes are exploited by two small-scale fleets i.e. Kru and Fanti, a costal industrial fleet, and an offshore industrial fleet at various extents.

Over the years, major policy documents have been prepared and adopted to guide development in the fisheries sector in Liberia, primarily focusing on sustainable management of the fisheries resources and value-addition. Recent empirical analyses have, however, shown that the sector has not been performing well in terms of profitability, fleet development, and value-addition in the post-harvest sector. This paper reviews the evolution of the Liberian fisheries and evaluates the performance of the sector in light of the current policies.

Fisheries statistics, both catch and effort data prior to and during the civil war period (1989-2003) are unreliable but appear to have been improving in recent years. The small and medium pelagic stocks in the Liberian coastal waters are considered to be moderately to lightly exploited. Even so the Fanti fleet which is generally profitable and targets the small pelagics has remained fairly constant in recent years, possibly because of limited availability of large trees needed for their construction. The offshore large pelagic fishery resources such as the tuna and tuna-like species are managed at the regional level by the International Commission for the Conservation of Atlantic Tunas and Liberia practically has no control over this stock.

The shallow-water demersals have been found to be overexploited, while the deep water demersal are considered to be moderately to fully exploited. The fleet of Kru canoes who primarily target shallow-water demersals has grown fast and was in 2020 around 11 times larger than it was at the end of the civil war in 2003, which may be the reason for the current overutilized state of this stock.

Crustacean species of commercial importance include shrimps, crabs, and lobsters. The collapse of the Liberian lucrative shrimp fishery in the early 1980s appears to be more associated with security and political issues as opposed to a fishery collapse. Today there is hardly any industrial shrimp fishery operating in Liberia perhaps because of the less availability of shrimp due to

environmental changes or because of the changes in policy in 2010 which restricts industrial trawling inside six nm where the coastal shrimp resources are most abundant. This seems to have resulted in underutilization of the coastal shrimp resources in Liberia.

The coastal shrimps and deep-water demersals are valuable stocks that are possibly underutilized in Liberia. In the 1970s, maximum economic yield (MEY) for the coastal shrimp resources was estimated at 800 tons for 14 vessels, valued at US$ 5.7 million. Today, the landed value of 800 tons of shrimp at US$ 10,200 ton^{-1} would be around US$ 8.2 million. It seems the same applies to the deep water demersals. The deep water demersal seem to be underutilized, but it is uncertain whether the stock is of economic quantity to benefit the Liberian society. It is possible that there may be some more stock there than recently estimated. This is something the government might want to look into and would probably be money well spent.

In this report, a conceptual model for evaluating the cost and benefit of management for different types of fisheries (fleets) is presented and management options discussed in this light. It is argued that it may be difficult to implement an economically efficient management for SSF, where the cost of management may be greater than the benefit. This may explain why SSF seem generally to be unmanageable, and this may also be the case for the Liberian coastal SSF. The design and nature of the Kru and Fanti vessels in terms of the small size boats, the primitive harvesting technology used, their disperse and sheer numbers as well as the unpredictable nature of informal operations, make practical economically efficient management quite challenging. There seem to be a substantial efficiency problem in the SSF in Liberia. However, empirical analysis only gave an indication that vessel length and skipper's age may be the cause of this observation in the SSF in Liberia.

Due to the open access nature of SSF, incremental improvements are unlikely to generate long-term net benefits for the society. Economically efficient management of many small-size unsophisticated small-scale vessels, such as the Kru canoes in Liberia, may therefore not be worth the required effort. All costs and benefits associated with management of each fishery (fleet) need to be estimated before a decision to manage is taken. This certainly would, however, depend on the government's intended management outcome(s) i.e. biological (maximum fish production) or social (short-term employment) or economic efficiency (rent generation/efficiency), for the fishery right from the outset. Still, fisheries managed successfully for economic efficiency have been

reported to increase value-addition and the sector's contribution to GDP and growth as well as better biological and social outcomes.

Progress is noted in most of the policy areas in Liberia including (i) fisheries improvement (ii) sustainable management of fisheries resources and ecosystems (iii) strengthening of fisheries management and development capacities; and (iv) enhancement of value-addition, marketing and fish trade. Despite the progress made in these four policy areas, empirical analyses have shown there is lot more to do and suggest certain policy measures be adopted to improve the fisheries sector performance. Annual catch in the SSF has increased by 58% year^{-1} between 2018-2020. This increase, however, can also be attributed to a new data collection system implemented for the SSF and makes it difficult to gage the real improvement. There have been improvements in sustainable fisheries management (governance) in terms of licensing and vessels registration, regulated harvesting, establishment of Co-Management Associations (CMAs), engagement with Regional Fisheries Management Organizations (RFMOs) and effective Monitoring Control and Surveillance (MCS).

Fisheries management and development capacities have been strengthened by the establishment of the National Fisheries and Aquaculture Authority (NaFAA), an autonomous authority, which replaced the former Bureau of National Fisheries. Human resource capacity and administrative processes have somewhat improved although it still persists as a major constraint, and new fisheries law and new fisheries regulations have been approved. Financial stability to some extent has been achieved at NaFAA through engagement with the European Union (EU) Sustainable Fisheries Partnership Agreement (SFPA) among other sources, although the SFPA with the EU was not renewed on December 15, 2020, due to a yellow card issue.

For progress made in the enhancement of value-addition, marketing and fish trade, a fish landing site cluster has been established and there are plans to establish new ones in selected coastal counties under Liberia Sustainable Management of Fisheries Project (LSMFIP). The strategies to achieve the goal(s) of increasing domestic fish supply by 2023 are not outlined in the Pro-poor Agenda for Prosperity and Development (PAPD), while the current development trend of the small-scale fleet, especially the Kru canoes, seem inconsistent with sustainable management of fisheries resources and ecosystems. The fish value chain in Liberia is typified by poor handling of the catch both onboard and ashore, with implications for value-adding and marketing in subsequent

links, and lack of transparency which stems from power asymmetries and lack of information flow in the SSF value chain.

The policy action framework lacks implementation costs, which makes it difficult to determine the management costs linked to these improvements. Typically, fisheries management costs linked to implementing fisheries policy and enforcement of rules can be quite substantial ranging between 3-25% of the gross value of the landings. While implementing management may be regarded as progress for the fishery based on past experiences, it could be a net cost to society for certain fisheries (fleets) such as the SSF as management costs seem to be sensitive to the number and size of the vessels as argued in the conceptual model. In order to improve the performance of the Liberian fisheries sector, the following recommendations are advanced for the government (NaFAA) to look into.

Conduct stock and economic assessments for coastal shrimp and deep-water demersal stocks

The coastal shrimp resources and the deep water demersals may be larger than previous analyses have indicated, and they are almost certainly under-exploited. It seems, therefore, worthwhile that the government look into conducting national stock assessments (survey) and economic analyses for the coastal shrimp resources and the deep water demersals to determine both stocks abundances and value of these resources. If the survey for the coastal shrimps shows the stock is abundant i.e. there is good economic quantity of the resource, then the government can determine a way to optimally exploit the shrimp stock. In this case, the management of the resource should be organized in such a way that the fishery (fleet) is manageable as argued in the conceptual model, using few well equipped vessels for the operation. The goal here is to focus on a management structure that generates greater benefits for the Liberian society. The same applies to the deep water demersals. If a survey establishes that there is economic resource (quantity) that could be exploited, the management of the resource should be arranged in such a way that the fishery (fleet) is manageable as illustrated in the conceptual model.

Management of the small-scale fisheries and fleets

While it has been shown that substantial benefits could be derived from management of the small-scale fleet (i.e. reducing the number of Kru canoes) in Liberia, managing small-size primitive vessels with unpredictable informal operations may not be worth the economic effort that would be required. The option to phase out the Kru canoes should be looked into due to conflict with

forestry or perhaps because they are unmanageable economically. The first step could be to stop issuing new fishing licenses and registration numbers to Kru canoes. If the Kru can be phased out, the government should explore the feasibility of introducing new harvesting technology like fiberglass reinforced plastic (FRP) vessels to both increase productivity and profitability in the Liberian fishing industry. There should, however, be an economic evaluation of any option to phase out the current small-scale fleet to shed light on the socio-economic implications of this policy. There are indications that most of the Kru and Fanti boats are inefficient and lacking appropriate technologies to harvest the valuable deep-water demersals and the coastal shrimp resources in Liberia as well as the medium and large pelagics offshore. The introduction of FRP vessels might help to address the current technical regress in the fishing industry and utilize the coastal fishery resources i.e. deep water demersals, coastal shrimps, medium and large pelagics, better in Liberia. Larger and more efficient vessels, such as FRP vessels, might make it possible to improve efficiency and the quality of the landed fish. Still, if there is going to be a technological leap in the fishery, one has to remember that this leap should be within the manageable area as argued in the conceptual model. This means the vessels have to be sufficiently big so that the fishery that emerges is manageable and capable of generating greater benefits for the Liberian society.

Establish basic fisheries infrastructure

The absence of basic fisheries infrastructure contributes to the poor handling of the landed catch in the SSF value chain. Interventions such as provision of basic fisheries infrastructure might address issue related to poor handling of the catch both onboard and ashore and improve value-addition services in the SSF value chain. It is, therefore, advisable that the government look into establishing critical fisheries infrastructure such as ice and chill facilities, suitable sanitary facilities, and hands-on training, to enhance value-addition services in the SSF value chain.

Establish access to financial services

Lack of transparency in the SSF value chain has resulted in captive or hierarchy relationships, and lower price and benefits for fishermen than if they were in a market relationship with the middlemen. In order to tackle the lack of transparency in the value chain, government could create access to financial services for the SSF subsector such as less demanding and restrictive

microloans as an alternative source of finance and increase access to information in the value chain from end-markets to the fishermen. The establishment of a single fish selling desk that represents the interests of the fishermen might address the current lack of information. Access to financial services might also give the fishermen access to the necessary investment finance to purchase improved harvesting technologies which are needed in the fisheries to increase efficiency and profitability.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

Conduct stock and economic assessments for coastal shrimp and deep-water demersal stocks iv

Management of the small-scale fisheries and fleets iv

Establish basic fisheries infrastructure v

Establish access to financial services v

1.0 INTRODUCTION 1

2.0 FISHERIES BACKGROUND 3

2.1 MAIN FISH SPECIES AND CATCH 3

2.2 FISHING FLEETS 5

2.2.1 SMALL-SCALE FLEET 6

2.2.2 INDUSTRIAL FLEET 7

2.3 STATE OF THE RESOURCES 9

2.3.1 PELAGIC STOCKS 9

2.3.2 DEMERSAL STOCKS 11

2.3.3 CRUSTECEAN SPECIES 13

2.4 FISHERY VALUE CHAIN 15

2.5 GOVERNANCE OF THE FISHERIES 16

2.5.1 THE FISHERIES MANAGEMENT SYSTEM 16

2.5.2 INSTITUTIONAL STRUCTURE 17

3.0 CONCEPTUAL MODEL OF FISHERIES MANAGEMENT 18

4.0 FISHERIES POLICY PERFORMANCE 24

5.0 CONCLUSION AND RECOMMENDATIONS 28

5.1 CONCLUSION 28

5.2 RECOMMENDATIONS 30

5.2.1 Conduct stock and economic assessments for coastal shrimp and deep water demersal stocks 30

5.2.2 Management of the small-scale fisheries 31

5.2.3 Establish basic fisheries infrastructure 31

5.2.4 Establish access to financial services 32

REFERENCES 33

APPENDIX 1 36

1.0 INTRODUCTION

Liberia, situated on the west coast of Africa, is bounded with Sierra Leone to the west, Cote D'Ivoire to the east, Guinea to the north and the Atlantic Ocean to the south with a coastline of 579 km. Liberia is among the poorest countries in the world and has an exclusive economic zone (EEZ) of 246,000 km^2, slightly larger than its closest neighbors Sierra Leone and the Ivory Coast (MRAG 2013, Chu et al. 2017). The fisheries are conducted in the coastal and offshore waters at small and industrial scales, using multiple fishing craft and methods (Ministry of Agriculture 2014; MRAG 2014; Chu et al, 2017).

The coastal fisheries are conducted on the continental shelf, which is on average 36 km wide, narrower in the north between Monrovia and Robertsport with trawling grounds down to 800 m, and wider in the south between Monrovia and Ivory Coast (Ssentongo 1987). The coastal waters are within the Guinea Current Large Marine Ecosystem and are generally warm (>24 °C) and permanently stratified with low salinity levels (< 35‰). The lack of vertical mixing of waters and low nutrient levels are reflected in relatively poor productivity (Ssentongo 1987).

There are six exploitable fish stock complexes in the Liberian waters including small, medium, and large pelagics, shallow- and deep-water demersals and crustaceans (MRAG 2014). The stock complexes are targeted by two coastal small-scale fishing fleets i.e. the Kru and Fanti vessels, a coastal industrial fleet as well as an offshore fleet.

The local Kru fleet consists mainly of non-motorized (paddle/sails) canoes 12-33 ft long with a crew of 1-4 (Jueseah et al. 2021). Operators of Kru canoes mostly deploy handlines and gillnets and target shallow-water demersal stocks above the thermocline, and deep-water demersal stocks below the thermocline (Ssentongo 1987). Kru canoes, using traps and gillnets, also to a lesser extent target some crustaceans, primarily lobsters and crabs (Jueseah et al, 2020b). The Fanti fleet, mostly operated by migrant fishermen from Ghana, consists of larger open wooden boats around 15-71 ft long generally propelled by outboard or inboard engines with 4-26 crew (Chu et al, 2017; Jueseah et al, 2021). Fantis mainly employ ring nets and target small pelagic stocks. Operators of Kru and Fanti vessels, to a much lesser extent, also catch some large and medium size pelagic species. Since 2010, the small-scale Kru and Fanti vessels have had exclusive access up to six nautical miles (nm) offshore, although they also may fish further out.

The coastal industrial fleet consists mostly of trawlers that employ bottom and mid-water trawls and target shallow- and deep-waters demersal finfishes, such as those targeted by the Kru, and coastal shrimp (MRAG 2013). The coastal trawlers have in recent years increasingly used mid-water trawls targeting small- and medium pelagics. The offshore fleet comprises large industrial tuna vessels that employ multiple fishing methods but primarily purse seines and target mostly large pelagic species (MRAG 2014). Most of these vessels are from EU countries fishing under Sustainable Fisheries Partnership Agreement (SFPA).

The fishing industry plays a major role in the Liberian economy. Today, fisheries are a prime source of food and nutritional security, where fish provides 65% of the animal protein consumed with average annual consumption per capita of 6 kg,[1] livelihoods for several thousand Liberians, revenues and foreign exchange for government and accounts for around 3.2% of GDP (Ministry of Agriculture 2014; Yokie 2019; Sherif 2019). Because of the high rate of unemployment and the open access regime of the SSF, the fisheries sector is regarded as a buffer for many jobless young Liberians (Togba 2008; Belhabib et al. 2016). In the past two decades, the coastal fisheries catch has ranged between 7,083 to 32,373 tons year^{-1} and averaged around 20,803 tons year^{-1}. The local catch is mostly supplied to the domestic markets but shortages in fish supply are supplemented by imports (MRAG 2013).

When the fisheries expanded in the early 1980s and before the civil war started in 1989, the governments had weak administrative capacity, was lacking trained personnel and managerial competence, and corruption was widespread. During the periods of the prolonged civil war which lasted until 2003, fisheries monitoring and research basically came to a halt resulting in a situation where very little was known about the fisheries and the status of stocks or the marine ecosystem in general (World Bank 2007; Ministry of Agriculture 2014; Belhabib et al. 2016). Data from this time are at best unreliable.

Over the years, key policies have been formulated and adopted by the government to guide developments in the fisheries sector (see e.g., Ministry of Agriculture 2014; Republic of Liberia 2018). Policies have mostly aimed at sustainable management of the fishery resources, strengthening of fisheries governance capacities, and improvement in value-addition activities (Ministry of Agriculture 2014; Republic of Liberia 2018). Recent studies by the author have

[1] FAO Fisheries & Aquaculture - Fishery and Aquaculture Country Profiles - The Republic of Liberia. Accessed 06.18.2021.

indicated that the Liberian fishing industry has not been performing well in terms of profitability and fleet development, level of harvesting technology used and value-addition in the post-harvest sector (see, Jueseah et al, 2020a, Jueseah et al, 2020b; Jueseah et al, 2021).

This paper aims to critically review the development of the Liberian fisheries and evaluate the performance of the sector in light of current policies. Key national development policy documents will be reviewed, i.e. the Pro-poor Agenda for Prosperity and Development (PAPD), which outlines a five-year (July 2018-June 2023) development plan priorities for Liberia (Republic of Liberia 2018), and the current Fisheries and Aquaculture Policy and Strategies (FAPS) (Ministry of Agriculture 2014), which states the overall goals and key objectives for sustainable utilization of the fisheries resources.

The report is in five parts. Section 2 describes and gives a background of the fisheries sector in Liberia. The main fish stocks and catches, development of the fleets, the status of stocks, the fishery value chain and governance of the fisheries sector are presented and discussed. A conceptual model of the costs and benefits of fisheries management is developed and discussed in section three. This model is then used to evaluate management options of the different fisheries (fleets). In section four, the performance of the existing national fisheries policies and supporting strategies are presented. The PAPD goals are first reviewed followed by the vision for the fisheries sector. This is followed by the review of the goal and key objectives of the current FAPS for sustainable utilization of the fisheries resources in Liberia. The progress made since the implementation of the policies in 2014 is reviewed. The conclusions and policy recommendations are presented in section five.

2.0 FISHERIES BACKGROUND

In this section, the key stocks and development of the fleets are first presented and discussed, followed by the state of the stocks, the fishery value chain, and the governance of the fisheries sector.

2.1 MAIN FISH SPECIES AND CATCH

The small, medium, and large pelagics, shallow- and deep-water demersal and crustaceans are groups of species that occur only within the Liberian waters or are part of larger sub-regional or reginal stocks (MRAG 2014). Small-pelagics range between 12-25 cm total length and are

primarily caught in coastal waters mostly where the depth is around 40–70 m (Boyer et al, 2017) and include bonny (*Sardinella spp.*), porjoe (*Chloroscombrus chrysurus*) and flying fish (*Cheilopogon melanurus*) (MRAG 2014). The medium pelagics, vary between 18-55 cm with a modal length of 41 cm, are found in turbid coastal and offshore waters and typically caught in areas straddling the thermocline around 0-40 m depth and include pike fish (*Sphyraena spp.*) and barracuda (*Sphyraena barracuda*) (Boyer et al, 2017). The large pelagics typically occur in offshore waters at 0-300 m depth and include tuna and tuna-like species such as yellowfin (*Thunnus albacares*), bigeye (*Thunnus abesus*) and skipjack (*Katsuwonus pelamis)* tunas, swordfish (*Xiphias gladius*), marlin (*Istiophoridae*), hammerhead shark (*Sphyrnidae*) and ray species (Fonteneau and Marcille 1993; MRAG 2014)

The main shallow-water demersal species are cassava fish (*Pseudotolithus spp.*), butternose (*Galeoides decadactylus*), solefish (*Cynoglossus spp.*) and catfish (*Arius spp.*), whereas deep-water demersals include groupers (*Epinephalus spp.*), snappers (*Lutjanus spp.*), grunts (*Pomadasys spp.*) and sparids (*Dentex spp*) (MRAG 2014). The shallow water demersals are usually caught at $\leq$ 30 m depth, but the deep water demersals are primarily found at depths $\geq$30 m (MRAG 2014). Crustaceans primarily occur in inshore waters mostly at 30–60 m depth (FAO 2001). Main species include the coastal shrimp (*Penaeus notialis*), deep-water shrimp (*Parapenaeus longirostris*), marine crab (*Callinectes sapidus*) and tropical spiny lobster (*Panulirus ornatus*) (MRAG 2014).

Based on published FAO data, catch landed in Liberia ranged from 6,463 to 18,731 tons year^{-1} in 1980-2019 (Figure 1). Total catch increased in the 1980s reaching a peak in 1987 of about 18,700 tons. Landings then decreased sharply, especially following the onset of the civil war to a low of 6,500 tons in 1990. Since then FAO has reported catches ranging from 7,000 to 16,000 tons, ranging from 12,000 to 16,000 tons in the last nine years (Figure 1). NaFAA catch statistics available from 2001 indicate similar catches as reported by FAO in 2009-2012, but about double the catches reported by FAO in all other years (Figure 1). The biggest catches of about 32,000 tons reported by NaFAA, have been attributed to changes in the data collection system for the SSF (MRAG 2014).

During and immediately after the civil war, Liberia's capacity to monitor its fisheries was almost non-existent (MRAG 2005; Ministry of Agriculture 2014; Belhabib et al. 2016). Catch data reported by FAO for Liberia, during these periods, can be said to be educated guesses (Belhabib

et al. 2016). Reconstruction of the small-scale fishing effort from 1950-2010 based on ethnic affiliation i.e. Kru and Fanti fleet, and their catch per unit effort was 66% higher than estimates of the coastal catches supplied by Liberia (NaFAA) to FAO (Belhabib et al. 2016).

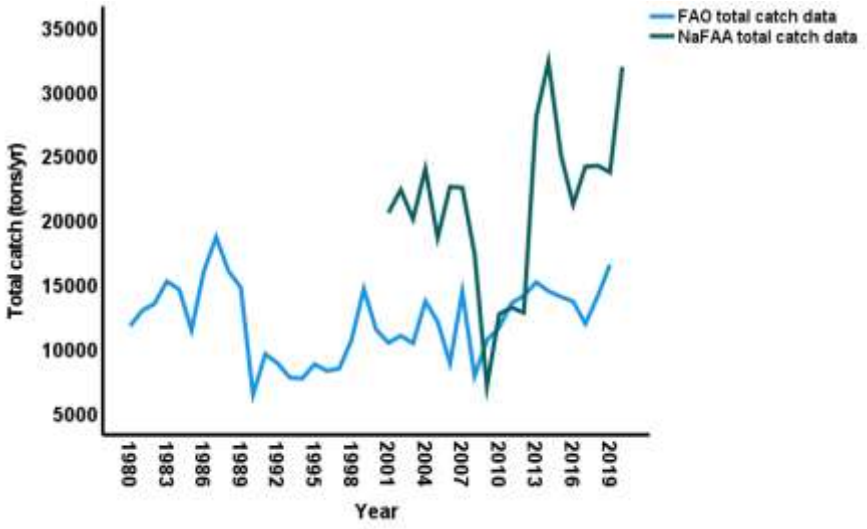

Figure 1. Liberia marine fishery production between 1980-2020.
Source: FAO[2] (1980-2019), NaFAA statistics (2001-2020)

In the sections that follow, the fleets targeting the fishery resources and the state of the main stocks in the Liberia coastal waters are described in detail. Because the total catch data from FAO are generally not disaggregated by fleets, the disaggregated catch and vessel data used in the sections that follow were obtained from multiple sources as indicated in the text.

2.2 FISHING FLEETS

This section discusses the structure and development of the fishing fleets in Liberia which can be divided into the small-scale Kru and Fanti and the coastal and offshore industrial vessels. The types of vessels, fishing methods use, major species targeted, and annual catch developments of the fleets are presented and discussed.

[2] FAO Fisheries & Aquaculture - Fishery and Aquaculture Country Profiles - The Republic of Liberia. Accessed 29.03.2021.

2.2.1 SMALL-SCALE FLEET

There are two main types of small-scale fishing fleets i.e. Kru and Fanti, that operate in the coastal waters of Liberia. The Kru operate on average 22 ft dugout canoes with 1 to 4 crew typically propelled by sails and/or paddles (Chu et al. 2017). Most authors refer to them as Kru fishermen mainly because of the type of dugout canoe they operate but they may be a mix of people belonging to several local tribes such as Kru, Bassa, Grabo and Vai (MRAG 2013). Operators of Kru canoes employ a range of fishing methods but mostly use hook and lines, longlines, gill nets, cast nets and traps and mainly target the shallow and deep waters demersal fish species such as cassava fish, butter-nose, sole-fish above the thermocline and sparids groupers, snappers, and grunters below the thermocline (Ssentongo 1983; MRAG 2014; World Bank 2015). They also target some crustacean species, mostly crabs and lobsters, using gill nets and traps (Chu and Meredith 2015; Jueseah et al. 2020b).

Today, there are over 3,800 Kru canoes operating in the SSF in Liberia, having increased from <50 canoes in 1960 to around 3,815 in 2019 (Figure 2a). Development of the Kru fleet has mainly been driven by profitability (Jueseah et al, 2020b). Kru canoes have limited ability to exploit deep-water demersal stocks and coastal shrimp resources as they are not able to apply appropriate harvesting technologies to do so (Jueseah et al, 2021).

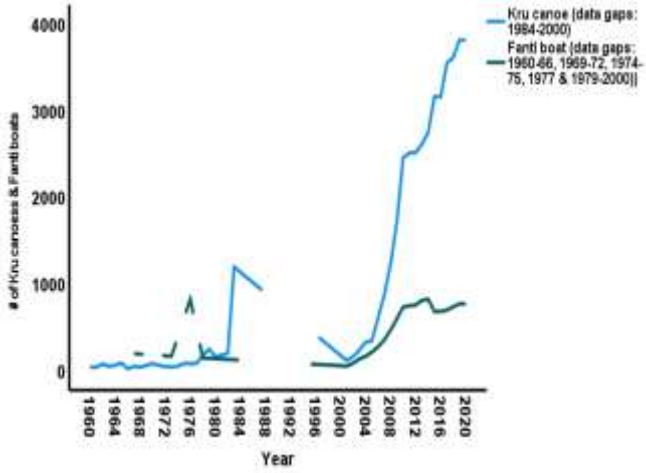

Figure 2a. Small-scale Kru and Fanti boats development trend.
Source: Shotton (1983), Ssentongo (1983), NaFAA Statistics (2001-2020)

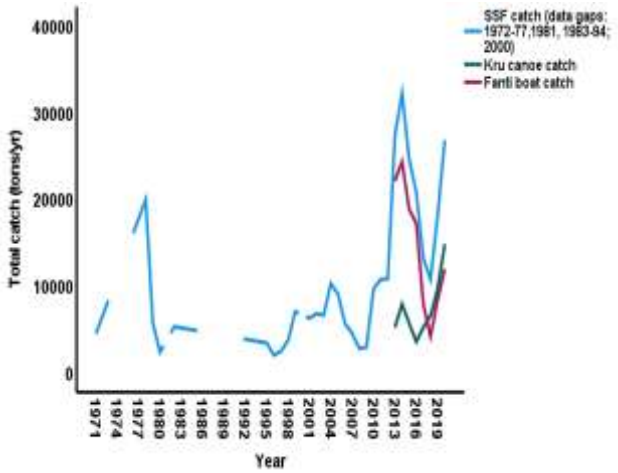

Figure 2b. Liberia SSF total catch overtime.
Source: Shotton (1983) (1971-1980, 1982), FAO[3] (1995-1999) NaFAA Statistics (2001-2020)

[3] FAO fishery country profile - the republic of Liberia (africanmarineatlas.org). Accessed 29.03.2021.

The Fantis are mainly Ghanaians who operate larger open wooden boats, with the keel and lower part of the boat constructed from a single tree trunk. These vessels mostly range from 15-71 ft in length. They have 4-26 crew and are propelled by 9-40 hp outboard and/or inboard engines (Chu et al, 2017). The Fantis mostly deploy large ring nets and target small-pelagics like bonny, porjoe, and Atlantic flying fish (MRAG 2014; Chu and Meredith 2015; Chu et al, 2017). Operators of Fanti boats also target some shallow- and deep-waters demersals using gill nets, set nets and handlines, (Chu and Meredith 2015; Chu et al, 2017). Kru and Fanti operators also catch some medium and large pelagics, but to a much lesser extent (MRAG 2014; Chu and Meredith 2015; Chu et al, 2017). The number of Fanti boats grew steadily from 200 in 1967 to 737 in 2010 but since then their numbers have been fairly stable (Figure 2a). The Fanti fleet is quite profitable, but its expansion since 2011 has been constrained by the lack of access to the required raw materials (big forest trees) used to build the keel of the boats (Jueseah et al, 2021).

There are large fluctuations in the SSF catch which can mostly be attributed to fluctuations in catches of small pelagics targeted by the Fanti (Figure 2b). Small pelagic species are short-lived and their stock sizes fluctuate greatly. These species are sensitive to environmental variations, such as upwelling, salinity and temperature, which can cause large fluctuations in year class strength. The entire catch from the SSF is consumed locally. Between 2013-2020 the Fanti accounted for around 63% of the total SSF catch and great fluctuations in the pelagic stocks have thus considerable impact on the food security of the local population which is further accentuated by poor post-harvest handling (Jueseah et al, 2020a).

2.2.2 INDUSTRIAL FLEET

The industrial fleet consists of coastal trawl and offshore large pelagic (tuna) vessels (MRAG 2013; Ministry of Agriculture 2014). Since 2008, however, there has been a marked decrease in the number of coastal trawlers and since 2013 there have been on average five coastal industrial vessels (Figure 3a) which are mostly owned by foreigners from Europe i.e. Spain, Greece and Russia, and China, who operate through joint ventures with locally registered fishing firms (MRAG 2013)

During the civil war, governance in the fisheries sector was nonexistent and fishing was generally unregulated resulting in rampant IUU fishing (Braimah 2012). Since 2004, successive

governments have concentrated on governance of the fisheries sector resulting in considerable disinvestment (exits) in the coastal industrial fishery (Figure 3a) (Chu et al, 2017; Jueseah et al, 2020b). Due to a key policy change in 2010, reserving a 6 mile zone for the SSF, the trawlers have no access to most of their main target species such as shallow water demersals and the coastal shrimp (Chu et al, 2017; Jueseah et al, 2020b). This has caused the coastal trawlers to increasingly target pelagic species resulting in a large increase in the trawlers total catch (Figure 3b). The coastal trawlers supply most of their catch to the local market as frozen whole fish, but some is also exported (MRAG 2013; Ministry of Agriculture 2014).

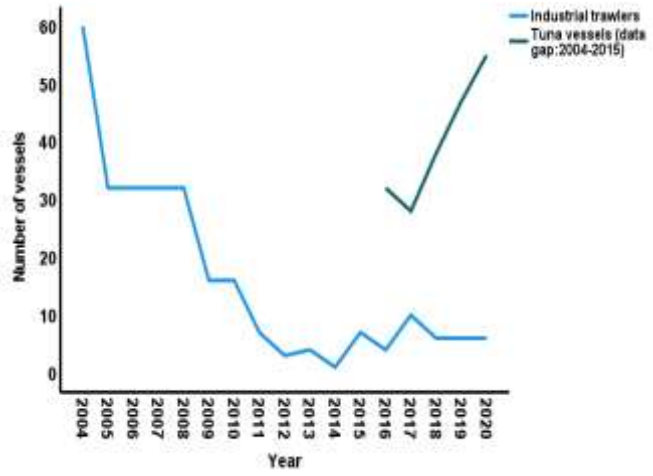

Figure 3a. Number of registered coastal trawlers and tuna vessels in Liberian waters 2004-2020.
Source: NaFAA Statistics

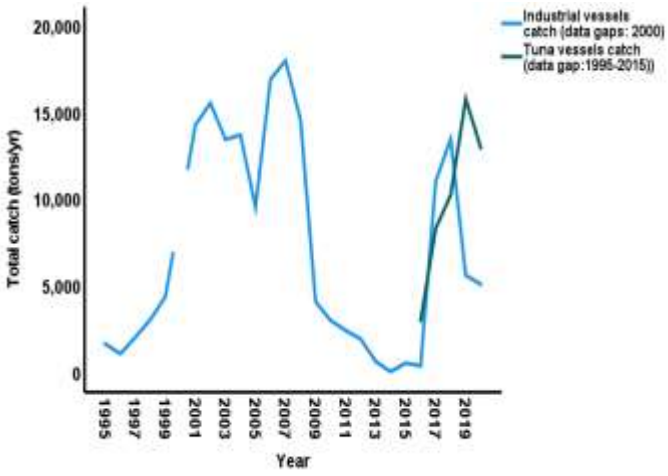

Figure 3b. Total catch of coastal trawlers and tuna vessels (1995-2020)
Source: FAO[4](1995-1999) & NaFAA Statistics (2001-2020).

Prior to 2016, all activities of the offshore tuna vessels operating in the Liberian EEZ were regarded as IUU mostly due to poor governance (Braimah 2012). Due to the governance reforms introduced by the Liberian Government in 2010, government revenues from fisheries grew from U$ 400,000 in 2011 to U$ 6 million in 2013, derived mainly from fines for violations of the new fisheries regulations (Ministry of Agriculture 2010).

Since 2016, the offshore tuna fleet has mostly consisted of large industrial vessels operating through SFPA with the EU (EU et al, 2020). They deploy multiple fishing methods including purse seines, longlines and pole and lines and mainly target tropical tuna and tuna-like species all year round (EU et al, 2020). The total catch of the offshore tuna fleet rose from 3,025 tons in 2016 to

[4] FAO Fishery Country Profile - the republic of Liberia (africanmarineatlas.org). Accessed 29.03.2021.

15,798 tons in 2019 but declined again to 12,993 tons in 2020 (Figure 3b). The catch is not landed in Liberia mostly due to limited infrastructure and weak local demand for tuna. Due to an unresolved yellow-card issue between Liberia and the EU, the EU tuna fleet left Liberian waters on December 8, 2020[5].

2.3 STATE OF THE RESOURCES

Information on the status of stocks and their productivity can be inferred from the analysis of data collected from the fisheries and from fisheries independent surveys reviewed in this section.

2.3.1 PELAGIC STOCKS

In 1981, surveys using the Soviet R/V Belagorsk and the Norwegian R/V Dr. Fridtjof Nansen were carried out to estimate the fish stocks on the continental shelf of Liberia (shotton 1983; Ssentongo 1983). The Soviet estimated the biomass of the pelagic stocks at 43,000 tons, while the Norwegian survey estimated it at 136,700 tons (Shotton 1983; Ssentongo 1983). Further surveys conducted by the Nansen program in 2006, 2007 and 2017 showed a reduction by an order of magnitude in the biomass of medium and small pelagics from 2006 to 2007 which cannot be explained by fishing according to the available catch statistics. Biomass estimates of the small pelagic species *Sardinella* and *Anchovy* mainly targeted by the Fantis vary less but the estimates doubled from 2006 to 2007, but were again reduced to 13000 tons in 2017, a third of the 2007 estimate (Table 1). The variation in abundance estimates of the pelagic stocks may be because of poor coverage. For instance, the most recent Nansen survey in 2017 lasted for only six days (i.e. August 11-17, 2017) (Boyer et al, 2017), but it can also to some extent be due to the different time of year the surveys were conducted and partly due to the migratory nature of the stock (Boyer et al, 2017). However, this may also be due to differences in recruitment, environmental variability or harvesting strategies of the fleets (Boyer et al, 2017), although the stark differences between the small and medium pelagic stocks do not support this suggestion.

[5] Liberia (europa.eu). Accessed 07.13.2021.

Table 1: Biomass estimates of pelagic fish stocks in Liberia based on R/V Dr. Fridtjof Nansen surveys in 2006, 2007 & 2017.

	Biomass estimate (tons)		
Stock	**2006**	**2007**	**2017**
Sardinella & anchovy	25,000	48,000	16,000
Carangids, scombrids, barracudas and hairtails	127,000	16,000	13,000
Total	**152,000**	**64,000**	**29,000**

Source: Boyer et al, (2017)

Biomass estimates of small and medium pelagics based on catch and effort data from 2013-2014 (MRAG 2014) and 2013-2016 (Jueseah et al 2020b) were similar, 70,000-80,000 tons for small pelagics and 25,000-30,000 tons for medium pelagics (Table 2), which is much higher than was indicated from the survey in 2017 (Boyer et al, 2017), with small pelagic stock of 16,000 tons and medium pelagics with 13,000 tons (Table 1).

Table 2: Biomass and MSY estimates of pelagic fish stocks in Liberia using catch & effort data in 2014 & 2020

Stock	**Biomass estimate (tons) 2014**	**Biomass estimate (tons) 2016**	**MSY estimate (tons) 2014**	**MSY estimate (tons) 2016**	**Stock status 2014/2016**
Small pelagic	79951	68830	17011	9520	moderately exploited
Medium pelagic	28688	25750	4912	3560	lightly exploited
Subtotal	**108,639**	**94,580**	**21,923**	**13,080**	

Source: MRAG (2014) & Jueseah et al, (2020b)

Since 2013 the catch of coastal pelagics has varied between 11,000 and 27,000 tons according to NaFAA data which is roughly four time greater than that reported by FAO (Figure 4) reflecting the lack of quality data on the Liberian fisheries. The pelagic stocks in the Liberian coastal waters have been found to be moderately to lightly exploited (Table 2).

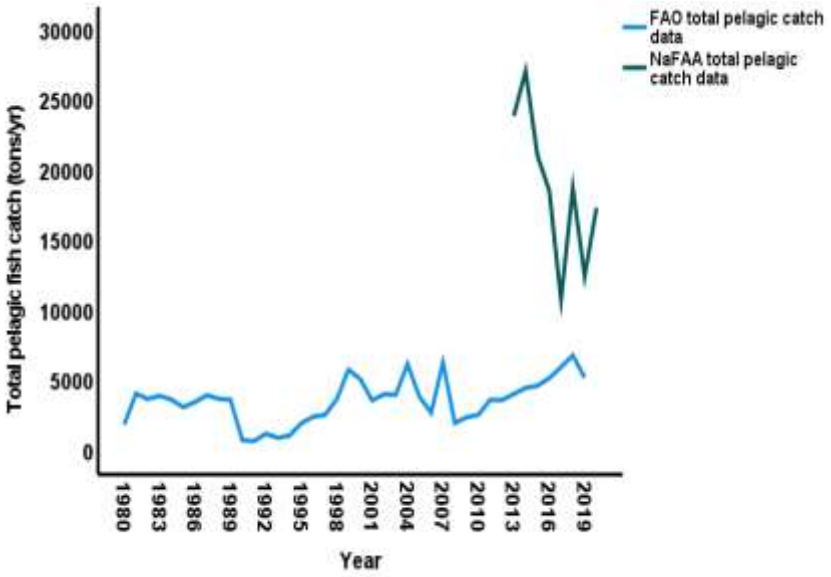

Figure 4. Pelagic species catch over time.
Sources: FAO[6] (1980-2019), NaFAA Statistics (2013-2020)

2.3.2 DEMERSAL STOCKS

The total biomass estimate for the demersal stock in the Liberian coastal waters, based on the Soviet survey in 1981 (AtlantNIRO 1981; Shotton 1983; Ssentongo 1983), was about 11000 tons (Table 3). It seems the survey was mainly carried out at depths below the thermocline. The main shallow-waters demersal species today such as cassava fish (*Pseudotolithus spp.*), butternose (*Galeoides decadactylus*) and solefish (*Cynoglossus spp.*) were not recorded and deep water demersals constituted about 90% of the biomass (Table 3).

Table 3. Biomass estimates of demersal stocks in Liberia based on Soviet R/V Belagorsk **survey 1981**

Stock	Biomass estimate (tons)
Boops boops (bream) (shallow-water)	800
Pteroscian peli (sparid) (shallow-water)	126
Penthroscion mbisi (shallow-water)	982
Dentex angolensis(deep-water)	3500
Dentex congoensis (deep-water)	3100
Pegellus coupei (deep-water)	200
Epinepheleus gigas (grouper)(deep-water)	185
Epinepheleus aeneu (grouper)(deep-water)	2010
Total	**10,903**

Source: Shotton (1983) & Ssentongo (1983)

[6] FAO Fisheries & Aquaculture - Fishery and Aquaculture Country Profiles - The Republic of Liberia. Accessed 05.25.2021.

In 1981 the biomass estimate of shallow water demersals was only about 1,000 tons, while it was about 9,000 tons for the deep water demersals. This contrasts strongly with biomass estimates for 2014 and 2016 based on catch and effort data where biomass of deep water demersals was estimated at about 3,000 tons and shallow water demersals at 12,000 – 13,000 tons (Table 4). Catch and effort data series used in MRAG (2014) and Jueseah et al, (2020b) are from periods when the coastal trawlers were in relatively poor condition and not well equipped to operate in deeper waters. The low biomass estimate may thus more reflect the status of the fleet than the state of the resource. Ssentongo (1983), based on FAO (1978) and Troadec and Garcia (1980), estimated that the potential yield of the demersal fish stocks in the Liberian waters varied between 9,000 to 15,000 tons year^{-1}.

Table 4: Biomass estimates of demersal fish stocks in Liberia using catch & effort data in 2014 & 2016

Stock	Biomass estimate (tons) 2014	Biomass estimate (tons) 2016	MSY estimate (tons) 2014	MSY estimate (tons) 2016	Stock status 2014/2020
Shallow-water demersal	12342	12870	5812	3910	over-exploited
Deep-water demersal	2952	3050	1323	900	moderately/fully exploited
Total	**15,294**	**15,920**	**7135**	**4810**	

Source: MRAG (2014) & Jueseah et al, (2020b)

In the 1980s, there was an industrial fleet targeting the demersal stocks (Shotton 1983). Total catch, however, from the industrial demersal fishery from 1957 and 2020 varied largely (Figure 5). For instance, from 1957 to 1965, it increased steadily varying between 1,080 to 6,728 tons year^{-1} but large fluctuations occurred between 1971-1979 with the highest demersal catch recorded in 1977 (Figure 5). The increase at the end of the data period (i.e. 2013-2020) is mostly due to the demersal catches of the SSF especially the Kru canoes and the new sampling scheme for the SSF as mentioned earlier. The prolonged civil war, weak administrative capacity to properly monitor the fisheries, and policy changes in the Liberia fishing industry at the end of the civil war could partly explain the large fluctuations in the trawlers total demersal catch. However, today because of the Government's zoning policy (Ministry of Agriculture 2010) only few trawlers operate in the coastal industrial fishery in Liberia (Figure 3a) (Jueseah et al, 2020b).

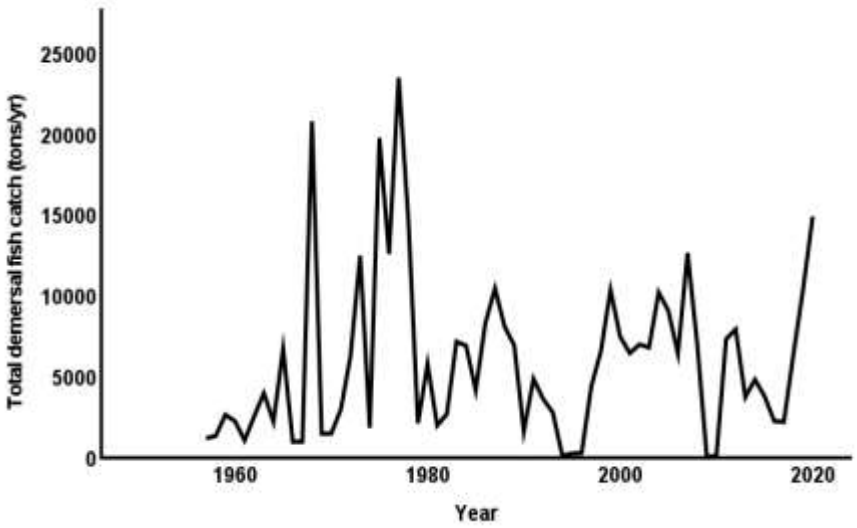

Figure 5. Total demersal fish catch of the coastal industrial fleet overtime.
Sources: Shotton (1983) (1957-65,68, 1971-79, 1981-82),
FAO [(1994-2010), 1966-67,69,70,80,1983-93, 2011-12, SSF total catch included].
NaFAA Statistics (2013-2020).

Total demersal fish catch for the trawlers between 2013 to 2020 varied from 57.3 to 3,974 tons year^{-1} (Figure 5). It is worth noting that between 2013-2016, the SSF catch of demersal fish ranged between 2,041 to 4,783 tons year^{-1} with the Kru accounting for about 85% (Jueseah et al, 2020b). Note that between 1957-1965 the total demersal catch reported by Shotton (1983) for the trawlers was on average four times the total demersal catch reported by FAO for Liberia, and between 1971-1979 it was roughly three times the total demersal catch reported by FAO. The conflicting information about the demersal resources and in particular the deep water stocks indicate a high level of uncertainty, but also the possibility that the deep water demersal resources may be more abundant than the most recent estimates indicate.

2.3.3 CRUSTECEAN SPECIES

Historical biomass estimates are scanty for the crustaceans in the coastal waters of Liberia (Ssentongo 1983). Today only a small amount of shrimp is being caught by the coastal trawlers mostly due to changes in policy in 2010, while Kru canoes catch some crabs and lobsters (Jueseah et al, 2020b). Jueseah et al, (2020b), estimated a total biomass for the crustacean including crabs, lobster, and shrimps, to be around 1,260 tons. It is worth noting that this estimate suffers similar limitations as observed with the deep-water demersal stocks. The coastal trawlers, due to the

zoning policy initiated by the government in 2010, has had no access within six miles where the coastal shrimp resources are most abundant (Ministry of Agriculture 2010).

FAO (1977) estimated the MSY of shrimp to be around 1,870 tons year^{-1}, assuming the shrimp stock was shared between Liberia and Sierra Leone (Ssentongo 1983). In 1983 potential yield of shrimp in the coastal waters of Liberia was estimated between 1,200 to 1,600 tons year^{-1} (Shotton 1983; Ssentongo 1983).

In the 1970s, there was an industrial shrimp fleet mainly targeting coastal shrimp (Shotton 1983). Total catch of shrimp increased from about 400 t in 1969 to around 1500 tons in 1974 to 1980 before collapsing in 1981 (Figure 6). The collapse of the lucrative shrimp fishery in Liberia appears to be more associated with security and political issues as opposed to a fishery collapse. It seems because the fishing company (i.e. Mesurado Group of Companies) that owned and operated the shrimpers targeting the coastal shrimp resources in Liberia was owned by the then first family, the company was forced to shut down following the 1980 military coup (Drammeh 2007).

According to Shotton (1983), the shrimp fishery during the 1970s was profitable and maximum economic profits of 14 shrimpers, catching around 800 tons year^{-1}, were estimated at around US$ 5.7 million. Today, the landed value of 800 tons of shrimp at US$ 10,200 ton^{-1}would be around US$ 8.2 million.

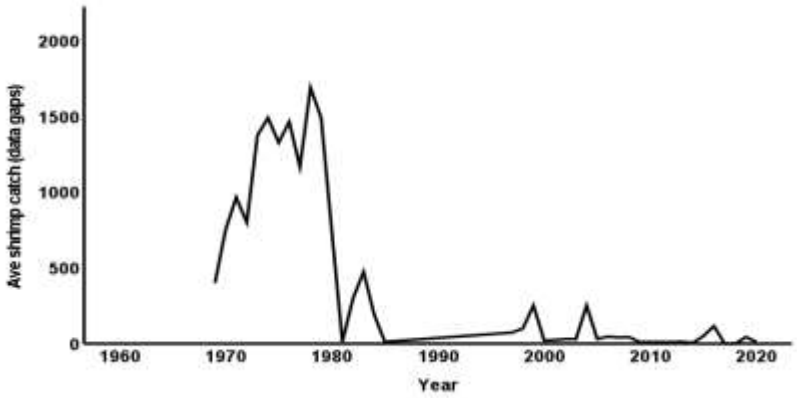

Figure 6. Shrimp fishery annual catch overtime.
Sources: Shotton (1983) (1969-83), Ssentongo (1983) (1984-85), FAO (2017) (1997-2012), NaFAA Statistics (2013-2020).

However, today there is hardly any industrial shrimp fishery operating in Liberia possibly because of the changes in policy in 2010 that restricts industrial trawling inside six nm (Ssentongo 1983). The shrimpers, in the 1970s, were allowed to trawl inside three nm, where the main coastal shrimp resources are concentrated (Shotton 1983; Ssentongo 1983). The few trawlers operating

today catch just a small amount of shrimp and between 2013-2020 total catch ranged from 0 to 116 tons year^{-1} and averaged around 30 tons year^{-1} (Figure 6).

The small-scale Kru canoes that operate inside the six nm today between 2013-2016 caught on average 343 tons year^{-1} of crustacean mainly crabs and lobsters, using gillnets and traps. It seems, therefore, the potential yield for shrimp could be much higher than the current catches indicate.

2.4 FISHERY VALUE CHAIN

The SSF value chain in Liberia is characterized by multiple actors participating in fish production (harvesting) and purchasing either for processing or for distribution and consumption (Jueseah et al, 2020a). When the weather is good the sea is calm and fishing conditions are favorable, during the dry season October-April, catches can be very high. The occasional arrival of large shoals of small pelagics in the inshore waters can lead to huge harvest and substantial increase in post-harvest activities (MRAG 2013; Jueseah et al, 2020a). Due to inadequate infrastructure, fish traders and processors don't have the means to buy and process all the landed catch typically resulting in large post-harvest losses (MRAG 2013; Jueseah et al, 2020a). On the other hand, during the rainy season May-October, unfavorable conditions strong ocean currents, heavy storms, and rainfall, inhibit small-scale operators from going to sea (MRAG 2013; Jueseah et al, 2020a). Consequently, fish supply, during the rainy season, can be six times less than during the dry season (Jueseah et al, 2020a).

In the SSF, there is little or no use of ice or chillers onboard the traditional boats which are too small to accommodate isolated boxes for storing ice and fish which leads to post-harvest loss due to spoilage (Drammeh 2007; Jueseah et al, 2021). Basic infrastructure to preserve, process and store fish onshore are also limited while onboard industrial vessels, fresh fish is packaged in cartoons and frozen to preserve the quality of the fish (Drammeh 2007). Note that the industrial fishery fish value chain is not discussed in detail, because the fishing firms are generally vertically integrated.

Generally, the actors engaged in the fishery value chain are fishermen, fish traders, who are predominantly women, and Korean traders (Drammeh 2007; Jueseah et al, 2020a). The main financiers of small-scale fishermen are the middlemen (i.e. fishers' wives and large-scale Korean

traders[7]). Middlemen provide informal loans to fishermen to purchase fishing inputs such as boats and equipment and occasionally pre-finance fishing trips (Jueseah et al, 2020a). Operational dependencies between small-scale fishermen and middlemen are commonplace in the SSF in Liberia (Jueseah et al, 2020a). Fishermen's main sponsors exercise greater power and control major portions of the total quantities of fish landed and traded (Jueseah et al, 2020a).

The fishery value chain is characterized by considerable power asymmetries and information externality. For instance, Jueseah et al, (2020a), found that Kru fishermen were unable to estimate the real costs of fishing inputs provided to them by the Koreans who take advance of their bargaining position to increase their benefits by providing fishermen with fishing inputs on credit. The lack of transparency in the value chain makes it difficult to determine the actual price fishermen obtain. This also applies to the fishermen's wives who offer support to the fishermen and pay lower price compared to prices based on market relationships (Jueseah et al, 2020a). Jueseah et al (2020a) argued that there was a quality incentive in the market that fishers were not receiving probably due to the lack of information flow along the value chain. The lack of transparency in the SSF value chains has resulted in captive hierarchical relationships and lower prices for fishermen compared with market relationship (Jueseah et al, 2020a).

2.5 GOVERNANCE OF THE FISHERIES

In this section, the fisheries management system (FMS) that is employed to manage the main fisheries and the legal basis of the system as well as the institutional framework supporting the fishing industry governance are presented. The FMS is described first followed by the description of the institutional framework supporting the sector governance.

2.5.1 THE FISHERIES MANAGEMENT SYSTEM

The overall objective of the Liberian FMS is to ensure the long-term sustainable utilization of the fisheries resources and associated environments for the benefit of Liberia (Ministry of Foreign Affairs 2019. section 2.1). The coastal industrial fisheries are managed through individual vessel catch quota, fishing licenses and technical measures such as minimum mesh size, area and gear restrictions, among others, while the SSF are managed through licensing and fishing rights such

[7] A large-scale Korean trader typically buys > 300 kg day^{-1} of cassava fish from Kru fishers and uses privately organized vehicles, to transport the fish to Monrovia, before exporting (Jueseah et al, 2020a).

as community fishing rights and territorial user rights fisheries (TURFs) as well as other technical measures like minimum size of fish, gear restrictions, among others (Ministry of Foreign Affairs 2019).

The legal framework supporting the Liberian fisheries management regime are the Natural Resources Law (1958), National Fisheries and Aquaculture Authority Act (2017), Fisheries and Aquaculture Management and Development Law (2019) and the FAPS (Ministry of Agriculture 2014). NaFAA in collaboration with the Liberian Coast Guard implements a monitoring control and surveillance (MCS) system to monitor and control all fishing activities in the Liberian EEZ (Ministry of Foreign Affairs 2019).

NaFAA operates a fisheries monitoring center (FMC) and implements a fisheries observer program to support its MCS function particularly with regard to the coastal industrial and offshore tuna fisheries, but MCS is limited in the SSF (Chu et al, 2017). The judicial system processes violations of the fisheries laws (and regulations) and issues appropriate sanctions to those judged to have broken the fisheries laws (Ministry of Foreign Affairs 2019). In 2013 Liberia generated around US$ 6 million, as administrative fines through negotiated settlements, for violations of the 2010 fisheries regulations (Chu et al, 2017).

2.5.2 INSTITUTIONAL STRUCTURE

The National Fisheries and Aquaculture Authority (NaFAA), established by an act of legislation in 2017, is an autonomous agency of government solely responsible for fisheries management and development in Liberia (National Fisheries and Aquaculture Authority Act 2017; Fisheries Management and Development Law 2019). NaFAA has a nine member Board of Directors, appointed by the President of Liberia, that serves as its governing body. The Board is chaired by the Minister of Agriculture and includes representatives from other ministries and agencies of government. There is also a 15 member Fisheries Advisory Council (FAC), appointed in 2020 by the Director General of NaFAA, based on nominations from several government ministries and agencies. The primary function of FAC is to advise the Director General on policy and related matters concerning the conservation, management, sustainable utilization and the development of fisheries and aquaculture in Liberia in accordance with international law and agreements (Fisheries Management and Development Law 2019).

Today, NaFAA is funded by revenues raised from license (access) fees, fish import permit fees, fish export permit fee, transshipment authorization (permit) and certificate fees, fines for violation of the laws and regulations, grants (or donations) among others (National Fisheries and Aquaculture Authority Act 2017). The total fisheries revenue collected is distributed between NaFAA and the Government on a percentage basis. Currently 60% of the total fisheries revenues generated remains with NaFAA and 40% is remitted to the government consolidated bank account.

NaFAA is supported by the Liberia Sustainable Management of Fisheries Project (LSMFIP), financed by the World Bank, whose objective is to improve the management and utilization of selected fisheries (World Bank 2019). LSMFIP services to NaFAA include support to strengthen and build NaFAA's capacity through improving the sector's governance framework and the national MCS functionality, and mobilization of regional technical experts who will support implementation of project funded activities at the national and community levels (World Bank 2019). LSMFIP is divided into two key components, and each consists of two sub-components for implementation of its activities at the national level (World Bank 2019). The first component is "management of selected fisheries" which includes sub-components (i) institutional strengthening and capacity building; and (ii) improving management of selected fisheries (World Bank 2019). The second component is "improving handling of fish and fish products" and includes sub-components (i) strengthening national post-harvest value systems; and (ii) support focused on women (World Bank 2019). There is a list of planned activities under these two components of LSMFIP that are expected to be financed by project funds.

At least three Co-management associations (CMAs) have been established by NaFAA, to support community-led fisheries management (Fisheries Management and Development Law 2019; EU et al. 2020) and this initiative is expected to be scaled up to support establishment of co-management and co-administration mechanisms between CMAs and the Liberia Artisanal Fishermen Association, a community-based SSF advocacy group (World Bank 2019).

3.0 CONCEPTUAL MODEL OF FISHERIES MANAGEMENT

Small scale fisheries management in the developing world has proven very challenging. Good fisheries management seems to be very difficult to achieve (World Bank 2017). Liberia is no exception. This raises questions like "what can really be managed?" and "what level of management is optimal?" One way to address these questions is to view fisheries management

from the angle of costs and benefits of management actions. Might the reason for generally poor management be that benefits of good management simply do not justify the costs?

In figure 7, revenues, biomass, and costs curves of a fishery are illustrated as a function of fishing effort according to a classic bioeconomic model. Here fishing effort may be construed as the employment of the fishing vessels, with differences in sophistications (efficiencies) to harvest, from least efficient (I) to most efficient (III). The revenues and biomass functions illustrate how different levels of fishing effort result in different points of equilibria between costs and revenues, termed sustainable biomass or sustainable revenues and costs. To achieve an equilibrium one must assume a constant environment and that the fishing fleet efficiency and price of fish remains constant.

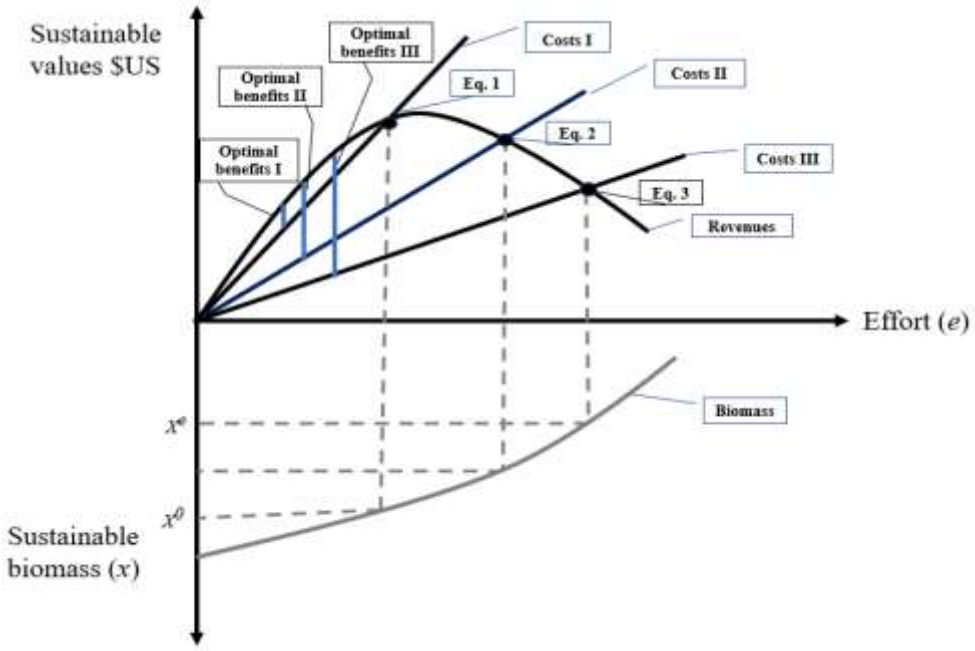

Figure 7: Sustainable fisheries model (adapted from Arnason 2009).
See text for further explanation.

The upper section of figure 7 describes the well-known sustainable fishery model adapted from Arnason (2009) but first introduced in the literature by Gordon (1954). The fishing costs are highest (i.e. costs I) the fishing fleet that is applied in the fishery is less efficient (unsophisticated) and the impact of harvesting on the biomass (natural capital) is at a minimum. As the fishing fleet efficiency increases, the costs of harvesting are reduced from costs I to costs II. If the fishing fleet gets more sophisticated the costs of fishing decline further from costs II to costs III. However,

without proper management, long term profits are still zero as competition between fishermen leads to increased effort and decreasing biomass. This may eventually lead to stock collapse if costs are sufficiently low, as it will continue to be profitable to harvest even at very low levels of biomass, as seen in the lower part of figure 7. The three vertical blue bars show the optimal net benefits, or sustainable rents, that can be obtained from the fishery at different levels of cost. Management is required to reach this, and management is not without cost. The question becomes: what is the optimal strategy for government to apply under different levels of fleet sophistication? Should it apply management or not?

Figures 8-10 are derived from figure 7 and illustrate costs and benefits curves as a function of vessel size. Vessel size may be regarded as a proxy for efficiency of the fleet characterized e.g. by the fishing power, technology, engine capacity or gross registered tonnage (GRT) of a typical fishing vessel. Figure 8 describes the costs and benefits of implementing practical fisheries management. As depicted in the figure, fisheries management cost (grey curve) is sensitive to the number and size of vessels. Managing many small and primitive vessels is much more expensive than managing few large vessels. The figure indicates that it may not be economically feasible to apply any fisheries management for the very smallest vessels because the benefits are simply not big enough to cover management cost (i.e. area A in Figure 8). The net social benefits (green curve) are less than zero, as seen by the net social benefits curve to the right of the broken vertical red line, for implementing a functioning fisheries management for these small size vessels.

On the other hand, if the vessel size is increased beyond this point (i.e. area B in Figure 8), the net social benefits for applying any practical economic efficient fisheries management are positive (green curve in area B). Note that the positive net social benefits for implementing fisheries management for large size vessels in figure 8, correspond to the net difference between the revenues and costs curves (i.e. optimal benefits and management costs) in the upper part of figure 8 (vertical blue bars in Figure 7).

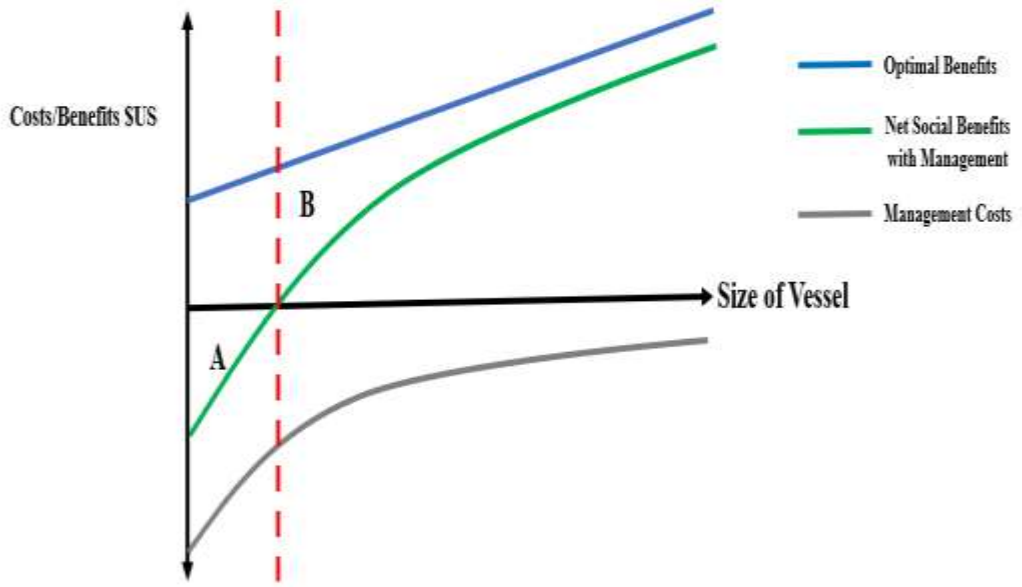

Figure 8: Conceptual model of the costs and benefits when applying practical fisheries management for many unsophisticated small-size vessels in area "A" and sophisticated big-size vessels in area "B" in a typical fishery.
Source: Author's

Figure 9 illustrates the conceptual model for not implementing any fisheries management. If no fisheries management is applied regardless of the size and number of vessels, the net benefits are zero to private operators (fishermen) (i.e. green dotted horizontal line in diagram corresponding to the open access equilibriums in figure 7). The net social cost (brown line) for no management is a reduced natural capital (biomass) (brown curve in area A). This cost increases with vessel size as natural capital stock in open access equilibrium declines, as seen in figure 7.

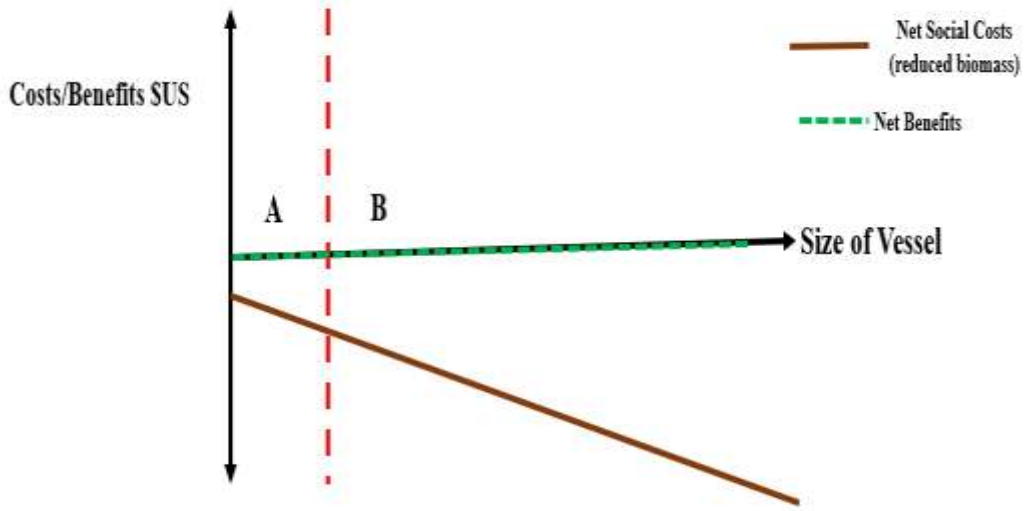

Figure 9: Conceptual model for not implementing any fisheries management derived from figure 8. Note the y-axis represents costs/benefits to fishermen and the society for no management and x-axis represents vessels size as in figure 8. In area B the vessels have become large enough to make management feasible (Figure 8). "

Source: Author's

Figure 10 illustrates the optimal choice for whether to apply economic efficient fisheries management or not, drawn from figures 8 and 9. As depicted, there are three options indicated by areas A, B and C in the diagram. It shows that the optimal strategy for the smallest vessels (area A in diagram) is no management, since the negative net social benefits (brown curve in area A) of a reduced natural capital stock, as seen in figure 9, is smaller than the negative net benefits of management, as seen in figure 8. If the size of the unsophisticated smaller vessels is increased above area A in diagram, the net social benefits (brown curve in area B) for no fisheries management is more negative than the net social benefit of management. The fishery is still a net-cost to society, but the cost is smaller with management than without management. At the other end as illustrated, if the vessel size is increased beyond area B into area C in diagram, the net social benefits (green curve in diagram) are positive for applying fisheries management. The fishery becomes a net source of revenue for society.

The optimal least-cost strategy for society, therefore, is no fisheries management as in area A, and management in areas B and C. The fishery is a net cost to society in areas A and B but a net source of revenue in area C. The best point in area A, from society's perspective, is associated with the smallest least sophisticated vessels. Area A in figure 10 is associated with better short-term employment (social outcomes) in the fisheries but low biological and economic outcomes (Danielsen and Agnarsson 2020). The best points in areas B and C are associated with larger more

sophisticated vessels. The optimal strategy for society in area A is to keep cost up, while it is to keep cost down in areas B and C. In areas B and C, the fishery should be managed to increase economic efficiency. While studies have shown that high employment is not typically associated with economically efficient managed fisheries such as ITQ fisheries (Hilborn 2007; Abbott, Garber-Yonts, and Wilen 2010; Gunnlaugsson and Saevaldsson 2016), Danielsen and Agnarsson (2020) have shown that a fishery managed successfully for better long-term economic outcomes can employ just about the same amount of people as an unsuccessful fishery and pay their fishers a higher wage. The wealth (resource rent) generated, for an economically efficient managed fisheries, can be redistributed for the rest of the society and used to fund and improved existing welfare services such as free health care and education among others (Cunningham et al. 2009; Danielsen and Agnarsson 2020). This approach to fisheries management increases value added and the sector's contribution to the GDP and growth (Cunningham et al. 2009) and has been reported to result in better biological, economic and social outcomes of the fisheries (Danielsen and Agnarsson 2020).

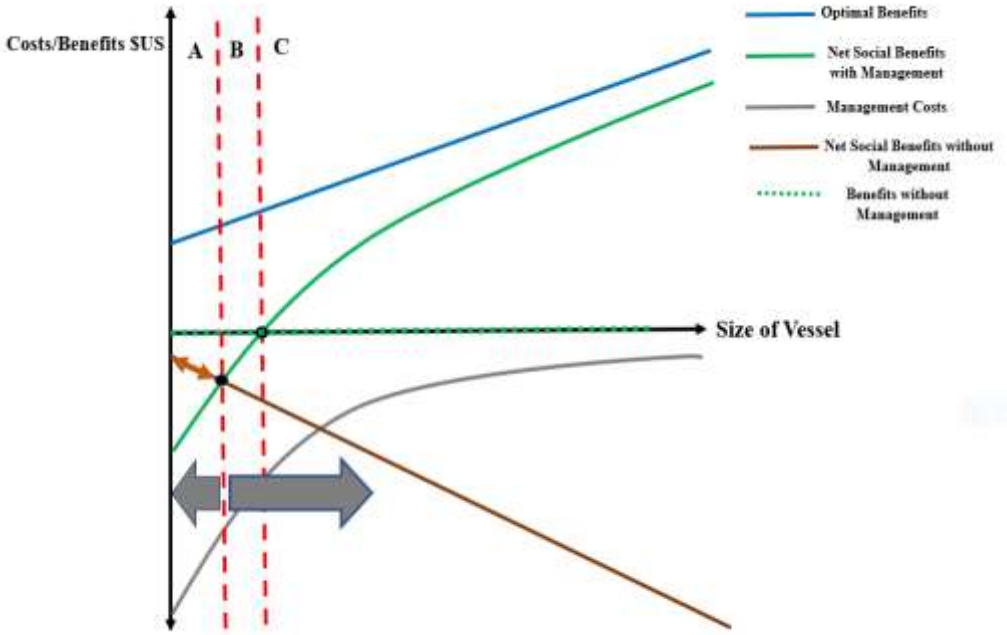

Figure 10: Conceptual model optimal choice for whether to apply economic efficient fisheries management or not derived from figures 8 and 9. Note y-axis represents the costs/benefits (US$) to private operators & the society and x-axis is vessels size. "A" represents the area for many unsophisticated small-size vessels, "B" is the area for many medium-size vessels with higher sophistication than vessels in area "A", and "C" signifies the area for large-size sophisticated vessels in a typical fishery.

Source: Author's

This may be highly relevant for the fisheries in Liberia. The small scale Kru and Fanti vessels operating in the Liberian SSF are examples of small and unsophisticated vessels (Jueseah et al, 2021). Because of their small size, Kru and Fanti can take their vessels ashore anywhere along the coast in Liberia. Operators may leave for a fishing trip and on return land their catches anyplace through informal (unregulated) channels along the coast and the departure and landing points may be different in most cases (MRAG 2013). This makes them practically difficult if not impossible to monitor, control, and manage. It seems the design and nature of the Kru and Fanti boats in terms of the small size boats, the archaic (unsophisticated) harvesting technology used (Jueseah et al, 2021), their disperse and sheer numbers as well as the unpredictable nature of their informal operations, make practical economic efficient fisheries management quite challenging. In this case, the small-scale Kru and Fanti boats fit quite well with the small size vessels description captured in the conceptual model (figures 8 to 10).

On the other hand, the industrial vessels, because of their large size and intensive scale, operate through authorized formal channels-fishing harbor, where they must depart for a fishing voyage and on return are required to land their catches. This makes the coastal trawlers relatively easy to monitor, control and manage. Arguably, the same applies to the offshore industrial tuna vessels, except that they are not currently landing their catch in Liberia due to limited capacity and the extensive operations of the tuna vessels which span several EEZs along the Atlantic Ocean. The design and nature of operation of the industrial vessels in terms of the large size vessels, the sophisticated harvesting technology typically employed, and their contained formal operation make practical economic efficient fisheries management (e.g. catch quota) (Arnason 2009) quite possible for this size of fleet. In this sense, the industrial vessels seem to fit quite well with the large size vessels described in figures 8 to 10.

4.0 FISHERIES POLICY PERFORMANCE

The key national policy documents, guiding the Liberian fisheries sector development since 2014 are the Pro-poor Agenda for Prosperity and Development (PAPD) and the Fisheries and Aquaculture Policy and Strategies (FAPS). These policy documents are reviewed to assess the performance of the fisheries sector since their adoption and make recommendations to strengthen

the performance of the Liberian fishing industry where needed. The vision and goals of the PAPD is first reviewed followed by the review of the current FAPS vision and objectives.

The PAPD goals are to build more competent and trusted state institutions and improve income security of the Liberian people (Republic of Liberia 2018). The overarching objective of the PAPD is consolidation of the peace and reconciliation efforts (Republic of Liberia 2018). The Government's vision for development of the fisheries sector is captured under the governance and transparency pillar and "increasing the competitiveness of existing industries-fisheries improvement" development outcome (Republic of Liberia 2018. page, 55). The government, under the "fisheries improvement" of the PAPD intends to "support artisanal communities to increase domestic fish supply from 8,000 tons to 16,000 tons annually by 2023" (Republic of Liberia 2018. page, 55). Government plans to facilitate private investment in the construction of a modern fishing harbor complex with facilities for repair and maintenance of fishing vessels and for storage, preservation, and processing of fish (Republic of Liberia 2018. page, 55).

Following this, the PAPD envisages increase employment and incomes, enhanced human and institutional capacity and creation of export opportunities. Government plans to tackle IUU fishing in its marine waters, to make the fishing industry viable and profitable, by establishing robust MCS systems in Liberia. The government intends to continue and expand its SFPA with the EU aiming to attract other interested and capable partners. Fishery managers at NaFAA regard the offshore tuna fishery to be a major contributor to the Government's fisheries income and therefore important to the Liberian economy. The PAPD activities is to increase fisheries contribution to Liberia's GDP from 3% in 2018 to 6% in 2023 (Republic of Liberia 2018.p 45).

While the Government's vision and goal(s) as described in the PAPD for improvement in the fisheries sector seem promising, the strategies for realizing its vision and goal(s) are not clearly outlined. It is not clear in terms of the strategies, for instance, how the government intends to support the artisanal communities to increase domestic fish supply, to achieve its fisheries improvement development outcome by 2023. For example, does the government plan to manage the coastal fisheries at maximum sustainable yield (MSY) as opposed to maximum economic yield (MEY) level i.e. produce more fish and more employment but less profits from harvesting activities? It is important to be quite clear about the management reference point such as MSY or MEY right from the outset of any management action. This is because it seems rather quite clear that the most inefficient fleet (fishery) such as the Kru and Fantis will reach an equilibrium at a

biomass below that which would sustain MSY or MEY stock levels as observed by Jueseah et al, (2020b).

Nonetheless, based on recent empirical analysis, the catch from the SSF sector alone between 2018-2020, according to NaFAA statistics, increased from around 10,780 tons in 2018 to 18,126 tons in 2019 and in 2020 it was around 26,856 tons. This represents an average annual increase of around 58% and indicates some progress towards the Government's goal for increasing domestic fish supply. This raises further question about the sustainable utilization of the fishery resources in the Liberian coastal waters

The FAPS overall goal is a "sustainably managed and economically viable fisheries that generate prosperity for the present and future generations" by 2030 (Ministry of Agriculture 2014). The FAPS has four specific objectives and 19 strategies describing pathways to achieving the objectives of the FAPS (see, Appendix 1a). Liberia has made progress in implementing the current FAPS, although its framework action plan lacked implementation costs (EU et al. 2020). There have been major improvements in the licensing and vessel registration regime, IEZ has been established to protect access of SSF and space to allow the coastal fishery resources to rebuild, inter-agency collaboration, establishment of CMAs although at early stages and routine boat registration. Furthermore, Liberia is a member (and/or cooperating non-member) of regional fisheries management organizations (RFMOs), establishment of vessel monitoring system /automated identification system tracking of fishing vessels and cooperation agreement with Liberia Maritime Authority. This indicates major improvements in international engagement on responsible fisheries (EU et al, 2020). These improvements are associated with the six strategies i.e. biomass restoration, stakeholders' participation in fisheries management, international cooperation, implementation of effective MCS and conflict management mechanism, aimed at achieving FAPS objective one "sustainable management of fisheries resources and ecosystems".

However, the current development trend of the small-scale Kru canoes (Figure 2a) in the coastal fisheries does not seem to be in line with sustainable management of fisheries resources and ecosystems as well as the accompanied strategies. The number of small-scale boats, especially the Kru canoes, is expected to continue to increase since both Kru and Fanti boats were found to be profitable at the end of 2016 (Jueseah et al, 2020b). Regulatory actions, especially for the Kru and Fanti fleets, are therefore needed to manage the fishery sustainably. Any management (regulatory) action needs to weigh the costs and benefits associated with such management action for small-

size vessels like the Kru and Fanti as illustrated in the conceptual model**.** This indicates designing an effective policy for small-scale boats is quite challenging considering the socio-economic implications.

Major improvements have been made towards policy objective three "strengthening of fisheries management and development capacities". For instance, NaFAA an independent institution was created by law, replacing the former Bureau of National Fisheries, for fisheries matters in Liberia (National Fisheries and Aquaculture Authority Act 2017). There have been improvements in human capacity and administrative processes, new detailed fisheries law has been approved (Ministry of Foreign Affairs 2019) and new draft regulations are being reviewed (EU et al. 2020). Also, some level of financial stability at NaFAA has been achieved through engagement with the EU SFPA, collection of other access fees and engagement with the World Bank (EU et al. 2020). Due to unresolved fisheries governance issue (yellow card), the SFPA between NaFAA and the EU, which expired on December 15, 2020, was not renewed. This has delved a serious blow to NaFAA's revenues according to fisheries managers and indicates a major setback to the government's intent for improvements in the fisheries sector as envisioned in the PAPD. However, discussions are still ongoing to resolve the yellow card issue and, thereafter, renew the SFPA with the EU. Human capacity persists as a major constraint, despite the improvements made so far (EU et al, 2020).

For progress made towards realizing policy objective IV i.e. "enhancement of value addition, marketing and fish trade", a fish landing site cluster has been established in Robertsport financed by the World Bank WARFP project and there are plans by NaFAA to establish new ones in selected coastal counties under LSMFIP component two i.e. improving handling of fish and fish products (World Bank 2019). Furthermore, under component two of LSMFIP, there are plans to expand the Mesurado Pier to include import and export terminals. Under this component, LSMFIP will finance fish landing sites and improvements of post-harvest processing facilities in selected small-scale fishing communities i.e. Buchanan, Greenville, Rivercess and Harper (World Bank 2019). Training and provision of financial and technical assistance to fishers on basic hygiene practices and sanitary procedures, value-addition, product branding and certification to adhere to standards and sustainability requirements are planned under this component (World Bank 2019).

It seems the needed financial resources, to implement the policy strategies associated with "enhancement of value addition, marketing and fish trade", have been secured by the Liberian

Government. On the other hand, research has shown that the SSF value chains in Liberia are typified by low value-addition services and poorly developed and that fishers receive less economic benefits in both dry and rainy seasons compared to other actors (Jueseah et al, 2020a). Jueseah et al, (2020a) argued that in order to raise fishers' benefits and increase overall efficiency in the small-scale fish value chains in Liberia, interventions such as provision of basic fisheries infrastructure and training to fishers would be needed as well as provision of microloans. While the former would serve to improve quality handling and processing in the small-scale fish value chains, the latter would serve as an alternative source of finance and help to break fishers' financial dependency on dominant middlemen and consolidate their ability to sell their fish at market prices. In this case, the planned interventions by the Government under the LSMFIP seem to be crucial steps in the right direction (World Bank 2019).

5.0 CONCLUSION AND RECOMMENDATIONS

This section concludes and summarizes the review and recommendations drawn out of this report. The conclusion is presented first, followed by the recommendations. The recommendations mostly focus on the way forward for improvements in the Liberian fishing industry.

5.1 CONCLUSION

The fishing industry is very important in the Liberian economy. Fisheries are a source of food and nutrition security, employment for several thousand Liberians, revenues, and foreign exchange for government. Fisheries catch and effort data prior to the civil war are largely unreliable although in recent years there has been improvements in the fisheries statistics. Small pelagic species are short-lived and likely to fluctuate quite a lot. The pelagic stocks in the coastal waters of Liberia annual potential yield estimate range between 13,000-22,000 tons year^{-1} and are considered to be moderately to lightly exploited. The Fanti fleet is largely profitable and mostly targeting the small pelagics in recent years, however, has remained fairly stable, perhaps due to limited availability of big trees required for their construction. Increased exploitation of small pelagics by the industrial coastal fleet may change the outlook for the Fantis and should be monitored closely.

The shallow-water demersals are found to be overexploited most probably because of the continuous increase in the number of Kru canoes in the SSF (Jueseah et al, 2020b). The Kru canoes increased in the SSF and by 2020 their numbers were around 11 times greater than what they were

at the end of the civil conflict (Jueseah et al, 2021). However, the design and nature of the Kru canoes make monitoring and controlling them quite challenging. Biomass of deep water demersals considered to be moderately exploited (Jueseah et al, 2020b) may be underestimated due to inappropriate harvesting technologies in the SSF and perhaps the relatively poor state of the coastal trawlers (Jueseah et al, 2021).

Crustacean species in the Liberian coastal waters includes shrimp, crabs, and lobsters. In the 1970s, there was a flourishing industrial shrimp fishery (Shotton 1983; Ssentongo 1983). This fishery today is nonexistent in Liberia possibly because of the 2010 policy changes which prohibits trawling within six miles where the coastal shrimp resources are abundant (Ministry of Foreign Affairs 2019). In the 1970s the MEY for the coastal shrimp resources was estimated at 800 tons for 14 vessels, valued at US$ 5.7 million (Shotton 1983). The landed value today for 800 tons of shrimp at US$ 10,200 ton^{-1} would be about US$ 8.2 million. The actual abundance and value of the coastal shrimp resources today is practically unknown. Between 2013-2020, the total shrimp catch of the few trawlers operating in Liberia averaged around 30 tons $year^{-1}$ (Jueseah et al, 2020b). The total catch of crabs and lobsters between 2013-2016 of the Kru canoes operating inside the six miles average 343 tons $year^{-1}$ (Jueseah et al, 2020b). Information on the state of these stocks is sparse.

A conceptual model used to evaluate the cost and benefit of management for different types of fisheries (fleets) indicates that the cost of management of the SSF is higher than the expected benefits. Therefore, implementing an economically efficient management for SSF may be quite difficult. This may be the reason why SSF seem generally to be unmanageable, and this phenomenon seems to manifest itself in the SSF in Liberia. The Liberian Government should consider this in its choice of management strategies and development of their fisheries sector. Still, SSF have been reported to contribute to both poverty alleviation and food security in economies of developing countries (FAO 2005). Keeping them may therefore be a necessity. In the Liberian SSF, there seems to be a substantial efficiency (Jueseah et al, 2021). Due to the open access nature of SSF, there is a problem generally that incremental developments are not likely to produce long-run net benefits for the society. Therefore, economically efficient management of many small-size primitive small-scale vessels like the Kru canoes in Liberia is simply not worth the required effort. The associated costs and benefits of management of each fishery (fleet) should be evaluated prior to a management decision taken. However, this would certainly depend on the envisaged or desired

management outcome(s) i.e. biological, social or economic efficiency, of the government for that fishery right at the outset.

Considerable progress has been made in most of the PAPD and FAPS policy areas (Ministry of Agriculture 2014, Republic of Liberia 2018). In spite of this, studies showed there is a lot more to do to improve the performance of the fishing industry (Jueseah et al, 2020a; Jueseah et al, 2020b; Jueseah et al, 2021). There are post-harvest losses in the fishery value chains due to poor handling of the catch both onboard and on land. There is lack of transparency which emerges from power asymmetries and lack of information flow in the SSF value chain. In the sections that follow, the key recommendations stemming from this review are summarized and justified as possible avenues forward for improving the fisheries sector in Liberia.

5.2 RECOMMENDATIONS

This analysis gives rise to several recommendations. The main one's are elaborated below:

5.2.1 Conduct stock and economic assessments for coastal shrimp and deep water demersal stocks

The coastal shrimp resources and the deep water demersals may be larger than previous analyses have indicated, and they are almost certainly under-exploited. It seems, therefore, worthwhile that the government look into conducting national stock assessments (survey) and economic analyses for the coastal shrimp resources and the deep water demersals to determine both stocks abundances and value of these resources. If the survey for the coastal shrimps shows the stock is abundant i.e. there is good economic quantity of the resource, then the government can determine a way to optimally exploit the shrimp stock. In this case, the management of the resource should be organized in such a way that the fishery (fleet) is manageable as argued in the conceptual model, using few well equipped vessels for the operation. The goal here is to focus on a management structure that generates greater benefits for the Liberian society. The same applies to the deep water demersals. If a survey establishes that there is economic resource (quantity) that could be exploited, the management of the resource should be arranged in such a way that the fishery (fleet) is manageable as illustrated in the conceptual model.

5.2.2 Management of the small-scale fisheries

While it has been shown that substantial benefits could be derived from management of the small-scale fleet (i.e. reducing the number of Kru canoes) in Liberia, managing small-size primitive vessels with unpredictable informal operations may not be worth the economic effort that would be required. The option to phase out the Kru canoes should be looked into due to conflict with forestry or perhaps because they are unmanageable economically. The first step could be to stop issuing new fishing licenses and registration numbers to Kru canoes. If the Kru can be phased out, the government should explore the feasibility of introducing new harvesting technology like fiberglass reinforced plastic (FRP) vessels to both increase productivity and profitability in the Liberian fishing industry. There should, however, be an economic evaluation of any option to phase out the current small-scale fleet to shed light on the socio-economic implications of this policy. There are indications that most of the Kru and Fanti boats are inefficient and lacking appropriate technologies to harvest the valuable deep-water demersals and the coastal shrimp resources in Liberia as well as the medium and large pelagics offshore. The introduction of FRP vessels might help to address the current technical regress in the fishing industry and utilize the coastal fishery resources i.e. deep water demersals, coastal shrimps, medium and large pelagics, better in Liberia. Larger and more efficient vessels, such as FRP vessels, might make it possible to improve efficiency and the quality of the landed fish. Still, if there is going to be a technological leap in the fishery, one has to remember that this leap should be within the manageable area as argued in the conceptual model. This means the vessels have to be sufficiently big so that the fishery that emerges is manageable and capable of generating greater benefits for the Liberian society.

5.2.3 Establish basic fisheries infrastructure

The absence of basic fisheries infrastructure contributes to the poor handling of the landed catch in the SSF value chain. Interventions such as provision of basic fisheries infrastructure might address issue related to poor handling of the catch both onboard and ashore and improve value-addition services in the SSF value chain. It is, therefore, advisable that the government look into establishing critical fisheries infrastructure such as ice and chill facilities, suitable sanitary facilities, and hands-on training, to enhance value-addition services in the SSF value chain.

5.2.4 Establish access to financial services

Lack of transparency in the SSF value chain has resulted in captive or hierarchy relationships and lower price and benefits for fishermen than if they were in a market relationship with the middlemen. In order to tackle the lack of transparency in the value chain, government could create access to financial services for the SSF subsector such as less demanding and restrictive microloans as an alternative source of finance and increase access to information in the value chain from end-markets to the fishermen. The establishment of a single fish selling desk that represents the interests of the fishermen might address the current lack of information. Access to financial services might also give the fishermen access to the necessary investment finance to purchase improved harvesting technologies which are needed in the fisheries to increase efficiency and profitability.

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APPENDIX 1

Table 1: Fisheries and aquaculture policy and strategies (FAPS) 2014

Objective	Strategies
Sustainable management of fisheries resources and ecosystems	i. Restoring fish biomass capacities to produce at maximum sustainable yield levels. ii. Conserving of aquatic ecosystems associated with fish production. iii. Encouraging community and stakeholder participation in fisheries management iv. Promoting International cooperation for management of shared stocks v. Implementing effective MCS mechanisms to prevent IUU fishing. vi. Developing and promoting conflict management mechanisms and structures for sustainable management of the fisheries resources.
Development of aquaculture to meet local fish demand deficits and for foreign exchange	i. Establishing the legal framework for development of responsible aquaculture. ii. Strengthening the institutional framework for development of aquaculture. iii. Setting up an enabling environment for development of Aqua- business for growth of the sub-sector. iv. Improving capacity for aquaculture promotion through human resource development and training.
Strengthening of fisheries management and development capacities for sustenance of a vibrant fisheries sector	i. Revising the legislative framework to support fisheries management and development. ii. Up-scaling the capacity of the Bureau of National Fisheries (BNF). iii. Implementing a comprehensive adaptive research program for improvement of the industry. iv. Implementing comprehensive capacity building and advisory programs for the fisheries sector. v. Promoting sustainable fisheries investments vi. Setting up sustainable funding mechanisms for fisheries development and management.
Enhancement of value addition, marketing and fish trade for improved foreign exchange earnings and employment opportunities	i. Improving economic returns through establishment of post-harvest infrastructure ii. Establishing national safety and quality assurance systems to enhance safety and quality of fish. iii. Promoting value addition, fish marketing and trade opportunities.

Source: Ministry of Agriculture (2014)