Final Report

Economic Feasibility Study Mesurado Industrial Pier and Other Fisheries Infrastructure

September 6th, 2023

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List of Abbreviations

Abbreviation	Definition
BMC	Bong Mines Company
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CAPM	Capital Asset Pricing Model
CFHF	Canoe Fishery Hub Facility
CPUE	Catch per unit effort
CSD	Cutter Suction Dredger
D	Deliverable
DCF	Discounted Cash Flow
DMAF	Dredged Material Assessment Framework
ECBA	Economic Cost Benefit Analysis
EEZ	Exclusive Economic Zone
E(S)IA	Environmental (Social) Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
E&S	Environmental & Social
FiSAT	FAO Fish Stock Assessment Tool
GoL	Government of Liberia
IEZ	Inshore Exclusive Zone
IFF	Industrial Fishing Facility
IS	International Standards
LMC	Liberia Mining Company
LRD	Liberian Dollar
LSF	Large-scale Fisheries
LSMFP	Liberia Sustainable Management of Fisheries Project
M	Meeting / Visit / Million
MCA	Multicriteria Analysis
MCC	Montserrado City Corporation
MSB	Maximum Sustainable Biomass
MSY	Maximum Sustainable Yield

Abbreviation	Definition
MTBS	Maritime & Transport Business Solutions
MV	Motor Vessel
NaFAA	National Fisheries and Aquaculture Authority
NIOC	National Iron Ore Company
NPV	Net Present Value
OPEX	Operational Expenditure
PHFL	Post-Harvest Fish Losses
POH	Polycyclic Aromatic Hydrocarbons
PPP	Public-Private Partnership
SIV	Semi-Industrial Vessel
SSF	Small-scale Fisheries
TBT	Tributylin
WACC	Weighted Average Cost of Capital
WARFP	West Africa Regional Fisheries Program

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Summary - Key Findings and Recommendations

Introduction to the Project and Assignment

The project encompasses the expansion/construction of the Mesurado industrial facility and other fisheries infrastructure The project focuses on the rehabilitation and expansion of the Mesurado Fishing Pier to a modern fishing port with onshore processing facilities for value addition. Enabling infrastructure is required to spur this development. The project is aimed at providing landing sites for industrial and artisanal fishers, and the development of shore facilities for fish auction, processing and marketing. The Mesurado Fishing Pier is located in the Freeport of Monrovia.

To support the development of the industrial fishing sector, a deep water berth is proposed at the Mesurado Fishing Pier. The purpose is to accommodate large vessels, such as industrial trawlers and refrigerated cargo vessels. Since 2015, various technical concepts have been proposed to inform decision-making in relation to the development of enabling infrastructure. We focus on two technical concepts, developed by J.A. Sciortino, which entail a concept based on the construction of a T-shaped load-out jetty with a berth platform on piles (Concept 5), and a design based on an alongside berth facility which consists of a sheet piled cofferdam at two sides (Concept 6).

The artisanal hub is envisioned to be situated outside the port basin. The development includes the construction of a bundwall, a breakwater and floating pontoons for offloading canoes. The proposed auxiliary buildings at the artisanal hub include icing halls, an administration building, retail halls, and serviced factory plots for leasing to fish processing enterprises. The artisanal hub will be run on a commercial basis and land and building structures will be made available for rent or lease to the private sector.

The objective of the Assignment is to determine the economic and financial feasibility of the envisioned the fishery hub project at the Mesurado Pier in Monrovia. Key components to determine economic and financial feasibility include cash flow projections, sensitivity analyses to key internal and external parameters and constraints, and the investment's impacts on the economic objectives of the country. The overall goal comes with several sub-objectives which are to obtain an understanding of the scale of the investment required to develop the fishery hub at the Mesurado Pier and to provide the decision makers within the Government of Liberia and the World Bank with the required baseline information and possible financing structures to justify the proposed investment.

Key Findings

The Liberian fishery sector includes artisanal and semi-industrial fisheries. Artisanal fisheries account for the majority of the landed fish volumes and vessel fleet. The artisanal fishery sector predominantly consists of artisanal fishers that operate Kru vessels, which are wooden dug-out non-motorized canoes. The artisanal Fanti vessels are larger open wooden boats. Industrial fishery includes boats that can sustain longer trips, catch more fish and target deeper waters.

The rationale for developing an artisanal hub is to improve the livelihoods of local fishing communities, by providing artisanal fishermen with access to good quality and affordable fishing input. It is expected that this will lead to a reduction of post-harvest fish losses, thereby increasing the quality and quantity of fish and fish products. Artisanal fisheries experience a lack of access to good quality materials and equipment. An artisanal fishing facility in the Montserrado country could play an important role to improve operations, e.g. by providing better communications (radios), lifejackets and vests, cool boxes and ice, and other equipment such as spare engine parts and fishing nets.

The purpose of the industrial hub is to provide large commercial vessels with a port of call in Liberia to land their catch. It is expected that this enabling infrastructure will increase the local supply of fish. In addition, it allows for the modernization of the domestic fleet. Due to a lack of port infrastructure, large vessels cannot land their catch in Liberia. Currently, a total of six industrial vessels have obtained a license to fish in Liberian waters. Only four vessels are able to land their catch in the Freeport of Monrovia. The other two vessels are larger and cannot call at Liberian ports. Instead, they deviate to neighbouring countries.

Since 2013, the landed catch from Liberian waters has increased from ca 16,000 tons to 28,600 tons. The increase can mainly be attributed to the increase in artisanal Kru vessels. The growth of Kru vessels has led to increased fish catch, while Fanti vessels, despite experiencing a decline in numbers, have demonstrated improved efficiency resulting in elevated catch levels. Industrial vessel operations have remained stable, contributing variably to the total fish catch. The years 2017, 2018, and 2019 displayed above-average fish production, primarily due to significant increases in the capture of large pelagic species.

The maximum sustainable yield (MYS) for Liberia is estimated at 25,000 tons per annum. To ensure the long-term profitability of the sector, overexploitation of fish stocks should be avoided. The MSY for a fish stock is the largest catch that can be taken from a population over an indefinite period without depleting the stock's ability to reproduce and replenish itself. I.e., it represents the optimal harvest level that allows for the long-term maintenance of the fish population at a relatively constant size.

The current overfishing observed in Liberian waters highlights the urgency of addressing unsustainable fish catch levels that surpass the maximum sustainable yield. The impact of overfishing is particularly evident among shallow-water demersal fish species. To mitigate this, the proposed fish quotas aim to reduce Kru vessels, the main contributors to the overfishing issue, while promoting industrial fishing activities. The envisioned shift towards semi-industrial vessels, informed by stakeholder consultations, seeks to support long-term marine resource management and sustainability. The fish quotas are aligned with the gradual vessel transition, aimed at facilitating long-term sustainability and effective marine resource management within the Liberian fishing sector.

The feasibility assessment is based on the discounted cash flow method. The financial and economic indicators used are the internal rate of return and the net present value. A WACC of 9.7% is used as hurdle rate for financial feasibility, while a social discount rate of 7.1% is applied as hurdle rate for economic feasibility.

The project is economically feasible, while the results of the financial feasibility assessment indicate that the fishery project is financially unfeasible in case the design of Concept 6 is applied. However if the design of Concept 5 is applied, the upfront investment costs are limited and the financial net present value becomes positive. The estimated upfront investment costs for the industrial hub are USD 15.7 M for Concept 6; and USD 6.2M for Concept 5. The investment costs for the artisanal hub are USD 8.8 M. The summary results of the financial and economic feasibility assessment are summarized in the table below.

Financial feasibility summary results; applied WACC is 9.7%

	Project		Industrial		Artisanal	
Design concept	**FNPV (M USD)**	**IRR (%)**	**FNPV (M USD)**	**IRR (%)**	**FNPV (M USD)**	**IRR (%)**
Con 5: T-jetty design	USD 4.3 USD	13.1%	USD 10.1 USD	23.2%	USD -6.6 USD	0.0%
Con 6: platform design	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.6 USD	0.0%

Economic feasibility summary results; applied SDR is 7.1%

	Project		Industrial		Artisanal	
Design concept	**ENPV (M USD)**	**EIRR (%)**	**ENPV (M USD)**	**EIRR (%)**	**ENPV (M USD)**	**IRR (%)**
Con. 5: T-jetty design	USD 47.9 USD	40.9%	USD 34.0 USD	49.8%	USD 13.9 USD	29.8%
Con 6: platform design	USD 39.9 USD	26.6%	USD 25.8 USD	25.1%	USD 14.0 USD	30.4%

Further sensitivity analysis was applied to test the robustness of the fishery port project outcomes under different circumstances. The modelled results are sensitive to changes in the capital expenditures, which highlights the risk of cost-overruns to the feasibility of the project. A potential upside lies in imposing a tax on the economic rent and utilizing these funds for the development of the fishery hub. In our analysis, it is tentatively assumed that 30% of the fish catch's market value qualifies as economic rent. Notably, the project becomes feasible when 4.5% of the economic rent is taxed and used for the project, emphasizing the impact of even a relatively modest tax on the project's financial feasibility. This is an important insight for decision-makers, as this provides the baseline necessary to support the project's profitability.

Although the industrial hub shows a positive business case in the financial analysis, the artisanal hub is not financially viable on its own, as its generated income is not enough to cover the loan repayment obligations for the project. It is important to note that the industrial and the artisanal project cannot be taken as two separate projects. While the industrial hub can function independently, simultaneous development of the artisanal hub offers a chance to repurpose dredged materials for land reclamation

Key recommendations

As the project is economically feasible, we advise the Government to implement the fishery project and proceed to the development and implementation of the project, subject to further confirmation through comprehensive and detailed studies. Furthermore, the results of the financial feasibility assessment indicate that the fishery project is financially unfeasible in case design concept 6 is applied, as it is unable to meet its loan repayment obligations without external financial support. To ensure the project's feasibility, we recommend to prepare a detailed financial plan during the next project stage.

We recommend a combination of external financial support, involving both a loan and a grant, to address the larger financial obligations of the artisanal hub and ensure the successful implementation of the overall project. The financial analysis reveals that the generated income of the industrial hub is expected to be sufficient to cover its loan repayment obligations without external financial support. However, the artisanal hub is not financially self-sustaining, though it can cover its operational costs.

Based on the combination of economic feasibility and financial challenges identified in this study, we propose the NaFAA and the World Bank to collaboratively engage in strategic planning By addressing the financial constraints through external support and emphasizing the project's economic viability, the fishery project can be an important step towards promoting sustainable fisheries and contributing to the economic development of Liberia.

Design concept

We suggest developing both the industrial and artisanal hubs simultaneously, as it allows for efficient utilisation of dredged materials for land reclamation and maximizes economic benefits to local fishing communities. Though the industrial hub can be developed as a stand-alone initiative, the dredged materials need to be disposed of. Developing the artisanal hub in parallel provides an opportunity to use (part of) the dredged materials for the reclamation of land. Also, developing the project in multiple phases increases the mobilization and supervision costs of contractors. Moreover, the economic analysis points out that the artisanal hub provides substantial economic benefits to local fishing communities.

To cater to the future needs of the local fisheries, we recommend that the design concept includes the following infrastructure components and auxiliary services: a breakwater, a marine store, ice-making facility and fuel depot to provide good quality and affordable fishing inputs; and a wet fish market to connect fishermen with local buyers. The artisanal hub must have a breakwater that provides protection against currents, waves and storm surges, enabling local fishermen to launch and land their vessels in a safe manner. Furthermore, local fishermen require access to good quality and affordable fishing inputs. Therefore, a marine store, ice-making facility and fuel depot are recommended. In addition, a wet market (or fish auction) is envisioned to better connect local fishermen with buyers. By developing a fish market at the artisanal hub, an incentive is provided to offer high quality products that can be sold to the highest bidder.

Based on our analysis, we advise developing a platform (Concept 6) rather than a T-jetty (Concept 5) for the industrial hub. Developing a deep water berthing platform is the most expensive element of the design concept. A T-jetty can be considered to lower the costs. However, from an operational point of view a platform is more desirable. Compared to Concept 5, Concept 6 includes more landside area which can be made available to support operations. Having more space improves the safety and efficiency of the (un)loading operations. This makes Concept 6 more 'future-proof'. At this stage of the project planning, it is difficult to quantify these benefits to allow for a better comparison between the relative merits of Concept 5 and Concept 6. However, as Concept 6 is financially feasible under the assumptions that are developed over the course of this assignment, we advise that if this Project is further developed, Concept 6 is used as the basis for the design of the industrial hub.

Public-private partnerships

We advise the Government to prepare a competitive PPP transaction (procurement) process to attract the best possible financial value from the project's business case. To develop this project, a project delivery method should be selected that formalizes the engagement between the owner and other parties. A particular delivery method is a public-private partnership ("PPP"). The terms of a PPP are typically set out in a contract or agreement to outline the responsibilities of each party and clearly allocate risk.

We recommend considering a Build-Operate-Transfer (BOT) project, as it aligns with NaFAA's aim to attract a private operator and is commonly utilised for developing greenfield assets. A BOT project grants the private sector the right to develop and operate the facility for a specified period, which is typically used for projects that would otherwise be public sector projects.

Through market sounding exercises, important feedback from the lender community can feed into the detailed financial planning and design phase. The lending market and the appetite of lenders can vary over time, due to a host of factors. These include legal and regulatory matters, global interest rate regimes, and capital market conditions. As such, bringing lenders' feedback on board can be very useful to make the project bankable. Following the new findings obtained during a detailed design stage, the financial feasibility study as performed by MTBS should be re-evaluated. Subsequently, the Government of Liberia should make an informed decision whether or not to go to market with the project as a PPP.

Risk assessment

We propose conducting a comprehensive fish stock assessment to mitigate the demand risk of the project, which is directly related to fish production. The data gaps and data quality presents challenges for rigorous estimation of the maximum sustainable yield of the fisheries at species level. Undertaking a new assessment will provide crucial information to establish the maximum sustainable yield and reduce uncertainty in the project's demand projections. Additionally, this data is essential for formulating appropriate fishery policies to ensure sustainable fishing practices in Liberian waters.

Our recommendation to NaFAA is to carefully plan the artisanal hub and engage relevant stakeholders from the outset. During consultations, artisanal fishers expressed their preference for upgrading and improving the fishing facilities in their own areas. Involving stakeholders in the planning process reduces the risk of dissatisfaction and resistance to the project.

To mitigate capex and opex risks of the project, we advise conducting follow-up studies for detailed design and contract/tender documentation. Overall, the reference studies provide a good starting point for the development of the Mesurado Fishing Pier. More studies are required to address the identified data hiatuses with regards to the construction of the project. Key identified risks and uncertainties include handling of contaminated dredged material, the location of onshore deposits for dredged material, the availability of dredging equipment, permitting, specifically for the canoe hub facilities and disposal sites, the lay-out of the canoe hub with respect to sedimentation within the port basin and the related maintenance dredging, and the involvement of local construction contractors.

We recommend conducting a detailed Environmental and Social Impact Assessment ("ESIA") for the fishery project development to identify local environmental and social costs. An ESIA plays a key role in reducing project risks. By conducting a comprehensive assessment of the environmental and social impacts early in the project development phase, potential risks and challenges can be identified and addressed proactively.

Sustainability of project results

We recommend investigating a micro-credit scheme to stimulate entrepreneurship among small-scale artisanal fishermen and enable them to invest in improved fishing boats, such as semi-industrial vessels. There is an expectation that by developing enabling infrastructure, the domestic fisheries sector is stimulated to modernise. However, a lack of access to finance impedes small-scale artisanal fishermen to invest in improved fishing boats (such as semi-industrial vessels). This initiative aims to modernize the domestic fisheries sector and improve access to finance for fishermen, fostering growth in the industry.

Additionally, we advise encouraging business people to invest in the enhancement of the provision of essential goods and services to coastal fishing communities. These business entities can buy, process, distribute and market the fish landed by these fishermen and employ the women fish processors and marketers in these landing sites, so as to develop and improve the fish value chain and create onshore job opportunities in the sector.

We propose the implementation of a fishing quota system in Liberia to address the issue of overfishing in its waters. By introducing a fishing quota system, the amount of fish that can be caught is regulated, ensuring the long-term viability of the fishery sector. Shifting a portion of the catch from Kru and Fanti vessels to industrial vessels can enhance the sustainability, profitability, and efficiency of the fishery sector in Liberia. This strategic approach can optimise the utilisation of resources while promoting responsible fishing practices.

Further actions

To address the data gaps identified, we recommend the development of tender documents to engage consultancy services for conducting specialised studies and assessments still required for the project development. These studies will offer valuable insights and data crucial for informed decision-making and effective project planning. By proactively filling these gaps, the project can enhance its overall feasibility and ensure a well-informed approach to implementation.

Furthermore, we advise to engage in discussions and negotiation with the World Bank to secure the necessary financial resources for the project. As the project is currently economically feasible but not financially feasible, a well-structured financing plan should be established to enhance project feasibility.

We suggest to acquire all necessary permits, approvals, and regulatory clearances for the implementation of the project. Ensuring compliance with legal and environmental standards is crucial for the successful completion of the project. Proactively obtaining these permissions will help avoid delays during the project's execution. The government plays a key role in facilitating acquiring the permits. By ensuring that the necessary permissions are obtained in a straightforward manner, the government contributes to project efficiency and prevents unnecessary delays.

It is recommended to create a project management team with the expertise and knowledge to execute the project efficiently. This will ensure that the project stays on track and meets its objectives. For the implementation of a successful public-private partnership, it is key to have the necessary knowledge. If such expertise is not available internally, seeking guidance from experienced consultancy services is recommended to ensure an efficient project execution.

1 Introduction

1.1 Introduction to the Assignment

The Republic of Liberia is a country on the West African coast. It is bordered by Sierra Leone to its northwest, Guinea to its north, Ivory Coast to its east, and the Atlantic Ocean to its south and southwest. Liberia has a coastline of 579 km. Along this coastline, numerous fisheries are located, including artisanal and (semi-)industrial fisheries. The fishery sector provides a means of livelihood and a core source of proteins and essential micro-nutrients for the population in Liberia, which is heavily dependent on fish as a source of protein intake. Yet, despite the economic, social, and environmental importance of Liberia's marine fish resources, they were unsustainably exploited, preventing them to make a greater and durable contribution to economic growth, poverty alleviation, and food security.

The Government of Liberia ("GoL"), with support from the World Bank through the closed West Africa Regional Fisheries Program ("WARFP"), has rebuilt the fish stocks to recovery status thus significantly increasing landings by artisan fishers. Weak fisheries governance and management were contributing to overfishing, illegal fishing, dissipation of resource rent, and depletion of fish resources. To harness the benefit from the resources to increase revenues, improve income and food security, GoL is seeking further assistance from the World Bank to support the development of the sector, with the objective to improve the management and utilization of selected fisheries. Through a follow up of the Liberia Sustainable Management of Fisheries Project ("LSMFP"), GoL aims to increase the overall wealth generated and captured by Liberia through better management of marine fisheries.

Fisheries in Liberia can broadly be split into two types: artisanal and semi-artisanal coastal fisheries, which make up around 86 % of fisheries in the country; and industrial fisheries. The National Fisheries and Aquaculture Authority ("NaFAA") reports that artisanal fisheries yielded 23,735 tons of fish in 2023; and industrial trawlers yielded 4,905 tons of fish in Liberian waters in the same year (total of ca. 28,639 tons). One of the main limiting factors in realising the potential of Liberia's fisheries are the civil wars the country faced from 1989 to 1997, and 1999 to 2003. The war caused damage to piers and port facilities, and ports have not been dredged since the war. This makes it impossible for larger vessels to dock, and the costs of dredging continue to increase the longer time goes on. This is one reason why it is not possible for larger commercial vessels that fish in Liberia's Exclusive Economic Zone ("EEZ") to unload their catch in Liberia, instead heading to other west African nations (e.g. Sierra Leone, Cote d' Ivoire). Currently, Liberia has no site for industrial fishing vessels to unload.

Furthermore, the profitability of the seafood industry in Liberia is limited by lack of roads, infrastructure, ice supply, and poor post-harvest practices. Poor handling practices and shortage of ice, both onboard artisanal vessels and onshore, result in losses in the quantity and quality of products. Although there are currently no available data on post-harvest fish loss in Liberia, one-third of reported catches are said to be wasted in various parts of the seafood value chain globally.

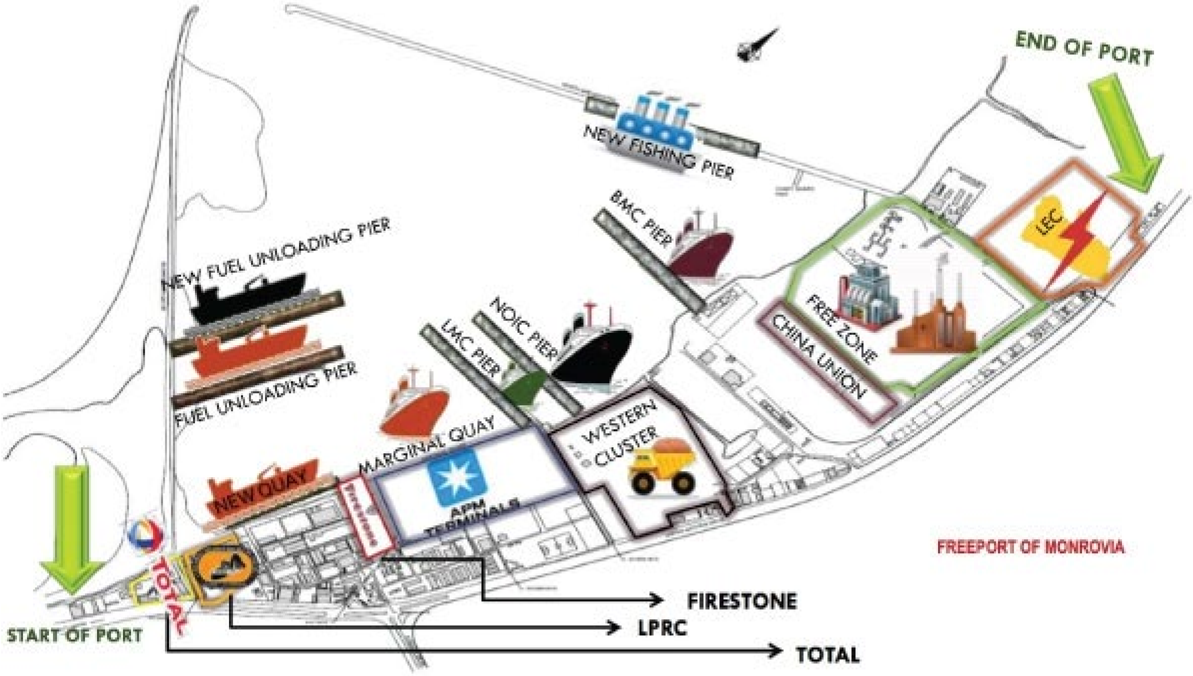
1.2 Project Background

As part of the LSMFP, tender No. LR-NAFAA-162601-CS-CQS was issued concerning the provision of "Consulting services to conduct Economic Feasibility Study for expansion/construction of the Mesurado industrial facility and other fisheries infrastructure" (the "Project"). Maritime & Transport Business Solutions ("MTBS", or the "Consultant") was appointed by the National Fisheries and Aquaculture Authority (NaFAA, or the "Client"), to conduct the Project.

The Project focuses on the rehabilitation and expansion of the Mesurado Fishing Pier to a modern fishing port with onshore processing facilities for value addition. The Mesurado Fishing Pier is located in the Freeport of Monrovia. The figure below provides an overview the port. The Freeport of Monrovia is a landlord port that has concessions partnerships with APM Terminals, Firestone, China Union, and Western Cluster. It is the largest port within Liberia.

Currently, the harbour at the Freeport of Monrovia is protected by two rock breakwaters approximately 2,300 meters and 2,200 meters long, enclosing a basin of 300 hectares of protected water. The marginal wharf (main pier) is 600 meters long and capable of berthing 3 to 4 ships, dependent on the vessel size. The Freeport of Monrovia also has three finger piers: Liberia Mining Company ("LMC"), National Iron Ore Company ("NIOC"), and Bong Mines Company ("BMC") Piers.

Figure 1-1: Overview of the Freeport of Monrovia



Source: National Port Authority (NPA), Liberia

The Mesurado Fishing Pier is situated along the Northern Lee Breakwaters. To the south, the harbour is shielded from the Mesurado River by a long (semi-) natural headland. To the north, the Northern Lee Breakwaters extend almost 2 km towards south-west, leaving only a narrow outlet to the Monrovia Bay.

As part of WARFP, technical design concepts and cost estimates have been prepared to inform the rehabilitation and expansion of the Mesurado Fishing Pier. These are presented in the following studies (so-called reference studies) and have been carried out by J.A. Sciortino, being:

- Reference 1: WARFP II (P162343) Liberia: Infrastructure needs assessment (March 2018);
- Reference 2: WARFP II (P162343) Liberia: Feasibility Study Mesurado Deep Water Berth (October 2020);
- Reference 3: WARFP II (P162343) Liberia: Investment Concepts for Mesurado (October 2020).

Section 3 of this report provides further information on the reference studies and the technical design concepts for the Mesurado Fishing Pier. MTBS will use the data presented in these reference studies for the preparation of the Economic Feasibility Study. The unit rates presented in these three reports will be used and adjusted (if applicable) using the inflation rates.

1.3 Objective of the Assignment

Any port project, no matter what size, needs to be financially and technically justified if it is going to be planned, designed and managed in a sustainable manner in harmony with the surrounding environment. Technically, the justification must be backed up with reliable data pertaining to: the fish stocks to be harvested; the methods of fishing to be employed (environmentally sustainable); the technical feasibility of the proposed or chosen site (environmentally sustainable); the financial feasibility of the entire project (including port, services, access roads); and fisheries management programmes concerning fleet development.

Therefore, an economic and financial analysis is required to determine the scale of investment for developing the enabling infrastructure at the Mesurado Fishing Pier.

Key components to determine economic and financial feasibility include:

- Cash flow projections, including the revenues, operating expenses and capital expenditures
- Sensitivity analyses to key internal and external parameters and constraints
- The investment's impacts on the economic objectives of the country

The objective of the assignment can be formulated as follows:

The objective of the Assignment is to determine the economic and financial feasibility of the envisioned construction / expansion of the fishery hub at the Mesurado Pier in Monrovia aimed at providing landing sites for industrial and artisanal fishers, and the development of shore facilities for fish auction, processing and marketing.

The overall goal comes with several sub-objectives which, in the view of the Consultant, are to: (i) obtain an understanding of the scale of the investment required to develop the fishery hub at the Mesurado Pier; (ii) provide the decision makers within the Government of Liberia and the World Bank with the required baseline information and possible financing structures to justify the proposed investment.

It is assumed that the outcome of this feasibility study will enable decision-making in order to prepare the detailed design and tender/contract documentation of the proposed works.

Project Phases

The Consultant envisages four phases for the Assignment, each with a sub-objective facilitating the fulfilment of the overall Project objective:

- **Phase 1 – Inception:** Confirm the objectives of the feasibility study and agree on the approach and timing of carrying out the key tasks. The Consultant will conduct a site visit to understand the project context and to speak to key project stakeholders.

- **Phase 2 – Diagnostics:** Generate all required information to assess the feasibility, economic and financial, of the proposed fishery hub investment at the Mesurado Fishing Pier.

- **Phase 3 – Feasibility:** Determine the technical & operational specifications of the Mesurado Fishing Pier and in turn determine the financial, economic and institutional feasibility of the project.

- **Phase IV – Finalization:** Finalisation steps include the processing of any final comments, identifying the way forward as well as providing full disclosure on any data used in the assessment.

1.4 Objective of the Report

The purpose of this Report is to provide a comprehensive overview of the technical and operational specifications of the Mesurado Fishing Pier project, along with the key findings from the feasibility study. The insights and conclusions presented in this report serve as inputs for the decision-making process of the Government of Liberia and the World Bank. With the necessary baseline information and potential financing structures, this report substantiates the rationale behind the proposed investment and offers guidance for future actions.

1.5 Reading Guide

This section presents the reading guide for the remainder of the report.

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2 Sector Background

2.1 Introduction

Liberia possesses a coastline that stretches 579 km, with a continental shelf ranging from 16 to 56 km wide and averaging 34 km (Ssentongo, 1987). Additionally, the country has an exclusive economic zone (“EEZ”) covering approximately 246,000 km2. The fishery resources in this region are currently utilized by offshore and coastal fleets. The estimated potential yield is around 40,000 tons per year (Ssentongo, 1987; MRAG, 2014), but the actual catch between 2013 and 2016 averaged about 26,700 tons. This means that the fishery sector seems to be underutilised.

Around 58% of Liberia's population resides in coastal communities. Traditionally, these communities rely heavily on fish. Circa 80% of their animal proteins come from aquatic sources. However, per capita fish consumption is among the lowest in west Africa, at 11.42 kg per capita annually (NaFAA, 2020). This is partly because local supply does not meet demand. Consequently, Liberia is an importer of fish and fish products. All else unchanged, the import dependency on fish and fish products will increase as the population continues to grow. Inefficiencies and high post-harvest fish losses (“PHFL”) contribute to the underutilisation of the fishery resource potential. PHFL result in nutrient and economic losses in the entire supply and value chain. For small-scale fisheries, this loss is estimated at ca. 25 %.

Liberia’s fishing sector can be roughly divided into two types: small-scale fisheries (“SSF”) and large-scale fisheries (“LSF”). The SSF fisheries sector predominantly consists of artisanal fishers that operate the ‘Kru-style’ wooden dug-out non-motorized canoes with 1–5 crew members. In addition, bigger motorized canoes of 12-20 crew and outboard engines are used. Beaches provide landing sites from where the canoes depart to the fishing grounds. Reportedly, the canoes used by artisanal fishers can go missing in the ocean. Moreover, adverse weather conditions prevent local fishermen from sailing out; whereas high ambient temperatures force fishermen to return to shore to land their catch before spoilage occurs. For artisanal fisheries and livelihood support, there is a need for technical and infrastructure improvements to enhance safety and reduce post-harvest losses. According to the Environmental Justice Department (2012), artisanal fisheries experience a lack of access to good quality materials and equipment. An artisanal fishing facility in the Montserrado country could play an important role to improve operations, e.g. by providing better communications (radios), lifejackets and vests, cool boxes and ice, and other equipment such as spare engine parts and fishing nets. A key objective of the Project is to decrease PHFL for the SSF sector, thereby increasing the local supply of fish and fish products.

The LSF, or coastal industrial fishery, include boats that can sustain longer trips, catch more fish and target deeper waters. However, due to a lack of port infrastructure, large vessels cannot land their catch in Liberia. Currently, a total of six industrial vessels have obtained a license to fish in Liberian waters. Out of these vessels, only four vessels are able to land their catch in the Freeport of Monrovia. The other two vessels are larger and cannot call at Liberian ports. Instead, these vessels deviate to neighbouring countries. Wuor and Mabon (2022) explain that civil wars caused damage to piers and port facilities. Moreover, ports have not been dredged since the war. This makes it impossible for larger vessels to dock. To accommodate industrial vessels and to support the development and modernization of the Liberian fishing fleet, there is a need to rehabilitate the fishing port infrastructure. An industrial hub in the Montserrado country could provide a port of call for (semi-)industrial vessels. As such, another key objective of the Project is to spur the sustainable development and modernization of Liberia’s (semi-)industrial fishing fleet, thereby increasing the catch of fish species in the EEZ, such as large pelagics and deep water demersals.

2.2 Policy, Legal and Administrative Framework

Liberia's fishing policies and legal framework are designed to promote sustainable resource management, prevent overfishing, and protect marine ecosystems. This is done through licensing, monitoring and regulation of fishing activities. Examples of this are the Inshore Exclusion Zone (IEZ) and the Exclusive Economic Zone (EEZ). The zones regulate certain types of fishing and enable international trade. Liberia's policies aim to sustain economic growth while ensuring long-term viability of its fisheries. However, current policies could be adapted to increase the profitability and sustainability of the fishing sector.

- **Inshore Exclusion Zone (IEZ)**
  In 2010, the Liberian government established a 6 nautical mile Inshore Exclusion Zone (IEZ) to regulate fishing activities. Within this zone, no industrial fishing activities are allowed, to prevent overfishing. However, the establishment of the IEZ has caused an imbalance in the regulation of the SSF and the LSF. The industrial fishery is strictly regulated, while the SSF has open access. Consequently, since establishing the IEZ, the SSF fleet has increased, whereas the industrial fleet has decreased.

- **Exclusive Economic Zone (EEZ)**
  Liberia has an exclusive economic zone, which extends up to 200 nautical miles from its coastline. The government established policies to manage fishing activities within this zone and collaborates with neighbouring countries on issues related to shared fish stocks. This zone is a valuable area that contributes to national development and economic growth.

- **Legal Framework**
  The Fisheries and Aquaculture Law is the primary legislation governing fisheries management in Liberia. This law provides the legal basis for the conservation, management, and development of fisheries resources. It establishes the responsibilities and powers of the National Fisheries and Aquaculture Authority (NaFAA), the government agency responsible for fisheries management and regulation.

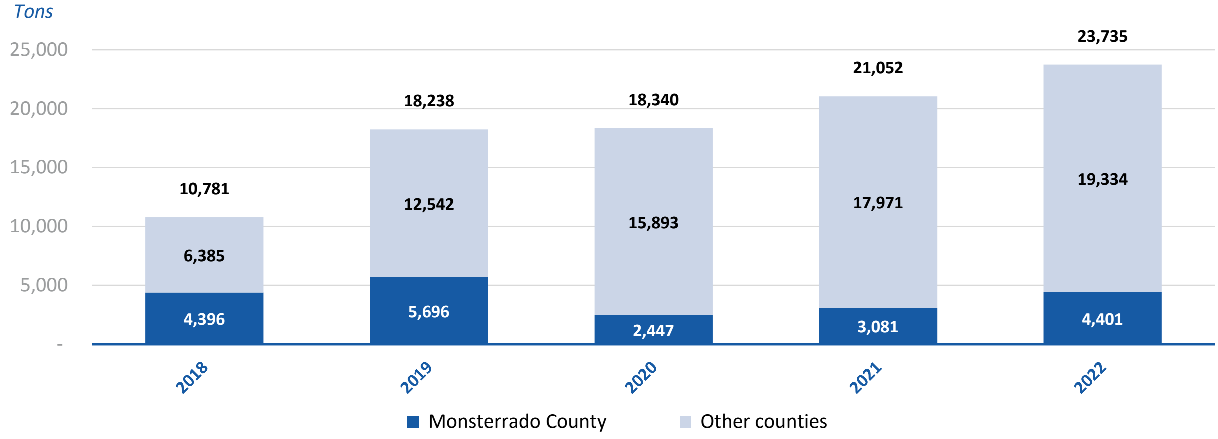
- **Licensing and vessel registration**
  All fishing vessels, both artisanal and industrial, operating in Liberian waters are required to obtain licenses and register with NaFAA. Licensing ensures that fishing activities are carried out within the framework of regulations and allows for monitoring and control of fishing effort.

- **Illegal, unreported and unregulated (IUU) fishing**
  While Liberia has been working hard to regulate fishing activities, the NaFAA estimates that 33% to 50% of fish catch is still landed illegally. IUU fishing can have significant economic, environmental and social consequences. The main consequences include: overfishing, loss of revenue and environmental damage.

2.3 Socio-economic Status of Fishing Communities in Project Area

Fisheries contribute to approximately 10% of the country's GDP (Belhabib et al., 2015). As such, it is an important pillar of the economy and the livelihood of coastal communities. Fishing in Liberia has strong cultural roots among coastal communities. Traditional fishing practices passed down through generations not only provide food but also preserve cultural identities and promote social unity within these communities. The sector comprises various skills and activities, such as fishermen, fish processors, traders, boat builders, and net makers. This involvement generates economic benefits for local communities, as the sale of fish and related products improves the local economy and enhances the overall income of fishing communities.

Figure 2-1: Historic fish volumes in Montserrado County and Liberia



Source: NaFAA

The development of the Mesurado Fishing Pier has the potential to modernize the Liberian fishing sector and improve the livelihood of local fishing communities. It is expected that by rehabilitating port infrastructure and construction an artisanal fishing facility, various societal benefits may be realised. A fishing port acts as a central hub. This has the potential to enable better regulation and administration. By consolidating the activities, monitoring of catch becomes easier. Improved administration and documentation systems can be set-up to enhance the traceability and transparency of the fishing process. This is an important step to counteract illegal, unregistered and unregulated fishing.

Secondly, an investment in infrastructure, equipment and facilities can help to reduce PHFL, increase the quantity and quality of the landed catch, enable safe berthing operations and improve the handling and distribution of fish and fish products. Enabling infrastructure and auxiliary services, such as retail shops, can cater to the needs of the artisanal and (semi-)industrial fishermen, such as the provision of safety equipment, repair services, cold chain infrastructure and cooling equipment. In addition, knowledge spillovers, i.e. the exchange of ideas and best-practises among local fishermen, can help to spread awareness about sustainability and help to further professionalize the sector. The following section of the report examines what infrastructure investments are required to develop to Montserrado Fishing Pier.

3 Project Design Description

3.1 Introduction

This section of the report considers the technical design and the operational aspects of the proposed fishing port. The function of the fishing port is to facilitate, receive, handle, process, store and dispatch fish. For the purposes of this Assignment, the Consultant has assessed the available reference studies that were made available by the Client.

We set out to answer the following questions:

- What enabling infrastructure is required to support the operations of the fishing port?
- What are the upfront investment costs?
- What are the reoccurring operating costs?
- What are the required preparatory and development works?
- What are the most significant technical risks?
- What follow-up studies are recommended to inform a detailed design for the fishing port?

3.2 Design Concept

The Project will focus on the rehabilitation and expansion of the Mesurado Fishing Pier to a modern fishing port with onshore processing facilities for value addition. Enabling infrastructure is required to spur this development. Technical and infrastructural requirements can be divided into two broad categories, which are not mutually exclusive:

- those necessary to support smaller-scale artisanal fisheries and support the livelihoods of Liberians.
- those necessary to grow a larger-scale commercial fisheries sector capable of bringing economic benefit.

The following section of the report discusses the proposed design and functioning of both types of infrastructure.

3.2.1 Industrial fishing facility

Reportedly, due to a lack of port infrastructure, large vessels cannot land their catch in Liberia. Wuor and Mabon (2022) explain that civil wars caused damage to piers and port facilities. Moreover, ports have not been dredged since the war. This makes it impossible for larger vessels to dock. Moreover, the costs of dredging continue to increase the longer time goes on.

Currently, a total of six industrial vessels have obtained a license to fish in Liberian waters. Out of these vessels, only four vessels are able to land their catch in the Freeport of Monrovia. These vessels have an average tonnage of ca. 270 DWT and call at the BMC Pier. It is understood that this is a privately owned facility by a Chinese investor. The BMC pier is situated in the Freeport of Monrovia, opposite of the Mesurado Fishing Pier. The vessels use the BMC Pier to berth, unload their catch and bunker for the next trip at sea. There is not enough space to accommodate all vessels at the same time. Therefore, the vessels are lined up beam to beam which increases the unloading time. The Consultant witnessed that the fish catch is packed in plastic bags, loaded onto trucks (which have to drive in reverse along the pier towards the vessels), and transported to cold storage facilities in Monrovia (outside the port area). The other two vessels are larger and cannot call at Liberian ports. Instead, these vessels deviate to neighbouring countries.

To support the development of the domestic fishing sector, a deep water berth is proposed at the Mesurado Fishing Pier. The purpose is to accommodate large vessels, such as industrial trawlers and refrigerated cargo vessels.
Within the harbour basin, the key components include:

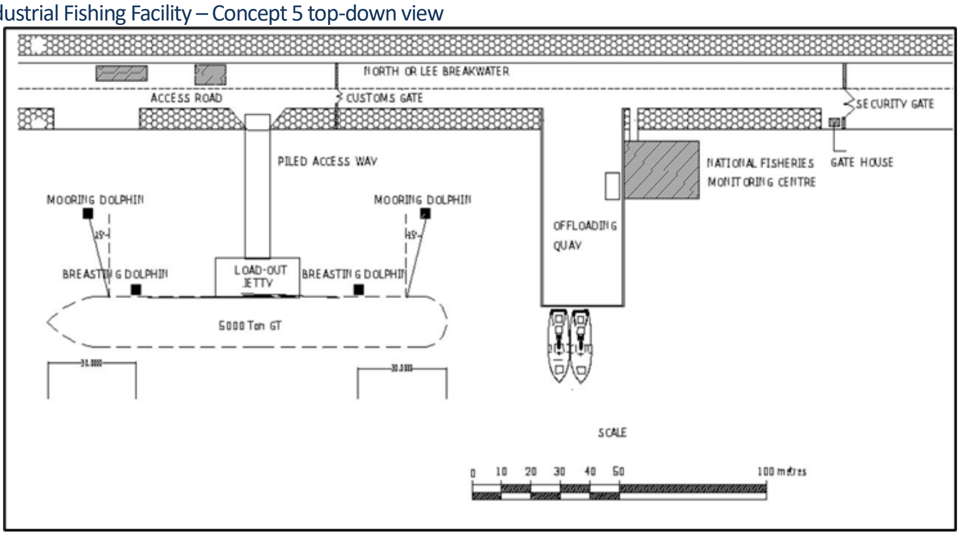
- New berthing facility.
- Turning basin with access channel, both at a level of -9.00 m;
- Improvement of the access road (500 m);
- Small office building for administrative purposes (100 m^2);
- Workshop (100 m^2);
- Auction hall (100 m^2)

- Customs gate;
- Power supply and electrical distribution;
- Water supply;
- Sewerage system.

Design concepts

Since 2015, various technical concepts have been proposed to inform decision-making in relation to the development of enabling infrastructure. This Assignment focusses on two technical concepts for an Industrial Fishing Facility ("IFF") that have been developed by J.A. Sciortino in relation to LSMFP, namely: 'Concept 5' and 'Concept 6'. Concept 5 is depicted in Figure 3.1 below. The design is based on a T-shaped load-out jetty with a berth platform on piles. The platform is ca. 330 m^2 and includes breasting and mooring dolphins.

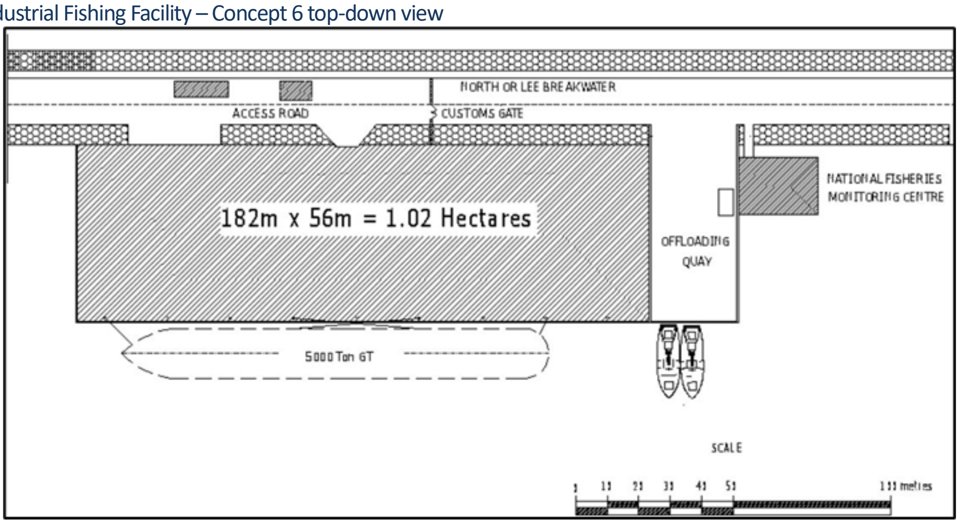
Figure 3-1: Industrial Fishing Facility – Concept 5 top-down view



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

Concept 6 is depicted in Figure 3-2. This design is based on an alongside berth facility which consists of a sheet piled cofferdam at two sides, filled with sand originating from the dredging activities within the port to create the access channel and turning basin.

Figure 3-2: Industrial Fishing Facility – Concept 6 top-down view



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

Compared to Concept 5, Concept 6 includes more landside area which can be made available to support operations. Having more space improves the safety and efficiency of the (un)loading operations. In addition, the berthing operations do not require mooring dolphins and breasting dolphins, as is the case in Concept 5. However, this comes at a price as Concept 6 requires higher upfront investment costs (refer to **Section 3.4**).

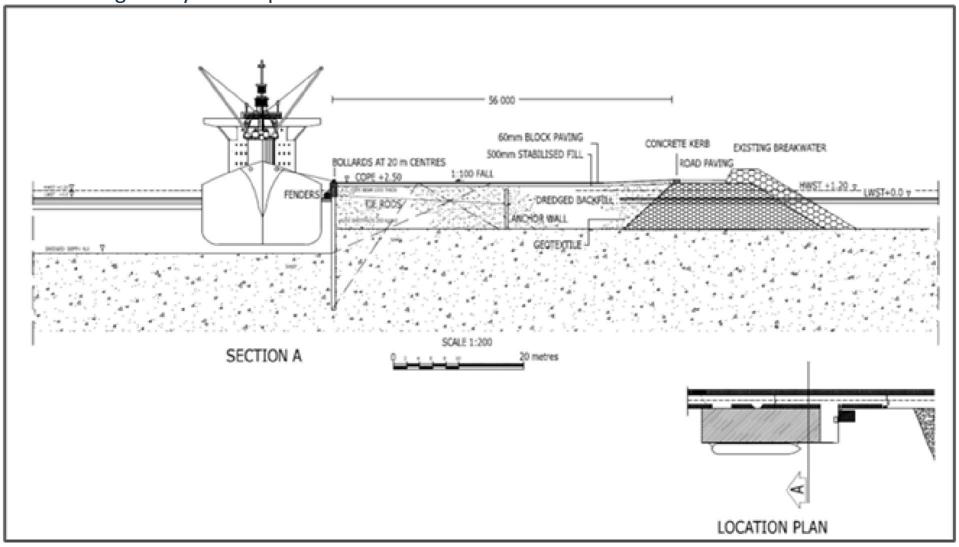
Envisioned operations

Fish is one of the most perishable commodities. The need for proper handling and processing of fish is important both for the fishing industry and for the consumers. In the absence of adequate facilities, both on the fishing vessels and ashore, spoilage and contamination by pathogenic bacteria may result in considerable post-harvest fish losses. High ambient temperatures, as is the case in Liberia, aggravate the already difficult conditions. As a consequence, high volumes of fish are either discarded or sold at relatively low prices because of quality deterioration. Therefore, developing modern and efficient fishing facilities can play an important role in the post-harvest handling of fish.

The IFF has been designed as a load-out station for refrigerated large cargo vessels. The design vessel is presented in section 3.3.4 and concerns a 5,000 DWT vessel. This is considered a 'mother vessel' calling the port either to unload imported fish and/or to load and export high-value fish. This mother vessel is equipped with cooling rooms and has an ice-making facility on board. Besides this design vessel, other vessels with a lower DWT may also call at the load-out jetty, such as industrial trawlers and semi-industrial fishing boats. These vessels are also equipped with cooling cells and ice-making machines to keep the fish catch fresh and frozen. The unloaded catch will be trucked to the cold storage facilities outside the port area.

The transport of the fish to/from the load-out jetty is carried out by smaller trucks. These need to park in the parking area close to the IFF. The parking and trucking operations have different approaches in Concept 5 and Concept 6 of the IFF. Concept 6 offers ample space on the platform for trucks to arrive, load/unload, turn and drive off. Concept 5 offers little room on the platform. Consequently, trucks have to turn and reverse to enable (un)loading.

Figure 3-3: Industrial Fishing Facility – Concept 6 cross-sectional view



On the platform of Concept 6, a small office for the administrator and hygienic officer is foreseen, as well as a workshop for repairs and an auction facility. A security gate is required to ensure safe and proper administration of inbound and outbound traffic. Facilities for water and power supply, as well as sewerage, will be provided near the berthing area. In case of Concept 5, these facilities would have to be erected outside the IFF facility and hence hamper efficient administration. Therefore, from an operational and logistical point of view, Concept 6 is preferred.

3.2.2 Artisanal fishing facility

The Liberian fisheries sector predominantly consists of artisanal fishers that operate the 'Kru-style' wooden dug-out non-motorized canoes with 1–5 crew members. In addition, bigger motorized canoes of 12-20 crew and outboard engines are used. Beaches provide landing sites from where the canoes depart to the fishing grounds. Reportedly, the canoes used by artisanal fishers can go missing in the ocean. Moreover, adverse weather conditions prevent local fishermen from sailing out; whereas high ambient temperatures force fishermen to return to shore to land their catch before spoilage occurs. For artisanal fisheries and livelihood support, there is a need for technical and infrastructure improvements to enhance safety and reduce post-harvest losses. According to the Environmental Justice Department (2012), artisanal fisheries experience a lack of access to good quality materials and equipment. An artisanal fishing facility, also referred to as the 'Canoe Fishery Hub Facility' ("CFHF"), could play an important role to improve operations, e.g. by providing better communications (radios), lifejackets and vests, cool boxes and ice, and other equipment such as spare engine parts and fishing nets.

Design concepts

From a concept design perspective, the CFHF is considered to be an integral part of the Project, because of the beneficial use of the dredged material originating from the dredging of the turning basin and access channel in the port basin.

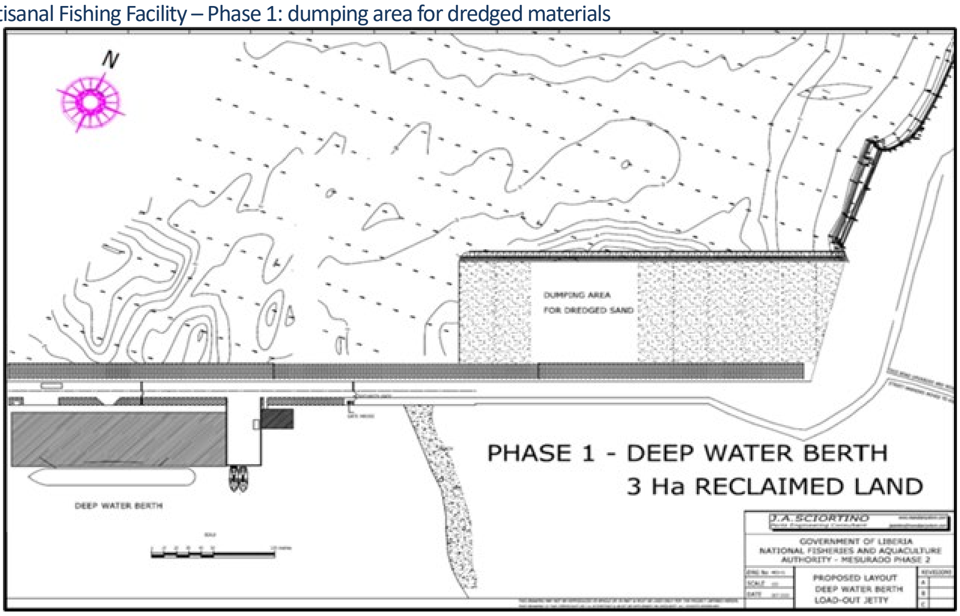
The CFHF as presented in the reference studies is to be implemented in two phases:

- Phase 1: construction of the reclaimed area by using the dredged material from the port basin;
- Phase 2: construction of all the required facilities on the reclaimed area to cater for the local fishermen.

Phase 1 of the CFHF development includes the construction of a bund wall and filling the area with material originating from the dredging operations in the port basin. The CFHF will be situated outside the port basin, adjacent to the Northern Lee Breakwater. The proposed location and outline of the reclaimed land area is depicted in Figure 3-4 below.

Due to the fact that the reclaimed area is not fully protected against sea waves, there is a possibility for a wash-out of sand, resulting in the loss of reclaimed land and additional costs to obtain the required construction levels. Hence it is advised to commence with the Phase 2 development upon the completion of Phase 1.

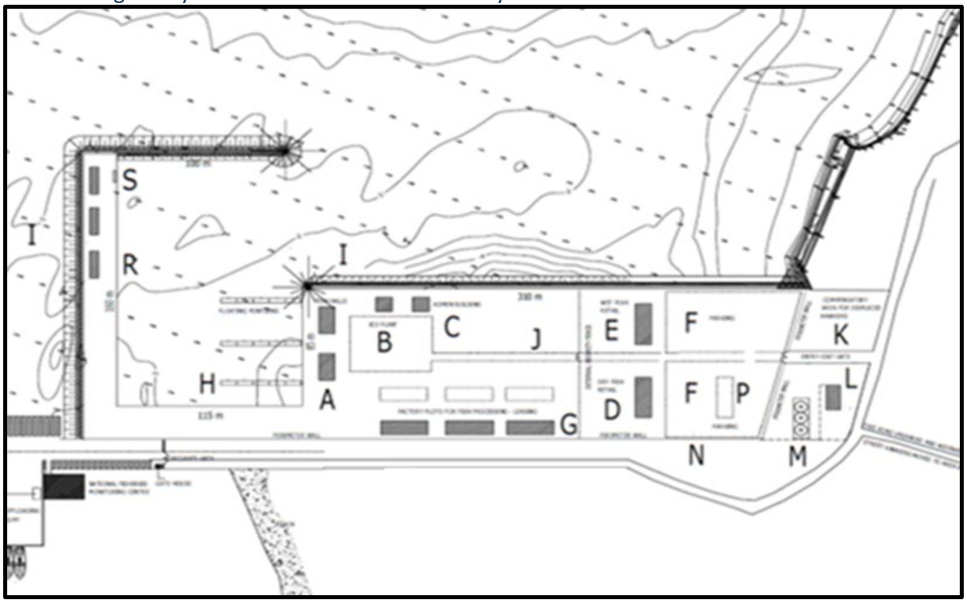
Figure 3-4: Artisanal Fishing Facility – Phase 1: dumping area for dredged materials



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

The Phase 2 development is more extensive and includes the construction of an L-shaped breakwater to protect the landed vessels within the CFHF-basin. This breakwater will be constructed perpendicular to the Northern Lee Breakwater. The sea defence provides protection against waves and bad weather conditions, enabling safe berthing operations for local fishermen. The buildings and facilities proposed for the CFHF are presented in Figure 3-5 and summarized in Table 3-1.

Figure 3-5: Artisanal Fishing Facility – Phase 2: construction of auxiliary facilities



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

Table 3-1: Description of infrastructure and superstructure at the CFHF

#	Item	#	Item
A	Fish landing first rinse and icing halls	J	Internal road network
B	Two 10 tons/day flake ice plants	K	Area set aside to compensate street hawkers
C	Hub administration building for NaFAA	L	Electricity substation
D	Smoked Fish Retail Hall	M	Liquid waste treatment
E	Wet Fish Retail	N	Boundary wall separating port
F	Open car parks	P	Underground 3-day emergency water reservoir
G	Serviced factory plots for leasing to fish processing enterprises	R	Fishing gear stores and workshops
H	Floating pontoons for offloading canoes	S	Fuel station for outboard engines
I	Rubble mound breakwater and spending bank		

Envisioned operations

Once constructed the CFHF will be fenced off and access will only be possible through an access gate. The CFHC will be run on a commercial basis and land and building structures will be made available for rent or lease to the private sector. The plans presented in the reference studies show that the following facilities are included to create an efficient and safe functioning CFHF:

- Serviced plot for an ice plant to supply ice to all the port users (200 m2);
- A wet fish market for rental to fresh fish traders;
- A dry fish market for rental to sundry traders;
- Serviced plots (water, power and sewage) for potential fish processing investors;
- Serviced shops for rental to service providers (bank, customs, engines and spares, marine equipment, fishing gear suppliers, supermarket for food supplies, etc.);
- Fishing workshop and gear stores (150 m2);
- Workshops for hull and engine repairs (150 m2);
- Refuelling station at the quayside;
- Potable water at the quayside.

The related layout and the overview of the facilities are presented in Figure 3-5 and Table 3-1 above.

Local fisherman may berth their canoes at the head side (west side) of the reclaimed area. The length of the head side is 85 meter. Perpendicular to the head side 3 rows of lightweight pontoons each 50 m long (at an interval of about 15-20 m) are present resulting in a total of 6 sides (50 m long) where larger vessels can berth. The total berth length along the floating pontoons for the current fleet of the fishing community amounts to 6 * 50 m = 300m. One of the sides (50 m) along the floating pontoons may be dedicated for the execution of repair works to the vessels, reducing the berth length for (un)loading the vessels to 250 m.

The number of vessels currently operating in the Monrovia area is too large to berth at the same time at these “floating pontoons”. Hence, these vessels will only use the CFHF for (un)loading operations and the administrator will organize the berthing schedule. The vessels will not stay overnight at the CFHF, but will either anchor close to the shore or be put onshore/beach. This way, current anchoring practices will not be influenced/changed by the presence of the CFHF. A change or shift to semi-industrialized vessels (detailed in Section 4.2.4) may change the current fishing operations. A specific vessel waiting/anchoring area close to the shore might be assigned to enable the fishermen to anchor their vessels once leaving the CFHF or before entering. The latter will depend on the number of vessels calling the CFHF.

The envisioned sequence of activities at the CFHF are likely:

- Fishermen land their vessels, report their catch and offload the fish for rinsing and processing to the auction hall;
- At the auction hall, buyers such as retailers or ‘fish smokers’ can bid for fresh fish after it is sorted and graded.

Fishing operations include the following sequence:

- Once the vessel is off-loaded, the local fishermen will prepare the vessel for their next trip;
- They can buy any spare parts or carry out any repair works to the vessel; if required;
- Additionally, they can buy ice at the CFHF and fill their cooling boxes;
- Once the vessel made ready for the next trip to sea, the vessel will leave the berth at the CFHF and anchor outside the CFHF. Likely, these filled vessels will be too heavy to be pushed onshore.
- Fishermen leave early morning and return in the afternoon, as they do not sail too far offshore.

3.3 Analysis of Technical Components

The development of the Mesurado Fishing Port comprises preparatory works and design studies, dredging activities, the construction of infrastructure (such as the berthing platform), superstructure (such as buildings and warehouses) and the purchase of equipment (such as ice-making machines). The following section reports on the availability and completeness of the currently available information, as it pertains to the technical feasibility of the project.

3.3.1 Availability and ownership of land

It is assumed that all the land required to develop the proposed IFF at the Mesurado Pier within the Freeport of Monrovia, and the CFHF outside the port basin, is not disputed and that the ownership lies with the Government of Liberia. In the reference studies this aspect has not been dealt with. As the Project moves to the next stage of planning and development, this assumption needs to be validated.

3.3.2 Bathymetric and topographic data

The reference studies include limited bathymetric data. It is assumed that the National Port Authority ("NPA") may be able provide this information, as it pertains to safe shipping and berthing operations within the harbour basin of the Freeport of Monrovia. Topographic data regarding the project area, including the CFHF and the Northern Lee breakwater, is included in various layout and cross-sectional drawings that are prepared for the concept design and bill of quantities. For the purposes of this assignment, the available data has been used. Based on the Consultant's review, it is recommended to execute the bathymetric and topographic surveys within the context of the detailed design studies and preparation of tender documentation.

3.3.3 Tides, coastal currents and waves

The reference level (0.00) used in the reporting is Lowest Astronomical Tide (LAT). The reference studies and outline designs indicate that the following water levels have been used for the designs within the port basin, as well as outside the port basin:

- HWST = 1.20 m+
- LWST (or LAT) = 0.00 m

These levels are to be verified when carrying out the detailed design studies. Studies regarding tides (low tides and high tide) are not presented in the reference studies. The same holds for the studies regarding the coastal currents, waves and littoral drifts aspects. This might specifically be of importance for the CFHF as it is located outside of the sheltered port basin and subject to open sea waves. The designs of the revetment works need to be verified based on the design wave. Sedimentation/erosion occurring at the CFHF needs to be assessed, in order to determine the maintenance dredging sequence.

3.3.4 Design vessel

Industrial fishing facility

The reference studies include an overview of reefer vessels that have called at the Freeport of Monrovia to unload fish in the past. Until the year 2008, the largest vessel that called at the port was motor vessel ("mv") 'Lian Run' with 2,754 DWT. However, after 2008 larger reefer vessels started calling the port. Hence, it was decided that the design vessel for the IFF should be based on the largest regional reefer vessel. As such, the mv 'Green Magic' (servicing tuna fisheries) was selected. The design vessel has the following characteristics:

Table 3-2: Design vessel characteristics of a reefer vessel

Dimension	Unit
• Length (LoA)	135.7 m
• Breadth/width (Bw)	15.85 m
• DWT	6,116 tons
• Gross tonnage	5,103 tons
• Maximum draft	7.90 m
• Allowance for swell	0.50 m
• Under keel clearance	0.50 m (at a soft sea bed)
• Dredging tolerance	0.10 m

Based on the design vessel characteristics, the required port basin bed level is minus 9.00 m for the turning basin and access channel.

Artisanal fishing facility

The reference studies do not include information about design vessel characteristics that have been considered to determine the layout and infrastructure requirements. However, it can be assumed that the design concept for the artisanal hub is based on the characteristics of the motorized and non-motorized wooden canoes that are currently used by local fishermen.

Based on stakeholder consultations (refer to Chapter 8 it is expected that in time, the wooden canoes will be replaced with polymer fiber glass vessels or semi-industrial vessels ("SIV") as listed in the table below.

Table 3-3: Design vessel characteristics of a semi-industrial vessel

Dimension	Unit
• Length (LoA)	18.55 m (between 15.78 -27.15 m)
• Breadth/width	5.47 m (between 4.60 – 6.74m)
• Depth	2.17 m (between 1.72 -2.96m), required water depth 1.3 times the vessels depth or 2.82m)

Source: Main Dimensions Characteristics of Gillnet Fishing, Global Scientific Journal (2018)

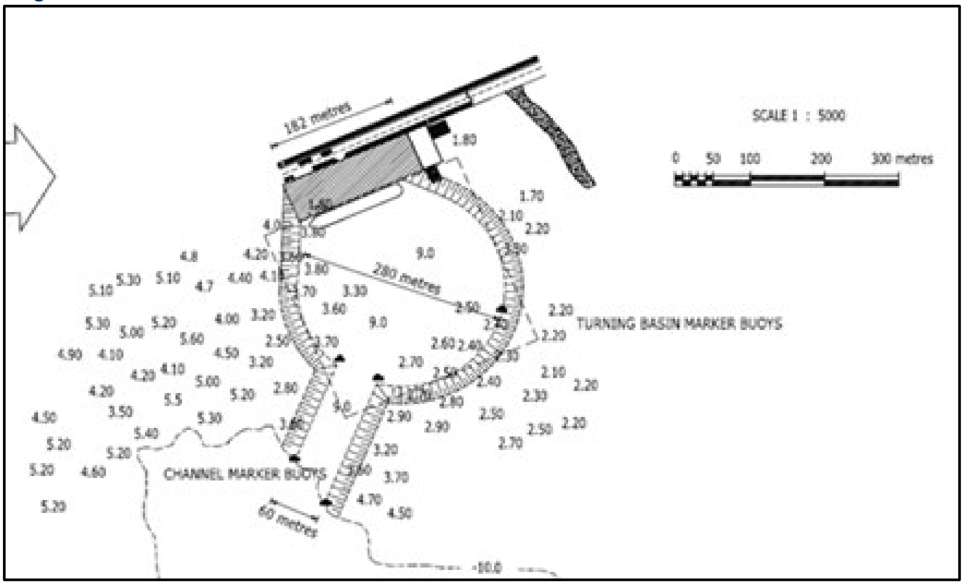
Having these dimensions the SIV's cannot be accommodated within the CFHF berthing places, as the water depth (bottom level minus 2.00m) is not sufficient. Hence these SIVs should call at the IFF. In this respect, it should be assessed whether the NPA allows these SIVs to enter the port basin. NAFAA estimates that throughout Liberia, a total 500 SIV's will be required to replace the current artisanal canoe fleet. The funds for the proposed/expected change from the current artisanal fleet to the SIV-fleet are difficult to be borne by the local fishermen. Consequently, NAFAA is exploring the possibility to create a Cooperation that would make the purchase and repayment of loans feasible for the local fishermen.

Local fishermen will require training and education to operate these vessels. The (un)loading and handling of the such vessels is significantly different than the handling of the current canoes. Moreover, to stay at sea for longer periods of time, specific skills and knowledge are required in terms of navigation, mechanics, electronic equipment, and compliance with governmental regulations (positioning, regularly communicating the position and the fish catch). The foundation of a specific training school for fishermen should be considered by government to optimize efficient and safe fishing activities and to prevent accidents.

3.3.5 Turning basin and access channel

The turning basin for sea ports is in general at least two times the length of the design vessel (of 135.7 m), resulting in a diameter of 271.4 m. The diameter in the reference reports is taken 280 m and complies with the International Standards ("IS"). The bed level depth of minus 9.00 m is also in line with IS. The access channel in general should have a width of 2.5 to 4 times the design vessel beam width (15.85m) being 38.65 – 63.40 m for one way traffic. The width selected in the reference reports is 60 m and is also in line with IS. The length of the access channel using the figures of the reference reports is estimated at approximately of 150 to 200 meters. The dimensions of the turning basin and access channel are depicted in Figure 3-6 below.

Figure 3-6: Turning basin and access channel dimensions



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

3.3.6 Geotechnical investigations

A geotechnical investigation has been carried out by Barway-Mosgeo (2014). In the vicinity of the Mesurado Pier, a borehole was drilled up to level minus 23m. Samples have been tested in a laboratory in the Netherlands. Details are presented in Appendix I of this report. The borehole log indicates that all the material to be dredged (down to -9.0m) consists of coarse sand with cobbles, which can be classified as cohesionless coarse sand. This type of sand is suitable to be used as fill material for land reclamation purposes and thus to be used for the reclamation of the CFHF area and for the Concept 6 IFF platform.

3.3.7 Dredging requirements

Dredging quantities

The required dredging depth for the access channel and the turning basin is based on safe and efficient access to the berthing place and operating of the design vessel (mv Green Magic) within the port basin. Hence, the required dredging depth is determined at LAT minus 9.0 m. The turning basin with a diameter of 280 m and the access channel width of 60 m and both with a dredging level of minus 9.00 m have been plotted on the available bathymetric maps of the port basin. This results in a dredging quantity of in total 520,000 m3. When the decision will be taken to bring the project to the stage of detailed design and preparation of tender documentation, it is recommended to execute a bathymetric survey within the port basin and recalculate the dredging quantities.

Dredging materials

A detailed analysis has been made of the material to be dredged, using the sample taken from the port basin, as presented in the reference studies. Based on the analysis of the sample carried in the laboratory, the sediment was found to contain various pollutants (lead, copper, zinc Polycyclic Aromatic Hydrocarbons ("PAH") and Tributylin ("TBT") and as a result it could be established the first meter of the port basin area is contaminated. The laboratory tests show that the presence of pollution exceeds the limits that are established in the London Convention (1972) and the revised Protocol (1996). However, Liberia is not a signatory to the London Convention. Regardless, the World Bank guidelines stipulate that contaminated dredged material must be disposed of correctly and according to and in line with international and national conventions. As such, NAFAA in conjunction with the Ministry of Environment are to seek Action Levels for the level of pollution and to prepare a Dredged Material Assessment Framework ("DMAF"). The laboratory testing was carried out in the Netherlands, the Dutch DMAF were applied. As a consequence, the quality of the material to be dredged of the first meter is such that it should not be disposed of offshore but placed inside a containment. The remaining part of the material to be dredged is assumed to be clean.

The division of the material to be dredged is in line with the quantities presented in reference studies. These amounts cannot be validated as the presented data is insufficient. The division is as follows:

- Contaminated dredged material: 31,000 m3
- Non-contaminated dredged material: 489,000 m3.

Handling of dredged materials

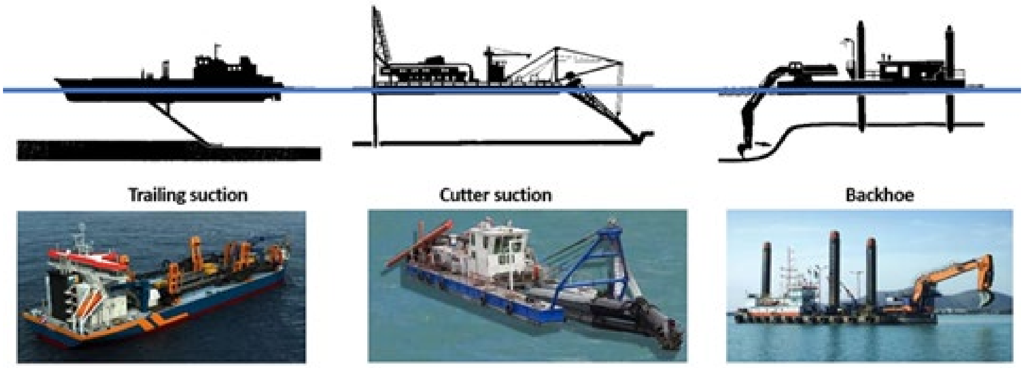
In line with international best practise, a specific disposal site is to be constructed onshore. This disposal site is an area surrounded by bunds to prevent untreated dredge water from being discharged into open waters. The polluted water needs to be treated and the disposal site needs to be covered with soil and closed. In general, this disposal site is not allowed to be used for construction purposes. However, the reference studies do propose to use the contaminated soil as fill material for the construction of the berthing platform (refer to IFF Concept 6). This could be proposed under the condition that the area to be filled is completely sealed and the capping is such that contaminated material cannot migrate outside the containment. An Environmental Impact Assessment ("EIA") study should establish the environmental and social sensitivity of the dredging activities and an Environmental Management Plan ("EMP") should list the activities involved, associated impact and suggested mitigation measures, as well as an implementation plan that covers monitoring, reporting and supervisory responsibility. The remaining part (non-contaminated dredge material) may be used for reclamation purposes.

However, in case the above cannot be adhered to or if an environmental permit is not provided, the contaminated dredged material needs to be deposited onshore in a specifically prepared disposal area. This area needs to have bund walls to ensure that the contaminated dredged material will be contained and have a drainage system in place to ensure that the contaminated spoil water can be treated prior to flowing into open waters. Subsequently, the area needs to be capped and sealed. The disposal area needs to be prepared to store a total of 31,000 m3. The dimensions of the disposal site depend on the assigned location. On average, the surface area will be about 200 * 200 m with a layer thickness of 0.75 m. In the reference studies the costs for this structure is not listed. Reference is made to "a new ESIA-study".

Dredging method

The required volume of dredging (520,000m2) is considerable but not large enough to mobilise self-propelled dredgers, unless it can be combined with dredging activities at other locations within the port area basin, like the execution of maintenance dredging at the commercial port. The equipment that could be used to dredge this amount of sediment is illustrated in Figure 3-7 below. However, the eventual choice could very well depend on which plant is already in the vicinity of Liberia as mobilisation costs alone could very well exceed USD 500,000.

Figure 3-7: Possible methods for dredging at the Mesurado Fishing Pier



Source: Investment concepts for Mesurado (2020), J.A. Sciortino

If the volume involved is too small for a trailing suction dredger to mobilise, a cutter suction dredger may be the preferred option, as illustrated above. A cutter suction dredger with a floating pipeline and continued with an onshore pipeline can pump the sediment ashore without having to utilise an additional two barges to dump the sediment offshore. However, for the purpose of this assignment it is assumed that the costs for disposing of dredged material by barges offshore is similar to the costs of disposing it by floating and onshore pipeline to the disposal site. Cutter suction dredgers come in all sizes and the small-to-medium versions are dismountable and can be shipped in 4 to 5 pieces and re-assembled on site.

The table below summarizes the volumes and handling of dredged materials for Concept 5 and Concept 6 of the IFF.

Table 3-4: Breakdown of dredging works for Concept 5 and Concept 6 of the IFF

Activity	IFF Concept 5	IFF Concept 6
Type of construction of berth	Concrete deck on piles	Sheet piled cofferdam
Top-level berth (m+)	2.50 m+	2.50 m+
Average existing ground level (m-)	-	-1.25 m
Average fill height (m)	-	3.75 m
Dimensions platform (l * b) (m)	12 *28 = 336m^2	56 * 182 = 10,192 m^2
Required filling volume (m3)	n/a	3.75x56x182= 38,220 m^3
Volume of required dredging (-9 m)	520,000 m^3	520,000 m^3
Contaminated dredged material	31,000 m^3	31,000 m^3
Non-contaminated dredged material	489,000 m^3	489,000 m^3
Size of useful land area of berth	336 m^2	10,192 m^2
Volume of fill material required IFF	n/a	41,000 m^3
Volume of fill material required CFHF	139,500 m^3	139,500 m^3
Dredged material balance	339,500 m^3	339,500 m^3
Non-contaminated dredged material to be disposed of (surplus material)	349,500 m^3	339,500 m^3
Disposal of contaminated dredged material	Specific prepared disposal site	Within the IFF-Concept 6 platform

The IFF Concept 6 could solve the most pressing issue with the contaminated sediment, if the contaminated sediment is allowed to be used as fill material for the construction of the platform. If the remaining clean sediment is pumped ashore, good industrial land can be created and for example be rented out to the private sector.

The use of a cutter suction dredger ("CSD") with a floating pipeline and onshore connected to an onshore pipeline is proposed as the preferred option. Applying this method a cutter suction dredger can pump the sediment ashore instead of utilising barges to sail the sediment offshore and dump it at sea. In addition, an amount of another 170,000 m^3 has to be dredged in the CFHF port basin to obtain a port basin bottom level of minus 2.00 m. This amount of 170,000 m^3 has also either to be stored in the onshore depositor to be transported offshore to be dumped at sea.

3.4 Cost Analysis

The following section summarizes the foreseen upfront capital expenditures (“capex”) and reoccurring operational expenditures (“opex”) that are associated with the construction and operation of the Mesurado Fishing Pier. A distinction is made between general costs, construction costs for the IFF and the CFHF. This allows us to analyse the financial feasibility of the stand-alone development of each component. The costs are derived from the reference studies. The base year for the cost estimate is 2020.

3.4.1 Capital expenditures

A breakdown of the capex is presented in Table 3-5 below.

Table 3-5: Breakdown of capital expenditures

#	Component	Item	Unit	Total (base year = 2020)
1	General	EIA studies	USD	500,000
2	General	Design studies	USD	150,000
3	General	Supervision	USD	225,000
4	General	Mobilization costs	USD	735,000
5	General	Road improvement	USD	100,000
6	IFF	Shipwreck clearance	USD	100,000
7	IFF	Dredging costs	USD	2,600,000
8	IFF	Berthing platform	USD	7,755,240 [1]
9	IFF	Utilities (power, water, sewage)	USD	382,000
10	IFF	Administration office	USD	40,000
11	IFF	Workshop	USD	40,000
12	IFF	Auction hall	USD	40,000
13	IFF	Customs gate and fencing	USD	20,000
14	CFHF	Bundwall and area preparation	USD	-
15	CFHF	Breakwater	USD	4,100,000
16	CFHF	Utilities (power, water, sewage)	USD	1,500,000
17	CFHF	Administration office	USD	160,000
18	CFHF	Artisanal workshop and gearshop	USD	120,000
19	CFHF	Processing hall	USD	200,000
20	CFHF	Fuel station	USD	10,000
21	CFHF	Shipwreck clearance	USD	100,000
22	CFHF	Perimeter fencing	USD	86,600
23	Σ	Subtotal	USD	18,963,840
24	Contigency	10% of subtotal	USD	1,896,384
25	**Σ**	**Grand total**	**USD**	**20,860,224**

The costs associated with the berthing platform in design Concept 6 for the IFF are estimated at ca. 7.75 M USD. In case of design Concept 5, the costs for the offshore berth on piles with T-jetty are estimated at 773 k USD. Table 3-6 below summarizes the total capex for Concept 5 and Concept 6. All other items are assumed to be equal in both concepts.

Table 3-6: Overview of total capital expenditures per component and design concept

#	Component	Item	Unit	IFF Concept 5	IFF Concept 6
a	General	Subtotal	USD	1,710,000	1,710,000
b	IFF	Subtotal	USD	3,995,485	10,977,240
c	CFHF	Subtotal	USD	6,276,600	6,276,600
d	Contingency	Subtotal	USD	1,198,209	1,896,384
e	**Σ**	**Grand total**	**USD**	**13,180,294**	**20,860,224**

It is assumed that the outcome of this Assignment will be the basis for the preparation of the Detailed Design and Tender/Contract documentation of the proposed works. Moreover, specific items that require specific attention have been listed hereunder.

Public investment commitment

Depending on the chosen development option, public investment commitment might be of importance, especially to provide the private investors comfort. The investment commitment can be given in terms of:

- The development of sufficient and efficient hinterland connections;
- Guaranteeing the connection of water and electricity supply to the project site.

Guaranteeing Road Connectivity

One of the main conditions to ensure an efficient and successful commercial/industrial fishing port is to create a well-developed and functioning road system with connection from the proposed facilities to the downtown Monrovia area (to the South), as well as to the hinterland in a northerly and easterly direction. Efficient road infrastructure supports the success of future port developments and guarantees a fast connection between the facilities and the hinterland.
A well-developed road connection is especially important in relation to:

- Fresh fish export;
- Current commercial trade and future commercial port developments.

The existing road between the proposed location and the downtown area of Monrovia is currently under construction and using the road is in certain hours of the day problematic resulting in long travel times. The duration of the work is not yet clear. However, it is assumed that the road will be ready prior to the operation of the proposed facilities

Unit rates

The unit rates presented in the reference studies do not show how these have been built up. The same is assumed for the sums listed in the Bill of Quantities. The reference studies included a 5% contingency, which is deemed to be low at this stage of the project planning cycle. Therefore, the Consultant applied a 10% contingency, which we consider to be more prudent.

Dredging materials

The use of dredged material influences the feasibility of the scenario to be selected. All volumes and quantities presented do need to be verified based on the surveys and investigations to be carried out prior or during the execution of the Detailed Designs and preparation of the Tender Documentation.

3.4.2 Operational expenditures

Recurring expenditures at the proposed Mesurado Fishing Pier pertain to labour and maintenance, associated with the use of the infrastructure, superstructure and equipment. Though the operations at the IFF and the CFHF are separated (the IFF is situated within the port basin, and the CFHF is located outside the port basin), we consider that a single management body needs to be established to efficiently manage the fishing port and represent the interests of stakeholders (reference is made to FAO paper 539).

The management body to manage the IFF and CFHF needs to ensure:

- Compliance with laws and regulations national and international;
- Compliance with regulations for the use of the facilities (such as fee structure for the available facilities);
- Compliance with food safety and hygiene requirements (health regulations);
- Transparency in decision making process.

The four major areas where management input is required are:

- Day-to-day management of the operations;
- Financial management;
- Landing statistics;
- Administration of hygienic standards.

Management structure

Once the IFF is completed it may be used as follows:

- Unloading fish: the 250 – 350 DWT Chinese fishing vessels will unload their catch and will bunker prior to go out fishing;
- The licensed tuna vessels (250 – 350 tons) will call the IFF and offload their catch, which in turn will be transported to the downtown cooling store houses;
- Upon arrival of the mother vessel (5,000 DWT) the tuna and other fish species will be transported from the cooling store houses to the mother vessel and exported to foreign destinations;
- Coast guard activities (SAR).

It is expected that the management operates within the context of the NPA of the Freeport of Monrovia. Services to be provided may include and be provided by:

- Immigration and police;
- Coastguard (SAR);
- NAFAA (landings, hygiene and monitoring, control and surveillance (MCS)).

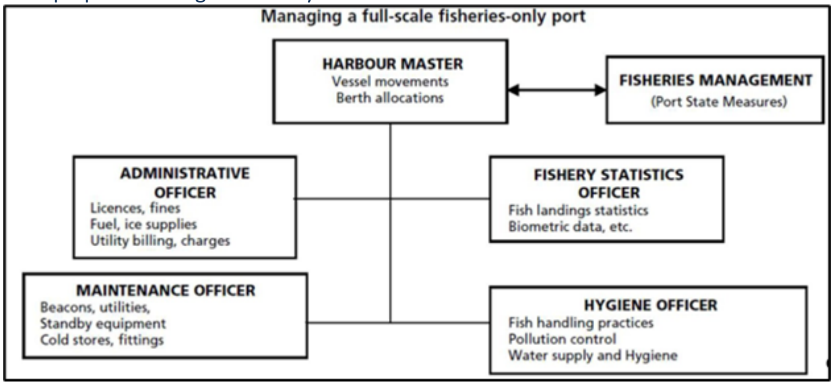
Cooperation between the management of the Mesurado Pier and of the Port of Monrovia is required to enable smooth, efficient and safe operations of vessels entering and leaving the port and within the turning basin. In addition, the protocol of the operations along and at the landing facility needs to be in line with the port regulations.

The IFF-management should therefore consist of:

- a pier master, responsible for the vessels movements and port allocations, and accountable to the NAFAA management;
- an administrative officer, dealing with licenses, fines, fuel, ice supplies, auction hall, fuel, charges and transport;
- a maintenance officer, dealing with the utilities, standby equipment, fittings, cleaning;
- a hygiene officer, dealing with fish handling practices, pollution control, water supply and hygiene;
- a fishery statistics officer, dealing with fish landing statistics, biometric data, reporting;
- a security officer and guards;
- various workers such as cleaners, workshop manager, auction hall officer.

The proposed management body is depicted in the next table.

Figure 3-8: Organogram of proposed management body



Of importance is stakeholder participation, specifically for the CFHF. Instead of a top-down approach a community-based based management is proposed to be introduced to achieve more involvement of the stakeholders in the management process, resulting in more transparency. This will result in a better participation of the stakeholders and by sharing this responsibility in a general upkeep, cleaning and housekeeping inside the CFHF. Hence, a legally constituted fisheries cooperative or fisheries management organization could be set up with delegated roles and tasks for the each of the stakeholders.

Table 3-7: Breakdown of the operational expenditures

#	Item	Amount	Monthly rate	Yearly total
A	**Staffing opex**	**FTE**	**USD**	**USD**
1	Masurado Pier Master	1	750	9,000
2	Administrative officer at IFF and CFHF	1	600	7,200
3	Maintenance officer at IFF and CFHF	1	400	4,800
4	Fishery Statisics officer at IFF and CFHF	1	400	4,800
5	Hygiene officer at IFF and CFHF	1	400	4,800
6	Secretary support at IFF and CFHF	2	250	6,000
7	Shift operators (3 * 8 hours)	3	250	9,000
8	Auction hall supervisor at IFF and CFHF	1	250	3,000
9	Workshop supervisor at IFF and CFHF	1	250	3,000
10	Workers (cleaners, technical staff, security staff) at IFF and CFHF	5	200	12,000
	Subtotal A			63,600
B	Maintenance opex	USD	%	USD
1	Capex IFF (concept 6)[1]	11,000,000	3%	330,000
2	Capex CFHF	6,300,000	3%	189,000
	Subtotal B			519,000
C	**Grand total annual opex**			**582,600**

[1] *In case of Concept 5, maintenance opex are estimated at 120,000 USD (= 4M USD x 3%).*

3.5 Findings and Recommendations

3.5.1 Introduction

The reference studies have considered within their scope of works the issues pertaining to the implementation of the IFF and the CFHF. Concept plans and cost estimates prepared and presented. Various options, scenarios and options were developed for the IFF and the CFHF. This section summarizes the main findings regarding the technical analysis of the design concept.

3.5.2 Concept design

From the concept design perspective, the main observations include:

- The design concept includes a new berthing facility for larger-scale commercial fishing vessels within the harbour basin.
- Outside the harbour basin, a landing site for smaller-scale artisanal fishers will be developed.
- There are two options for the new deep water berthing facility within the harbour basin: (i) a T-jetty (referred to as Concept 5); and (ii) an operational platform (referred to as Concept 6).
- From a technical and operational point of view, Concept 6 is the preferred solution. It offers more flexibility, safer mooring operations and is future-proof (in terms of capacity and the ability to accommodate different vessel types).
- However, Concept 6 is more expensive (ca. USD 7.75M vs USD 773k for Concept 5).

Going forward, the Consultant assumed that the development of Concept 6 is part of the financial/economic 'base case'. In addition, the feasibility analysis will also determine the returns in case of Concept 5.

3.5.3 Main technical risks and uncertainties:

Based on a review of the available information, the main identified risks and uncertainties involve:

- Handling of contaminated dredged material
- Location of onshore deposits for dredged material
- Availability of dredging equipment
- Permitting, specifically for the CFHF facilities and disposal sites
- Lay-out of the CFHF with respect to sedimentation (need of wave and littoral drift studies) within the CFHF port basin and the related maintenance dredging
- Involvement of local construction contractors (quality and quantity)

Additional studies are required to address these data hiatuses.

3.5.4 Information requirements

Overall, the reference studies provide a good starting point for the development of the Mesurado Fishing Pier. However, based on an assessment of the available technical information, follow-up studies are required for the preparation of a detailed design and contract/tender documentation.

We have identified the main information requirements for the next phase of this Project:

- Execution of topographic and bathymetric surveys to obtain up-to-date map;
- Geotechnical investigations consisting of performing boreholes and execution of laboratory tests on samples taken. The current data is obtained from only one borehole and does not suffice to inform a detailed design for this type of infrastructure development;
- Geologic maps;
- Coastal study including littoral drift;
- Study on sea conditions, including:
  - Wind: 30 years analysis, indicating daily, monthly and annual circumstances
  - Wave study
- Offshore wave heights and estimate of intrusion;
- Wave rose – with monthly wave heights, periods and direction;
- Qualitative analysis of swell intrusion for IFF and CFHF;
- Estimate of extreme local wind waves:
  - Tidal analysis
  - Current analysis
- Above analysis can be used in support of the location analysis, i.e. to determine which type of breakwater would be needed at the CFHF location;
- Land use maps and area destination plans;
- Environmental and Social Impact Assessment (ESIA);
- Up-to-date inventory of canoe vessels operating in the Monrovia are and the area affected;
- Rules and regulations of where to prepare onshore disposal sites for (non) contaminated dredged material.

4 Methodology

4.1 Introduction

This chapter presents the methodologies applied for the demand forecast, the financial feasibility as well as the economic feasibility assessment.

- Section 4.2 – Demand forecast methodology: First, we determine the demand forecast for Liberia by analysing historical trends within the Liberia fishery sector. Subsequently, we estimate the demand for Montserrado County and the project based on a market share analysis.
- Section 4.3 – Financial feasibility methodology: The financial feasibility assessment is based on the capital and operating expenditures presented in Chapter 3, along with the demand forecast. All essential inputs for the financial model are detailed.
- Section 4.4 – Economic feasibility methodology: This section explains the methods used to evaluate the economic feasibility of the project. We compare the project to a scenario without the project, convert financial cash flows to cash flows, and estimate economic indicators and the social discount rate.

The result of the financial and economic feasibility assessment are presented in Chapter 6.

4.2 Demand Forecast

4.2.1 Introduction

This section present the methodology for the demand forecast for the Mesurado Fishing Pier. An important basis for the forecast approach is the report 'A bio-economic analysis of the Liberian coastal fisheries' by Jueseah et al. (2020), which describes a bio-economic analysis of the Liberian coastal fisheries.

The general approach of the demand forecast consisted of three main steps.

1. **Analyse data on historic fish catch volumes and vessel distribution:** We analyse the historic trends in fish catch, fish species, and vessels in the Liberian and Montserrado fishing sector.
2. **Maximum sustainable yield**: We estimate the maximum sustainable yield for the Liberian fishing industry. Based on the MSY, we project the annual fish stock that can be sustainably caught in Liberia.
3. **Implementation of fishing quota:** To address the issue of overfishing, the demand forecast incorporates that specific policies will be implemented. In this section, we outline how fishing quotas are anticipated to impact the amount of fish production in Liberia. This results in an estimate of the future fish catch in Liberia and Montserrado County.
4. **Project demand forecast:** Building on the previous steps, we project the market demand for the fishery project. This involves estimating the project's market share in Montserrado County and accounting for post-harvest fish losses.
5. **No-project forecast:** One of the major inputs for the economic analysis, is the no-project case forecast. We estimate the expected outcomes for the Liberian fishing sector in the absence of the fishery hub and without the implementation of additional policies.

The demand forecast results in the following projections:

- Project demand forecast
- Montserrado County demand forecast if the project materialises
- Montserrado County demand forecast in the no-project case

4.2.2 Analysis of historical data

In this section, we analyse the historical trends in fish catch, fish species, and vessels within the Liberian and Montserrado fishing sector. Table 4-1 presents an overview of number of vessels and fish production in Liberia. We observe that:

- The number of Kru vessels has experienced growth, rising from 2,615 vessels in 2013 to 3,815 vessels by 2019. Since then, the number of Kru vessels has remained stable at that level. This growth in Kru vessels has also led to an increase in the amount of fish catch landed by them.
- Conversely, the number of Fanti vessels has experienced a decline over the past decade. In 2013, there were approximately 814 Fanti vessels active in Liberia, but this number decreased to 774 by 2022. However, despite the decrease in vessel numbers, the efficiency of Fanti vessels has improved over the years. This is evidenced by an increase in the amount of fish catch per vessel per year. As a result, the total amount of fish catch landed by Fanti vessels has increased during the period from 2013 to 2022.
- Since 2018, the number of industrial vessels operating in Liberian waters has remained constant at 6 vessels. The total fish catch landed by these vessels has fluctuated between 3,233 and 5,816 tons per year.
- Year 2017, 2018 and 2019 show above average fish production. This can be attributed to a great increase in catch of large pelagic.
- The average ton catch per vessel p.a. averaged at 1.6 tons for Kru vessels, 20.0 tons for Fanti vessel and 604.4 tons for industrial vessels.

Table 4-1: Historic vessels and fish production in Liberia

Item	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Vessels											
Kru	#	2,615	2,748	3,163	3,163	3,552	3,615	3,815	3,815	3,815	3,815
Fanti	#	814	827	685	685	702	740	774	774	774	774
Industrial	#	4	1	7	4	10	6	6	6	6	6
Total	**#**	**3,433**	**3,576**	**3,855**	**3,852**	**4,264**	**4,361**	**4,595**	**4,595**	**4,595**	**4,595**
Fish catch landed											
Kru	tons	3,895	3,755	4,071	4,128	7,002	6,569	9,975	4,683	5,807	6,461
Fanti	tons	10,404	10,030	10,874	11,025	18,704	17,545	26,644	12,509	15,510	17,257
Industrial	tons	1,738	609	688	3,850	339	3,233	5,816	5,039	4,443	4,905
Total	**tons**	**16,037**	**14,394**	**15,633**	**19,003**	**26,045**	**27,347**	**42,436**	**22,231**	**25,760**	**28,622**
Fish catch landed per vessel											
Kru	tons/vessel	1.5	1.4	1.3	1.3	2.0	1.8	2.6	1.2	1.5	1.7
Fanti	tons/vessel	12.8	12.1	15.9	16.1	26.6	23.7	34.4	16.2	20.0	22.3
Industrial	tons/vessel	434.4	609.4	98.3	962.5	33.9	538.8	969.4	839.8	740.5	817.4
Total	**tons/vessel**	**449**	**623**	**115**	**980**	**63**	**564**	**1,006**	**857**	**762**	**841**

Source: NaFAA (2023)

It is assumed that the historical fish catch data, as listed above, does not account for Post-Harvest Fish Loss ("PHFL"). Currently, on average 22% of the artisanal fish catch in Liberia is lost due to PHFL on board the vessels.[1] This implies that the actual volume of fish that is caught on the ocean is higher than the landed fish volume. For the industrial vessels, the amount of PHFL is assumed to be limited due to adequate equipment. The following table presents the fish catch per vessel out of the sea (before losses due to spoilage etc.), based on the assumption of 22% of PHFL on board of the vessel. We observe the following average values:

- Kru vessels: 2.1 tons/vessel p.a. of fish catch before any PHFL
- Fanti vessels: 25.7 tons/vessel p.a. of fish catch before any PHFL
- Industrial vessels: 604.4 tons/vessel p.a. of fish catch before any PHFL

Table 4-2: Fish catch per vessel before any PHFL

Item	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Kru	tons/vessel	1.9	1.8	1.7	1.7	2.5	2.3	3.4	1.6	2.0	2.2
Fanti	tons/vessel	16.4	15.5	20.4	20.6	34.2	30.4	44.1	20.7	25.7	28.6
Industrial	tons/vessel	434.4	609.4	98.3	962.5	33.9	538.8	969.4	839.8	740.5	817.4

Source: MTBS

[1] Liberia Artisanal Fishery Postharvest Fish Loss Assessment Report, National Fisheries & Aquaculture Authority, 2022

The table below presents the total catch per species in Liberia over the past ten years. We observe that:

- Small pelagic fish catch has shown fluctuations over the years, with a substantial increase from 2018 to 2021, followed by a decrease in 2022.
- Medium pelagic fish catch has varied, with relatively stable catch amounts until 2017, followed by a significant increase in 2018 and 2019, and then a decrease in 2020 and 2021.
- Large pelagic fish catch experienced a substantial increase from 2016 to 2017, followed by a gradual decline in the subsequent years.
- Shallow-water demersal fish catch showed fluctuations, with notable increases in 2017 and 2018, followed by relatively stable catch amounts in the following years.
- Deep-water demersal fish catch demonstrated growth from 2013 to 2018, followed by fluctuations in the later years.
- Crustacean catch exhibited variations, with a significant drop in 2017, followed by relatively low catch amounts in the subsequent years.
- The total fish catch in Liberia has shown an overall increasing trend from 2013 to 2018, followed by fluctuations in the later years.

Table 4-3: Fish catch per species

Item	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Small pelagic	tons	8,356	8,129	9,107	9,027	5,632	6,190	10,629	12,555	16,712	13,493
Medium pelagic	tons	1,392	1,360	1,405	1,146	117	673	2,715	2,111	2,099	3,662
Large pelagic	tons	250	264	229	3,355	13,035	12,670	18,295	1,249	1,686	3,558
Shallow-water d.	tons	4,174	2,961	3,123	3,400	4,625	5,162	6,138	3,425	3,214	4,463
Deep-water d.	tons	1,800	1,622	1,720	1,834	2,484	2,506	4,640	2,838	2,006	2,873
Crustacean	tons	65	58	49	241	153	146	18	51	42	573
Total	**tons**	**16,037**	**14,394**	**15,633**	**19,003**	**26,045**	**27,347**	**42,436**	**22,231**	**25,760**	**28,622**

Source: NaFAA (2023)

Table 4-4 shows the share of the total catch of a species assemblage per vessel type:

- The small pelagic and the medium pelagic are mostly fished by Fanti vessels
- The large pelagic fish, the shallow-water demersals and the deep-water demersals are mostly caught by the Kru vessels.
- The industrial vessels are mostly focused on the shallow-water and deep-water demersals.

It is essential to acknowledge that there are discrepancies between the data from Jueseah et al. (2020) and the data provided by NaFAA. Particularly, the scientific study indicates substantially lower total industrial fish catch per year compared to NaFAA's data. This suggests that the share of industrial catch for the different fish species is likely underestimated in the given data.

Table 4-4: Species per vessel

Item	Unit	Kru	Fanti	Industrial
Small pelagic	%	6.0%	93.5%	0.5%
Medium pelagic	%	22.0%	77.9%	0.1%
Large pelagic	%	78.0%	16.5%	5.5%
Shallow-water demersal	%	81.2%	6.6%	12.2%
Deep-water demersal	%	87.6%	0.7%	11.7%
Crustacean	%	47.1%	51.9%	1.0%

Source: Jueseah et all. (2020)

The findings of Jueseah et al. (2020) indicate that shallow-water demersal fish species are subject to overfishing, while many other species are not being fully utilized. The proliferation of the Kru fleet is an important contributing factor to the overfishing of the shallow-water demersal, given that these fish are their primary target. On the other hand, other fish stocks are not fully exploited, likely because artisanal vessels lack the necessary technology to effectively harvest these species (such as deep water demersals and large pelagics). A combination of policies and investments in modern vessels and fishing technologies is required to develop the Liberian fishing sector in a sustainable manner.

4.2.3 Maximum sustainable yield

We estimate the maximum sustainable yield for the Liberian fishing industry. Based on the MSY, we project the annual fish stock that can be sustainably caught in Liberia. The MSY for a fish stock is the largest catch that can be taken from a population over an indefinite period without depleting the stock's ability to reproduce and replenish itself. In other words, it represents the optimal harvest level that allows for the long-term maintenance of the fish population at a relatively constant size. In this section, we estimate the MSY for the Liberian fishing sector.

Resource assessment analysis

Surplus production models with simplified assumptions and the FAO Fish Stock Assessment Tools ("FiSAT") were used in the assessment of maximum sustainable yield ("MSY") and fish population dynamics for the Liberian fisheries because of the following reasons:

- Data Limitations: Assessing fisheries stocks and estimating MSY requires reliable and comprehensive data on fish populations, catch rates, and fishing effort. However, in Liberia, there has been limited resources and capacity to collect extensive data. As a result, simpler models with fewer data requirements should be used.
- Cost and Time Constraints: Implementing complex models and conducting detailed data collection can be expensive and time-consuming. Simplified surplus production models offer a quicker and more cost-effective approach, allowing for the assessment of MSY with limited resources and time.
- Decision-Making Purposes: MSY assessments are typically conducted to inform fisheries management decisions. In some cases, policymakers may prioritize timely assessments and recommendations over the precision and accuracy offered by more complex models. Simplified models can provide reasonable estimates of MSY that can be used as a reference point for setting catch limits and implementing management measure

Schaefer and Fox models to estimate MSY in the Liberian fisheries

The Schaefer and Fox models are commonly used in fisheries assessment to estimate the Maximum Sustainable Yield (MSY) of a fishery. The MSY is the largest catch that can be continuously taken from a fish stock without depleting the stock's reproductive capacity in the long term.

The Schaefer model is a widely used biomass-based model that assumes that fish population growth is influenced by two main factors: growth and mortality. The model assumes that the rate of population increase is proportional to the biomass of the fish population and is also influenced by the fishing mortality rate. The Schaefer model can be expressed as follows:

$$dN/dt = rN(1 - (N/K)) - F*N$$

Where: *dN/dt is the rate of change of the fish population over time,*
r is the intrinsic population growth rate,
N is the fish population size,
K is the carrying capacity of the environment (maximum sustainable biomass),
F is the fishing mortality rate.

The Schaefer model estimates the maximum sustainable biomass ("MSB") that can be harvested from the fishery, and the corresponding fishing effort that achieves MSY.

The Fox model is an age-structured model that incorporates more detailed information about the fish population, such as age classes and their corresponding reproductive and mortality rates. This model provides a more realistic representation of the population dynamics and can be more accurate in estimating MSY. The Fox model accounts for changes in the age structure of the fish population over time and the effect of fishing on different age classes.

Both the Schaefer and Fox models require data on fish population dynamics, including information on population size, growth rates, natural mortality, and fishing mortality. These models use historical data to estimate the parameters and then project future population trends under different fishing scenarios. By comparing different fishing mortality rates, the models can determine the level of fishing effort that maximizes sustainable yield for the fishery.

Data requirements for the MSY estimation

- Historical data on the abundance or biomass of the target fish species is required to fit into the model, but this is not available as comprehensive fish stock assessment was last done in 1981.
- Species specific historical catch data, are necessary to understand the relationship between fishing effort and catch rates, but this data set was available for only one year (January to December of 2022).
- Information on fishing effort, such as the number of fishing vessels, gear types, or fishing hours, is required to assess the level of fishing activity over time. Data shared has historical number of fishing vessels, historical catch and effort data for the period 2010 to 2022 is not disaggregated to species level. We only have total annual catch and the catch per unit of effort ("CPUE"), whereby the unit of effort was said to be fishing boat days (i.e. number of boats multiplied by number of days fished).
- Factors like water temperature, salinity, and primary productivity can influence fish population dynamics and often considered in the Schaefer and Fox models, but this is currently not available

In the absence of above comprehensive dataset, the Schaefer and Fox Surplus Production Models was used for estimating the Maximum Sustainable Yield. This model does not take into account age and growth. Hence, it could be safely applied to tropical stocks, where calculation of age of tropical fish is more cumbersome. When catch and effort data are applied for a number of years, the MSY thus generated will be more meaningful for sustainable fishery.

Schaefer model

In this model, the catch per unit of effort (CPUE) or yield per unit of effort is designated as Y/f. The Y/f is a function of effort, 'f'. MSY could be computed from the following equation.

$$Y(i)/f(i) = a + b \times f(i) \qquad (1)$$

In Schaefer model, the slope 'b' will be negative if the catch per unit of effort 'y/f', decreases for increasing effort. This model implies one effort level for which 'y/f' value obtained just after the first boat fishes on the stock for the first time. Hence, the intercept value is positive. Thus '- a/b' is positive and 'y/f' is zero for f = -a/b. As the negative value of catch per unit effort, 'y/f' is will not be a reality, this model applies to f values lower than '- a/b'.

The Catch and effort data shared for the period 2010 to 2022 was used to estimate a and b for the Schaefer model and MSY calculated as:

- MSY = - 0.25 . a2/ b
- FMSY = - 0.5 * a / b

In the Fox model,

- MSY = - (1 / d) * Exp. (c-1).
- FMSY = - 1 / d.

Note : The constants 'a' and 'b' are the intercept on the yield axis and the of the predicted yield trend line.

Estimated MSY

This MSY estimation was done by analysing the CPUE data for the period of 2010-2022 and applying the Schaeffer Surplus model.

The MSY is estimated at 25,000 tons per year.

4.2.4 Implementation of fishing quota

As there is currently observed overfishing in Liberian waters, it means that the amount of fish being caught exceeds the Maximum Sustainable Yield (MSY), which is not sustainable in the long run. Section 4.2.2. highlights that shallow-water demersal fish species are particularly affected by overfishing. The state of other fish species underpin the potential of a redistribution of catch per vessel type and the possibilities of new technological investments.

To address this issue, the fish demand forecast assumes that specific policies will be implemented:

- The assumed policies aim to reduce the number of Kru vessels, which are primarily responsible for overfishing the shallow-water demersal fish species. By doing so, it is hoped that the pressure on these fish populations will be alleviated.
- At the same time, the assumed policies prioritise the promotion of more industrial fishing activities, allowing utilisation of different marine species within the Liberian EEZ.
- Based on stakeholder consultations, it is anticipated that a gradual transition will occur, where traditional wooden canoes will be replaced with more advanced polymer fiber glass vessels or semi-industrial vessels (SIV). This shift in fishing practices aims to support long-term sustainability and the effective management of marine resources in the region.

We assume that by shifting a part of the catch from Kru and Fanti vessels to industrial vessels, the sustainability, profitability and efficiency of the fishery sector in Liberia can be guaranteed. Furthermore, the large pelagic species is added to the target species as this can provide additional sustainable catch to the total fishery sector of Liberia. Large pelagic are already being caught in the Liberian waters, however, current port facilities do not allow the vessels that catch these fish to berth and unload the fish. This means that these volumes are being brought to other ports. The realisation of the fishery port in Monrovia allows for larger vessels which means that the large pelagic species can then enter the local market in Montserrado.

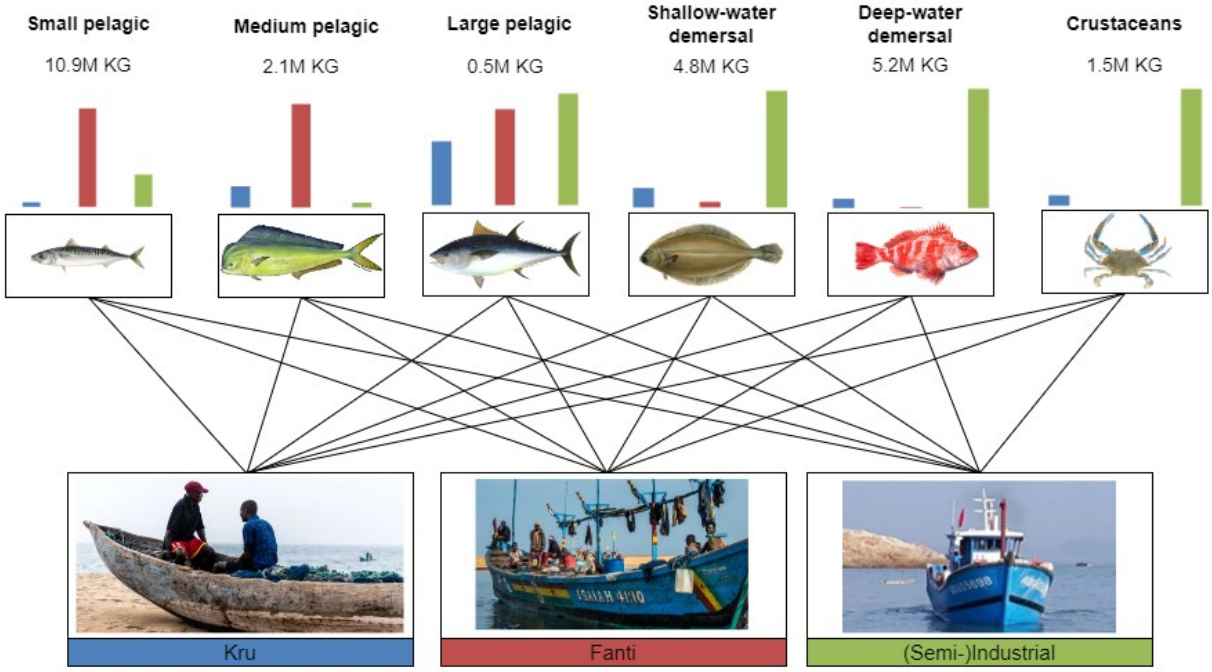
Table 4-5 provides an overview of the assumed fish quotas. The 2025 quotas are set in alignment with the current fish catch in Liberian waters per vessel type. However, the long-term quotas are strategically implemented to facilitate the transition from Kru vessels to (semi-)industrial vessels. This shift aims to support long-term sustainability and effective management of marine resources.

Table 4-5 Liberian fish catch forecast based on fishing quotas

Item	Unit	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
Production											
Kru	tons	5,932	5,446	5,000	4,782	4,573	4,373	4,183	4,000	3,000	2,000
Fanti	tons	16,469	15,717	15,000	14,794	14,592	14,392	14,195	14,000	13,000	12,000
Industrial	tons	4,936	4,968	5,000	5,348	5,720	6,119	6,544	7,000	9,000	11,000
Total	**tons**	**27,337**	**26,131**	**25,000**	**24,924**	**24,885**	**24,884**	**24,922**	**25,000**	**25,000**	**25,000**

Source: MTBS

Figure 4-1: Target species assemblage per vessel type (Post quota)



Source: MTBS

Based on historic data, it is observed that, on average, 18% of the artisanal fish catch in Liberia occurs in Montserrado County. Consequently, we assume that 18% of the total Kru and Fanti vessels in Liberia will operate in Montserrado County. Additionally, as Montserrado County serves as the primary facility for industrial vessels to land, we assume that all projected industrial vessels will also be served by Montserrado County.

Table 4-6: Montserrado County forecast based on quotas (before any PHFL)

Item	Unit	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
Production											
Kru	tons	1,100	1,010	927	887	848	811	776	742	556	371
Fanti	tons	2,872	2,872	2,781	2,743	2,705	2,668	2,632	2,596	2,410	2,225
Industrial	tons	4,936	4,968	5,000	5,348	5,720	6,119	6,544	7,000	9,000	11,000
Total	**tons**	**8,908**	**8,850**	**8,708**	**8,978**	**9,274**	**9,598**	**9,952**	**10,337**	**11,967**	**13,596**

Source: MTBS

Montserrado fish landed forecast (project case)

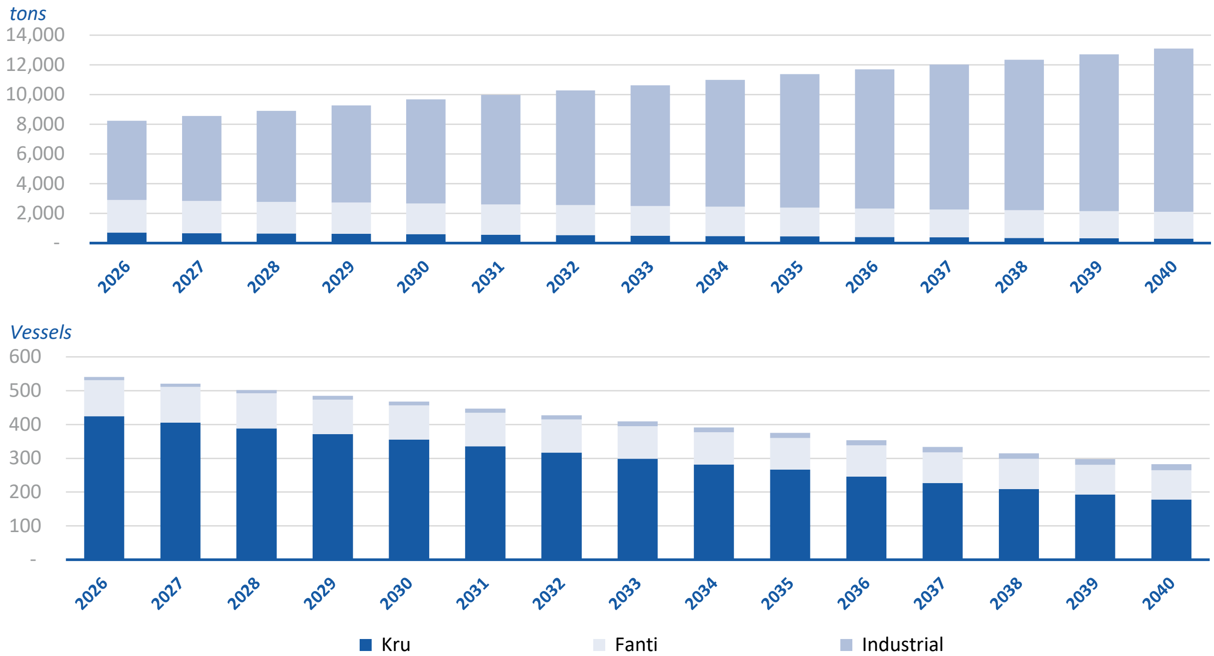
The table and figures below present the overall forecast for the Montserrado County. The forecast includes the total fish production (after PHFL) and vessels active in Montserrado County. A share of this fish production and vessels are landed at the project facility.

Table 4-7: Montserrado County (after PHFL)

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Fish landed in Montserrado County								
Kru	tons	708	677	648	621	594	448	300
Fanti	tons	2,189	2,161	2,134	2,107	2,080	1,941	1,802
Industrial	tons	5,348	5,720	6,119	6,544	7,000	9,000	11,000
Total	**tons**	**8,245**	**8,559**	**8,901**	**9,272**	**9,674**	**11,389**	**13,103**
Vessels in Montserrado County								
Kru	#	424	406	388	371	355	266	178
Fanti	#	107	105	104	103	101	94	87
Industrial	#	9	9	10	11	12	15	18
Total	**#**	**540**	**521**	**502**	**485**	**468**	**375**	**282**

Source: MTBS

Figure 4-2: Montserrado County Forecast – Fish landed and number of vessels



Source: MTBS

4.2.5 Project demand forecast

Building on the previous steps, we project the market demand for the fishery project. This involves estimating the project's market share in Montserrado County and accounting for post-harvest fish losses:

- Market shares: We estimate the percentage of the market in Montserrado County that the fishery project is likely to capture.
- Post-harvest fish losses: We take into account the potential losses of fish that may occur after the harvesting process. By considering these post-harvest losses, we distinguish between the fish caught from the sea and the fish that arrive in good condition on land.

Market share assumptions

In our analysis of the fishery project's market share, we consider the volume of fish that will be caught and served by the project. Several key assumptions have been taken into account to arrive at this estimation:

- 100% of the (semi-)industrial vessels will be served by the fishery project, meaning all the fish caught by these vessels will be part of the project's market share.
- 15% of the Kru and Fanti fish production will be facilitated by the fishery project in the first year of operations. Thereafter, if fish prices and other services are attractive at the port, more fishers are expected to start landing fish at the project and using its services. Therefore, we assume that by 2040, 25% of the artisanal vessels in the county will land at the port.

We assume that all industrial vessels would be required to land their catch at the project for compliance for port inspection reasons. As the artisanal fishers indicated during the market consultations that they prefer their own areas, we assume a considerable lower market share for the artisanal vessels to land at the project.

PHFL assumption

Table 4-6 presents the fish catch forecast before any PHFL. To project the volume of fish being landed a the fishery hub project, we need to take into account the PHFL levels. We assume that the PHFL for the vessels served by the project will be reduced. Currently, around 22% of the artisanal fish catch in Liberia is lost due to post harvest fish losses on board the vessel. An assessment report on PHFL in the artisanal fishery in Liberia from NaFAA names a number of causes. PHFL can be attributed to poor equipment and technology, mishandling and lack of preservation practices. Especially, in the lack of preservation practices, the absence of proper cold storage equipment and facilities play a big role. [2]

We assume that due to the fishery port project, the PHFL for the artisanal vessels can be reduced to 10% due to the fact that the fishery port will facilitate the artisanal vessels by providing proper (cold storage) equipment and ice. We assume that the fishery port does not impact the share of PHFL for the industrial vessels and that there is only limited PHFL for the industrial vessels. Based on this, the catch per vessel for the artisanal vessels can improve significantly by using the fishery port. We assume that for the artisanal vessels not making use of the project, the PHLF remains at the 22% level.

The following table provides an overview of the fish catch per vessel per year for vessels served by the project and vessels not going to the fishery hu, which are based on the average values over the period 2013-2022. These assumptions are applied when converting the total fish production for the project to the number of vessels calling the fishery hub.

Table 4-8: Vessel efficiency assumptions

Item	Unit	Before PHFL	Project	No-Project
PHFL assumption	%	-	10.0%	22.0%
Kru	tons/vessel p.a.	2.1	1.9	1.6
Fanti	tons/vessel p.a.	25.7	23.1	20.0
(Semi-)industrial	tons/vessel p.a.	604.4	604.4	604.4

Source: MTBS

[2] Liberia Artisanal Fishery Postharvest Fish Loss Assessment Report, National Fisheries & Aquaculture Authority, 2022

Project demand forecast

Based on the aforementioned assumptions and the Montserrado county forecast, we forecast the project demand. Table 4-9 presents the project projections for the volume of fish landed at the fishery hub, as well as the number of vessels calling the port. The project demand forecast results in the following observations:

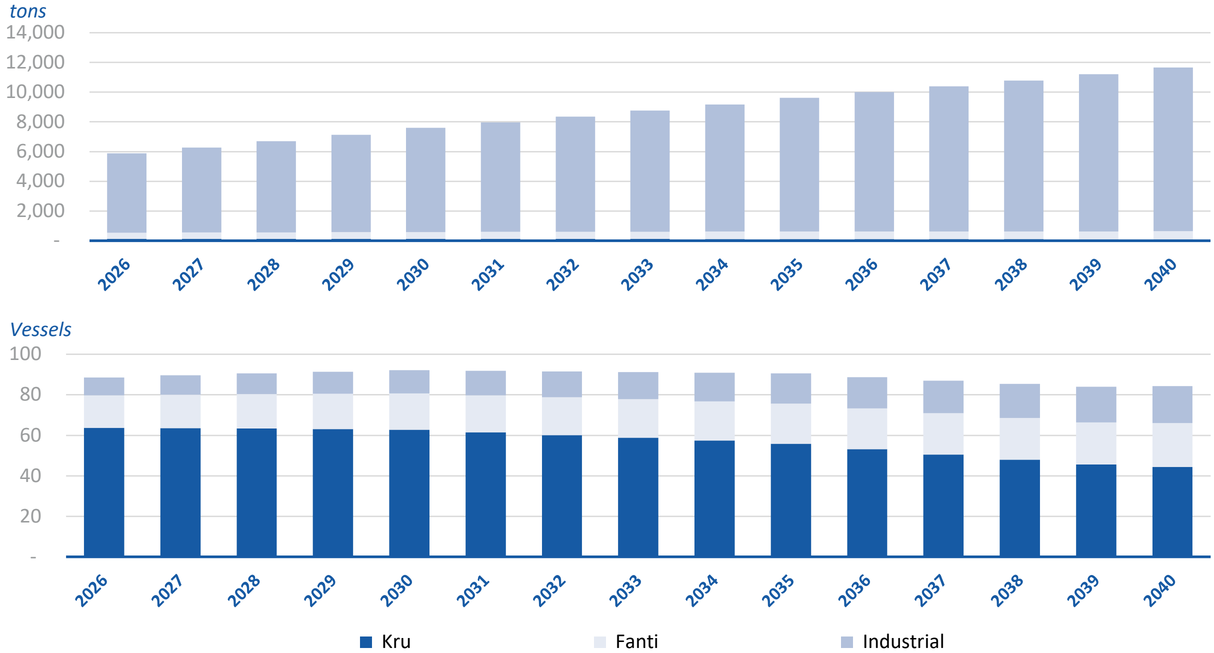
- Fish landed at the port:
  - For Kru vessels, the fish landed at the port is projected to decrease over the years, from 120 tons in 2026 to 83 tons in 2040, which is a result of the quotas implemented.
  - For Fanti vessels, the fish landed at the port is expected to increase from 370 tons in 2026 to 500 tons in 2040.
  - For industrial vessels, the fish landed at the port is forecasted to increase, reaching 11,000 tons in 2040.
  - Overall, the total fish landed at the port is estimated to fluctuate over the first years, and thereafter increase to 11,584 tons by 2040.
- Number of vessels:
  - The number of Kru vessels is anticipated to decrease, from 64 in 2026 to 44 in 2040.
  - In contract, the number of Fanti vessels is projected to increase, from 16 in 2026 to 22 in 2040.
  - Additionally, the number of industrial vessels is expected to increase, reaching 18 in 2040, which is a direct result of the quotas assumed.

Table 4-9: Project Forecast

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Fish landed at the port								
Kru	tons	120	120	119	119	118	105	83
Fanti	tons	370	381	392	403	413	456	501
Industrial	tons	5,348	5,720	6,119	6,544	7,000	9,000	11,000
Total	**tons**	**5,838**	**6,221**	**6,630**	**7,066**	**7,531**	**9,561**	**11,584**
Vessels								
Kru	#	64	64	63	63	63	56	44
Fanti	#	16	17	17	17	18	20	22
Industrial	#	9	9	10	11	12	15	18
Total	**#**	**89**	**90**	**91**	**91**	**92**	**91**	**84**

Source: MTBS

Figure 4-3: Project Forecast – Fish landed and number of vessels



Source: MTBS

4.2.6 No-Project Forecast

One of the major inputs for the economic analysis, is the no-project case forecast. This scenario describes the business as usual (BUA) scenario, which is based on the assessment of Jueseah et al. (2020). In the BUA evaluation presented in the paper, a decision rule is employed based on profit conditions where fishing effort increases when profits are positive and decreases when profits are not. The assessment by Jueseah et al. (2020) reveals the following projected patterns in different fish species:

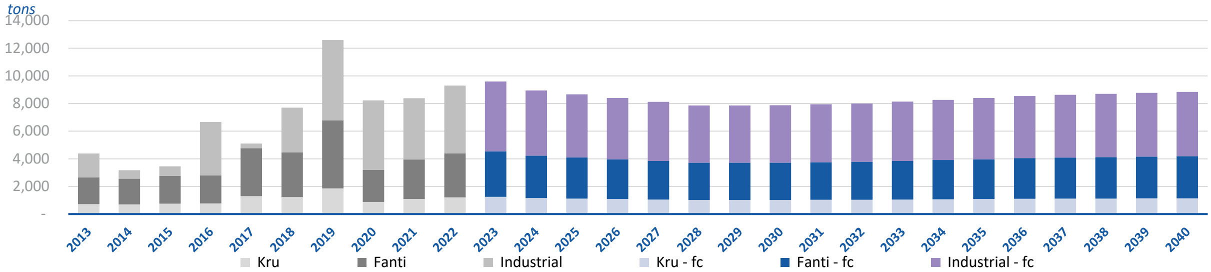
- Both small and medium pelagic species show a substantial decline. However, while the medium pelagic species manage to remain above their MSY, the small pelagic species experience a decline of below their MSY. Sustainable yields for these species illustrate the observed trends.
- The shallow-water demersal fish species fall to nearly 54% below the MSY. The deep-water demersal display a similar trend but manage to remain above their MSY.
- The crustaceans face a severe decline, even including their sustainable harvest levels. However, they still maintain 45% above their MSY.
- The overall profits of the vessels decrease to zero, which is a crucial point. This means there are no incentives for new entrants to join the fisheries. It could have a substantial impact on the fishing industry in the region.

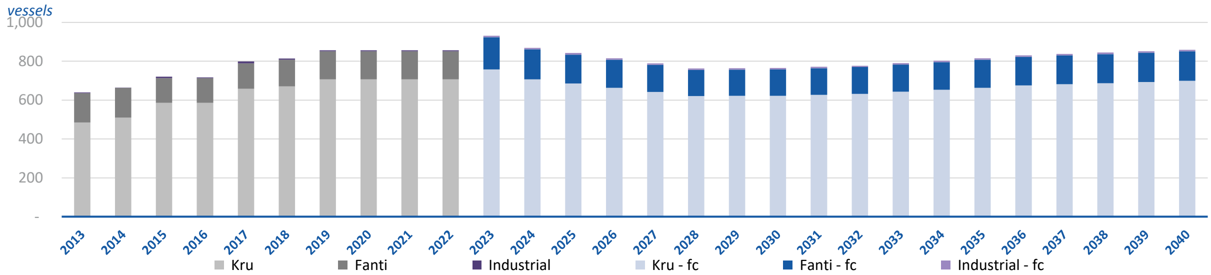
We apply the growth rates over the period 2022-2040 as presented in the study to the 2022 fish catch levels as provided by NaFAA. We assume that the ton per vessel catch remains constant over time. The estimation results in the projections for Montserrado region[3] as presented in the tables below.

Table 4-10: No-project case forecast for Montserrado County

Item	Unit	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
Vessels											
Kru	#	758	707	686	664	642	621	622	623	664	699
Fanti	#	165	154	149	144	140	135	135	135	144	152
Industrial	#	8	8	8	7	7	7	7	7	7	8
Total	**#**	**932**	**869**	**842**	**816**	**789**	**763**	**764**	**765**	**816**	**859**
Production											
Kru	tons	1,236	1,152	1,117	1,082	1,046	1,012	1,013	1,015	1,082	1,139
Fanti	tons	3,300	3,078	2,984	2,889	2,795	2,703	2,705	2,710	2,889	3,044
Industrial	tons	5,059	4,718	4,573	4,429	4,284	4,143	4,147	4,155	4,429	4,665
Total	**tons**	**9,595**	**8,948**	**8,674**	**8,400**	**8,125**	**7,858**	**7,865**	**7,880**	**8,400**	**8,848**

Figure 4-4: No-project case Montserrado County – Fish landed and number of vessels





Source: MTBS

[3] Assuming a market share of 18% of the total Liberian artisanal market and 100% of the industrial market

4.2.7 Results

The demand forecast results in the following projections:

- Project demand forecast
- Montserrado County demand forecast if the project materialises
- Montserrado County demand forecast in the no-project case

Project demand forecast

The project demand forecast is closely aligned with the proposed policies. Due to overfishing in Liberian waters, the current fish catch exceeds the sustainable level (MSY). To address this, we propose to implement simultaneously with the project various specific policies, aiming to reduce the number of overfishing Kru vessels and promote more sustainable industrial fishing activities. The transition from traditional canoes to advanced vessels will support long-term sustainability. The new fishery port in Monrovia will enable the (semi-)industrial vessels to land in Montserrado County, facilitating the adoption of more sustainable fishing methods. NaFAA should play a key role in monitoring and enforcing compliance with the policies.

Additionally, it is essential to enhance data gathering and monitoring efforts within the fishing sector. The establishment of the fishery hub can serve as a catalyst in this regard, as the hub can facilitate the collection of data on fish catch, vessel distribution, and species composition. This data will be instrumental in policy formulation and in enabling stakeholders to make more sustainable choices to protect marine resources effectively.

For the project demand forecast, we make several assumptions regarding the vessels served by the project. Initially, in the first year, the project is expected to serve 15% of the artisanal vessels. However, if favourable fish prices and other services are offered at the port, more fishers are likely to be attracted, leading to an increase in the number of artisanal vessels using the project's services. By the year 2040, we assume that 25% of the county's artisanal vessels will be landing their fish at the port.

Based on our forecast, we estimate that the port attracts 80 artisanal vessels and 9 semi-industrial vessels in 2026. As time progresses, the numbers are expected to change, with 66 artisanal vessels and 18 industrial vessels projected to be served by the port in 2040. Furthermore, the overall volume of fish landed is estimated to experience substantial growth, increasing from 5,838 tons in 2026 to 11,584 tons by 2040. These projections indicate a substantial increase in fish landing at the port.

Project and no-project case

The no-project case describes the business as usual scenario and is based on the assessment of Jueseah et al. (2020). The decision rule is based on profit conditions, with fishing effort increasing when profits are positive and decreasing when profits are not. In the no-project case, we observe a decline in fish production from 9,595 tons in 2023 to 7,858 tons in 2028. However, following this decline, the fish catch gradually recovers and increases to 8,848 tons by the year 2040. For the project case, the Montserrado fish production when the project materialises and the policies are implemented, the fish landed in the county grows from 8,245 to 13,103 tons by 2040.

4.3 Financial Feasibility

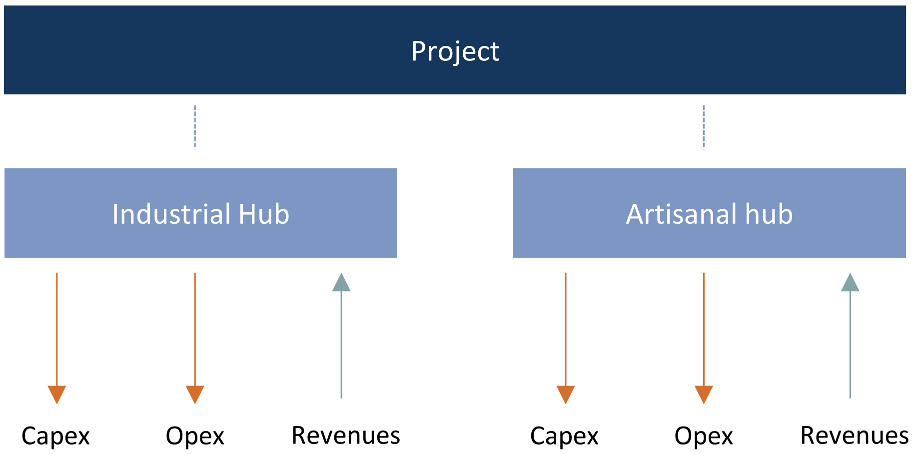
4.3.1 Introduction

This section presents the methodology for the financial feasibility assessment of the fishery project. To determine whether the project is financially feasible, a tailor-made financial model has been developed. The approach to assess the financial feasibility is based on the discounted cash flow ("DCF") method, which projects the future free cash flows of the project (revenues, capex, opex and tax). Subsequently, these future cash flows are discounted to their present values using the weighted average costs of capital ("WACC"). The sum of the discounted cash flows is the net present value ("NPV") of the project which is used as a key indicator to assess the financial feasibility.

4.3.2 Project structure as starting point for financial feasibility

First, we assess the overall project feasibility of the fishery port, encompassing both its constituent elements: the industrial hub and the artisanal hub. The schematic representation of this methodology is provided in the figure below. Through this evaluation, we aim to determine the viability of the entire fishery port project, as well as independently ascertain the feasibility of the industrial hub and the artisanal hub.

Figure 4-5: Overview of assumed project structure for financial model



Source: MTBS

If the entire fishery port project is found to be financially feasible, it implies that the project has the potential to generate sufficient revenues and profits to cover its costs and provide a positive return on investment. On the other hand, if any part of the project is found to be financially unfeasible, further analysis and adjustments may be necessary.

4.3.3 General assumptions

All financial outputs presented in this chapter are based on the following general assumptions:

- **Model Timing**: The timing of the financial model starts in 2024, which is the assumed first year of the project's construction period that leads to the first cash flows.
- **Construction**: The construction period starts in 2024 and concerns 2 years construction time. The operational period of the thereby starts in January 2026. The construction is based on the "Concept 6" designs as presented in Chapter 3.
- **Operations:** An operational period of 14 years is assumed for the financial feasibility analysis, meaning that the project's final year of operations comprises the year 2040.
- **Fishery port capacity:** The industrial fishery hub is projected to have a capacity of 20 vessels p.a. for each of the concept designs presented in chapter 4.
- **USD/LRD exchange rate:** A Purchase Power Parity (PPP) Exchange Rate is assumed, which means that the USD/LRD exchange rate is adjusted with the deviation of the inflation between the respective countries. The LRD exchange rate applied for the year 2023 is 160 LRD/USD.
- **Applied currency**: USD based model
- **Applied traffic scenario**: All volume related revenues and OPEX are based on the fish production demand forecast for the fishery hub as presented in section 4.2.
- **Corporate tax**: Included in the model in line with the current Liberian corporate tax rate of 25.0%.
- **Depreciation and re-investment**: A linear depreciation over the lifetime of the assets is applied. Once an asset is fully depreciated, re-investment takes place o(no infrastructure or equipment investments take place in respectively the last 5 or 3 years of the project's operational period).
- **Project WACC:** a nominal WACC of 9.7% is estimated and applied to the business case financial outcomes. In the derivation, we set the country risk premium to zero as it is expected that the government will invest in the project. Government-backed projects may have access to financing at lower interest rates due to their association with the government. This can result in a lower cost of debt, which, in turn, contributes to a lower overall WACC. See Annex I: WACC Calculation Table for the underlying assumptions.

4.3.4 Revenues

The revenue of the fishery hub consists of the following components:

- **Landing revenues:** The port becomes a hub for fish landings, attracting local and international fishing vessels. The fees levied on fish landings contribute to the financial viability of the port project. The landing revenues are calculated based on the vessel demand forecast and the current vessel landing revenues as observed in Monrovia. The landing fees only apply to industrial vessels and therefore result in financial revenues for the industrial hub only.
- **Auction commission revenues:** The implementation of the project generates auction commission revenues as revenue flow. The port provides a platform for fish auctions, where buyers bid on the catch. The commission earned from these auctions contributes are included as financial cash flows in the model. The auction commission revenues is determined by considering fish production demand projections, assumptions regarding the proportion of fish production sold in the fish auction, and the commission percentage applied to the volume of fish sold.
- **Miscellaneous revenues:** This revenue flow accounts for miscellaneous revenue flows such as fuelling, ice supply, provisioning, repair and maintenance, waste disposal. The miscellaneous revenues will be derived from an assumed revenue rate per vessel.

Table 4-11 presents an overview of the foreseen revenue flows of the project. The catch prices per kg per vessel type are based on the research done by Jueseah et al. (2020) and updated to the 2023 prices according to inflation. We assumed that the current distribution of fish species per catch by a vessel type, is constant. I.e. the vessels keep catching the same species in the same percentages. The miscellaneous net revenues are the net revenues associated with food, water and ice supplies for the vessels calling the fishery port. The rates applied are a result of the market consultations. We anticipate that most of the fish landed at the fishery project will be going to the auction. To remain conservative, we assume that 75% of the fish will be sold via the auction hall.

Table 4-11: Overview of revenue components

Item	Unit	Industrial	Kru	Fanti
Landing revenues				
Landing fee	USD/vessel/trip	255 USD/trip	-	-
Auction commission revenues				
% of fish production to auction	%	75%	75%	75%
Value of kg fish	USD/kg	4.7 USD/kg	3.1 USD/kg	1.7 USD/kg
Commission percentage	%	6.0%	6.0%	6.0%
Miscellaneous net revenues				
Miscellaneous net revenues	USD/vessel/trip	150	15	25

Source: MTBS

The revenue projections are based on the traffic projections as presented in the demand forecast section. Both the landing revenues as well as the miscellaneous revenues depend on the number of trips made per year, whereas the auction commison revenues depend on the total market value of the fish caught by the vessels being served at the fishery hub. To estimate the number of fishing trips per annum for each of the vessel types, we assume that the kru, fanti and industrial vessels make 200, 120, and 22 trips per year, respectively. We provide an overview of the relevant forecast in the following table and it shows that:

- The kru vessels account for the majority of vessel landings, mainly because they are assumed to make 200 trips per year and also because they have the highest projected number among all types of vessels.
- The number of industrial trips per year is substantially lower, with projected figures indicating 8 vessels in 2026 and 16 vessels in 2040. Industrial vessels make only 22 trips per year, because of their extended time at sea.
- Conversely, the fish market value of industrial vessels is the highest due to their high volume catch per vessel and the assumed value of 4.7 USD per kg fish.

Table 4-12: Traffic input for revenue calculations (real prices)

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Vessels								
Kru	#	79	73	67	64	64	60	51
Fanti	#	18	17	16	16	17	19	20
Industrial	#	8	8	8	9	9	13	16
Total	**#**	**105**	**98**	**91**	**89**	**90**	**92**	**87**
Vessel trips								
Kru	trips p.a.	12,732	12,718	12,680	12,622	12,544	11,183	8,876
Fanti	trips p.a.	1,924	1,982	2,038	2,092	2,145	2,367	2,601
Industrial	trips p.a.	195	208	223	238	255	328	400
Total	**trips p.a.**	**14,851**	**14,908**	**14,941**	**14,952**	**14,943**	**13,878**	**11,877**
Fish market value								
Kru	000 USD	366	366	365	363	361	322	255
Fanti	000 USD	613	632	650	667	684	755	829
Industrial	000 USD	25,215	26,970	28,848	30,856	33,004	42,433	51,863
Total	**000 USD**	**26,195**	**27,968**	**29,862**	**31,886**	**34,048**	**43,510**	**52,948**

Source: MTBS

We provide an overview of the revenue forecast for the artisanal hub and the industrial hub in Table 4-13. In summary, the industrial hub is expected to achieve the highest revenues, resulting from the high volume of catch and valuable fish caught by industrial vessels. The revenues of the industrial hub are projected to substantially increase due to the increasing number of industrial vessels. On the other hand, the revenues of the artisanal hub consist mainly of the miscellaneous revenues.

Table 4-13: Overview of revenue projections

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Industrial hub								
Landing revenues	000 USD	29	32	35	38	42	59	80
Auction commission revenues	000 USD	1,228	1,340	1,462	1,595	1,740	2,470	3,333
Miscellaneous revenues	000 USD	32	34	38	41	45	64	86
Total	**000 USD**	**1,289**	**1,406**	**1,534**	**1,674**	**1,826**	**2,593**	**3,499**
Artisanal hub								
Landing revenues	000 USD	-	-	-	-	-	-	-
Auction commission revenues	000 USD	48	50	51	53	55	63	70
Miscellaneous revenues	000 USD	259	265	272	278	283	294	283
Total	**000 USD**	**307**	**315**	**323**	**331**	**338**	**356**	**353**
Project								
Landing revenues	000 USD	29	32	35	38	42	59	80
Auction commission revenues	000 USD	1,276	1,390	1,513	1,648	1,795	2,533	3,403
Miscellaneous revenues	000 USD	290	300	309	319	328	357	369
Total	**000 USD**	**1,596**	**1,721**	**1,857**	**2,005**	**2,165**	**2,949**	**3,851**

Source: MTBS

4.3.5 Capex

In Chapter 3 the project costs are detailed. Concept 5 relates to a design based on a T-shaped load-out jetty with a berth platform on piles, while Concept 6 is based on an alongside berth facility which consists of a sheet piled cofferdam. We assume Concept 6 as the base case scenario of the financial and economic feasibility. In the financial model, we have excluded the EIA studies and the design fees from the project costs, as these are expected to be performed before the construction period. The financial model incorporates a contingency rate of 10% to account for unforeseen expenses and implements a maintenance rate of 3% for all items, except for the supervision and mobilization costs. In the estimation of total project costs for both the artisanal and industrial hubs separately, we consider that each facility accounts for an equal share of 50% of the general costs, consisting of supervision, mobilization and the road improvement costs.

Table 4-14: Capex Items per Concept (2023 prices)

Item	Unit	Concept 5	Concept 6 (base case)
Industrial hub	000 USD	5,882	14,956
Artisanal hub	000 USD	8,846	8,846
Total capex	**000 USD**	**14,728**	**23,802**

Source: MTBS based on Reference Study

4.3.6 Opex

The major operational expenses (opex) categories included in the financial assessment are based on the findings presented in Chapter 3 and are provided in the following table.

Table 4-15: Opex Categories (2023 prices)

Category	Unit	Concept 5	Concept 6 (base case)
Industrial Hub			
Labour costs	USD per annum	31,800	31,800
Maintenance Costs (3% of capex)	USD per annum	160,000	430,000
Artisanal hub			
Labour costs	USD per annum	51,600	31,800
Maintenance Costs (3% of capex)	USD per annum	250,000	250,000

Source: MTBS Internal Database, Local Stakeholder Interviews

4.4 Economic Feasibility

4.4.1 Introduction

This chapter presents the methodology of the economic feasibility of the project. The general approach for conducting the economic cost benefit analysis ("ECBA") has five steps:

1. **Project case & reference case definition:** The economic benefits and costs are further described for the project. To highlight the incremental economic value generated by the project, a reference case is defined in which the project is not implemented and the project benefits and costs do not materialize: the "No-Project Case".
2. **Articulation of the project's economic benefits and costs:** The (direct and indirect) economic benefits and costs that are foreseen to be generated by the project are identified and articulated. Thereafter, the direct and indirect benefits and costs of executing the project are identified. Similar to the financial CBA, a project horizon up to 2040 is applied.
3. **Financial cashflow adjustment:** The cashflows are adjusted to their corresponding economic values through conversion factors. Furthermore, as the discount rate for the ECBA, the social discount rate, consists of a real growth factor, the cash flows are presented in real terms.
4. **Economic indicators:** The last step represents the calculation of the economic indicators. The Economic Internal Rate of Return ("EIRR") is based on the economic project cash flows calculated in step five. In addition, the Economic Net Present Value ("ENPV") is calculated based on the discounted cashflows, using the social discount rate.

4.4.2 The project case and the no-project Case

The project definition distinguishes two cases: The project case and the no-project case (counterfactual scenario).

- In the **no-project case**, a Do-Minimum scenario is defined. "Do minimum" assumes that there will be sufficient investment to keep the existing port and artisanal infrastructure operational in the future to facilitate all current commercial fishing activities. As such, the fishery activities will be performed in similar fashion as is done today (business as usual).
- In the **project case**, a new fishery port in Liberia involves the development and establishment of a dedicated fishery port that caters to both artisanal and industrial fishing activities. The new port would be equipped with modern facilities and infrastructure, designed to enhance the efficiency, productivity, and competitiveness of the fishery sector in Liberia. With the new fishery port, several benefits and opportunities would arise.
  - Firstly, the port would provide improved landing facilities for artisanal fishermen, ensuring safer and more efficient offloading and handling of their catch. This would contribute to the preservation of fish quality on board of the vessels and a reduction of accidents.
  - Secondly, the industrial fishing sector would benefit from the new port's facilities, including larger berths. The SIVs cannot be accommodated within the CFHF berthing places, as the water depth (bottom level minus 2.00m) is not sufficient. Hence, with the project, these SIVs are able to call at the IFF.

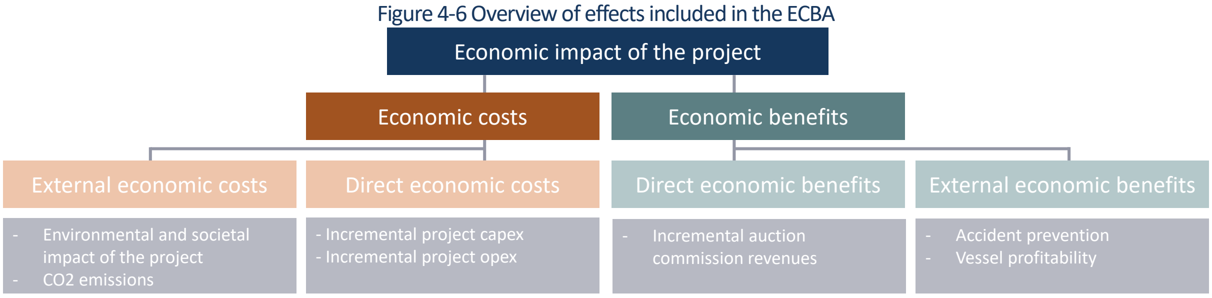
It is crucial to highlight that the primary distinction between the no-project and project cases lies in the absence of government policies in the **no-project scenario**. As a result, the small pelagic species shallow-water demersal fish species experience a decline below their MSY. Furthermore, the medium pelagic species, deep-water demersal, and crustaceans also face a severe decline, although they manage to remain above their respective MSY levels. Ultimately, the overall profits of the fishing vessels decrease to zero.

The **project case** assumes specific policies to reduce the number of Kru vessels responsible for overfishing shallow-water demersal species. It prioritizes promoting industrial fishing activities for sustainable marine resource utilization. Stakeholder consultations anticipate a gradual shift to semi-industrial vessels for long-term sustainability. This shift aims to guarantee the profitability, efficiency, and sustainability of Liberia's fishery sector. Additionally, including large pelagic species as target species enhances the sector's sustainable catch potential and local market access. Furthermore, in the project case, the vessels served by the project facility experience reduced PHFL and fewer accidents. As a result, their revenues increase despite putting in the same amount of effort. This positive impact on the vessels' financial performance contributes to the overall economic benefits of the fishery hub project.

4.4.3 Estimating the economic impact of the project

The following figure presents the structure of the ECBA. The overall economic effect is the result of the combination of economic costs and economic benefits. Both components consist of a direct part and an indirect or "external" part.

Figure 4-6 Overview of effects included in the ECBA



<u>Direct Economic Costs</u>

The direct economic costs consist of the incremental CAPEX and the incremental OPEX that result from the project. The financial capex and opex cash flows from the previous chapter are translated to economic cash flows by means of conversion factors to properly reflect the economic costs for Liberia.

<u>Indirect Economic Costs</u>

The indirect economic costs include the local environmental and social costs that result from the construction of the project, which are to be determined in a detailed project Environmental and Social Impact Assessment ("ESIA") for the fishery project development. As this assessment is currently ongoing and not made available to the Consultant, no adequate cost estimates can be provided for the external economic cost. Therefore, these indirect economic costs are not incorporated in the ECBA.

Secondly, as the fishery hub is projected to result in more active fishery vessels, we take into account the increase in emissions of greenhouse gases of which the most important one is CO2, for the incremental amount of fishery vessels active due to the project. For the purpose of the calculation of the climate change costs, we use the estimate of the avoidance costs established by CE Delft et al (2019), which established the central value of the carbon price to be USD 134 per ton CO2.[4]

We estimate the amount of CO2 emissions per kg catch for the Fanti and industrial vessels based on the findings of the paper 'Global trends in carbon dioxide (CO2) emissions from fuel combustion in marine fisheries from 1950 to 2016' by Greet et all. (2020). We assume that the Kru vessels are not associated with CO2 emissions, as these are non-motorised vessels. The main assumptions in the emission intensity estimation are provided in the table below. The following emission intensity is assumed:

- For Fanti vessels, 1.2 kg CO2 is emitted per kg catch
- For industrial vessels, 2.9 kg CO2 is emitted per kg catch

Table 4-16: Emission intensity calculation

Scenario	Unit	Fanti	Industrial
Engine capacity	kw	59	386
Active hours per fishing day	hours	4	24
Days per trip	days	1	20
Specific fuel consumption rate	kg fuel / kwh	0.35	0.20
Emission factor	kg CO2 / kg fuel	3.01	3.17
kwh per trip	kwh/trip	236	185,280
Fuel consumption per trip	fuel/trip	83	37,056
CO2 emission per trip	kg CO2 /trip	249	117,468
Average catch per trip	kg/trip	200	40,000
Emission Intensity	**kg CO2/kg catch**	**1.2**	**2.9**

Source: Greet et all. (2020), MTBS

[4] We applied an average 2019 USD/EUR exchange rate of 1.12 on the 2019 price of 100 EUR/ton CO2 and corrected for inflation over the period 2019-2023.

Based on the incremental volume of vessels relating to the implementation of the fishery project, the carbon price of USD 134 per ton CO2 and the estimated CO2 emission per vessel per year, we establish the indirect economic costs of the project. The results are presented in the following table.

Table 4-17: Project CO2 emission costs

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Industrial hub								
Incremental catch	tons	919	1,436	1,975	2,397	2,845	4,571	6,335
Incremental climate costs	000 USD	(357)	(558)	(768)	(931)	(1,105)	(1,776)	(2,461)
Artisanal hub								
Incremental catch	tons	(341)	(288)	(235)	(311)	(388)	(1,004)	(1,587)
Incremental climate costs	000 USD	23	14	6	12	18	77	132
Total								
Incremental catch	tons	578	1,148	1,740	2,086	2,458	3,567	4,747
Incremental climate costs	000 USD	(334)	(544)	(762)	(920)	(1,087)	(1,699)	(2,330)

Source: MTBS

Direct Economic Benefits

The financial feasibility methodology presents the three revenue flows assumed for the fishery port project, which are the landing revenues, the auction commission revenues, and the miscellaneous revenues. As the landing revenues and the miscellaneous revenues are already captured by the existing fishery infrastructure, we do not include these elements as direct benefits to avoid double-counting or overstating the project's economic impacts.

The auction revenues is included as direct benefits in the ECBA because it represents a new and additional source of income that the project generates for the region. The auction commission revenues result from the establishment of a new fish auction facility in Liberia, where one did not exist previously. The direct economic benefit reflects the incremental income generated by the new facility that would not have been available without the project's implementation. The financial revenue flows related to the auction hall are translated to economic cash flows by means of conversion factors to properly reflect the economic revenues for Liberia.

Indirect Economic Benefits

The indirect economic benefits for the project are achieved by the increased profitability and reduced accidents for the vessels being served by the project fishery hub.

Vessel Profitability

In the project case, the vessels served by the project facility experience reduced PHFL. As a result, their revenues increase despite putting in the same amount of effort. This positive impact on the vessels' financial performance contributes to the overall economic benefits of the fishery hub project. By minimising losses, the project ensures a more efficient and profitable fishing operation for the vessels, thereby promoting sustainable growth in the fishery sector. The main assumptions for the calculation of the profits are provided in Table 4-18.

Table 4-18: Assumptions for profit calculations – 2023 prices

Item	Unit	Kru	Fanti	Industrial
Revenues				
Value of fish landed	USD/ton	3.1	1.7	4.7
Costs				
Crew share of revenues	%	50%	40%	8%
Fixed costs	USD/vessel	880	2,650	143,930
Variable costs of fish caught (before any PHFL)	USD/ton	364	523	2,612

Source: MTBS based on Jueseah et al. (2020)

Table 4-19 illustrates the project's indirect benefits in terms of incremental profits for the vessels:

- Due to the assumed fish quotas implemented in the project case, there are less artisanal vessels projected in the project scenario than in the no-project case. Therefore, the project results in an overall reduction of artisanal profits in Montserrado County. It should be noted that the profitability of the artisanal vessels that are served by the fishery hub are assumed to have a higher profit as for these vessels, the PHFL reduces.
- The fish quotas assumed for the project scenario prioritize the industrial fishing activities in Montserrado County. Therefore, there are more industrial vessels projected for Montserrado County in the project case than in the no-project case, resulting in incremental profits for the industrial sector in the project case.
- Overall, the project scenario results in higher overall profits for the fishing sector in Montserrado County.

Table 4-19: Indirect benefits - incremental profits

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Industrial	000 USD	1,490	2,328	3,203	3,887	4,613	7,412	10,271
Artisanal	000 USD	(309)	(290)	(271)	(293)	(315)	(500)	(677)
Total incremental profits	**000 USD**	**1,181**	**2,038**	**2,932**	**3,594**	**4,299**	**6,911**	**9,594**

Source: MTBS

Accidents prevention

An important outcome of the project is the expected reduction in accidents for vessels utilizing the project's fishery hub. Based on historical data as presented in the study 'Strengthening monitoring and controlling of artisanal fisheries using pelagic data system in Liberia' (Yahn et al., 2019), there were 60 fatal accidents related to artisanal fishing activities in 2019. To assess the future likelihood of accidents in Montserrado County, the following assumptions are made:

- On average, 0.07 accidents occur per year per artisanal vessel.
- Artisanal vessels using the safe landing site provided by the project will not experience fatal accidents.
- The project is assumed to have no substantial impact on the occurrence of accidents related to industrial vessels.

These assumptions provide a basis for evaluating the potential safety benefits of the project, aiming to create a safer and more secure environment for artisanal fishing activities, thereby reducing the occurrence of fatal accidents in the region. The table below presents an overview of the reduction of accidents due to the project.

Table 4-20: Indirect benefits – accident prevention

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Project case accidents	accidents	32	30	29	28	26	20	14
No project case accidents	accidents	57	55	53	53	53	57	60
Reduction of accidents	**accidents**	**25**	**25**	**24**	**26**	**27**	**37**	**46**

Source: MTBS

We include the reduction of accidents resulting from implementing the project vis-à-vis the no-project case as an indirect benefits of the project. Accident prevention is quantified in terms of its financial value through the reduction of productivity losses associated with loss of life, an approach that is prescribed by the Guide to Cost-Benefit Analysis of Investment Projects from the European Commission. The reduction of productivity losses is an estimate of the economic value society places on reducing the average number of casualties by one. In our approach, we utilise the findings from the study 'Variations between countries in values of statistical life' (Miller, 2000), which established that this estimate is at least 120 times the per capita income in the country. This method is implemented due to the scarcity of empirical data for most low-income countries on the economic value of reducing the average number of casualties by one.

Table 4-21: Indirect benefits – economic value of accident prevention

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Artisanal	000 USD	2,205	2,245	2,275	2,470	2,664	3,978	5,111
Industrial	000 USD	-	-	-	-	-	-	-
Total	**000 USD**	**2,205**	**2,245**	**2,275**	**2,470**	**2,664**	**3,978**	**5,111**

Source: MTBS

4.4.4 Conversion of financial cashflows to economic cashflows

Step 4 in the ECBA concerns the translation of the financial results into economic cash flows. These economic cash flows are derived by means of conversion factors. Through conversion factors, the shadow prices of the costs and benefits are calculated. The CAPEX required for the investments often includes purchasing and importing construction materials, labour, and other machinery originating from countries outside the EAC. As these material and labour inputs are not purchased in Liberia, the money to purchase these inputs flows out of the country's economy. As such, the ECBA accounts for the fact that project development costs are not borne by the economy in full; specifically, CAPEX costs are slightly decreased to account for import duties and the potential employment of unemployed unskilled labour during construction. In Liberia, the customs duty is imposed at an average rate of 7%.[5] We assume that the materials used for the project are mostly imported from outside Liberia, for which the import tax applies. For the costs assumed to be related to labour, an income tax of on average 25%[6] is applied. Lastly, we assume that the remaining costs relate to other categories, for which no taxes apply. The conversion factors for each of the scenarios are presented in the table below.

Table 4-22: Conversion factors per scenario

Scenario	Share materials	Share labour	Share others	Conversion factor[7]
Costs Concept 5	40%	40%	20%	0.87
Costs Concept 6	45%	45%	10%	0.86
Revenues	-	100%	-	0.75

Source: MTBS

4.4.5 The economic indicators and the social discount rate

Step 5 in the ECBA calculates the social discount rate (SDR) and the economic indicators. The EIRR is calculated based on the economic cash flows resulting from the previous steps. The ENPV is calculated by discounting the economic cash flows against the SDR which is set to 7.2% in this assessment. The ECBA for capacity focuses on determining the ENPV and EIRR for all priority projects. Any project that has a positive ENPV and an EIRR value that exceeds the SDR of 7.1% is economically feasible. In this regard, the SDR is a key assumption for an ECBA as it sets the hurdle rate for the EIRR and is used to calculate the ENPV. Table 4-23 shows that the SDR (r) is calculated by the following formula: r = e * g + p. The term 'e' represents the elasticity of marginal social welfare with respect to public expenditure. The term 'g' represents expected per-capita consumption growth and the term 'p' represents the rate of pure time preference.

Table 4-23 The Social Discount Rate

Factor	Components	Value
e	elasticity of marginal social welfare with respect to public expenditure	1.5
g	expected per-capita consumption growth rate	3.42%
p	rate of pure time preference	2.0%
r	**Social Discount Rate (SDR): r = (e * g) + p**	**7.1%**

Source: MTBS

The elasticity of marginal social welfare ('e') is generally between 1 and 2, with 1 representing a low elasticity and 2 a high elasticity of social welfare with respect to public spending. A low elasticity implies that for every extra dollar spent by public authorities, the social welfare increases only marginally. In contrast, an elasticity close to 2 implies a strong increase in social welfare in case of increased public spending. In the ECBA, the elasticity of social welfare with respect to public spending is set at 1.5. The expected per-capita consumption growth ('g') is calculated by taking the expected average annual compounded GDP per capita growth rate in Liberia for the coming five years, which equals 3.42%. For the ECBA, inflation is not included given the fact that the discount rate is also based on a real growth rate. The pure time preference term ('p') can be decomposed into two elements, one related to individuals' impatience and myopia, and the other one related to the risk of death or human race extinction. Economic literature generally estimates a value for p between 1.0% (e.g. Newbery, 1992, Arrow, 1995, Evans, 2007) and 3.0% (Nordhaus, 1993). Here, a value of 2.0% is taken, which is relatively conservative considering the region's death rate.

[5] https://www.trade.gov/country-commercial-guides/liberia-import-tariffs

[6] https://gsl.org/en/taxes/tax-zones/liberia/

[7] Material percentage%*(1-customs duty)%+labour percentage%*(1-income tax)%+(1-material percentage – labour percentage)%*100%

5 Description of Data Used for the Assessment and Data Validation

5.1 Introduction

In this chapter, we discuss the data collection process and validation methods used for the financial feasibility and the economic feasibility assessment. This chapter outlines the sources of data, the variables considered, and the validation techniques employed to ensure the quality and integrity of the dataset.

Data sources can be divided into primary and secondary data sources. Primary data sources refer to original data, collected firsthand by the researcher or organization for a specific research or analysis. Secondary data sources, on the other hand, are existing data that have been collected by someone else for purposes other than the current study. For the demand forecast and feasibility studies, both forms of data sources have been used.

5.2 Data Sources and Main Assumptions

The objective of the Assignment is to determine whether or not the proposed investment in the Mesurado Fishing Pier is justified from a financial and economic point of view.

The financial analysis is concerned with the project cash flows. Specific assumptions for the financial analysis are described in chapter 4 of this report. Here follows a brief description of the data used and validation process.

Based on the project design concept and available reference studies regarding the investment components and associated development and construction costs, the Consultant determined the capital expenditures. Subsequently, the Consultant made an independent assessment of the operating costs based on the expected full-time equivalent employees and salaries, maintenance and replacement at the Mesurado Fishing Pier. To determine the project revenues, the Consultant evaluated the proposed business model at the fishery port. Revenues are typically driven by quantities (fish volumes, vessel landings, provision of auxiliary services and retail sales) and prices (fish market prices, license fees). To inform the fish volume forecast, the Consultant reviewed various scientific papers and information that was made available by the Client regarding historical landed fish volumes, the historical composition of the vessel fleet and the historical catch effort. Reference is made to Appendix II for a full overview of the literature review.

Based on the above-mentioned data sources, the Consultant estimated the MSY for the Liberian fishery sector. The MSY is interpreted as the optimal long-term harvest level. By assigning a market share to the Mesurado Fishing Pier, the associated fish landing volumes are calculated per vessel type. The market share is estimated as a proxy of the number of the artisanal fishing vessels in the Montserrado county, relative to the total Liberian artisanal fleet. It is assumed that 100% of the industrial fleet will call at the Mesurado Fishing Pier, because it is the only port of call with sufficient depth to berth the vessels.

Subsequently, a financial model is structured to calculate the project cashflows, split between the industrial hub (within the port basin) and the artisanal hub (outside the port basin). Future cash flows are discounted to their present values based on the weighted average cost of capital ("WACC"). In accordance with the capital asset pricing model ("CAPM"), the rate of return is estimated taking into account the riskiness of the proposed investment.

Finally, the Consultant used the financial model to examine if the forecasted revenues are sufficient to offset the operating expenses and retrieve the upfront investments.

Table 5-1 below summarized the main data sources.

Table 5-1: Overview of data sources for the feasibility assessment

Component	Item	Source
Macro-economic data	Population	World Bank
	Consumer price index	World Bank
	Import/export quantities	FAO
Capex	Design concept	Sciortino
	Bill of quantities	Sciortino
	Investment costs	Sciortino
Opex	Labour costs	Desk research
	Maintenance and repairs	Desk research
Revenues	Fish market prices	Desk research / primary sources
	Landing fees	Desk research
	Concession fees	Own calculations
Volumes	Historical catch volumes	NaFAA
	Historical fleet composition	NaFAA
	Historical catch effort	NaFAA
	Historical PHFL	NaFAA / desk research / primary sources
	Maximum Sustainable Yield	Desk research / own calculations
	Future port market share	Own calculations

Source: MTBS

5.3 Data Validation

In order to ascertain the main assumptions and variables in the financial and economic assessment, the Consultant took the following steps. As part of the core project team, the Consultant onboarded an independent regional fishery expert. The fishery expert was involved in two site visits to the project area to conduct public consultations with project beneficiaries and the Client (refer to chapter 8 of this report). The fishery expert independently calculated the MSY for different species assemblages. The results were contrasted and compared with the findings of recent scientific publications. In addition, the fishery expert collected information about market prices and distribution channels.

Public consultations were aimed at verifying underlying assumptions regarding the current state and future needs of the artisanal fishing sector. Through semi-structured interviews with representatives from local fishing communities information regarding the main risks and opportunities in the sector was collected. Subsequently, the Consultant examined the project design and infrastructure components of the reference studies that were completed by Mr. Sciortino is an earlier phase of the LSMFP. As such, the Consultant was able to ascertain the investment concept and associated costs.

The methodology of the economic analysis, including the anticipated economic effects (benefits and costs) was described in the Inception Report at the start of this Assignment. The proposed methodology was reviewed and approved by experts from the World Bank.

6 Results of the Assessment

6.1 Introduction

In this report, we present the overall financial and economic feasibility of the project, with the objective to provide a clear recommendation towards the Government and the World bank whether or not to proceed with the project.

This chapter follows a step-wise approach:

- First, the financial feasibility is determined to assess if the project is financially feasible, with and without external investment support. The primary objective is to determine the project's capability to repay the potential loan provided by the World Bank.
- Secondly, the economic feasibility is determined to assess if the project will generate a net economic benefit for the economy as a whole. In case the economic feasibility is demonstrated, we advise the government and the World Bank to move forward with its implementation.

6.2 Financial Feasibility

6.2.1 Introduction

The financial feasibility assessment is conducted with the primary objective of determining the project's capability to repay the potential loan provided by the World Bank. Through analysis of the financial aspects as presented in the methodology section in Chapter 4.3, the feasibility study aims to assess whether the project's generated income will be sufficient to cover the loan repayment obligations without external financial support.

In the event that the projected revenue falls short of meeting the loan repayment requirements, the assessment also explores the possibility of partial grant assistance from the World Bank. This consideration is intended to ensure the successful implementation of the project by providing the necessary financial support to bridge the gap between the project's income and the loan repayment obligations.

The financial feasibility assessment is based on the methodology as prescribed in Chapter 4.3, the demand forecast as presented in Chapter 4.2, and design Concept 6, which is recommended in Chapter 3.

6.2.2 Financial assessment results

Table 6-1 presents the outcome of the financial feasibility assessment for the total project, as well as for the industrial and artisanal project separately. The projected cash flows of the separate projects are presented in Appendix I.

Table 6-1: Financial Feasibility Results

	WACC	IRR	NPV (USD)
Industrial hub	9.7 %	11.0 %	USD 1.7 M
Artisanal hub	9.7 %	- %	USD -6.6 M
Total project	**9.7 %**	**7.4 %**	**USD -4.2 M**

Source: MTBS

In summary, we find that under the current configuration of assumptions:

- The project is financially unfeasible with an overall project NPV of - 4.2 USD M and an IRR of 7.4%, which falls under the assumed WACC of 9.7%. These results indicate that the total project is unable to meet the financial requirements for a viable investment under the given assumptions.
- However, the financial results show that the industrial hub shows a positive business case, with a NPV of USD 1.7 M and an IRR of 11.0%, meaning that its generated income is expected to be sufficient to cover its loan repayment obligations without external financial support.
- On the other hand, the artisanal hub is not financially viable on its own, as its generated income is not enough to cover the loan repayment obligations for the project. The NPV of USD - 6.6 M USD indicates that the project's costs exceed its benefits, resulting in financial losses over its lifetime. However, while the project may not be able to cover the initial investment costs, the generated income is enough to cover its ongoing operational costs. This implies that the project would require external financial support, in the form of a grant, to cover its larger financial obligations.

It is important to note that the industrial and the artisanal project cannot be taken as two separate projects. Though the industrial hub can be developed as a stand-alone initiative, the dredged materials need to be disposed of. Developing the artisanal hub in parallel provides an opportunity to use (part of) the dredged materials for the reclamation of land.

The results of the financial feasibility assessment indicate that the fishery project is financially unfeasible. This implies that the loan repayments obligations cannot be met without external financial support. On the other hand, the industrial hub does show a financially feasible business case, meaning that the generated income for the industrial hub is sufficient to cover the repayment obligations.

6.2.3 Sensitivity analysis

In this section, we perform a sensitivity analysis to test the robustness of the fishery port project outcomes from the previous section under different circumstances. The sensitivity analysis is conducted on the financial indicators of the project. The assumptions of the project are compared with various scenarios.

Economic rent

As a part of the sensitivity analysis, we analyse the possibility of imposing a tax on economic rent, defined as the difference between the landed value of fish and the full economic costs of bringing a catch to port, net of any other types of rent which may be earned.[8] The economic rent is likely to be substantial and we assume that the economic rent in Liberia is 30% of the annual market value of the fish landed at the port. [9] This implies that the fishing activity is generating more revenue than is necessary to cover the costs of production, including normal returns to labor, capital, and other factors.

It should be noted that the actual determination of economic rent involves a more detailed analysis of factors such as market conditions, production costs, resource scarcity, and competition. Therefore, economic rent is included in the sensitivity analysis rather than the core financial analysis of the fishery hub due to its complexity, reliance on subjective assumptions, and sensitivity to external market dynamics. The assumptions utilised in this analysis are derived from findings that have not been verified within the specific context of Liberia.

By instituting a collaborative tax framework for distributing economic rent within the fisheries industry, involving both public and private entities, the potential for supporting subsequent investments in the sector (and thus the fishery port project) will increase.

We assess the potential of imposing a tax on the economic rent and utilising these funds for the development of the fishery hub. As previously detailed, our assumption is that 30% of the fish catch's market value qualifies as economic rent. We assess the impact of allocating a share of this economic rent to facilitate the development of the fishery hub. Subsequently, we evaluate the specific proportion of economic rent needed to establish a feasible business case.

[8] Measurement and collection of economic rent in a managed tuna fishery, Owen, 1996

[9] Assessing potential contribution of fisheries to economic development, Neiland et al, 2016;It should be noted that the paper is not clear on how the assumption of 30% was established.

We assume that the tax on the economic rent generated from fishing activities will be levied within the entire county. This is due to the potential implications of exclusively imposing a tax within the hub, as this could potentially place the port at a competitive disadvantage

The table below provides an overview of the sensitivity analysis for the economic rent taxation. Notably, the project becomes feasible when 4.5% of the economic rent is taxed and used for the project, emphasising the impact of even a relatively modest tax on the project's financial feasibility. This is an important insight for decision-makers, as this provides the baseline necessary to support the project's profitability.

Table 6-2: Sensitivity analysis economic rent taxation

	Project		Industrial		Artisanal	
Scenario	NPV (M USD)	IRR (%)	NPV (M USD)	IRR (%)	NPV (M USD)	IRR (%)
Base Case Scenario	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.6 USD	0.0%
Economic Rent						
75% taxation	USD 65.6 USD	38.4%	USD 69.5 USD	58.2%	USD -4.2 USD	0.0%
50% taxation	USD 42.3 USD	27.3%	USD 46.9 USD	38.0%	USD -5.0 USD	0.0%
25% taxation	USD 19.1 USD	17.9%	USD 24.3 USD	24.1%	USD -5.8 USD	0.0%
10% taxation	USD 5.1 USD	12.0%	USD 10.7 USD	16.5%	USD -6.2 USD	0.0%
5% taxation	USD 0.5 USD	9.8%	USD 6.2 USD	13.8%	USD -6.4 USD	0.0%
Critical Value	4.5%		n/a		n/a	

Source: MTBS

Smoking facilities

We incorporate the scenario of a broader operational vision for the use of the arbour development, by taking into account the opportunities for processing the fish on the project site.

Fish smoking demand

We assume 50% of fish landed by artisanal fishers at the port will be smoked and 20% of industrial catch landed at the port will be smoked in the processing facilities within the port. Others will smoke the fish outside the port facilities and given that the market is close by, some fish traders can quickly take fresh or iced fish to the market and sell, without the need to smoke it. The table below presents an overview of the projected fish smoking demand at the port facility, based on these assumptions.

Table 6-3: Fish smoking demand at project facility

Item	Unit	2026	2027	2028	2029	2030	2035	2040
Kru Catch	tons	60	60	60	59	59	53	42
Fanti Catch	tons	185	191	196	201	206	228	250
Industrial Catch	tons	1,070	1,144	1,224	1,309	1,400	1,800	2,200
Total Catch	**tons**	**1,315**	**1,395**	**1,479**	**1,570**	**1,665**	**2,080**	**2,492**

Source: MTBS

Smokehouse demand

The preliminary design of the artisanal hub encompasses an area dedicated to offering factory plots for lease, specifically tailored for fish processing businesses. Since the exact measurements of these plots were not detailed in Sciortino's report (2020), we assume that each plot occupies an area of 350 sqm and that there are six such plots available for rental. Our working assumption is that these plots will be made available for lease with infrastructure prepared for immediate construction ('ready-to-build'), and it is understood that the responsibility for developing any structures on the plots rests with the lessees rather than the project developer.

We assume that each 350 sqm area can accommodate two smokehouses with Matis ovens. Matis ovens are advised as they produce high quality smoked fish while ensuring that processors are not exposed to smoke. Each of these smokehouses would contain 12 ovens, resulting in a combined total of 24 ovens housed in two separate shelters. This arrangement aims to prevent overcrowding. The projected capacity for one smokehouse, housing 12 ovens, is estimated to be 864 tons per year.[10] Based on the concept design, we assume that there are six plots of 350 sqm available for this purpose, this thus allows for 12 smokehouses.

Collectively, these facilities are anticipated to have a total capacity of processing 10,400 tons of fresh fish for smoking annually. It should be noted that the weight one ton of fresh fish tends to decrease to around 400 kg after the smoking process. Consequently, these facilities are capable of generating an approximate yield of 4,200 tons of smoked fish p.a.

Taking into consideration the anticipated demand for smoking facilities at the port, we assume that developing two smokehouses would sufficiently address the demand for smoking services. Consequently, a plot of 350 sqm is deemed sufficient to accommodate the smoking operations at the port.

Leasing revenues

We assume an annual leasing fee amounting to USD 1,350 for the utilisation of a land plot 350 sqm. This is estimated based on current practises, expected that lessees are willing to pay minor premium at the hub. The lessee of the land will be leasing the prepared land, which is ready for construction, and is expected to independently undertake the construction of the smokehouses. We allocate the leasing revenues to the artisanal hub, due to the location of the plots.

Business operators using the smoke ovens need to recover their investment costs, followed by operational expenses encompassing labor, materials, maintenance, and more. If the land lease fees become excessively high, entrepreneurs might find it more beneficial to acquire land nearby and construct their processing facilities. Over time, the government might assess and revise lease rates, and business owners, having invested in immovable infrastructure, may probably agree to adjusted rates later on.

Results

The table below shows the impact of incorporating the leasing revenues for the smoking facilities. We consider leasing revenues for the artisanal hub with two possibilities: leasing 1 plot and leasing all 6 plots, along with an increase to a critical value. It shows that the incorporation of leasing revenues, given the low leasing fees, has a minor impact on the feasibility of both the artisanal hub and the overall project.

Table 6-4: Sensitivity analysis fish smoking facilities

	Project		Industrial		Artisanal	
Scenario	**NPV (M USD)**	**IRR (%)**	**NPV (M USD)**	**IRR (%)**	**NPV (M USD)**	**IRR (%)**
Base Case Scenario	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.6 USD	0.0%
Leasing Revenues						
1 plot (350 sqm) leased	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.5 USD	0.0%
All (6) plots leased	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.5 USD	0.0%
Critical value	1.4%		n/a		67%	

Source: MTBS

[10] Based on a capacity of 0.5 tons of fish per cycle per oven of 12 racks; 1 cycle per 2 days; 12 cycles per month (excluding 4 Sundays per month); 12 months per year

Sensitivity analysis financial feasibility factors

The table below presents the results from 4 distinct scenarios, each of which examines a specific aspect:

- **Design concept 5 scenario**: This scenario focuses on the feasibility of a T-jetty design (Concept 5) in comparison to a platform (Concept 6) for the project.
- **Opex sensitivity:** We explore the impact of operational expenses through three scenarios: a +10% adjustment, a -10% adjustment, and an increase to a critical value.
- **Capex sensitivity:** This scenario assesses the implications of capital expenses with three variations: a +10% adjustment, a -10% adjustment, and an increase to a critical value.
- **Tariffs/demand sensitivity:** Here, we analyse the influence of tariffs and demand with three scenarios: a +10% adjustment, a -10% adjustment, and a decrease to a critical value.

Table 6-5: Sensitivity Analysis Financial Feasibility

	Project		Industrial		Artisanal	
Scenario	**NPV (M USD)**	**IRR (%)**	**NPV (M USD)**	**IRR (%)**	**NPV (M USD)**	**IRR (%)**
Base Case Scenario	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.6 USD	0.0%
Opex						
Opex + 10%	USD -4.8 USD	7.1%	USD 1.4 USD	0	USD -6.8 USD	0
Opex – 10%	USD -3.7 USD	7.7%	USD 2.0 USD	0	USD -6.3 USD	0
Critical value opex	n/a		50%		n/a	
Capex						
Capex + 10%	USD -6.5 USD	6.3%	USD 0.3 USD	9.9%	USD -7.5 USD	0.0%
Capex – 10%	USD -2.0 USD	8.5%	USD 3.1 USD	12.1%	USD -5.7 USD	0.0%
Critical value capex	-20%		12%		-75%	
Tariffs						
Tariffs + 10%	USD -2.4 USD	8.4%	USD 3.3 USD	12.0%	USD -6.3 USD	0.0%
Tariffs – 10%	USD -6.1 USD	6.2%	USD 0.1 USD	9.8%	USD -6.8 USD	0.0%
Critical value	24%		11%		270%	
Demand						
Demand +10%	USD -2.4 USD	8.4%	USD 3.3 USD	12.0%	USD -6.3 USD	0.0%
Demand -10%	USD -6.1 USD	6.2%	USD 0.1 USD	9.8%	USD -6.8 USD	0.0%
Critical value	24%		11%		270%	

The primary findings of the sensitivity analysis for the financial outcomes are as follows:

- **Concept 5:** When considering a T-jetty (Concept 5) instead of a platform (Concept 6) for the overall project, it is found to be financially feasible. This is primarily due to the lower construction costs associated with the T-jetty. However, it is important to note that from an operational perspective, the platform (Concept 6) is preferred. It should also be emphasized that the change in construction cost assumptions impacts only the results of the industrial hub, which is already financially feasible. The artisanal hub remains financially unfeasible regardless of the construction option.
- **Opex sensitivity:** Modifying operational expenses by ±10% has limited impact on the financial feasibility. The overall project remains unfeasible, and the artisanal hub shows no substantial change in NPV and IRR, staying financially unviable. The industrial hub project remains feasible.
- **Capex sensitivity:** Adjusting capital expenses by ±10% leads to changes in NPV and IRR for both hubs. While the industrial hub remains feasible, the artisanal hub remains unfeasible regardless of the changes in capital expenses.
- **Tariffs/demand sensitivity:** Modifying tariffs/demand by ±10% affects the financial feasibility. However, even with a 10% increase in tariffs/demand, the overall project remains financially unfeasible, and the artisanal hub does not achieve financial viability.

6.3 Economic Feasibility

6.3.1 Introduction

The economic feasibility assessment is conducted to determine whether the proposed project will generate a net economic benefit for the economy as a whole. If the assessment demonstrates that the project is economically feasible, it justifies proceeding with the project, and we recommend to the government and the World Bank to move forward with its implementation. However, if the project is found to be economically infeasible, the project does not generate a net economic benefits for Liberia. Then, decision-makers may reevaluate the project's design, costs, revenue potential, and economic impacts. The economic feasibility assessment is based on the methodology as prescribed in Chapter 4.4, the project and no-project forecasts as presented in Chapter 4.2, and design Concept 6, which is recommended in Chapter 3.

6.3.2 Economic assessment results

The table below presents the economic assessment results for the overall project. The results show that the fishery project is economically feasible showing an economic NPV of USD 39.9 M with an economic IRR of 26.6%:

- USD 9.2 M direct benefits resulting from the auction commission revenues.
- USD 60.4 M indirect benefits due to the increased profitability of the fishing vessels as well as the reduction of accidents.
- USD - 20.6 M direct costs related to the incremental capex and opex of the project
- USD -9.1 M indirect costs due to the increased amount of CO_2 emissions related to the incremental activity of industrial vessels.

Table 6-6: Economic feasibility results

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Direct benefits	M USD	9.2	-	-	0.9	0.9	1.0	1.1	1.1	1.5	1.8
Indirect benefits	M USD	60.4	-	-	3.4	4.3	5.2	6.1	7.0	10.9	14.7
Total benefits	**M USD**	**69.6**	**-**	**-**	**4.3**	**5.2**	**6.2**	**7.1**	**8.1**	**12.4**	**16.5**
Direct costs	M USD	(20.6)	(5.6)	(9.5)	(2.0)	(0.4)	(0.3)	(0.3)	(0.3)	(0.2)	(0.2)
Indirect costs	M USD	(9.1)	-	-	(0.3)	(0.4)	(0.5)	(0.6)	(0.6)	(0.7)	(0.7)
Total costs	**M USD**	**(29.7)**	**(5.6)**	**(9.5)**	**(2.3)**	**(0.8)**	**(0.9)**	**(0.9)**	**(0.9)**	**(0.9)**	**(0.8)**
Free Cash Flows	**M USD**	**39.9**	**(6.5)**	**(11.6)**	**1.3**	**4.2**	**4.9**	**5.7**	**6.5**	**10.1**	**13.6**
IRR (%)	%	26.6%									
SDR (%)	%	7.1%									

The economic feasibility results imply that the project generates a net economic benefit for the Liberian economy. Considering the positive outcomes and potential benefits, and following confirmation of these results by comprehensive and detailed studies, we advise the government to proceed to develop and implement the project. Furthermore, the positive economic feasibility justifies a potential grant assistance provided by the World Bank, which is deemed necessary for the artisanal hub as indicated by the financial assessment results. **The combination of positive economic outcomes and external financial support makes the new fishery port a viable project for Liberia.**

6.3.3 Economic assessment results for separate entities

The table below presents the economic feasibility assessment results for the industrial and the artisanal hub separately. It shows that both projects generate a net economic benefit for the Liberian economy. The results imply that both projects justify the implementation of the fishery hub. Appendix I provides an overview of the projected flows for each of the entities.

Furthermore, the economic feasibility of the artisanal hub is an important finding, as it was initially not financially feasible as a separate project. However, the positive economic results justify the potential grant assistance provided by the World Bank specifically for the artisanal hub. This financial support can bridge the gap between the project's income and its financial obligations, ensuring the successful execution of the artisanal hub.

Table 6-7: Economic Feasibility Results

Item	WACC	IRR	NPV (USD)
Industrial hub	7.1%	25.1%	USD 25.8 M
Artisanal hub	7.1%	30.4%	USD 14.0 M
Total project	**7.1%**	**26.6%**	**USD 39.9 M**

Source: MTBS

6.3.4 Sensitivity analysis

In this section, we conduct a sensitivity analysis to examine the stability of the economic outcomes of the fishery port project from the previous section, considering various circumstances. The sensitivity analysis is conducted on the economic indicators of the project. The assumptions of the project are compared with various scenarios.

Impact of SDR

We are examining the influence of the SFR on the project's economic feasibility. As evident from the IRRs provided by Table 6-8, the table below demonstrates that the project's economic feasibility persists within the SDR range often adopted by multilateral banks.

Table 6-8: Sensitivity analysis SDR

Item	NPV (USD)
Industrial hub	
Base case	USD 14.0 M
SDR of 10%	USD 9.5 M
SDR of 15%	USD 4.8 M
Critical value of 30.4%	-
Artisanal hub	
Base case	USD 25.8 M
SDR of 10%	USD 16.9 M
SDR of 15%	USD 7.7 M
Critical value of 25.1%	-
Total project	
Base case	USD 39.9 M
SDR of 10%	USD 26.4 M
SDR of 15%	USD 12.5 M
Critical value of 26.6%	-

Source: MTBS

Fish smoking value-added

To assess the value-added resulting from fish smoking, we assume that the market value of fish doubles after the smoking process, leading to a 100% increase in its market value. The estimated projected profit (and value-added) is set at 25% of the value of the smoked fish. [11]

We compare the value-added obtained from smoking fish caught in the project scenario within Montserrado County with the value-added from smoking fish in the no-project scenario implemented. Within Montserrado County, we consider an average of 43% of the total artisanal catch being smoked, while 30% of the total industrial fish catch undergoes smoking. [12]

Displayed in the table below are the outcomes of the sensitivity analysis, revealing a positive yet modest impact of the value-added resulting from smoking the fish on the project's economic feasibility.

Table 6-9: Sensitivity analysis smoking value-added

	Project	
Scenario	NPV (M USD)	IRR (%)
Base Case Scenario	USD 39.9 USD	26.6%
Processing value-added		
25% profit margin	USD 45.7 USD	27.8%
10% profit margin	USD 42.2 USD	27.1%
Critical Value	n/a	

Source: MTBS

6.4 Conclusion of the Feasibility Assessment

As described in this chapter, our key recommendations to the NaFAA and the World Bank regarding the feasibility of the fishery project and proposed next steps are presented below:

1. As the project is economically feasible, we advise the Government to implement the fishery project and proceed to the development and implementation of the project, subject to further confirmation through comprehensive and detailed studies.

2. Secondly, the results of the financial feasibility assessment indicate that the fishery project is financially unfeasible, as it is unable to meet its loan repayment obligations without external financial support. To ensure the project's feasibility, we recommend to prepare a detailed financial plan during the next project stage.

3. Thirdly, the financial analysis reveals that the generated income of the industrial hub is expected to be sufficient to cover its loan repayment obligations without external financial support. However, the artisanal hub is not financially self-sustaining, though it can cover its operational costs. Therefore, we recommend a combination of external financial support, involving both a loan and a grant, to address the larger financial obligations of the artisanal hub and ensure the successful implementation of the overall project.

In conclusion, the combination of economic feasibility and financial challenges highlights the need for strategic planning and collaboration between the NaFAA and the World Bank. By addressing the financial constraints through external support and emphasizing the project's economic viability, the fishery project can be an important step towards promoting sustainable fisheries and contributing to the economic development of Liberia.

[11] Based on our observations of fish traders in Liberia, if a dozen fish of 1,000 LBD is smoked, traders are able to sell the same quantity of a dozen (12 fish) for 2,000 LBD.

[12] The National Fisheries and Aquaculture Authority (NaFAA) of Liberia reported in its 2018 annual report that 43% of fish captured in the artisanal sector are preserved by smoking while 2% is preserved by freezing and 55% is sold fresh or preserved by other methods like salting and fermenting (NaFAA, 2018)

7 Recommendations

7.1 Introduction

Based on the comprehensive analysis presented in the Report, this chapter provides a summary of the main recommendations for the NaFAA and the World Bank. These recommendations are derived from the key findings of the report and aim to facilitate the decision-making process for the successful implementation of the project.

7.2 Design Concept 5

We suggest developing both the industrial and artisanal hubs simultaneously, as it allows for efficient utilisation of dredged materials for land reclamation and maximizes economic benefits to local fishing communities. The project involves two components, an industrial hub within the harbour basin and an artisanal hub outside the harbour basin. From a financial point of view, it is recommended to minimise or postpone major investments. As such, the Consultant examined if it is possible to develop the project in phases. Due to the nature of the project, this is difficult. Though the industrial hub can be developed as a stand-alone initiative, the dredged materials need to be disposed of. Developing the artisanal hub in parallel provides an opportunity to use (part of) the dredged materials for the reclamation of land. Also, developing the project in multiple phases increases the mobilization and supervision costs of contractors. Moreover, the economic analysis points out that the artisanal hub provides substantial economic benefits to local fishing communities.

To cater to the future needs of the local fisheries, we recommend that the design concept includes the following infrastructure components and auxiliary services: a breakwater, a marine store, ice-making facility and fuel depot to provide good quality and affordable fishing inputs; and a wet fish market to connect fishermen with local buyers. The rationale for developing the project is to provide enabling infrastructure that can spur the development and modernization of the Liberian fishing fleet. The domestic fleet consists of small-sized Kru vessels and medium-sized Fanti vessels. These are traditional wooden canoes that predominantly operate within the IEZ. The artisanal hub must have a breakwater that provides protection against currents, waves and storm surges, enabling local fishermen to launch and land their vessels in a safe manner. Furthermore, local fishermen require access to good quality and affordable fishing inputs, such as fishing materials (nets, ropes, etc.), safety materials (life vests, radios), cooling materials (cooling and storage boxes, cooling ice), mechanical components (machine parts, replacement items, etc.) and fuel supply. Therefore, a marine store, ice-making facility and fuel depot are recommended. In addition, a wet market (or fish auction) is envisioned to better connect local fishermen with buyers. By developing a fish market at the artisanal hub, an incentive is provided to offer high quality products that can be sold to the highest bidder. Furthermore, the consolidation of fishing activities will likely contribute to positive spillover effects such as knowledge sharing, increased awareness about good/sustainable practices.

Based on our analysis, we advise implementing Concept 6 (platform) for the fishery project rather than Concept 5 (T-jetty). The industrial hub within the harbour basin is dedicated to larger commercial vessels. Currently, large commercial fishing vessels cannot call at the Mesurado Pier because there is not sufficient depth. Developing a deep water berthing platform is the most expensive element of the design concept. A T-jetty (Concept 5) can be considered to lower the costs; however from an operational point of view a platform (Concept 6) is more desirable. The financial analysis indicates that the investment costs of the overall concept when implementing Concept 6 cannot be retrieved within the 15-year time horizon of the project. To support this development, we advise seeking external funding in the form of a grant to cover the gap in investment costs and enable its successful implementation.

7.3 Project Implementation Arrangements and Flow of Funds

External financial support

As the project is economically feasible, we advise the Government to implement the fishery project and proceed to the development and implementation of the project, subject to further confirmation through comprehensive and detailed studies. Furthermore, the results of the financial feasibility assessment indicate that the fishery project is financially unfeasible, as it is unable to meet its loan repayment obligations without external financial support. To ensure the project's feasibility, we recommend the World Bank to support the project by providing the necessary financial assistance.

We recommend a combination of external financial support, involving both a loan and a grant, to address the larger financial obligations of the artisanal hub and ensure the successful implementation of the overall project. The financial analysis reveals that the generated income of the industrial hub is expected to be sufficient to cover its loan repayment obligations without external financial support. However, the artisanal hub is not financially self-sustaining, though it can cover its operational costs.

Based on the combination of economic feasibility and financial challenges identified in this study, we propose the NaFAA and the World Bank to collaboratively engage in strategic planning. By addressing the financial constraints through external support and emphasizing the project's economic viability, the fishery project can be an important step towards promoting sustainable fisheries and contributing to the economic development of Liberia.

Public-private partnerships

We advise the Government to prepare a competitive PPP transaction (procurement) process to attract the best possible financial value from the project's business case. To develop this project, a project delivery method should be selected that formalizes the engagement between the owner and other parties. A particular delivery method is a public-private partnership ("PPP"). The terms of a PPP are typically set out in a contract or agreement to outline the responsibilities of each party and clearly allocate risk.

Various output focused PPP arrangements can be considered under the Liberian PPP Law. In partnership with the World Bank, the Government of Liberia established the Amendment and Restatement of the Public Procurement and Concessions Act, 2005 ("the Act"). This Act regulates all forms of public procurement and Concessions. The Act does not define a PPP but defines a concession:

"Concession" means the grant of an interest in a public asset by the Government or its agency to a private sector entity for a specified period during which the asset may be operated, managed, utilized or improved by the private sector entity which pays fees or royalties under the condition that the Government retains its overall interest in the asset and that the asset will revert to the Government or agency at a determined time. Under this Act, the term "Concession" shall include all its variants, including but not limited to the following: BOT BTO, BOOT, BOO, Joint Ventures, Partial Privatization, Natural Resources.

We recommend considering a Build-Operate-Transfer (BOT) project, as it aligns with NaFAA's aim to attract a private operator and is commonly utilized for developing greenfield assets. A BOT project grants the private sector the right to develop and operate the facility for a specified period, which is typically used for projects that would otherwise be public sector projects.

Through market sounding exercises, important feedback from the lender community can feed into the detailed financial plan and design phase. The lending market and the appetite of lenders can vary over time, due to a host of factors. These include legal and regulatory matters, global interest rate regimes, and capital market conditions. As such, bringing lenders' feedback on board can be very useful to make the project bankable. Following the new findings obtained during a detailed design stage, the financial feasibility study as performed by MTBS should be re-evaluated. Subsequently, the Government of Liberia should make an informed decision whether or not to go to market with the project as a PPP.

7.4 Risks Assessment

Risk assessment is a crucial aspect of project planning and management, aimed at identifying potential uncertainties and threats that could impact the project's success. By analysing and understanding the various risks associated with the implementation and operation of the project, stakeholders can proactively develop strategies to mitigate and manage these risks effectively.

Overall, the sensitivity analysis suggests that the industrial hub is financially feasible under various scenarios, but the artisanal hub remains financially unfeasible. Adjusting expenses, tariffs and demand have limited effects on the overall project's feasibility, indicating the critical importance of addressing financial constraints for the artisanal hub. As the contingency rate applied in the analysis is set to 10% of the construction costs, a part of the potential construction cost overruns risk is mitigated.

We propose conducting a comprehensive fish stock assessment to mitigate the demand risk of the project, which is directly related to fish production. Currently, historical data on the abundance or biomass of the target fish species is unavailable, as the last comprehensive fish stock assessment was done in 1981, leaving uncertainty about the current state of fish populations in Liberian waters. The data gaps and data quality presents challenges for rigorous estimation of the maximum sustainable yield of the fisheries at species level. Undertaking a new assessment will provide crucial information to establish the maximum sustainable yield and reduce uncertainty in the project's demand projections. Additionally, this data is essential for formulating appropriate fishery policies to ensure sustainable fishing practices in Liberian waters. Fisheries are complex systems, and a comprehensive understanding of the ecology and dynamics of the target species is crucial for effective and sustainable management.

Our recommendation to NaFAA is to carefully plan the artisanal hub and engage relevant stakeholders from the outset. During consultations, artisanal fishers expressed their preference for upgrading and improving the fishing facilities in their own areas. Involving stakeholders in the planning process reduces the risk of dissatisfaction and resistance to the project. Conversely, the risk is lower for the industrial hub, as we assume that all industrial vessels will be required to land their catch at the project for port inspection compliance reasons.

To mitigate capex and opex risks of the project, we advise conducting follow-up studies for detailed design and contract/tender documentation. Overall, the reference studies provide a good starting point for the development of the Mesurado Fishing Pier. However, based on an assessment of the available technical information, more studies are required to address the identified data hiatuses with regards to the construction of the project. Key identified risks and uncertainties include handling of contaminated dredged material, the location of onshore deposits for dredged material, the availability of dredging equipment, permitting, specifically for the CFHF facilities and disposal sites, the lay-out of the CFHF with respect to sedimentation (need of wave and littoral drift studies) within the CFHF port basin and the related maintenance dredging, and the involvement of local construction contractors (quality and quantity).

We recommend conducting a detailed Environmental and Social Impact Assessment ("ESIA") for the fishery project development to identify local environmental and social costs. An ESIA plays a key role in reducing project risks. By conducting a comprehensive assessment of the environmental and social impacts early in the project development phase, potential risks and challenges can be identified and addressed proactively. The ESIA process ensures compliance with regulations, boosting project credibility and minimizing legal risks. Additionally, stakeholder engagement and community support from ESIA help avoid opposition and protests, leading to smoother project implementation.

7.5 Project Coverage and Selection of Targeted Locations for all Activities as Specified

The Freeport of Monrovia is located within the Greater Monrovia Area, close to the Central Business District and major population centers. Various cold storage operators are situated in the direct vicinity of the port. As such, developing an industrial hub within the port basin at the Mesurado Pier ensures a close connection to domestic markets, consumers and processors. Roberts International Airport is about 60km outside Monrovia. In time, this may provide an distribution channel for high value fish products that have export potential. In addition, financial incentives may woo foreign vessel operators to land their catch in Liberia, provided that the service level in the fishery port is adequate.

The fishery project is expected to serve all (semi-)industrial vessels in Liberia, as it is anticipated that they will be required to land their catch at the project for port inspection compliance. However, due to the artisanal fishers' preference for their current areas, the market share for artisanal vessels landing at the project is expected to be lower. The longer distance to the project facility may pose a challenge for the artisanal vessels. **To encourage more fishers to use the project, offering attractive fish prices and other services at the port could potentially lead to increased participation and utilisation of the project's facilities.**

7.6 Any Further Actions Needed to Secure Project Financing and Implementation

To address the date gaps identified in the risk assessment provided in section 7.4, we recommend the development of tender documents to engage consultancy services for conducting specialised studies and assessments still required for the project development. These studies will offer valuable insights and data crucial for informed decision-making and effective project planning. By proactively filling these gaps, the project can enhance its overall feasibility and ensure a well-informed approach to implementation.

Furthermore, we advise to engage in discussions and negotiation with the World Bank to secure the necessary financial resources for the project. As the project is currently economically feasible but not financially feasible, a well-structured financing plan should be established to enhance project feasibility.

We suggest to acquire all necessary permits, approvals, and regulatory clearances for the implementation of the project. Ensuring compliance with legal and environmental standards is crucial for the successful completion of the project. Proactively obtaining these permissions will help avoid delays during the project's execution.

It is recommended to create a project management team with the expertise and knowledge to execute the project efficiently. This will ensure that the project stays on track and meets its objectives. For the implementation of a successful public-private partnership, it is key to have the necessary knowledge. If such expertise is not available internally, seeking guidance from experienced consultancy services is recommended to ensure an efficient project execution.

7.7 Sustainability of Project Results

We recommend implementing a micro-credit scheme to stimulate entrepreneurship among small-scale artisanal fishermen and enable them to invest in improved fishing boats, such as semi-industrial vessels. There is an expectation that by developing enabling infrastructure, the domestic fisheries sector is stimulated to modernise. However, a lack of access to finance impedes small-scale artisanal fishermen to invest in improved fishing boats (such as semi-industrial vessels). This initiative aims to modernize the domestic fisheries sector and improve access to finance for fishermen, fostering growth and development in the industry.

Additionally, we advise encouraging business people to invest in the enhancement of the provision of essential goods and services to coastal fishing communities. These business entities can buy, process, distribute and market the fish landed by these fishermen and employ the women fish processors and marketers in these landing sites, so as to develop and improve the fish value chain and create onshore job opportunities in the sector.

We propose the implementation of a fishing quota system in Liberia to address the issue of overfishing in its waters. Currently, the amount of fish being caught exceeds the maximum sustainable yield (MSY), leading to unsustainable fishing practices. By introducing a fishing quota system, the amount of fish that can be caught is regulated, ensuring the long-term viability of the fishery sector. Shifting a portion of the catch from Kru and Fanti vessels to industrial vessels can enhance the sustainability, profitability, and efficiency of the fishery sector in Liberia. This strategic approach can optimise the utilisation of resources while promoting responsible fishing practices, contributing to the overall health of marine ecosystems and supporting the livelihoods of fishing communities.

Enforcing fish quotas is vital for sustainable fisheries management, preventing overfishing, and safeguarding marine ecosystems. This involves clear and transparent regulations, monitoring systems, regular inspections, and collaboration with fishing communities. Strong penalties and incentives encourage compliance to the quotas, while data availability and analysis informs management decisions. Regional and national cooperation is crucial in managing the shared fish stocks.

7.8 Monitoring and Evaluation of Project Results

We recommend implementing a monitoring and evaluation system to ensure a successful result of the project. Closely monitoring the key aspects of the fishery sector and the project, facilitates informed decisions and timely actions to enhance project outcomes and address challenges. The specific areas to be monitored are as follows:

- **Landed catch:** Regularly monitoring the quantity and species of fish caught will enable accurate assessment of the fishery sector's compliance with established fishing quotas and the maximum sustainable yield. This will ensure sustainable fishing practices and prevent overexploitation of fish stocks.

- **Post-harvest losses reduction**: Implementing a monitoring system for post-harvest losses will help track the effectiveness of measures taken to minimise the losses. By identifying areas with substantial losses, interventions can be implemented to improve post-harvest practices.

- **Number of users at the artisanal and industrial hubs**: Setting up a registration and monitoring system for users at both the artisanal and industrial hubs will provide valuable data on facility utilisation. Understanding user patterns helps to assess the hubs' effectiveness and identify opportunities for better resource allocation.

- **New built semi-industrial vessels**: Monitoring the number of newly built semi-industrial vessels enables measuring the success of initiatives aimed at modernising the fishing fleet. This data also allows to measure the impact of financial incentives and support programs for vessel upgrades.

- **Reduction of Accidents**: Maintaining incident records and analysing trends in accidents will guide the development and enforcement of safety regulations at the fishery port. This proactive approach will enhance safety measures and minimize the occurrence of accidents during fishing operations.

- **Improvement of quality:** Implementing quality control measures at the fishery port will ensure that fish products meet national standards.

- **Collection of data:** Establishing a centralised data collection and management system will provide crucial information on the various aspects of the fishery project. This should provide information on fish stock assessments, catch volumes, revenue generation, and socio-economic impacts. Analysing this data facilitates evidence-based decision-making, enable effective project evaluation, and facilitate future planning.

8 Summary of Results of Public Consultations

8.1 Introduction

At the start of this Assignment, during the Inception Phase of the Project, a site visit was conducted to a local fishing community in the vicinity of the proposed Mesurado Fishing Pier. The purpose of the site visit was to understand the current state and future needs of artisanal fishermen. Through semi-structured interviews, a set of pre-determined and open questions were discussed with stakeholders to explore challenges and opportunities.

Subsequently, during the Diagnostics Phase, an additional site visit to the project area was organized. Together with the Client, additional fishing communities in the Monrovia area were visited, as well as fish processors, markets and cold storage operators to further the understanding of distribution channels, market prices and aspects of market failure that impede the sustainable development of the sector. This section provides a summary of the results of the public consultations.

8.2 Responses from the Artisanal Fishermen

The artisanal fishermen have provided the following responses:

- Fishermen mostly use traditional wooden Kru canoes. Beaches provide landing sites from where the canoes depart to the fishing grounds. Some fishermen at the West Point community use the Mesurado River inlet to sail upstream and anchor their vessels on the river bed, somewhat sheltered from the ocean. They indicated that the river mouths require dredging to enable unobstructed access for their vessels to pass through.
- Weather conditions are an overarching factor that determine the fishing operations. Rough seas inhibit fishermen from sailing out. The wooden vessels are small and unsafe. Reportedly, each year fishermen perish when boats go missing in the ocean, or when canoes capsize in rough seas.
- Generally, the fishermen indicated that there is a lack of good quality fishing inputs at affordable prices, such as nets, ropes, floats and leads (sinkers). Reportedly, such materials are cheaper in neighbouring countries such as Guinea and Ghana. As a consequence, the operating costs of fishermen are relatively high. Additionally, it is difficult to obtain mechanical spare parts, e.g. to maintain engines.
- Motorized vessels, such as the Fanti boats require fuel. There are no gas stations in the direct vicinity of the fishing communities, and therefore the fishermen rely on intermediaries to bring fuel to the landing sites.
- The traditional vessels do not have insulated fish holds or insulated boxes of appropriate sizes to carry the fish. Importantly, the freshly caught fish is not packed in ice. As a consequence, fishermen sail out in the early morning and return around noon, to avoid spoilage due to high ambient air temperature and exposure to the sun. To maximize the time fishing, the length of the trip is shortened (i.e. fishermen stay relatively close to the shoreline). In turn, artisanal fishermen target similar species in the fishing grounds that are within their reach.
- Fishermen indicated that they want to change their fishing practices if they have access to new technologies or better equipment, such as cooling boxes. If possible, they would like to make longer trips to increase the catch volumes.
- Most of Liberia has one wet season between May and November. This rainfall season is largely controlled by the movement of the tropical rain belt. During the rainfall season, the artisanal vessels cannot go far on the open ocean. The traditional fishing vessels are open canoes that do not provide shelter against the rainfall and wind. As a result, the fish catch decreases.
- In the dry season, catch volumes increase. Sometimes, supply exceeds demand (contrary to the wet season when demand outstrips supply). Due to a lack of storage and/or processing facilities, fishermen are price-takers. Fresh fish spoilage can be very rapid after it is caught, and therefore fishermen are pressured to sell their catch before the quality deteriorates. Without good hinterland connections and with limited private transportation options, fishermen are mostly dependent on local buyers. These are generally fish smokers in local communities. Mostly women engage in this activity.
- Contrary, during the wet season when landed catch volumes are lower, fishermen have more bargaining power. However, there is a limit to what fishermen can reasonably ask because they compete with importers who purchase fish and fish products in neighboring countries. Due to economies of scale, cost savings can be achieved by increased levels of production in those countries (e.g. because of bigger fishing vessels and lower post-harvest losses). Seasonality therefore has an significant impact on the livelihoods of the fishermen.
- Local fishermen lack access to finance to expand or modernize their business. This is a fundamental problem that inhibits market growth. In the absence of access to capital at reasonable rates, small scale fisheries and fishing communities cannot

invest in equipment or indeed infrastructure. Moreover, fishermen indicated that they lack knowledge and information about business management and (sustainable) operating models.
- There is a concern about the increase of industrial fishing activities by foreign operators (i.e. Chinese trawlers) in Liberian waters. There is a fear that overfishing by these vessels may cause fish stocks to collapse, which in turn harms the livelihoods and food security of local populations.

Figure 8-1: Public consultations at fishing communities in the Greater Monrovia Area

Source: Dr. Sankoh, fishery expert on behalf of MTBS; Upper left: New Kru Town fishing community; Upper right: New Kru Town fishing community; Lower left: West Point fishing community; Lower right: West Point fishing community

8.3 Responses from NaFAA

NaFAA has provided the following responses:

- There is an expectation that new infrastructure, such as improved landing sites, storage facilities, and processing facilities can improve the quantity and quality of the catch. The purpose is to enable year-round operations for artisanal fishermen.
- In addition, the introduction of new fiberglass vessels could help to improve operations. These vessels are considered to be safer, more fuel efficient and can be equipped with cooling technology to reduce PHFL.
- There is an increasing emphasis on promoting sustainable fishing practices in artisanal fisheries. Future needs may include initiatives to raise awareness about sustainable fishing techniques, reducing bycatch, and minimizing the impact on vulnerable species and habitats.
- Providing training and capacity-building programs to artisanal fishers can enhance their skills and knowledge in areas such as fishing techniques, post-harvest handling, value addition, and business management. These initiatives can contribute to improved livelihoods and the sustainable development of the artisanal fishery.
- Supporting market linkages and improving market access for artisanal fishers can create economic opportunities and increase the value of their catch. Future needs may include initiatives to strengthen market channels, improve product quality, and promote value-added products.
- Ensuring equitable access to fishing resources, such as fishing grounds and gear, can be important for sustaining artisanal fishing communities. Future needs may include policies and measures to address potential conflicts over resource access and promote fair distribution of fishing opportunities.

9 Conclusions

The main conclusions of the Report are listed below:

- The Liberian fishery sector includes artisanal and semi-industrial fisheries. Artisanal fisheries account for the majority of the landed fish volumes and vessel fleet.

- Since 2013, the landed catch from Liberian waters has increased from ca 16,000 tons to 28,600 tons.

- The increase can mainly be attributed to the increase in artisanal Kru vessels who target species assemblages that are found in the Inshore Exclusion Zone, within which trawling by industrial fishing vessels is prohibited.

- The maximum sustainable yield is estimated at 25,000 tons per annum. To ensure the long-term profitability of the sector, overexploitation of fish stocks should be avoided.

- The construction of an industrial hub and an artisanal hub at the Mesurado Fishing Pier can spur the development of the Liberian fishery sector.

- The purpose of the industrial hub is to provide large commercial vessels with a port of call in Liberia to land their catch. It is expected that this enabling infrastructure will increase the local supply of fish. In addition, it allows for the modernization of the domestic fleet.

- The rationale for developing an artisanal hub is to improve the livelihoods of local fishing communities, by providing artisanal fishermen with access to good quality and affordable fishing input. It is expected that this will lead to a reduction of post-harvest fish losses, thereby increasing the quality and quantity of fish and fish products.

- Two design concepts for the industrial hub are analysed: a T-shaped load-out jetty with a berth platform on piles (Concept 5), and a design based on an alongside berth facility (Concept 6).

- Concept 5 can be considered to lower the costs. However, from an operational point of view, Concept 6 is more desirable because it includes more landside area which can be made available to support operations. Having more space improves the safety and efficiency of the (un)loading operations. Therefore, Concept 6 is 'future-proof'.

- The upfront investment costs for developing Concept 6 of the industrial hub are estimated at USD 15.7 M. The investment costs of the artisanal hub are estimated at USD 8.8 M. The financial analysis indicates that these combined investment costs cannot be retrieved by the anticipated revenues at the fishery port.

- An economic feasibility assessment is conducted to determine whether the proposed project will generate a net economic benefit for the economy as a whole. The assessment demonstrates that the project is economically feasible, indicating that there are significant societal benefits. The result are presented below.

Financial feasibility summary results; applied WACC is 9.7%

	Project		Industrial		Artisanal	
Design concept	FNPV (M USD)	IRR (%)	FNPV (M USD)	IRR (%)	FNPV (M USD)	IRR (%)
Con 5: T-jetty design	USD 4.3 USD	13.1%	USD 10.1 USD	23.2%	USD -6.6 USD	0.0%
Con 6: platform design	USD -4.2 USD	7.4%	USD 1.7 USD	11.0%	USD -6.6 USD	0.0%

Economic feasibility summary results; applied SDR is 7.1%

	Project		Industrial		Artisanal	
Design concept	ENPV (M USD)	EIRR (%)	ENPV (M USD)	EIRR (%)	ENPV (M USD)	IRR (%)
Con. 5: T-jetty design	USD 47.9 USD	40.9%	USD 34.0 USD	49.8%	USD 13.9 USD	29.8%
Con 6: platform design	USD 39.9 USD	26.6%	USD 25.8 USD	25.1%	USD 14.0 USD	30.4%

- Further sensitivity analysis was applied to test the robustness of the fishery port project outcomes under different circumstances. The modelled results are sensitive to changes in the capital expenditures, which highlights the risk of cost-overruns to the feasibility of the project.

- A potential upside lies in imposing a tax on the economic rent and utilizing these funds for the development of the fishery hub. Notably, the project becomes feasible when 4.5% of the economic rent is taxed and used for the project, emphasizing the impact of even a relatively modest tax on the project's financial feasibility.

Our key recommendations to the NaFAA and the World Bank regarding the feasibility of the Mesurado Pier project and proposed next steps are presented below:

1. As the project is economically feasible, we advise the Government to implement the fishery project and proceed to the development and implementation of the project, subject to further confirmation through comprehensive and detailed studies.

2. Secondly, the results of the financial feasibility assessment indicate that the fishery project is financially unfeasible in case design concept 6 is adopted, as it is unable to meet its loan repayment obligations without external financial support. To ensure the project's feasibility, we recommend to prepare a detailed financial plan during the next project stage.

3. Thirdly, the financial analysis reveals that the generated income of the industrial hub is expected to be sufficient to cover its loan repayment obligations without external financial support. However, the artisanal hub is not financially self-sustaining, though it can cover its operational costs. Therefore, we recommend a combination of external financial support, involving both a loan and a grant, to address the larger financial obligations of the artisanal hub and ensure the successful implementation of the overall project.

In conclusion, the combination of economic feasibility and financial challenges highlights the need for strategic planning and collaboration between the NaFAA and the World Bank. By addressing the financial constraints through external support and emphasizing the project's economic viability, the fishery project can be an important step towards promoting sustainable fisheries and contributing to the economic development of Liberia.

Appendix I

I.I - Annexes to the Project Design Description

Geotechnics and port basin seabed conditions

The reference 2 report presents the following data.

In order to complete the design of the 2 jetties, in July 2014, a geotechnical investigation of the seabed around the Mesurado terminal was carried out by Barway-Mosgeo. Figure 4 illustrates thebore log of borehole No 1 in the area of the ship lift.
During the geotechnical investigation, a bottom sediment sample was also retrieved to test forchemical pollutants left over from the ex-cannery ship lift.

This was required to assess the **disposal options** for the dredging of the export berth.

Physical Characteristics

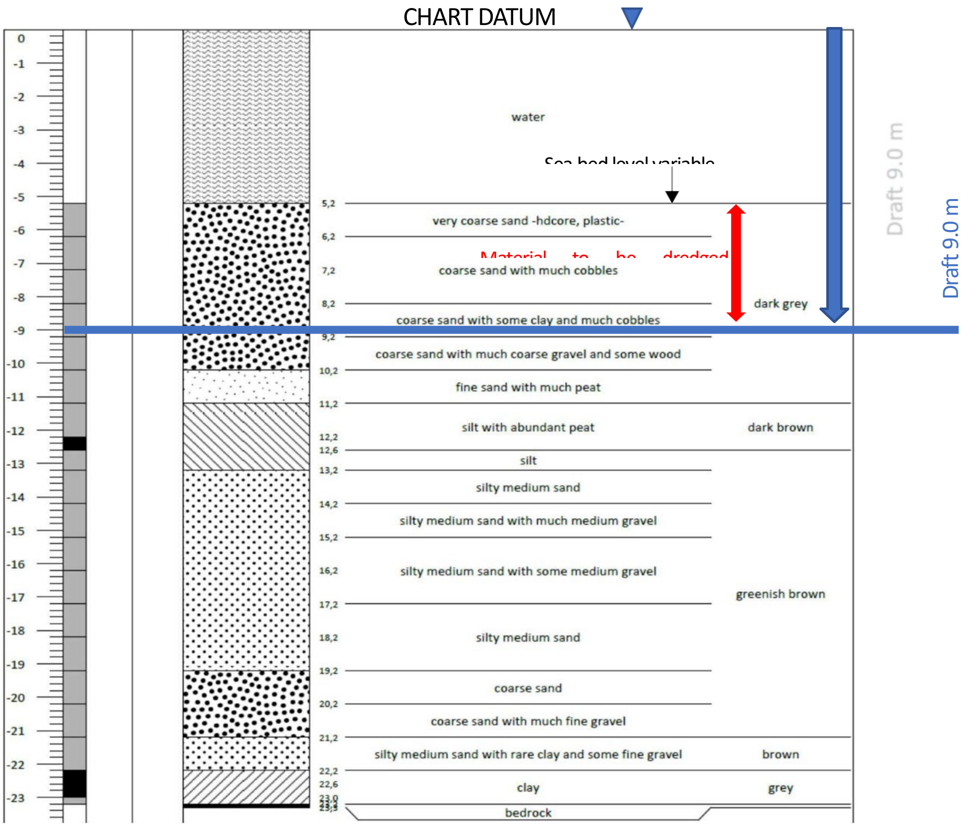


Figure 4 – Borehole 1 log at Mesurado quay *Barway-Mosgeo – July 2014*

The borehole log indicates that all the material to be dredged (down to -9.0m) consists of coarsesand with cobbles, which can be classified as **cohesionless coarse sand**.

Chemical Characteristics

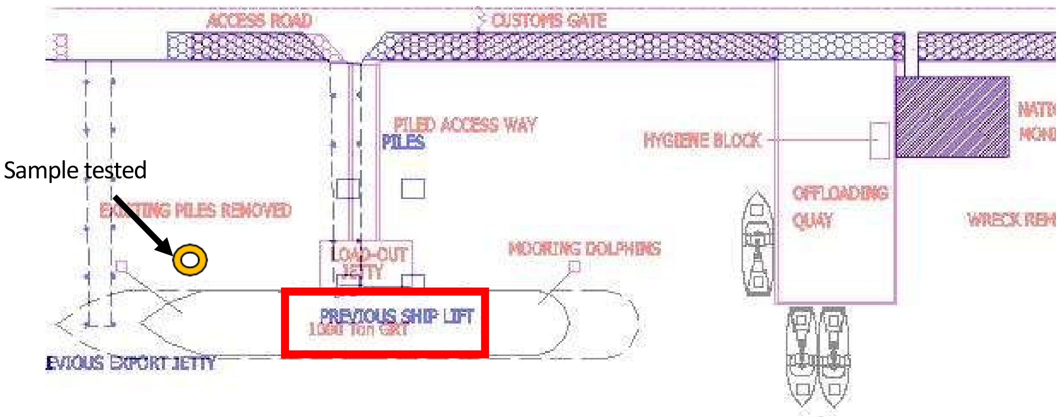


Figure 5 – Location of ex-cannery ship-lift

Figure 5 illustrates the location of the **proposed Phase 2 load-out jetty** and hence the general areato be dredged under this project. This is the area where the previous Mesurado ship lift operated by the cannery was located and where fishing vessel maintenance was carried out.

The sample taken from the sea bed was tested in Holland in accordance with international requirements and the dry sediment was found to contain, amongst other things:

- Lead 460 ppm*
- Copper 920 ppm
- Zinc 1400 ppm
- Polycyclic Aromatic Hydrocarbons (PAH) 11 ppm (sum 10 PAH VROM)
- Tributyltin (TBT) 110 ppb* (parts per billion) or 0.110 ppm

The above chemical pollutants are synonymous with hull maintenance operations.

** (ppm = parts per million also expressed as milligrams/Kg of dry sediment)(ppb = parts per billion also expressed as micrograms/Kg of dry sediment)*

The convention that governs the disposal of dredged marine sediments is the London Convention (1972) and the revised Protocol (1996). Under this convention, each country has to establish limitsof pollutant levels in dredged sediments and their disposal method.

Briefly, the classification of the sediments to be dredged falls into 3 distinct categories:

1. For negligible(background) levels, the sediment may be dumped offshore;
2. For mild levels, the sediment needs to be dumped in special offshore areas away fromfishing and nursery grounds;
3. For high levels, the sediment must be dumped in a confined area and capped.

The limit levels of pollution are known as **National Action Levels** and determine the cut-off limitsbeyond which disposal moves from a lower level to a higher level. However, **<u>Liberia is not a</u> <u>signatory to the London Convention.</u>**

As at 17/08/2020	IMO Convention 48	SOLAS Convention 74	SOLAS Protocol 78	SOLAS Protocol 88	SOLAS Agreement 96	LOAD LINES Convention 66	LOAD LINES Protocol 88	TONNAGE Convention 69	COLREG Convention 72	CSC Convention 72	CSC amendments 93	SFV Protocol 93	Cape Town Agreement 2012	STCW Convention 78	STCW-F Convention 95	SAR Convention 79	STP Agreement 71	Space STP Protocol 73	IMSO Convention 76	INMARSAT OA 76
Lebanon	x	x	x			x	x	x	x	x				x		x			x	x
Lesotho																				
Liberia	x	x	x	x		x	x	x	x	x		x		x		x			x	x
Libya	x	x	x	x		x	x	x	x					x		x			x	x
Liechtenstein																				
Lithuania	x	x	x	x		x	x	x	x	x		x		x	x	x				
Luxembourg	x	x	x	x		x	x	x	x	x				x		x				

As at 17/08/2020	IMSO amendments 2006	IMSO amendments 2008	FACILITATION Convention 65	MARPOL 73/78 (Annex I/II)	MARPOL 73/78 (Annex III)	MARPOL 73/78 (Annex IV)	MARPOL 73/78 (Annex V)	MARPOL Protocol 97 (Annex VI)	London Convention 72	London Convention Protocol 96	INTERVENTION Convention 69	INTERVENTION Protocol 73	CLC Convention 69	CLC Protocol 76	CLC Protocol 92	FUND Protocol 76	FUND Protocol 92	FUND Protocol 2003	NUCLEAR Convention 71	PAL Convention 74
Lebanon			x	x	x	x	x				x		x		x					
Lesotho																				
Liberia			x	x	x	x	x	x			x	x	d	x	x	x	x		x	x
Libya			x	x	x	x	x		x				x							x
Liechtenstein																				
Lithuania			x	x	x	x	x	x							x		x	x		
Luxembourg			x	x	x	x	x	x	x	x			d	x	x		x			x

As at 17/08/2020	PAL Protocol 76	PAL Protocol 90	PAL Protocol 02	LLMC Convention 76	LLMC Protocol 96	SUA Convention 88	SUA Protocol 88	SUA Convention 2005	SUA Protocol 2005	SALVAGE Convention 89	OPRC Convention 90	HNS Convention 96	HNS PROT 2010	OPRC/HNS 2000	BUNKERS CONVENTION 01	ANTI FOULING 2001	BALLASTWATER 2004	NAIROBI WRC 2007	HONG KONG CONVENTION
Lebanon						x	x				x				x	x	x		
Lesotho						x	x												
Liberia	x			x	x	x	x			x	x	x		x	x	x	x	x	
Libya	x					x	x				x								
Liechtenstein						x	x	x	x										
Lithuania			x	x	x	x	x			x	x	x			x	x	x		
Luxembourg	x	x		x	x	x	x								x	x			

websitehttp://www.imo.org/About/Conventions/StatusOfConventions/Pages/Default.aspx

Figure 5 Status of Conventions as at August 2020 *(IMO)*

Under World Bank guidelines, the contaminated dredged material must be disposed of correctly according to international or national convention where this exists. Since Liberia is not a signatoryto the Convention, NAFAA, in conjunction with the Ministry for the Environment, should seek to adopt the Action Levels of another country and prepare a **D**redged **M**aterial **A**ssessment **F**ramework (**DMAF**) guide this project on the correct disposal of the contaminated dredged sediments.

Table 4-1 Overview of some existing legislations in different countries regarding dredging and/or disposal

Country	Port		Cd	Hg	As	Cr	Cu	Ni	Pb	PAH	Min. oil	TBT
Belgium	Antwerp	Measured	25.7	1.24	41.1	140	122	35	- 324	7.07	- 2,200	
		Ref.	**30**	**15**	**110**	**1,400**	**600**	**250**	**2,500**	**40**	**5,000**	
	Zeebrugge	Measured	2.61	0.4	13.4	40.7	28.8	22.2	67.2	1.853		0.030
		Ref.	**7**	**1.5**	**100**	**220**	**100**	**280**	**350**	**180 (mg/g...)**	**36 (mg/g...)**	**0.007**
Netherlands	Rotterdam	Measured										
		Class 0	**<0.8**	**<0.3**	**<29**	**<100**	**<36**	**<35**	**<85**		**<50**	**<0.01**
		Class 1	**0.8-2**	**0.3-0.5**	**29-55**	**100-380**	**36-36**	**35-35**	**85-530**		**50-1,000**	**<0.01**
		Class 2	**2-7.5**	**0.5-1.6**	**55-55**	**380-380**	**36-90**	**35-45**	**530-530**		**1,000-3,000**	**0.01-0.04**
		Class 3	**7.5-12**	**1.6-10**	**55-55**	**380-380**	**90-190**	**45-200**	**530-530**		**3,000-5,000**	**0.04-4**
		Class 4	**>12**	**>10**	**>55**	**>380**	**>190**	**>200**	**>350**		**>5,000**	**>4**
Germany	Hamburg	Measured	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
	Bremen	Measured	4.3-8.4	0.44-0.65	17-26	94-120	87-110	49-68	140-240	1.2-7.9	105-312	<0,01-0,05
		Ref.	**2.5**	**1**	**30**	**150**	**40**	**50**	**100**	**1**		**<0,01**
		Max.	**12.5**	**5**	**150**	**750**	**200**	**250**	**500**	**3**		**<0,03**
France		**Level 1**	**1,2**	**0,4**	**2,5**	**90**	**45**	**37**	**100**			
		Level 2	**2,4**	**0,8**	**5,0**	**180**	**90**	**74**	**200**			
Portugal	Lisboa	Measured										
		Class 1	**<1**	**<0.5**	**<20**	**<50**	**<35**	**<30**	**<50**	**<300**		
		Class 2	**1-3**	**0.5-1.5**	**20-50**	**50-100**	**35-150**	**30-75**	**50-150**	**2,000-6,000**		
		Class 3	**3-5**	**1.5-3**	**50-100**	**100-400**	**150-300**	**75-125**	**150-500**	**2,000-6,000**		
		Class 4	**5-10**	**3-10**	**100-500**	**400-1000**	**300-500**	**125-250**	**500-1000**	**6,000-20,000**		
		Class 5	**>10**	**>10**	**>500**	**>1,000**	**>500**	**>250**	**>1,000**	**>20,000**		
Spain	Barcelona	Measured										
		Level 1	**1.0**	**0.6**	**80**	**200**	**100**	**100**	**120**			
		Level 2	**5.0**	**3.0**	**200**	**1,000**	**400**	**400**	**600**			
Italy	Genua	Level A	A	1	0,5	15	20	40	45	45	1	
		Level B	B	5	2	25	100	50	50	100	10	
		Level C	C	20	10	50	500	400	150	500	20	
Canada	Saint-Laurent	Measured										
		SSE	**0,2**	**0,05**	**3**	**55**	**28**	**35**	**23**			
		SEM	**0,9**	**0,2**	**7**	**55**	**28**	**35**	**42**			
		SEN	**3**	**1**	**17**	**100**	**86**	**61**	**170**			
China	Hong Kong	LCEL	1,5	0,5	12	80	65	40	75	2.2		0.15
		UCEL	4	1.0	42	160	110	40	110	12.7		0.15

Figure 6 Overview of some existing legislation in different countries (PIANC WG13)

The sediment tests on the Mesurado sample were carried out in Holland. With Holland being at thecentre of gravity of the dredging industry, the Dutch **D**redged **M**aterial **A**ssessment **F**ramework isone of the most complete and up-to-date in Europe and could be used as a model for this project.

The table in Figure 6 illustrates the 5 classes of levels of contamination and the table in Figure 7illustrates the action to be taken corresponding to each class.

Figure 7 Overview of the Decision Classes in Holland *PIANC WG 13*

Table 4-2 Overview of the applicable norms for contaminants in several countries

Country	Number of classes	Number of parameters	Decisions
Belgium	3	12	- parameters < reference value ⇒ dumping at sea - parameters (– 2) < limit value ⇒ dumping at sea + survey programme - 3 parameters > limit value ⇒ upland controlled disposal
Netherlands	5	41	Class 0 ⇒ no restriction Class 1 ⇒ dumping at sea Class 2 ⇒ dumping at sea possible (EIA necessary) Class 3 ⇒ upland disposal (if possible) Class 4 ⇒ upland disposal (compulsory)

If the Netherlands values in Figure 7 are adopted, the value of the TBT content (0.11) in the **sampleputs the sediment in Class 3** in Figure 6.
The value of the Copper (Cu) content (920>190) takes the sediment off the chart.
If the above classification is held true, then the contaminated sediment (based on the current sample analysis) from the dredging at Mesurado **<u>should not be dumped offshore</u>** but placed inside a containment.

A closer look at the borehole log indicates that only the **first metre of sediment may be contaminated** (contains anthropogenic material). The rest may be assumed to be clean.

Concept 6 - sheetpile calculations

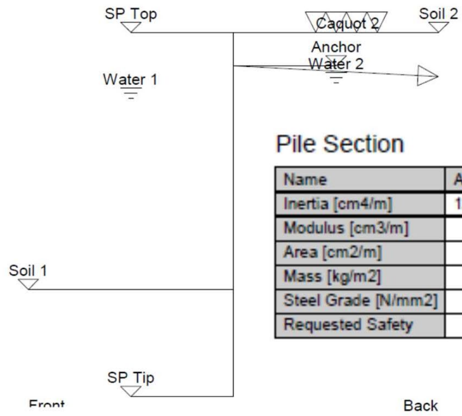
The concept 6 consisting of a sheetpile front wall and a platform enabling berthing alongside berthing. The sheet pile has been calculated and the results are presented hereunder and in reference report 2.

Sheet Pile Design According to Blum-Method

Project Name: Example
Date: 16-Sep-20
Author: ArcelorMittal Sheet Piling
Company:
Comment: Free earth support retaining structure.

Geodata

	Unit
Sheet Pile Top Level [m]	0.000
Sheet Pile Tip Level [m]	16.290
Soil Level in Front [m]	11.500
Soil Level behind [m]	0.000
Anchorlevel [m]	1.500
Water Level in Front [m]	2.500
Water Level behind [m]	1.800
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kN/m2]	0.000
Caquot Surcharge behind [kN/m2]	10.000
Anchor Inclination [Deg]	3.000
Earth Support	Free



Pile Section

Name	AZ50
Inertia [cm4/m]	121060.000
Modulus [cm3/m]	5015.000
Area [cm2/m]	322.200
Mass [kg/m2]	252.900
Steel Grade [N/mm2]	355.000
Requested Safety	1.500

Soil Layers

Layers in Front

	Layer Tip [m]	Density Moist [kN/m3]	Density Submerged [kN/m3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kN/m2]
Layer 1	2.500	18.000	10.000	3.103	25.000	-8.000	0.000
Layer 2	13.500	18.000	10.000	3.103	25.000	-8.000	0.000
Layer 3	34.500	21.000	11.000	3.928	30.000	-8.000	0.000

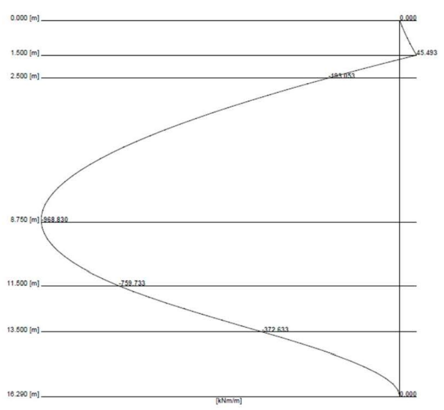
Layers behind

	Layer Tip [m]	Density Moist [kN/m3]	Density Submerged [kN/m3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kN/m2]
Layer 1	2.500	18.000	10.000	0.374	25.000	8.000	0.000
Layer 2	13.500	18.000	10.000	0.374	25.000	8.000	0.000
Layer 3	34.500	21.000	11.000	0.309	30.000	8.000	0.000

Pile Check

		Depth [m]
Name	AZ50	
Inertia [cm4/m]	121060.000	
Modulus [cm3/m]	5015.000	
Area [cm2/m]	322.200	
Mass [kg/m2]	252.900	
Steel Grade [N/mm2]	355.000	
Minimal Moment [kNm/m]	-969.008	8.670
Maxmimal Moment [kNm/m]	45.493	1.500
Normal Forces at Max. Moment [kN/m]	45.601	8.670
Normal Forces at Min. Moment [kN/m]	16.797	1.500
Deflection at Min. Moment [m]	-0.080	8.670
Deflection at Max. Moment [m]	0.000	1.500
Min. Stress at Min. Moment [N/mm2]	-192.538	8.670
Max. Stress at Min. Moment [N/mm2]	195.368	8.670
Min. Stress at Max. Moment [N/mm2]	-8.550	1.500
Max. Stress at Max. Moment [N/mm2]	9.593	1.500
Safety > Req. Safety = 1.500	1.817	
Sheet Pile Top Level [m]	0.000	
Sheet Pile Tip Level [m]	16.290	
Sheet Pile Length [m]	16.290	
Included OverLength [m]	0.000	
Vertical Equilibrium [kN/m]	37.490	
Anchor Force (horiz.) [kN/m]	-285.167	

Moment Diagram



I.II - Annexes to the Financial Feasibility Methodology

Table I-1: WACC Calculation Table

Component	Fishery Hub	Comment	Source
R_F	3.75%	Risk free rate on 10 year USD government bond	[1]
Equity risk premium	0%	Government-backed project	[2]
Debt ratio	75%	MTBS Assumption - Long term	
D/E	3.00		
β_U	0.87	unleveraged beta (transportation industry) from link	[3]
β_L	2.8	β_U*(1+(1-τ)*(D/E))	
$R_{E,L}$	**20.6%**	Leveraged cost of equity: $\beta_L * R_M + R_F$	
τ_C	25.0%	Corporate tax rate	
R_D	8.2%	TO: 6-month LIBOR (2.63%) + 500 bps	[4]
R_D less Tax shield	**6.1%**	Marginal cost of debt, less tax shield	
WACC	**9.7%**	**E/(tot liabilities) * $R_{E,L}$ + D/(total liabilities) * R_D * (1-τ_C)**	

Source: MTBS based on [1], [2], [3] and [4]
[1] https://www.bloomberg.com/markets/rates-bonds/government-bonds/us
[2] http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html
[3] http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html
[4] https://nl.global-rates.com/rentestanden/libor/libor.aspx

I.III - Annexes to the Financial Feasibility Results

Table I-2: Financial cash flows Project

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Revenues	M USD	13.8	-	-	1.6	1.7	1.9	2.0	2.2	2.9	3.9
Capex	M USD	(19.4)	(7.9)	(14.4)	(2.9)	-	-	-	-	-	-
Opex	M USD	(4.5)	-	-	(0.6)	(0.8)	(0.8)	(0.8)	(0.8)	(0.8)	(0.8)
Tax	M USD	(0.6)	-	-	-	(0.0)	-	-	(0.0)	(0.2)	(0.4)
Free Cash Flows	**M USD**	**(4.2)**	**(7.9)**	**(14.4)**	**(2.0)**	**0.9**	**1.1**	**1.2**	**1.4**	**1.9**	**2.6**
IRR (%)	%	7.4%									
WACC (%)	%	9.7%									

Source: MTBS

Table I-3: Financial cash flows Industrial Hub

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Revenues	M USD	11.9	-	-	1.3	1.4	1.5	1.7	1.8	2.6	3.5
Capex	M USD	(12.4)	(7.5)	(8.2)	-	-	-	-	-	-	-
Opex	M USD	(2.9)	-	-	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
Tax	M USD	(1.0)	-	-	-	(0.0)	(0.0)	(0.1)	(0.1)	(0.3)	(0.5)
Free Cash Flows	**M USD**	**1.7**	**(7.5)**	**(8.2)**	**0.7**	**0.9**	**1.0**	**1.1**	**1.2**	**1.8**	**2.5**
IRR (%)	%	11.0%									
WACC (%)	%	9.7%									

Source: MTBS

Table I-4: Financial cash flows Artisanal Hub

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Revenues	M USD	2.0	-	-	0.3	0.3	0.3	0.3	0.3	0.4	0.4
Capex	M USD	(7.0)	(0.4)	(6.2)	(2.9)	-	-	-	-	-	-
Opex	M USD	(1.6)	-	-	(0.1)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
Tax	M USD	(0.0)	-	-	-	(0.0)	-	-	-	-	-
Free Cash Flows	**M USD**	**(6.6)**	**(0.4)**	**(6.2)**	**(2.7)**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**
IRR (%)	%	0.0%									
WACC (%)	%	9.7%									

Source: MTBS

I.IV - Annexes to the Economic Feasibility Results

Table I-5: Economic cash flows Project

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Direct benefits	M USD	9.2	-	-	0.9	0.9	1.0	1.1	1.1	1.5	1.8
Indirect benefits	M USD	60.4	-	-	3.4	4.3	5.2	6.1	7.0	10.9	14.7
Total benefits	**M USD**	**69.6**	**-**	**-**	**4.3**	**5.2**	**6.2**	**7.1**	**8.1**	**12.4**	**16.5**
Direct costs	M USD	(20.6)	(5.6)	(9.5)	(2.0)	(0.4)	(0.3)	(0.3)	(0.3)	(0.2)	(0.2)
Indirect costs	M USD	(9.1)	-	-	(0.3)	(0.4)	(0.5)	(0.6)	(0.6)	(0.7)	(0.7)
Total costs	**M USD**	**(29.7)**	**(5.6)**	**(9.5)**	**(2.3)**	**(0.8)**	**(0.9)**	**(0.9)**	**(0.9)**	**(0.9)**	**(0.8)**
Free Cash Flows	**M USD**	**39.9**	**(6.5)**	**(11.6)**	**1.3**	**4.2**	**4.9**	**5.7**	**6.5**	**10.1**	**13.6**
IRR (%)	%	26.6%									
SDR (%)	%	7.1%									

Source: MTBS

Table I-6: Economic cash flows Industrial Hub

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Direct benefits	M USD	9.0	-	-	0.9	0.9	1.0	1.0	1.1	1.4	1.8
Indirect benefits	M USD	39.6	-	-	1.5	2.3	3.2	3.9	4.6	7.4	10.3
Total benefits	**M USD**	**48.6**	**-**	**-**	**2.3**	**3.2**	**4.2**	**4.9**	**5.7**	**8.8**	**12.0**
Direct costs	M USD	(13.3)	(6.2)	(6.6)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
Indirect costs	M USD	(9.5)	-	-	(0.4)	(0.6)	(0.8)	(0.9)	(1.1)	(1.8)	(2.5)
Total costs	**M USD**	**(22.8)**	**(6.2)**	**(6.6)**	**(0.7)**	**(0.9)**	**(1.1)**	**(1.3)**	**(1.4)**	**(2.1)**	**(2.8)**
Free Cash Flows	**M USD**	**25.8**	**(6.2)**	**(6.6)**	**1.6**	**2.3**	**3.1**	**3.7**	**4.3**	**6.7**	**9.2**
IRR (%)	%	25.1%									
SDR (%)	%	7.1%									

Source: MTBS

Table I-7: Economic cash flows Artisanal Hub

Item	Unit	PV	2024	2025	2026	2027	2028	2029	2030	2035	2040
Direct benefits	M USD	0.3	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indirect benefits	M USD	20.7	-	-	1.9	2.0	2.0	2.2	2.3	3.5	4.4
Total benefits	**M USD**	**21.0**	**-**	**-**	**1.9**	**2.0**	**2.0**	**2.2**	**2.4**	**3.5**	**4.5**
Direct costs	M USD	(7.3)	(0.3)	(5.0)	(2.3)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Indirect costs	M USD	0.4	-	-	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Total costs	**M USD**	**(7.0)**	**(0.3)**	**(5.0)**	**(2.3)**	**(0.2)**	**(0.2)**	**(0.2)**	**(0.2)**	**(0.1)**	**(0.1)**
Free Cash Flows	**M USD**	**14.0**	**(0.3)**	**(5.0)**	**(0.4)**	**1.8**	**1.9**	**2.0**	**2.2**	**3.4**	**4.4**
IRR (%)	%	30.4%									
SDR (%)	%	7.1%									

Source: MTBS

I.V - Annexes to the Financial and Economic Model

Non-time based model input assumptions

General financial assumptions	Value	Unit
USD/LBD Exchange rate 2023	160	LRD/USD
Primary Model Currency	USD	year
Annual Inflation Rate	2.0%	%
Application of Inflation: 0 = no (real); 1 = yes (nominal)	1	binary
Escalation Period Start	2023	year
Debtor Days (collections)	30	days
Creditor Days (payments)	30	days
Terminal Value - Selected Case - Name	Perpetuity	Name
Terminal Value - Selected Case - Number	2	Number
Valuation Date	01/01/2023	date
Discounting - Selected Case - Name	End-year	Name
Discounting - Selected Case - Number	1	Number
Project - Financial - Discount Rate	10%	Rate
Project - Social - Discount Rate	7%	Rate
Artisanal Hub - Financial - Discount Rate	10%	Rate
Artisanal Hub - Social - Discount Rate	7%	Rate
Industrial Hub - Financial - Discount Rate	10%	Rate
Industrial Hub - Social - Discount Rate	7%	Rate
Corporate Tax Rate	25%	%
Terminal Value - Average Preceding Years CAPEX	10.0	years
Terminal Value - Terminal Growth Rate	0.0	% of total investments

Economic assumptions	Value	Unit
Econ. Conversion factor revenues	0.75	factor
Economic conversion factor opex/capex - Concept 6 - Full	0.86	factor
Economic conversion factor opex/capex - concept 5 full	0.87	factor
Economic conversion factor opex/capex - concept 6 full	0.86	factor
Economic conversion factor opex/capex - concept 5 phase 1	0.93	factor
Economic conversion factor opex/capex - concept 6 phase 1	0.88	factor
Climate change avoidance costs - EUR 2019	100	EUR/ton CO2
EUR/USD exchange rate 2019	1.120	USD/EUR
Climate change avoidance costs - USD 2019	112	USD/ton CO2
United States - Inflation -2019-2023	1.20	Inflation correction
Climate change avoidance costs CO2 - USD 2023	134	USD/ton CO2

CAPEX assumptions – price level 2020 excl. contingency	Unit	Value	
EIA studies	Unit	Concept 5	Concept 6
Design fees	USD		
Supervision (18 months)	USD	225,000	225,000
Mobilisation and demobilization of contractor	USD	735,000	735,000
Allowance for wreck clearance	USD	100,000	100,000
Dredging down to -9.0m (520,000 m3)	USD	2,600,000	2,600,000
Alongside berth cofferdam	USD	773,485	7,755,240
CFHF - breakwaters ph1 + ph2	USD	4,100,000	4,100,000
CFHF - Utilities	USD	1,500,000	1,500,000
CFHF-Admin block, two levels each of 200 square metres	USD	160,000	160,000
CFHF-Fishermen's workshops and gear stores of 300 square metres.	USD	120,000	120,000
CFHF-Fish receiving, first rinse and icing halls, 10 m x 20 m.	USD	200,000	200,000
CFHF-Perimeter fencing in chainlink mesh.	USD	26,600	26,600
CFHF-Perimeter wall in masonry along Freeport boundary	USD	60,000	60,000
CFHF-Wreck removal (2 pieces)	USD	50,000	50,000
CFHF-Demolition of old ship lift	USD	50,000	50,000
CFHF-Fuel station	USD	10,000	10,000
IFF- Utilities, (Power supply, water supply and sewerage)	USD	382,000	382,000
IFF facility: office (100 m2)	USD	40,000	40,000
IFF-facility: workshop (100 m2)	USD	40,000	40,000
IFF-facility: auctionhal (100 m2)	USD	40,000	40,000
IFF-Custom gate and fencing	USD	20,000	20,000
Road improvement (500 m)	USD	100,000	100,000
Sum total capex	USD	11,332,085	18,313,840

Revenue assumptions	Value	Unit
Landing tarrifs		
Landing tariff per vessel - kru	-	USD/vessel/month
Landing tariff per vessel - fanti	-	USD/vessel/month
Landing tariff per vessel - indust	255	USD/vessel/month
Auction commission revenues		
Share to auction - kru	75%	%
Share to auction - fanti	75%	%
Share to auction - ind	75%	%
Value per kg - kru	3.1	USD/kg
Value per kg - fanti	1.7	USD/kg
Value per kg - ind	4.7	USD/kg
Auction commission	6%	%

Miscellaneous		
Misc. rev - kru	15.0	USD/vessel/trip
Misc. rev - fanti	25.0	USD/vessel/trip
Misc. rev - indu	150.0	USD/vessel/trip
Lease rate smokehouses	1,350	USD/350 sqm/year
Economic rent % market value	30.0%	%

Traffic assumptions	Value	Unit
Trips per year per vessel - kru	200	trips p.a.
Trips per year per vessel - fanti	120	trips p.a.
Trips per year per vessel - semi-industrial	22	trips p.a.
Trips per year per vessel - industrial	22	trips p.a.
Small pelagic - fishing effort - kru	18.54%	%
Medium pelagic - fishing effort - kru	17.60%	%
Large pelagic - fishing effort - kru	6.28%	%
Shallow-water demersal - fishing effort - kru	32.74%	%
Deep-water demersal - fishing effort - kru	18.75%	%
Crustacean - fishing effort - kru	6.09%	%
Total check	100%	%
Small pelagic - fishing effort - fanti	78.84%	%
Medium pelagic - fishing effort - fanti	16.95%	%
Large pelagic - fishing effort - fanti	1.89%	%
Shallow-water demersal - fishing effort - fanti	1.89%	%
Deep-water demersal - fishing effort - fanti	0.41%	%
Crustacean - fishing effort - fanti	0.01%	%
Total check	100%	%
Small pelagic - fishing effort - industrial	20.02%	%
Medium pelagic - fishing effort - industrial	0.58%	%
Large pelagic - fishing effort - industrial	1.67%	%
Shallow-water demersal - fishing effort - industrial	30.14%	%
Deep-water demersal - fishing effort - industrial	36.95%	%
Crustacean - fishing effort - industrial	10.64%	%
Total check	100%	%

I.VI – FAST Modelling Standard

MTBS COMPETENTCE STATEMENT

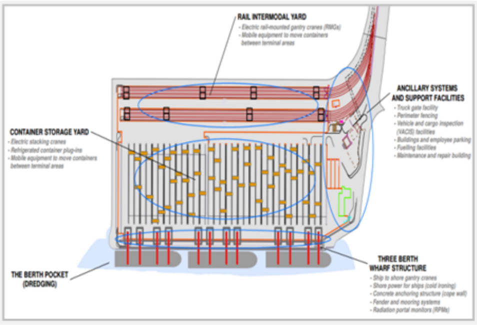
FAST MODELLING STANDARD

FINANCIAL MODELING SERIES

THE FINANCIAL MODEL – CORE OF STRATEGIC ADVISORY

Financial models reside at the heart of many strategic advisory processes. Models are used to replicate the project's characteristics for further research such as bid bandwidth establishment, feasibility and bankability testing, scenario analyses and sensitivity testing. Besides, financial models are applicable as a shadow models to simulate competing bids and to assess the impact of bids on the performance of bidders and authorities.

MTBS develops project-specific financial models, providing tailor-made solutions for each client and each project.

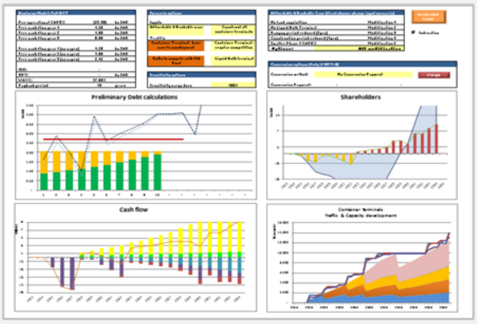


THE FAST MODELING STANDARD – THE STATE OF THE ART

MTBS is a **FAST Signatory** and adheres to the FAST Modelling Standard. The FAST Modelling Standard is a set of rules providing guidance on the structure and design of efficient spreadsheets for financial models.

This set of rules provides:

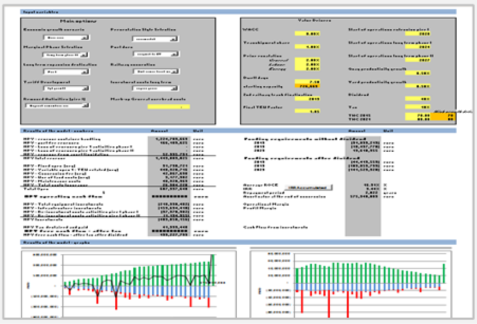
- A clear route to good model design for the individual modeller; and
- A common style platform enabling modellers and reviewers to work efficiently when passing models amongst themselves and external auditors.



THE FAST ACRONYM – RATIONALE TO MODELING

The FAST acronym depicts the value this common modelling language has to offer to both the modeller and the model's users and auditors:

- **Flexible**: allowing scope changes during project development and facilitating a multitude of scenarios
- **Accurate**: reflecting key business assumptions directly and faithfully
- **Structured**: rigorous consistency in layout and organisation
- **Transparent**: simple & clear formulas understandable to other modellers and non-modellers alike



THE USERS – SIGNATORIES TO THE STANDARD

Together with MTBS, the undersigned organisations adopted the FAST Modelling Standard to build and maintain their financial models.

John laing – making infrastructure happen; carillion; European Bank for Reconstruction and Development; Lend Lease; Grant Thornton – An instinct for growth; PARSONS BRINCKERHOFF; EDINBVRGH – THE CITY OF EDINBURGH COUNCIL; MAZARS; CAPITA

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Appendix II: Fisheries Resource Assessment

Fisheries Resources Assessment Report

Economic and Financial Feasibility Assessment for the Expansion of the Fishing Port in Monrovia, Liberia

By

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July 2023

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Executive Summary

This report presents the findings of a comprehensive fisheries assessment conducted to evaluate the feasibility of constructing a fishing port in Messurado, Monrovia, Liberia. The purpose of the assessment was to analyze the potential impacts of the proposed fishing port on the fish stocks, fishing communities, and the overall sustainable management of fisheries resources in the country. The assessment involved secondary data collection, stakeholder consultations, and scientific/statistical analyses to provide a holistic understanding of the project's implications.

Key Findings:

Liberia's coastal waters are rich in diverse fishery resources that support both artisanal and commercial fishing activities. The major fish stocks include pelagic species, demersal species, and shellfish, which are critical for the livelihoods of local communities and contribute significantly to the national economy (10% to the GDP).

Several coastal fishing communities in Liberia rely heavily on fishing as their primary source of income and sustenance. The proposed fishing port has the potential to enhance their livelihoods by improving fish handling, processing, and market access.

Sustainable management of fisheries resources is essential to prevent overfishing and ensure the long-term viability of the marine ecosystem. The introduction of a fishing port should be accompanied by strong regulatory measures, including effective monitoring of quotas, mesh-size limits, and gear restrictions, to prevent overexploitation and maintain healthy fish stocks.

The success of the fishing port project will depend on active participation and engagement with various stakeholders, including local fishing communities, government agencies, non-governmental organizations, and private sector investors. Involving stakeholders from the early planning stages and incorporating their feedback is vital for sustainable and inclusive development.

The assessment identified key infrastructure and logistic requirements for the fishing port. These include cold storage, fish processing units, waste management systems, and transportation networks to ensure efficient and safe operations. Ice and other fishing inputs such as fishing gears and fuel supply were also emphasised by local fishermen. They also pointed a chronic problems of artisanal and industrial fisheries conflicts and the slow pace at which NaFAA are addressing these issues.

The construction of a fishing port has the potential to create employment opportunities and stimulate economic growth in the country. However, careful consideration should be given to minimize potential negative social impacts, such as displacement of traditional fishing practices and cultural changes.

Recommendations:

Based on the findings of the fisheries assessment, the following recommendations are proposed for the successful construction and operation of the fishing port:

1. Review the existing fisheries management plan that includes sustainable harvesting practices, monitoring of fish stocks, and enforcement of regulations on mesh-sizes and quota management. Industrial fisheries data seem to be under reported
2. Foster collaboration between government agencies, fishing communities, and other stakeholders to ensure effective governance and management of the fishing port.

3. Prioritize investment in training and capacity-building programs for local fishers and port staff to enhance skills and knowledge in sustainable fishing practices and port operations and maintenance.

4. Explore opportunities for public-private partnerships to secure funding and expertise for the construction and management of the fishing port.

5. Train and deploy trusted and well-motivated enumerators and at sea observers to be able to effectively monitor and report catch accurately.
6. Monitor catch and effort for different fishing gears and crafts and record separately as lumping catch by different crafts and fishing gears is difficult to standardise and predict yields, especially for a multi species fisheries, whereby a gill net and sein net can catch 10 to 50 different species in one fishing trip.
7. Refine the unit of effort in recording catch and effort to for example hours of trawling instead of fishing days, especially for the artisanal fleet
8. Consider introducing fiberglass semi-industrial fishing vessels in the artisanal fisheries sector and enhance access to these by organising fishers into functional professional groups
9. Encourage business people to invest in the improvement of small-scale landing sites and infrastructure, provision of goods and services to coastal fishing communities such as fuel supply (gas stations), fishing inputs (marine store supplying/selling different fishing inputs), cold stores and ice making machines to supply ice to fishermen.

Conclusion:

The fisheries assessment indicates that the construction of a fishing port in Liberia has the potential to significantly benefit fishing communities and the national economy. However, successful implementation requires a well-designed management plan, close collaboration with stakeholders and private sector. With proper planning and sustainable practices, the fishing port can contribute to the development and prosperity of Liberia's fisheries sector while safeguarding its marine resources for future generations.

1.0 Introduction

1.1 Background

Liberia's 570 km coastline possesses a continental shelf that ranges in width from 16 to 56 km with an average width of 34 km (Ssentongo, 1987), and an exclusive economic zone (EEZ) of about 246.000 km^2. The fishery resources are currently exploited by offshore and coastal fleets (MRAG, 2014). Potential yield has been estimated at around 40.000 tons $year^{-1}$ (Ssentongo, 1987; MRAG, 2014) but total catch between 2013 –2016 averaged around 26,700 tons. The fisheries account for about 10% of GDP (Belhabib et at. 2015).

The country's coastal communities are home to around 58% of Liberia's population. While per capita fish consumption in Liberia is relatively low (compared to the global average), coastal communities are large consumers of fish and 80% of animal proteins are sourced from the aquatic sources[1]. Fisheries and aquaculture in Liberia are important job creators, and both sectors play an important role in the local economies and export development.

[1] http://www.fao.org/ag/agp/agpc/doc/counprof/liberia/liberia.htm.

Liberia has a rich marine ecosystem and is known for its diverse fish resources. The expansion of the fishing port in Monrovia presents an opportunity to further harness and utilize these resources for economic growth and development. However, a thorough assessment of the fish resources is necessary to ensure sustainable exploitation, environmental protection, and long-term viability of the fishing industry.

The specific objectives of fish resource assessment as part of the economic and financial feasibility of the Messurado fishing port expansion are:

1. To evaluate the abundance, distribution, and health of fish stocks in the area where the fish harbor is proposed.
2. To identify and characterize the different fish species present in the area.
3. To analyse historical catch data and estimating fish production potential.
4. To examine the fishing gear and techniques used in the area.
5. To assess the socio-economic aspects of the fishery, including the livelihoods and economic contributions of fisher communities.

The information gathered through this assessment will be vital in determining the potential for increased fishing activities and the economic viability of expanding the fishing port.

1.2 Scope

The scope of the fish resource assessment involved desk review, data analysis, economic evaluation, and stakeholder consultations. The specific to be completed include:

- Fish species abundance, composition and distribution analysis
- Fishing effort and fishing gear analysis
- Socioeconomic assessment of the fishing industry
- Stakeholder Engagement and Consultations
- Fisheries policy and regulatory review:

2 Methodology

This fish resource assessment work involved the collection and analysis of data from various sources, including fishery statistics, and stakeholder consultations. It should be noted that time and resources for the assignment did not permit much primary data sourcing, so the assessment depended mostly on secondary data on several key aspects the Liberian fisheries.

2.0 Desk Review:

- A comprehensive review of existing literature, reports, and studies related to the fish resources in the coastal waters of Monrovia, Liberia was conducted.
- Relevant scientific publications, government reports, and industry publications were identified to gather baseline information on fishing fleet composition, fish species harvested and fishing activities.

- A comprehensive review of existing data and information was conducted to identify the various fish species present in the coastal waters of Monrovia. The assessment was aimed at understanding the different fish species harvested and their abundance, taking into account seasonal variations.

- The status of fish stocks in the country was assessed by reviewing data/reports on biomass, length structure, growth rates, and reproductive patterns.

- The fishing effort and the types of fishing gear used was assessed through review of literature and limited field visit in Liberia, whereby a few coastal fishing communities, mostly around Monrovia were visited and discussions, interviews and consultations held with fishers and other stakeholders.

2.1 Data Collection

- A combination of primary and secondary data sources were utilised to gather information.

- Primary data collection included market surveys to assess common species of fish in the local markets (both landed by local fishermen and imported by frozen foods importers in Liberia..

- Secondary data sources included fishery statistics, catch records, landing data, and relevant reports from NaFAA, online publications and reports by researchers.

- Historical catch data, fishing effort, and other relevant factors were sourced for the assess of fish stock dynamics and sustainability.

2.2 Fishing Effort and Fishing Gear Analysis

- Shared data on fishing effort, including the number of fishing vessels and fishing days, types of fishing gear used, their selectivity, and potential impact on the target and non-target species were analysed.

- Reports/scientific publications on technical efficiencies of different fishing methods and gear in relation to the fish resources and ecosystem health were reviewed.

2.2.1 Assessment of the impact of IUU fishing and climate change

IUU fishing can have significant socio-economic impacts on local communities and legitimate fishing operations. Assessing the economic losses, livelihood disruptions, and social consequences caused by IUU fishing can provide a comprehensive understanding of its impact on the fisheries sector and coastal communities. Limited field work provided an insight into the impacts of fishing in the IEZ on the livelihoods of the artisanal fishers with several reports of fishing gears destruction by industrial operators who illegally fish in the 6 miles IEZ. The MTBS team were informed that the 6 miles IEZ has been reduced to 3 miles, but local fishermen said they were not aware of the change.

No data was shared on IUU fishing to support this assessment, but we understand that World Bank is working with NaFAA on VMS data analysis. The result of this analysis can support this assessment.

Analysis of surveillance reports and catch discrepancies may reveal some information on the impact of IUU fishing in Liberian waters

2.2.2 Fishing and support vessels types requirement to support the fishery sector

Analysis of the fishery sector in Liberia was conducted to understand its current status, target species, fishing methods employed, and the scale of operations. This analysis included data on fishing activities, catch volumes and, fishing gear used, and the distribution of fishing effort.

2.2.2.1 Stakeholder Consultation

Relevant stakeholders, including government agencies (NaFAA), fisheries research institutions, local communities, and fishing industry representatives were engaged through key informant interviews, consultative meetings and field observations. Local knowledge, perspectives, and concerns regarding the fish resources and the expansion of the fishing port were gathered during the field visit and stakeholder feedback incorporated into the assessment process.

would be most suitable and beneficial for supporting the sector's needs and their willingness to support the sustainable operations of the proposed port infrastructure.

2.2.2.2 Fishery Infrastructure Assessment

We evaluated the existing fishery infrastructure, such as landing sites, fish processing facilities (smoking kiln), and cold storage facilities. This assessment helped determine the requirements for vessels that can effectively transport catches, facilitate landing operations, and ensure the quality and preservation of fish products and refrigerated trucks that can distribute the landed fish into local markets within and outside Liberia

2.2.2.3 Fishing Fleet Analysis

We assessed the current fishing fleet in Liberia, including the types, sizes, and conditions of fishing vessels. Identified gaps or shortcomings in the fleet's capabilities and determined if additional or upgraded vessels are needed. Consider factors such as vessel size, gear compatibility, fuel efficiency, and safety features and fish handling facilities on board.

2.2.2.4 Support Vessel Requirements

Besides fishing vessels, we considered the need for support vessels to enhance the efficiency and safety of fishing operations. These may include supply vessels for delivering fuel, provisions, and equipment to fishing vessels; research vessels for conducting scientific surveys and assessments; and enforcement vessels for monitoring and surveillance purposes.

2.2.2.5 Technological Advances

we explored the potential for integrating new technologies and innovations in vessel design and equipment to improve the sustainability, efficiency, and safety of fishing operations. This included features like electronic monitoring systems, some of which are already being used by industrial vessels, gear selectivity enhancements, and fuel-saving technologies.

2.2.2.6 Policy and Regulatory Framework

The existing policy and regulatory framework governing fisheries management and conservation in Liberia were reviewed to evaluate how these can contribute to the management and operations of the proposed fishing port. The effectiveness of current regulations was assessed with a view to identify gaps or areas for improvement.

2.2.2.7 Capacity Building and Financing

we assessed the capacity of local stakeholders, including fishers and vessel operators, to operate and maintain different types of vessels and shore-based fisheries infrastructure. Identify potential capacity-building needs and explore financing options to support vessel acquisition, training, and ongoing maintenance.

2.2.2.8 Economic Assessment

Limited fish market survey to gather data on fish and seafood demand, prices, and market trends at the national and international levels were conducted between 18th and 23rd June 2023. The potential economic benefits of expanding the fishing port, considering investment costs, potential revenues, and return on investment were also conducted with support from other members of the MTBS team with the use of financial and economic models and data input from the fisheries assessment work.

2.3 Resources Assessment Analysis

Surplus production models with simplified assumptions and the FAO Fish Stock Assessment Tools (FiSAT) were used in the assessment of maximum sustainable yield (MSY) and fish population dynamics for the Liberian fisheries because of the following reasons:

1. **Data Limitations**: Assessing fisheries stocks and estimating MSY requires reliable and comprehensive data on fish populations, catch rates, and fishing effort. However, in Liberia, there has been limited resources and capacity to collect extensive data. As a result, simpler models with fewer data requirements should be used.

2. **Cost and Time Constraints**: Implementing complex models and conducting detailed data collection can be expensive and time-consuming. Simplified surplus production models offer a quicker and more cost-effective approach, allowing for the assessment of MSY with limited resources and time.

3. **Decision-Making Purposes**: MSY assessments are typically conducted to inform fisheries management decisions. In some cases, policymakers may prioritize timely assessments and recommendations over the precision and accuracy offered by more complex models. Simplified models can provide reasonable estimates of MSY that can be used as a reference point for setting catch limits and implementing management measure

2.3.1 Schaefer and Fox models to estimate MSY in the Liberian fisheries

The Schaefer and Fox models are commonly used in fisheries assessment to estimate the Maximum Sustainable Yield (MSY) of a fishery. The MSY is the largest catch that can be continuously taken from a fish stock without depleting the stock's reproductive capacity in the long term.

The Schaefer model is a widely used biomass-based model that assumes that fish population growth is influenced by two main factors: growth and mortality. The model assumes that the rate of population increase is proportional to the biomass of the fish population and is also influenced by the fishing mortality rate. The Schaefer model can be expressed as follows:

$$dN/dt = rN(1 - (N/K)) - F*N$$

Where: *dN/dt is the rate of change of the fish population over time,*

r is the intrinsic population growth rate, *N is the fish population size,*

K is the carrying capacity of the environment (maximum sustainable biomass),

F is the fishing mortality rate.

The Schaefer model estimates the maximum sustainable biomass (MSB) that can be harvested from the fishery, and the corresponding fishing effort that achieves MSY.

The Fox model is an age-structured model that incorporates more detailed information about the fish population, such as age classes and their corresponding reproductive and mortality rates. This model provides a more realistic representation of the population dynamics and can be more accurate in estimating MSY. The Fox model accounts for changes in the age structure of the fish population over time and the effect of fishing on different age classes.

Both the Schaefer and Fox models require data on fish population dynamics, including information on **population size**, **growth rates**, **natural mortality**, and **fishing mortality**. These models use historical data to estimate the parameters and then project future population trends under different fishing scenarios. By comparing different fishing mortality rates, the models can determine the level of fishing effort that maximizes sustainable yield (MSY) for the fishery.

2.3.2 Data Requirements for the MSY estimation

- Historical data on the abundance or biomass of the target fish species is required to fit into the model, but this is not available as comprehensive fish stock assessment was last done in 1981
- Species specific historical catch data, are necessary to understand the relationship between fishing effort and catch rates, but this data set was available for only one year (January to December of 2022)
- Information on fishing effort, such as the number of fishing vessels, gear types, or fishing hours, is required to assess the level of fishing activity over time. Data shared has historical number of fishing vessels, historical catch and effort data for the period 2010 to 2022 is not disaggregated to species level. We only have total annual catch and the CPUE, whereby the unit of effort was said to be fishing boat days (ie number of boats multiplied by number of days fished
- Factors like water temperature, salinity, and primary productivity can influence fish population dynamics and often considered in the Schaefer and Fox models, but this is currently not available

In the absence of above comprehensive dataset, the Schaefer and Fox Surplus Production Models was used for estimating the Maximum Sustainable Yield. This model does not take into account age and growth. Hence, it could be safely applied to tropical stocks, where calculation of age of tropical fish is more cumbersome.

When catch and effort data are applied for a number of years, the MSY thus generated will be more meaningful for sustainable fishery.

2.3.2.1 Schaefer model

In this model, the catch per unit of effort (CPUE) or yield per unit of effort is designated as Y/f. The Y/f is a function of effort, 'f'. MSY could be computed from the following equation.

$Y(i)/f(i) = a + b \times f(i)$ ---> (1)

In Schaefer model, the slope 'b' will be negative if the catch per unit of effort 'y/f', decreases for increasing effort. This model implies one effort level for which 'y/f' value obtained just after the first boat fishes on the stock for the first time. Hence, the intercept value is positive. Thus '- a/b' is positive and 'y/f' is zero for f = -a/b. As the negative value of catch per unit effort, 'y/f' is will not be a reality, this model applies to f values lower than '- a/b'.

The Catch and effort data shared for the period 2010 to 2022 was used to estimate a and b for the Schaefer model and MSY calculated as:

$MSY = - 0.25 . a^2/ b$

$FMSY = - 0.5 * a / b$

In the Fox model,

$MSY = - (1 / d) * Exp. (c-1).$

$FMSY = - 1 / d.$

Note : The constants 'a' and 'b' are the intercept on the yield axis and the of the predicted yield trend line

3 Assessment Results

3.0 Fish Species Abundance, Composition and Distribution, in Liberian Waters

3.0.1 Fish Abundance

A comprehensive fish stock assessment survey has not been conducted in Liberia waters in recent times. The last comprehensive survey of fish stock in Liberian waters was conducted by the USSR using the research vessel BELOGORSK in 1981. The results of this trawl survey estimated the fishery biomass of demersal species in metric tons as shown in Table 1:

Table 1: Estimated demersal fish stocks biomass in Liberian waters (Source: Ssentongo, 1987)

Family	***Species***	**Estimated Fishery Biomass (MT)**
Sparidae	*Dentex angolensis*	3 500
	Dentex congoensis	3 100
	Pagellus belottii	200
	Boops boops	800
Serranidae:	*Epinephelus gigas*	185
	Epinephelus aeneus	2 010
Sciaenidae:	*Pteroscion peli*	126
	Pentheroscion mbizi	982
Total	**All Species**	**10. 903**

Another survey was conducted in 1981 using the Research vessels RV DR. F. NANSEN (in 1981) and R/V BELOGORSK (in 1981) estimated the following range of biomass for coastal pelagic species for the entire Liberian shelf area with the biomass estimates presented in Table 2:

Table 2: Estimated pelagic fish stocks biomass in Liberian waters (Source: Ssentongo, 1987)

Species groups	**R/V BELOGORSK Biomass estimate(in t) Jan.-Feb.1981 (ATLANTNIRO, 1981)**	**R/V DR. F. NANSEN Biomass estimate (in t) June 1981 (Stromme, 1983)**
Balistes	-	2 175
Clupeidae/Engraulidae	40 700	51 087
Carangidae	2 000	43 478
Sphyraena	500	-
Brachydeuterus	200	-
Auxis thazard	200	-
Other fish species	-	40 217
Total all species	**43, 600**	**136, 957**

The differences in the above estimated biomasses were reported to be possibly due to the different sampling periods and to the fact that the R/V BELOGORSK failed to locate *Balistes* and much of the carangids in the sampled area.

Demersal finfish estimated to be in the order of 9, 000 to 15, 000 t, whereas the potential for the coastal pelagic species was estimated to be between 19, 400 to 41, 000 t. Available data at the time also indicated that the maximum economic yield (MEY) for the Liberian shrimp fishery was 800 t (Shotton, 1982, 1983) whereas the MSY was estimated at between 1, 200 to 1, 600 t (Burgess et al.).

Aggregate fisheries MSY for the Liberian coastal waters by Jueseah et al (2020) was estimated to be roughly 18,700 tons year−1 (Table 2). Their bio-economic models suggested that the shallow-water demersal fish stocks were overexploited, while biomass estimates for other species assemblages were reported to be well above Xmsy levels. MSY estimate for crustacean from same model was 710 tons, only‘44% of the estimated MSY of 1600 tons in 1983 (Shotton, 1983). The difference in the estimated MSY for the crustaceans is suggested to be due to the fact that Shotton’s 1983 MSY estimates was based on industrial shrimp fishery, whereas Jueseah et al.’s 2020 MSY estimate was based on the catch of artisanal Kru canoe fishery, which primarily catch shallow water crabs and lobsters., with very small quantities of shrimps caught in shallow coastal waters.

Table 3: Fish Stock size estimates as at end of 2016 (source: Jueseah et al (2020))

Species Assemblage	**MSY (1000 t)**	**Xmsy (1000 t)**	**Xmax (1000 t)**	**Stock (1000 t)**	**Stock/Xmax**	**Stock.Xmsy**
Small pelagic	9.52	46.95	93.90	68.83	0.7	1.5
Medium pelagic	3.56	15.41	30.82	25.75	0.8	1.7
Shallow-water demersal	3.91	19.16	38.32	12.87	0.3	0.7
Deep-water demersals	0.99	1.67	3.34	3.05	0.9	1.8
Crustacean	0.71	0.86	1.72	1.26	0.7	1.5
	18.70	**84.05**	**168.09**	**111.76**	**0.7**	**1.3**

Likely explanation for the healthy state of fish stocks in the Liberian waters are believed to be due to the prolonged civil war in the country, low investment in the coastal fisheries, and changes in the country’s fisheries policy. The conflict prevented the expansion of fishing effort in the SSF (Belhabib et al., 2013). The Liberian Government had introduced a zoning regulation in 2010, which prohibited industrial trawling within 6 nautical miles inshore zone where the main coastal shrimp resources are concentrated [Ssentongo, 1987; Shotton, 1983). The Kru canoes, that are allowed to operate the inshore exclusion zone (IEZ), catch some crabs and lobsters, but are inefficient (Jueseah et al, 2021), and their operations are highly seasonal, indicating underutilization of this valuable resources. It is also suggested that the introduction of the 6 nm IEZ regulation in 2010 had forced the fairly old fishing trawlers operating in Liberian waters to withdraw from fishing in Liberia, as they could not trawl in deeper waters beyond the 6 nautical miles limit (Ministry of Agriculture, 2014)

3.0.2 Fish Species Composition

Data shared with the MTBS team by NaFAA, showed that there are over 130 commercially exploited finfish and shellfish species in Liberia. Of these, the 20 most abundant in the catch of both artisanal and industrial fleet are provided in Table 4 below:

Table 4: Annual fish catch of the 10 industrial fishing vessels in 2022 as recorded by NaFAA Statistics Office

Species Name	***Quantity of fish landed in the month (Kg)***												***Annual Total (Kg)***
		Feb	**March**	**April**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	
Sardinella maderensis	*,980.62*	*2,655.28*	*3,150.27*	*3,173.25*	*1,090.15*	*4,499.77*	*1,855.97*	*1,744.27*	*1,086.68*	*1,332.99*	*4,599.24*	*4,094.35*	*33,262.85*
Sphyraena guachancho	*519.76*	*5.91*	*522.44*	*177.77*	*).68*	*235.19*	*251.63*	*2,963.88*	*1,897.47*	*1,035.78*	*284.61*	*311.39*	*8,836.53*
Sardinella aurita	*169.00*	*1,488.45*	*805.30*	*788.93*	*276.08*	*172.42*	*264.80*	*80.30*	*85.48*	*1,919.37*	*179.69*	*9.13*	*6,238.95*
Pseudotolithus typus	*322.31*	*505.53*	*344.59*	*320.11*	*361.48*	*435.42*	*247.72*	*797.00*	*438.85*	*419.30*	*427.80*	*300.05*	*4,920.17*
Ilisha africana	*213.69*	*383.04*	*256.19*	*186.19*	*114.57*	*91.42*	*36.29*	*116.32*	*352.90*	*1,946.51*	*125.40*	*81.68*	*3,904.18*
Osteichthyes	*325.40*	*312.38*	*168.10*	*192.86*	*209.37*	*195.11*	*234.50*	*258.36*	*526.04*	*176.35*	*121.96*	*176.14*	*2,896.57*
Lutjanus agennes	*497.72*	*67.04*	*126.59*	*222.45*	*207.52*	*216.52*	*196.48*	*317.89*	*307.27*	*64.91*	*247.56*	*317.99*	*2,789.93*
Chloroscombrus chrysurus	*809.85*	*489.99*	*408.08*	*119.75*	*7.01*	*2.64*	*11.71*	*85.47*	*55.25*	*16.43*	*12.50*	*5.88*	*2,024.55*
Euthynnus alletteratus	*153.43*	*134.73*	*525.81*	*70.15*	*74.11*	*87.02*	*4.03*	*377.02*	*154.10*	*231.97*	*63.34*	*92.49*	*1,968.21*
Alectis ciliaris	*102.73*	*109.66*	*852.65*	*42.75*	*94.46*	*146.69*	*81.17*	*103.73*	*51.74*	*104.50*	*71.04*	*52.55*	*1,813.67*
Galeoides decadactylus	*83.24*	*319.31*	*116.80*	*105.34*	*84.03*	*68.57*	*27.46*	*218.06*	*161.34*	*522.06*	*33.94*	*27.08*	*1,767.24*
Pseudotolithus senegalensis	*63.32*	*125.06*	*109.94*	*146.02*	*368.59*	*79.52*	*52.68*	*48.25*	*243.39*	*168.73*	*144.90*	*99.85*	*1,650.23*
Sphyraena barracuda	*161.54*	*86.53*	*103.65*	*70.83*	*28.88*	*102.29*	*20.69*	*69.50*	*210.51*	*583.73*	*107.31*	*74.82*	*1,620.27*
Pseudotolithus elongatus	*12.83*	*22.29*	*14.12*	*10.02*	*11.73*	*40.03*	*20.06*	*482.28*	*374.33*	*97.39*	*11.91*	*2.56*	*1,099.55*
Hemiramphus brasiliensis	*196.44*	*34.82*	*210.39*	*177.65*	*194.94*	*3.20*	*19.56*	*16.73*	*12.51*	*61.96*	*154.51*	*14.45*	*1,097.16*
Lutjanus fulgens	*69.77*	*5.94*	*8.60*	*26.73*	*130.02*	*327.41*	*136.99*	*76.15*	*139.98*	*20.36*	*25.53*	*18.40*	*985.88*
Exocoetidae	*12.17*	*247.61*	*19.55*	*8.97*	*14.42*	*44.49*	*0.03*	*0.10*	*1.44*	*82.36*	*346.21*	*109.82*	*887.19*
Caranx hippos	*89.73*	*17.17*	*163.13*	*15.87*	*39.62*	*111.31*	*14.21*	*66.64*	*106.22*	*15.20*	*19.53*	*170.22*	*828.85*
Lutjanus goreensis	*67.58*	*19.09*	*25.47*	*24.20*	*14.73*	*21.84*	*17.03*	*298.11*	*259.60*	*53.93*	*6.10*	*13.57*	*821.22*
Polydactylus quadrifilis	*19.92*	*78.42*	*64.03*	*60.69*	*275.71*	*42.61*	*28.81*	*30.11*	*77.17*	*27.86*	*36.67*	*71.56*	*813.56*

The most dominant species in the catch are small pelagic stocks like sardines (sardinella aurita and sardinella madenrensis), Lati (*Illisha africana*), Atlantic bumper (*Chloroscombrus chrysurus),* and the large pelagics such as Kuta (*Sphyraena guachancho), little tunny (Euthynnus alletteratus), African pompano or threadfin trevally (Alectis ciliaris),* The Brazilian halfbeak *(Hemiramphus brasiliensis).*

Limited field visit to artisanal fishing communities also confirmed Sardines, Lati and cassava fish as most common species landed in the communities visited.

3.0.3 Fish Stock Assemblages and Distribution

Available data indicate that the distribution of a number of species is limited by water temperatures, nature and type of bottom deposits (sand and silts) and the depths of the continental shelf. Some of the fish communities are recorded to be fairly homogenous in their distribution. However, there are other ecological fish assemblages that are heterogenous in their distribution. Migration of cohort species from the estuaries and creeks to the open shelf areas and vice versa also do occur in response to seasonal changes in salinities and temperatures.

The following fish communities are reported to be exploited by the various fishing units:

i. the coastal estuarine sciaenid community (on soft deposits
ii. the coastal sparid community (on sandy and harder substrates);
iii. the lutjanid community
iv. the deep-water sparid community
v. the eurybathic fish species
vi. the pelagic fish species
vii. the deep shelf and continental slope community and
viii. the continental Slope Community

3.0.3.1 Estuarine sciaenid community

The sciaenid community, which consists of various species of fish belonging to the family Sciaenidae, can often be found in estuarine environments. Estuaries are transitional zones where freshwater from rivers mixes with saltwater from the ocean, creating unique ecological conditions

The Sciaenids within estuaries show preferences for different types of substrates. Some species prefer sandy or muddy bottoms, while others may utilize seagrass beds, oyster reefs, or mangrove habitats. These substrate preferences are often influenced by factors such as feeding behavior, prey availability, and shelter requirements. Common species recorded in the catch of Liberian fishermen include

- West African Croaker (*Pseudotolithus senegalensis*), Cassava Croaker (*Pseudotolithus typus*), Black Croaker (*Pseudotolithus elongatus*), Blackspotted Croaker (*Protonibea diacanthus*), Atlantic Croaker (*Micropogonias undulatus*), Spotfin Croaker (*Roncador stearnsii*), Tiger Croaker (*Otolithes ruber*), Roundhead Croaker (*Pennahia anea*), Threadfin Drum (*Equetus acuminatus*), Black Drum (*Pogonias cromis*), Silver Croaker (*Plagioscion squamosissimus*)

Other Fish Communities of commercial importance in estuarine environment include:

- *Barracuda (Sphyraena spp.), Snapper (Lutjanus spp.), Flathead Sole (Hippoglossoides platessoides), Polydactylus quadrifilis, Pomadasys jubelini, Drepane africana, Arius spp., Cyno glossus spp., Ilisha africana, Ethmalosa fimbriata, Penaeus duorarum notialis, Parapenaeopsis atlantica, and Trichiurus lepturus*

3.0.3.2 Coastal sand and rocky bottom sparid community

The sand and rocky bottom habitats of coastal Liberian waters support a diverse sparid community including the following:

Common Dentex (*Dentex dentex*), Red Porgy (*Pagrus pagrus*), White Seabream (*Diplodus sargus*), Annular Seabream (*Diplodus annularis*), *Sparus caeruleostictus), Pagrus ehrenbergi, Pagellus belottii,*
Decapterus punctatus, Dentex spp., Epinephelus

3.0.3.3 The lutjanid community

Lutjanids, commonly known as snappers, are a diverse family of fish known for their economic and ecological significance. Common species recorded in Liberian waters include:

- Red Snapper (*Lutjanus campechanus*), Dogtooth Snapper (*Lutjanus jocu*), Mangrove Red Snapper (*Lutjanus argentimaculatus*), Lane Snapper (*Lutjanus synagris*), Mahogany Snapper (*Lutjanus mahogoni*), Vermilion Snapper (*Rhomboplites aurorubens*), Cubera Snapper (*Lutjanus cyanopterus*), Mutton Snapper (*Lutjanus analis*), Yellowtail Snapper (*Ocyurus chrysurus*), Blackfin Snapper (*Lutjanus buccanella*), Queen Snapper (*Etelis oculatus*), Silk Snapper (*Lutjanus vivanus*), Gray Snapper (*Lutjanus griseus*), Schoolmaster Snapper (*Lutjanus apodus*)

3.0.3.4 Deep-water sparid community

Data from deep water hauls carried out during the Spanish Research trawling Survey 'GUINEA -90', conducted in Sierra Leone, Liberia, Ivory Coast and Ghana, between 100 and 700 m depth recorded a total of 91 fish species caught between 100 and 700 m depth. The maximum species richness and the highest abundances were found between 300 and 2000 m (60 species), depth range corresponding to the breaking of the continental shelf and to the upper part of the slope[2].

The deep - water sparid (also known as sea breams or porgies) community which occurs on both sandy and muddy bottoms below the thermocline, down to the edge of the continental shelf were most dominant and include:

- Blackspot Seabream (*Pagellus bogaraveo*), Axillary Seabream (*Pagellus acarne*), Common Pandora (*Pagellus erythrinus*), *Dentex angolensis, Dentex polli, Priacanthus arenatus, Pagellus bellottii, Boops boops, Epinephelus aeneus, Arioma ledanoisi (particularly abundant in Liberia) and Balistes capriscus (Villegas and Garcia, 1983).*

3.0.3.5 Eurybathic fish species

Eurybathic fish species are those that can tolerate a wide range of depths, spanning from shallow coastal areas to deeper offshore waters. This eurybathic fish species group is harvested both by the artisanal fishermen and the industrial fleet. But there is no proper documentation on migration patterns of species constituting this fish group. Fish species with a large depth distribution range on the continental shelf of Liberia are:

- Atlantic Tarpon (*Megalops atlanticus*), Swordfish (*Xiphias gladius*), Tuna Species (*Thunnus spp*.), Billfish Species (*Marlin and Sailfish*), Barracuda (*Sphyraena spp*.), *Cynoglossus*, *Vomer setapinnis, Brachydeuterus auritus*, *Trichiuruslepturus*, *Raja spp*., *Penaeus notialis*,

3.0.3.6 Pelagic fish species

Liberian waters are home to a variety of pelagic fish species, which are characterized by their open-water habitat and active swimming behavior (Okera, 1976; Longhurst, 1983). These species are commonly found in the offshore and pelagic zones of the ocean. some examples of pelagic fish species that are known to occur in the region include:

[2] https://www.researchgate.net/publication/237618790_Composition_of_Demersal_Fish_Assemblages_in_Deep-waters_of_the_Western_Guinean_Gulf [accessed Jul 15 2023].

- **Tuna Species** (*Thunnus spp*.): Several species can be found in Liberian waters, including:
- Yellowfin Tuna (*Thunnus albacares*), Skipjack Tuna (*Katsuwonus pelamis*), and Bigeye Tuna (*Thunnus obesus*).
- Other pelagic species include Blue Marlin (*Makaira nigricans*), White Marlin (*Kajikia albida*), Sailfish (*Istiophorus platypterus*), and Swordfish (*Xiphias gladius*), Mahi-Mahi (*Coryphaena hippurus*), Wahoo (*Acanthocybium solandri*), Barracuda (*Sphyraena spp*.), *Caranx, Sphyraena, Cybium, Trichiurus, Sardinella, Ethmalosa, Chloroscombrus, Vomer, Ilisha africana*

3.0.3.7 Deep shelf and continental slope community

The deep shelf and continental slope communities are fish communities that inhabit the deeper offshore areas beyond the continental shelf. These communities are characterized by distinct ecological conditions and species adapted to deeper waters. Examples include:

- Grouper (*Epinephelus spp*.), Snapper (*Lutjanus spp*.), *Illex coindetii*, *Squalus fernandinus* and *Squatina oculata*

3.0.3.8 Continental Slope Community

The fish community found in the continental slope is diverse and consists of a wide range of species adapted to the unique conditions of this deep-sea environment. Common species assemblages include

- Deep-water Cardinalfish (*Epigonus spp*.), Lanternfish (*Myctophidae*), Grenadier Fish (*Macrouridae*), Slope Hatchetfish (*Argyropelecus spp*.), *Hypoclidonia bella, Chlorophtalmus atlanticus, Synagrops microlepsis, Merluccius polli, M. cadenati) and Paracubiceps multisquamis*

3.1 Fish landings, Fishing effort and fishing gears

Data shared by NaFAA and other information/data accessed online shows that there are over 130 commercially exploited species in the Liberian waters, suggesting significant fish species diversity and healthy fisheries. The total marine capture production by the 10 industrial fishing vessels licensed in 2018 shows that Snapper *(Dentex Spp),* Lion Fish *(Perulibatrachus elminensis),* Sole Fish *(Cynoglossus spp),* Stinger *(Dasytis margarita) and* Snapper (Loose) *(Pagrus spp)* were the top most abundant in the catch composition of the demersal industrial catch. These are all high value finfish species.

The tuna vessels on the other hand recorded a significant jump in catches of tuna and tuna like species, generally referred to as large pelagic species, from 2, 878.19 tons in 2016 to 10, 640.15 tons. in 2017. There were no reported catches for small pelagic species in the industrial fisheries, but these dominated in the artisanal fisheries landings with the Pike fish (*Sphyraena guachancho*, Forbor fish (*Coryphaenidae*), Whiteboy or shortneck cassava fish (*Pseudotolithus elongatus*), Butternose (*Galeoides decadactylus*), Barracuda (*Sphyraena barracuda)* Red Grouper (Lutjanus goreensis) and Blood fish (*Sarda sarda*) are the dominant species in the reported catches of the artisanal fishers in 2018. Overall, the total landings of the artisanal fisheries was 13,201 tons valued at US$37,478,082.28 is higher than the industrial fisheries catches and showing upward trends to a total of 23,735 metric tons in 2022 (Table 4)

Limited data shared by NaFAA shows trends from 2018 to 2022. I this dataset, Pike which dominated the catches in 2018 was 4th in 2019 and continued declining in subsequent years. In 2019 to 2022, flat bonny dominated the catches, but declining, until in 2022, Gbakpelleh became the dominant species in the catch.

Based on these fluctuations in catches, we can add Long neck cassava fish, Flat bonny, big butter nose and Gbakpelleh in the list of dominant species in the Catches and focus on these species for the assessment

3.1.1 Fishing effort and catch per unit of effort

Fishing effort refers to the amount of fishing activity exerted in a specific area or over a given period. It is typically measured in terms of fishing hours, fishing trips, fishing days or the number of fishing vessels. The analysis of fishing effort in Liberian fisheries involves collecting data on fishing vessel activity, including the number of active vessels, their fishing duration, and the areas they target.

Data shared by NaFAA on catches and catch per unit of effort for both the small-scale and industrial fishing fleet for the period 2010 to 2022. Catch per unit of effort (CPUE) is a metric commonly used in fisheries science and management to assess the status of fish stocks. CPUE represents the amount of fish caught per unit of fishing effort, such as the number of fish caught per hour of fishing or per unit of gear deployment. NaFAA's unit of effort in this shared dataset is number of vessel fishing days. The CPUE in this dataset provides valuable insights into the abundance, productivity, and sustainability of fish stocks.

The CPUE for the small-scale fishery had steadily increased from 14.84kg/day to 24.15kg/day (Fig 1). Similar trends were recorded for the industrial fleet (Fig 2), although the CPUE values for the industrial fleet were much more variable that those of the artisanal fishing fleet, with the lowest CPUE values recorded in 2015 and 2017 with values of 313.11 and 108.10 kg per fishing day respectively. An increase in CPUE values over time is suggesting that fish stocks are healthy and productive. A declining CPUE on the other hand may suggest a decrease in fish abundance, indicating potential overfishing or declining stock status.

The CPUE values can be used to estimate changes in stock biomass. By comparing CPUE values over different time periods or across different fishing grounds, it is possible to identify trends in stock size. A consistent decline in CPUE may indicate a reduction in stock biomass, signaling the need for management measures to prevent overexploitation.
The recorded CPUE values by NaFAA are also supportive of the reduction in fishing pressure by the industrial fleet from 2010 to date, as a result of the introduction of the 6 miles IEZ by the Liberian Government.

The recorded changes in the CPUE values could also be partly reflecting variations in fishing efficiency and selectivity. For instance, an increase in CPUE could indicate improved fishing gear, changes in fishing practices, or better targeting of high-density fish populations. Conversely, a decline in CPUE may imply reduced fishing efficiency or shifts in fish behavior or distribution.

Analysis of VMS data can identify areas of areas in the Liberian waters that are hotspots for industrial fishing operations, and this would help in providing an insight into fish stocks distribution in the coastal waters and EEZ.

3.1.2 Historical Fisheries production and Catch Composition

Historical catch data for Liberia for the Period 1960 to 2021 shows general increase in fish production in the country. Fish production peaked at 18, 734 metric tons in 1987 and dropped again to 6,463 metric tons in 1990. After 1990, there was a gradual increase in total fish production with several fluctuations in annual production from a low of 6,463 metric tons to the highest recorded total production level of 31,917 metric tons in 2020, and by 2021, total production dropped again to 25,444 metric tons per year. General fluctuations in production data can be accounted for by variations in fishing effort particularly number of fishing trawlers/fishing boats (see Fig. 1)

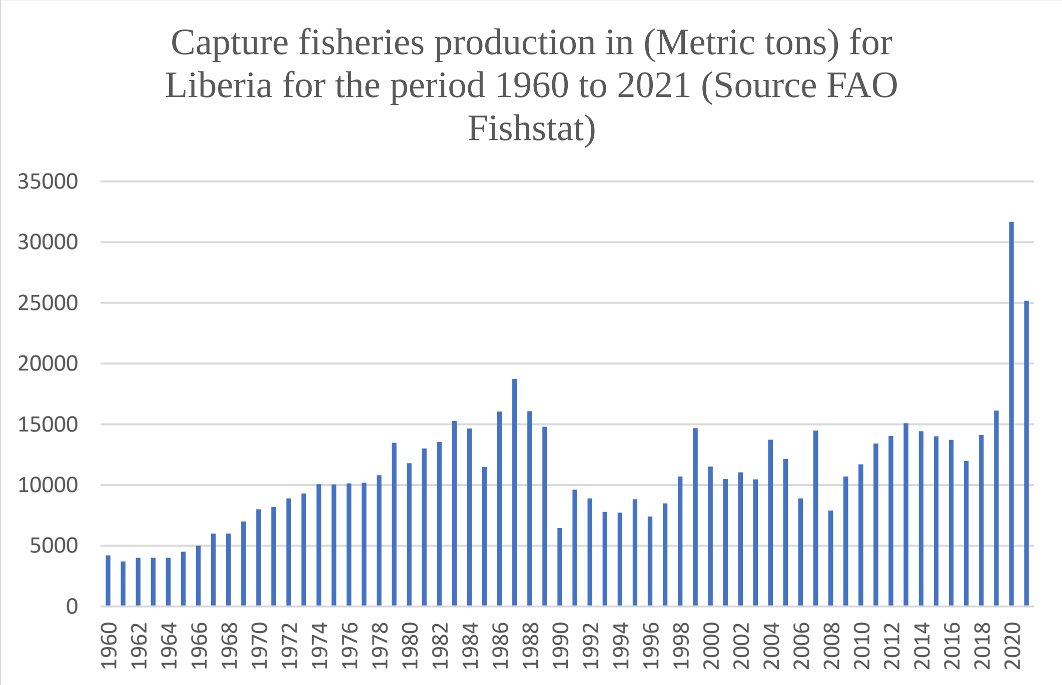

Figure 1: Trends in total fish Production for Liberia from 1960 to 2021

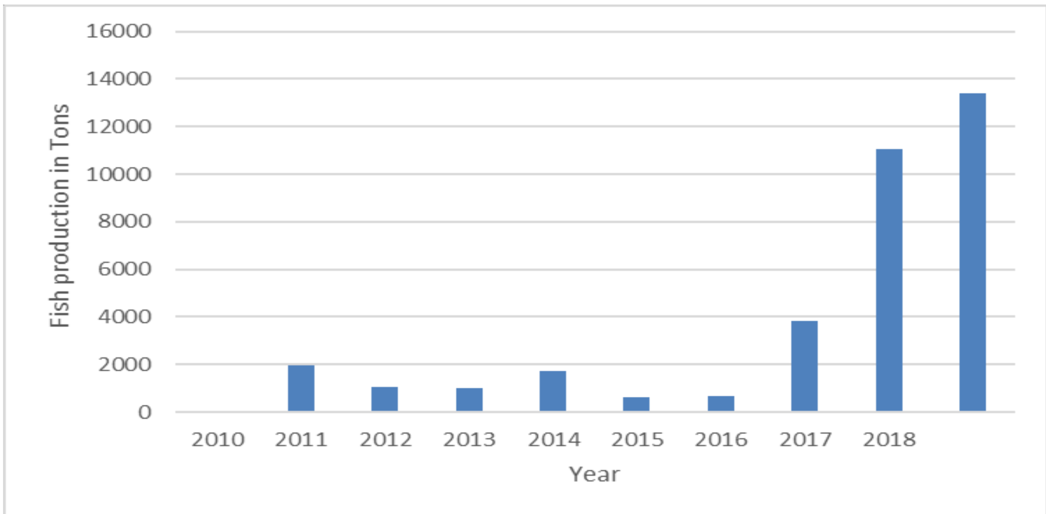

Figure 5. Marine Industrial fish production in tons from 2010-2018 (NaFAA, 2018)

Table 5: Total industrial catch (tonnes) per species for the period 2018 to 2022

#	Local Name of fish species	Year				
		2018	**2019**	**2020**	**2021**	**2022**
1	Gbakpelleh	-	*72*	*75*	*246*	*1,840*
2	Long neck Cassva Fish	*333*	*283*	*241*	*367*	*586*
3	Flat bonny	*37*	*3,755*	*1,245*	*816*	*531*
4	Pike Fish	*2,104*	*140*	*288*	*147*	*229*
5	Mixed fish	-	*130*	*126*	*284*	*151*
6	Barracuda	*505*	*40*	*40*	*31*	*143*
7	Mackerel	*1*	*10*	*36*	*28*	*118*
8	Big butternose	-	*249*	*28*	*26*	*109*
9	Pojoe/ Petepe/ Yewon	-	*0*	*6*	*2*	*104*
10	Sole Fish	*12*	*15*	*29*	*26*	*90*
	Other	*1,405*	*1,001*	*333*	*1,109*	*502*
	Total	*4,396*	*5,696*	*2,447*	*3,081*	*4,401*

Table 6: Tuna Production 2016-2022 and expected revenue based on legislation

YEAR	*PROD (KG)*	*VALUE(USD)*
2016	*2,878,190.00*	*7,063,475.00*
2017	*10,640,150.00*	*25,943,015.00*
2018	*10,259,815.00*	*25,646,777.50*
2019	*9,691,330.00*	*23,907,525.00*
2020	*15,218,780.00*	*37,543,181.72*
2021	*10,290,100.00*	*25,533,150.00*
2022	*17,724,780.00*	*43,975,179.18*

3.1.3 Number of fishing boats/fishing efforts

Total number of boats that fished “legally” in Liberian waters between 2004 and 2021 are provided in the Table 2, showing an upward trend in the number of fishing boats for the artisanal fisheries, but a general downward trend for the industrial fisheries with a minimum of 1 fishing vessel in 2014. From 2016 to 2022, over 40 tuna vessels were licensed every year to fish for tuna and tuna like species. MTBS team were told this is precautionary measures to cut down on fishing effort, as the fish stocks have not be assessed for over 40 years in Liberian waters. The general reduction in the number of industrial fishing trawlers, may have resulted in the recovery of the stocks and hence the increase in the landings of the artisanal fisheries operators.

The number of officially licensed industrial fishing trawlers may have been reducing in Liberian waters, but fishery authorities and coastal artisanal fishers believe there is significant level of illegal unreported and unregulated (IUU) fishing going on, with many reported unresolved cases of conflicts between artisanal and industrial fishers and some ridiculous fish catches reported by licensed fishing vessels. Analysis of some of the reported catches suggest that the fishing operations of these vessels are not profitable and therefore should not be able to continue fishing, except for the suggestion that the Chinese government is subsidising the fishing industry for them to continue to fish around the world. A regional study comparing vulnerability, prevalence and response to IUU fishing threats in West Africa recorded a relatively high IUU fishing index for Liberia and Sierra Leone (Table 4). The higher scores for Liberia and Sierra Leone indicate poorer performance and hotspot of possible IUU activity across the two zones of Liberia and Sierra Leone (Macfadyen *et al.*, 2019)

Table 7*: Numbers of registered/licensed fishing boats/canoes in the Liberian Fisheries for the period 2004 to 2021*

	ARTISANAL BOATS			***INDUST. VESSELS***		
Year	***Non-motorized boats (Kru)***	***Motorized Boats (Fanti)***	***Total Artisanal Boat***	***Trawlers***	***Indust. Tuna***	***Indust. Total***
2004	*331*	*168*	*499*	*60*		*60*
2005	*348*	*217*	*565*	*32*		*32*
2006	*612*	*278*	*890*	*32*		*32*
2007	*879*	*360*	*1239*	*32*		*32*
2008	*1238*	*471*	*1709*	*32*		*32*
2009	*1714*	*602*	*2316*	*16*		*16*
2010	*2459*	*737*	*3196*	*16*		*16*
2011	*2517*	*752*	*3269*	*7*		*7*
2012	*2515*	*760*	*3275*	*3*		*3*
2013	*2615*	*814*	*3429*	*4*		*4*
2014	*2748*	*827*	*3575*	*1*		*1*
2015	*3163*	*685*	*3848*	*7*		*7*
2016	*3163*	*685*	*3848*	*4*	*42*	*46*
2017	*3552*	*702*	*4254*	*10*	*42*	*52*
2018	*3615*	*740*	*4355*	*6*	*48*	*54*
2019	*3815*	*774*	*4589*	*6*	*52*	*58*
2020	*3815*	*774*	*4589*	*6*	*48*	*54*
2021	*3815*	*774*	*4589*	*6*	*51*	*57*

Table 8: IUU Fishing Index for coastal States near Liberia (Source: Macfadyen *et al.*, 2019).

Coastal State	**Vulnerability**	**Prevalence**	**Response**	**IUU Overall**
Ghana	2.33	2.86	1.71	1.95
Togo	3.22	1.00	2.45	2.08
Guinea	3.22	1.43	1.86	2.13
Senegal	3.17	3.8	100	2.31
Cote D'Ivoire	2.89	1.43	2.43	2.33
Guinea Bissau	3.56	1.43	2.43	2.45
Sierra Leone	4.00	3.2	1.00	2.53
Liberia	3.22	2.00	1.86	2.59
Africa (Average)	3.06	1.57	2.60	2.38
World (Average)	2.91	1.54	2.48	2.29

3.2 Gears used by the Artisanal Fisheries

Marine artisanal fisheries in Liberia takes place widely in the coastal seas, both within the IEZ which is from shore up to 6nm, and further out of the IEZ, up to 8nm. Most of the canoes are motorized and non-motorized. Motorized canoes with large crew, fishing further out and stay longer time at sea, so they used more advanced gears and huge quantity. Table 3 shows the gears that are mostly used by those fleets and in fishing efforts

3.3 Fish Stocks and Species Composition

The fish stocks and species composition in the fishery waters of Liberia are diverse and provide significant potential for fisheries development and economic growth. The coastal waters of Liberia are rich in marine resources and support a variety of fish species. The following provides an overview of the fish stocks and species composition commonly found in Liberian fishery waters:

3.3.1 Pelagic Fish Species

- Species such as tuna (including yellowfin, skipjack, and bigeye tuna), mackerel, and sardines are commonly found in the offshore waters of Liberia.

- These pelagic fish species are highly migratory and can exhibit seasonal variations in their abundance and distribution.

- Bonga shad (*Ethmalosa fimbriata*) is a small pelagic fish species found in both marine and estuarine environments along the Liberian coast. It is an important commercial fish species and is often used for local consumption and fishmeal production.

- Barracuda (Sphyraena spp.): Barracuda species can be found in the coastal waters of Liberia. They are predatory fish known for their elongated bodies and sharp teeth.

- Mackerel (Scomber spp.): Various mackerel species are present in Liberian waters, including Atlantic mackerel (Scomber scombrus). Mackerel are pelagic fish that form schools and are commercially important for their flesh.

3.3.2 Demersal Fish Species

- Demersal fish species are found in the nearshore and bottom-dwelling habitats. Common demersal species include various types of snappers, groupers, breams, croakers, and flatfish. These species are typically targeted by artisanal and small-scale fishermen using bottom-set gillnets, longlines, and handlines. Examples include:

- Cassava Fish (Hypselecara temporalis): Cassava fish, also known as eartheater cichlid, is a freshwater fish species found in various rivers and lakes. It is known for its ability to feed on detritus and algae, and it is popular among aquarists.

- Grouper species are often found in rocky reefs, coral areas, and submerged structures. They are known for their large size and are popular among recreational and commercial fishermen. The squaretail grouper (*Epinephelus polyphekadion*) is one example.

- Snapper species inhabit a range of coastal habitats, including reefs, mangroves, and rocky areas. They are sought after for their taste and are often targeted by subsistence, recreational and commercial fishermen. Examples are Red snapper (*Lutjanus campechanus*) and Mangrove snapper (*Lutjanus griseus)*.

- Sea breams are demersal fish that inhabit rocky bottoms and reef areas. They are known for their tasty flesh and are targeted by both recreational and commercial fishermen example include the pink dentex (*Dentex gibbosus*)

- Flatfish species, including flounders and sole, found in sandy or muddy areas along the seabed. They include the common sole (*Solea solea*) and the European flounder (*Platichthys flesus*).

- Lizardfish are demersal fish species commonly found near the bottom in coastal waters. They have elongated bodies and sharp teeth. Various species of lizardfish belonging to the family Synodontidae may be present in Liberian waters.

- Moray eels are a family of eels that often inhabit crevices and rocky areas in coastal and reef environments. They have long snake-like bodies and can be encountered in Liberian waters.

3.3.3 Shellfish and Crustaceans:

- Liberia's fishery waters are also rich in shellfish and crustaceans, including shrimps, lobsters, crabs, and oysters.

- Shrimp trawling and crabbing are important fishing activities in the country.

- Several species of shrimp (*Penaeus spp*.), including the white shrimp (*Penaeus setiferus*) and the brown shrimp (*Penaeus aztecus*) can be found in Liberian waters. Shrimp are commercially valuable and are often targeted by both artisanal and industrial fisheries.

- Lobsters (*Panulirus spp*.) are prized crustaceans found in Liberian waters. The spiny lobster (*Panulirus spp*.) is the most common species, known for its spiky exoskeleton and delicious meat. Lobsters are often harvested by local fishermen and exported for international markets.

- Several species of crabs can be found along the Liberian coast, including swimming crabs (*Portunus spp*.) and blue crabs (*Callinectes spp.*). These crabs inhabit estuaries, mangroves, and coastal areas and are valued for their meat.

- Oysters are bivalve mollusks that can be found in the mangrove areas and estuaries of Liberia. The Pacific oyster (*Crassostrea gigas*) is commonly cultivated for commercial purposes.

- Various species of clams can be found in Liberian waters. The hard clam (*Mercenaria spp*.) and the blood cockle (*Paphia spp.*) are examples of bivalve mollusks that are harvested for their meat.

- Mussels are also present in Liberian waters, particularly in rocky intertidal areas and nearshore habitats. The blue mussel (*Mytilus edulis*) is a common species known for its commercial value.

3.3.4 Inshore and Estuarine Fish Species

- Inshore and estuarine habitats, such as mangroves and lagoons, support a variety of fish species that are adapted to brackish and freshwater conditions.
- Species like tilapia, catfish, barracuda, and various species of mullet are commonly found in these habitats.

3.3.5 Freshwater fish species

- Tilapia (Oreochromis spp.): Tilapia is a group of freshwater fish species that are widely distributed in Liberia. They are popular for aquaculture and are often farmed in ponds and cages for food production.

- Catfish (Clarias spp.): Catfish species, particularly African catfish (Clarias gariepinus) and sharptooth catfish (Clarias gariepinus), are common in Liberian rivers and lakes. They are nocturnal bottom dwellers and are valued for their taste and commercial importance.

3.3.6 Endangered and Protected Species:

The fishery waters of Liberia are also home to certain endangered and protected species, including sea turtles and various species of sharks and rays. Conservation measures and regulations are in place to protect these species and ensure their long-term survival.

3.4 Fishing Methods, Gear in Usage and Fishing Effort

Fishing effort and gear usage in the fisheries of Liberia vary depending on the targeted fish species, fishing methods employed, and the scale of fishing operations. Below is an overview of the fishing effort and gear usage in the Liberian fisheries:

3.4.1 Artisanal and Small-Scale Fisheries:

- Artisanal and small-scale fishing operations are prevalent along the Liberian coast.
- Traditional fishing methods include handline fishing, beach seining, gillnetting, and trap fishing.
- Handlines are commonly used for targeting pelagic species and demersal species near the shore.
- Beach seining involves the use of a large net that is hauled onto the beach to catch schooling fish, such as sardines and mackerel.
- Gillnets, both bottom-set and drift nets, are used to target demersal species and are set in specific locations or allowed to drift with the current.

3.4.2 Industrial Fisheries:

- Liberia also has industrial fisheries that operate on a larger scale and employ mechanized fishing techniques.
- Industrial fishing vessels, including trawlers and purse seiners, are used for targeting pelagic species such as tuna and mackerel.
- Trawlers use large nets that are dragged along the seabed or through the water column to catch fish, and they can have a significant fishing capacity.
- Purse seiners use large nets to encircle schools of fish near the surface and then close the bottom of the net to capture the fish.

3.4.3 Shrimp Trawling

- Shrimp trawling is another significant fishing activity in Liberian waters.
- Shrimp trawlers use specialized nets designed to catch shrimp while minimizing bycatch.
- Shrimp trawling operations typically target areas with suitable bottom habitat for shrimp.

3.4.4 Fishing Effort:

- The fishing effort in Liberian fisheries is influenced by various factors, including the number of fishing vessels, fishing trips, and fishing hours.

- Artisanal and small-scale fisheries have a higher number of fishing vessels, often consisting of canoes or small boats operated by individual or small groups of fishermen.
- Industrial fisheries involve larger vessels with higher fishing capacity and can operate for extended periods, covering larger areas.

3.5 Fisheries Management and Regulations

Liberia has implemented fisheries management and regulations to ensure the sustainable utilization of fishery resources, protect marine ecosystems, and promote the socio-economic development of fishing communities.

3.5.1 Legal Framework

The Fisheries and Aquaculture Law is the primary legislation governing fisheries management in Liberia. This law provides the legal basis for the conservation, management, and development of fisheries resources. It establishes the responsibilities and powers of the National Fisheries and Aquaculture Authority (NaFAA), the government agency responsible for fisheries management and regulation.

3.5.2 Licensing and Vessel Registration

All fishing vessels, both artisanal and industrial, operating in Liberian waters are required to obtain licenses and register with NaFAA. Licensing ensures that fishing activities are carried out within the framework of regulations and allows for monitoring and control of fishing effort.

3.5.3 Fisheries Access Agreements

Liberian fisheries laws permit the country to enter into fisheries access agreements with foreign countries or fishing entities to allow foreign vessels to fish in its waters. These agreements are negotiated based on sustainable fishing practices and mutual benefits, including financial contributions and technology transfer.

3.5.4 Fishing Effort Management

NaFAA sets limits on fishing effort, including the number of vessels, fishing trips, and fishing hours, to prevent overfishing and ensure the sustainability of fish stocks. Effort control measures include the establishment of limited access zones, seasonal closures, or restrictions on fishing gear and techniques.

3.5.5 Minimum Size Limits and Gear Restrictions

Minimum size limits for targeted fish species are enforced to protect juveniles and allow them to reach reproductive maturity. Gear restrictions are in place to reduce bycatch and minimize the impact on non-target species and sensitive habitats. However, enforcement of some of the above measures are faced with some challenges

3.5.6 Closed Areas and Protected Areas

NaFAA designates closed areas and protected areas where fishing activities are prohibited or restricted. These areas serve as sanctuaries for vulnerable species, breeding grounds, and areas of ecological importance.

3.5.7 Data Collection and Fisheries Monitoring

NaFAA collects fisheries data through catch reporting, landing surveys, and onboard observer programs.
Data on fish catch, species composition, effort, and fishing operations are essential for stock assessments and informed decision-making.

3.5.8 Stakeholder Engagement and Community Participation in Fisheries Management

NaFAA promotes stakeholder engagement and collaboration with fishing communities, industry representatives, research institutions, and NGOs. Participatory approaches are encouraged to incorporate local knowledge, traditional practices, and community perspectives into fisheries management decisions.

3.5.9 Compliance and Enforcement:

NaFAA enforces fisheries regulations through inspections, patrols, and surveillance. Non-compliance with regulations may result in penalties, license suspensions, or other enforcement measures.

3.5.10 International Cooperation:

Liberia actively participates in regional and international fisheries management organizations and initiatives, such as the West Africa Regional Fisheries Program, to promote regional cooperation, share scientific information, and address transboundary fisheries issues.

3.6 Socio-economic Aspects

The fisheries sector in Liberia plays a significant role in the country's socio-economic development. The socio-economic benefits of the Liberian fisheries include:

1. **Employment and Livelihoods**: Fishing and related activities provide employment and livelihood opportunities for a considerable number of people in coastal communities. Artisanal and small-scale fishing support the livelihoods of many local fishermen and their families, serving as a crucial source of income and food security.

2. **Food Security**: Fish is a vital source of protein and essential nutrients for the population of Liberia. The fisheries sector contributes to food security by providing a source of affordable and accessible protein, particularly for communities living along the coast.

3. **Income Generation**: Fisheries activities generate income not only for fishermen but also for fish processors, traders, boat builders, net makers, and other individuals involved in the value chain. The sale of fish and related products contributes to the local economy and the overall income of fishing communities.

4. **Foreign Exchange Earnings**: Liberia exports a portion of its fish and seafood products, primarily to regional markets. The revenue generated from fish exports contributes to the country's foreign exchange earnings and supports economic growth.

5. **Tourism and Recreation**: Liberia's coastal areas, with their rich marine biodiversity, have the potential to attract tourists interested in fishing, diving, and other recreational activities. These

activities can contribute to tourism development, creating additional income and employment opportunities.

6. **Cultural Heritage and Traditional Practices**: Fishing in Liberia is deeply rooted in the cultural heritage of coastal communities. Traditional fishing practices, passed down through generations, not only provide sustenance but also preserve cultural identities and social cohesion within these communities.

7. **Environmental Conservation**: The sustainable management of Liberian fisheries contributes to the conservation of marine ecosystems and biodiversity. Healthy fish populations and well-managed fisheries ensure the long-term viability of the sector and the preservation of the marine environment for future generations.

4 Discussion

4.1 Fish Market assessment with focus on how the fish market structure, distribution networks, fish prices, demand and supply can support the expansion for Messurado fishing port

4.1.1 International, Regional, national and Local fish market structure

The fish market structure is complex with whole frozen fish supply sources comprising of imports from as far as Chillie, Argentina, Morocco, Mauritania, Senegal, and neighbouring Sierra Leone. Processed fish products like can sardines, mackerel, tuna were also reported to be available in the market and these were reported to be part of the imported fish products.

Fish supplies from local fish production comes mainly from the artisanal fisheries sector, whereby nearly 4000 fishing canoes, mostly non-motorised are deployed and the exploit over 130 species of fin- and shellfish species and mostly sold in the local market for local consumption.

4.1.2 Fish supply and demand situation

4.1.2.1 Supply Side:

1. Artisanal and Small-Scale Fisheries:
   - Artisanal and small-scale fishing operations contribute significantly to the fish supply in Liberia.
   - These fisheries involve a large number of small boats or canoes operated by individual fishermen or small fishing communities.
   - They target a range of fish species, including pelagic, demersal, and inshore species, using traditional fishing methods.
2. Industrial Fisheries:
   - Industrial fishing operations, both domestic and foreign-owned, also contribute to the fish supply in Liberia.
   - These operations involve larger vessels equipped with mechanized fishing gear, such as trawlers and purse seiners.
   - Industrial fisheries primarily target pelagic species, including tuna and mackerel, using efficient fishing techniques.
3. Aquaculture:
   - Aquaculture, although still at a relatively nascent stage, has the potential to contribute to the fish supply in Liberia.
   - Tilapia farming is the most common form of aquaculture practiced in the country, with some small-scale operations also focusing on catfish farming.

4. Imports:
    - Liberia also imports a significant portion of its fish and seafood products to meet domestic demand.
    - Imported fish products come from various countries and include both fresh and frozen products.

Demand Side:

1. Domestic Consumption:
    - Fish is an important part of the Liberian diet, and there is a substantial demand for fish and seafood products in the domestic market.
    - Fish is a primary source of animal protein for many Liberians, particularly those living in coastal areas and fishing communities.
2. Export Market:
    - Liberia exports a portion of its fish and seafood products to regional and international markets.
    - Exported products often include high-value species, such as tuna and shrimp, which cater to the demand in foreign markets.
3. Processing and Value-Added Products:
    - There is a growing demand for processed and value-added fish products in Liberia.
    - Processed products include fillets, smoked fish, canned fish, and fish-based snacks, which cater to consumer preferences for convenience and variety.
4. Tourism Sector:
    - Liberia's tourism industry creates additional demand for fish and seafood products, particularly in coastal resort areas.
    - Fresh seafood is often in high demand among tourists visiting beachside restaurants and hotels.

Challenges and Opportunities:

- The Liberian fish market faces several challenges, including limited infrastructure for storage, processing, and distribution, which can impact the availability and quality of fish products.
- Illegal, unreported, and unregulated (IUU) fishing practices can also affect the sustainability of fish stocks and undermine the market.
- However, there are opportunities to improve the fish market in Liberia by investing in infrastructure development, promoting sustainable fishing practices, enhancing value-addition activities, and improving market linkages between producers and consumers.

Fish consumption, import and export data

Per capita fish consumption for Liberia from 2005 to 2007 fluctuated from 7.3 kg in 2015 to 12.62kg in 2016, dropped slightly to 11.07 kg in 2017 and further drop to 9.29 in 2018. The per capita fish consumption is seen to correlate well with fish importation, suggesting that local production is not able to meet with local fish demand.

Table 9: Estimated fish import, export, local production and per capita consumption for the period 2015 to 2022

Year	Import (Kg)	Export (Kg)	Capture Fisheries Prod. (Kg)	Aquaculture Prod. (Kg)	Population	Per capita fish consumption
2015	25,940,340	0	6,863,500	40000	4,499,621	7.30
2016	51,267,740	55,200	6,957,430	40000	4,613,823	12.62
2017	44,300,000	43500	8,093,000	40000	4,731,906	11.07
2018	28,814,670	187500	16,415,322	40000	4,853,516	9.29
2019	33,701,760	*324,830*	*24,054.20*	40000		
2020	30,215,750	6,000	*23,453.13*	40000		
2021	14,468,640		*25,343.62*	40000		
2022	13,552,120		*28,868.65*	40000		

.

Table 8: Estimated per capita fish consumption per year from 2015 to 2018

Year	Import (Kg)	Export (Kg)	Capture Fisheries Prod. (Kg)	Aquaculture Prod. (Kg)	Population	Per capita fish consumption
2015	25,940,340	0	6,863,500	40000	4,499,621	7.30
2016	51,267,740	55200	6,957,430	40000	4,613,823	12.62
2017	44,300,000	43500	8,093,000	40000	4,731,906	11.07
2018	28,814,670	187500	16,415,322	40000	4,853,516	9.29

4.1.3 Regulatory Framework for seafood Trade

- **National Fisheries and Aquaculture Authority (NaFAA)** is the primary regulatory body responsible for the management and development of fisheries and aquaculture in Liberia. It oversees the implementation of fisheries laws and regulations, issues licenses, and monitors compliance.
- NaFAA Regulations provide a legal framework for the management, conservation, and sustainable utilization of fisheries resources. They outline requirements for fishing licenses, registration of vessels, fishing gear regulations, closed fishing seasons, and catch limits, among other aspects related to fishing operations.

- **The Ministry of Commerce and Industry** (MOCI), has an unaccredited National Standards Laboratory (NSL) that provides facility and fee-based services such as product testing, measuring, and calibrating for safety and quality standards.
- The lab, established under the West Africa Quality Program, is part of Liberia’s efforts to remain World Trade Organization (WTO) compliant.
- It provides technical services to food producing industries in Liberia to enhance the production of safe food, and trains inspectors of various government regulatory bodies.
- Its mandates include establishing a reliable standards framework to facilitate trade and to enforce the criteria of the International Organization for Standardization (IOS).
- The NSL helps to improve Liberia’s sanitary and phytosanitary (SPS) systems – regulating food safety, animal, and plant health – to ensure quality control for food and basic commodities.
- It is also part of a regional program to strengthen quality assurance systems to support competitiveness and harmonization of technical barriers to trade (TBT) and SPS measures in West Africa.
- The facility also nominally helps the government monitor and prevent counterfeit and substandard goods from entering the Liberian market.
- Liberia’s membership in ECOWAS, means the country is subject to ECOWAS biosecurity and SPS requirements.
- The lab conducts microbiological and chemical analyses of food and non-food products, and metrological services such as calibration and verification of length, mass, temperature, and volume.

4.1.4 Standards Testing, Inspection and Certification

- Liberia accepts standards developed by U.S.-domicile standards developing organizations and generally tend to favor the standards of the United States.

- Liberia has no mutual recognition agreements with U.S. organizations on product certification, but the government accepts product standards and certification developed by the United States and other international standard organizations.

- Various agencies handle certifications in Liberia, depending on the product, sector, and industry.

- Bureau Veritas Liberia (BIVAC) handles customs inspections. It conducts pre-shipment inspection services including verification of quality and quantity for exports. It also performs destination inspections to verify imports including customs classification and value based on documents importers provide.

  - Several agencies handle accreditations depending on the areas of concern:

  - For instance, the Ministry of Health and the Liberia Medicines & Health Products Regulatory Authority (LMHRA) handle health system and product accreditation.

  - The Ministry of Commerce and Industry handles accreditations of most consumer products including seafoods.

- **The Liberia Revenue Authority (LRA**) oversees the import and export of fish and seafood products. Importers and exporters are required to comply with customs procedures, provide relevant documentation, and adhere to health and sanitary regulations. Specific permits and certifications may be required for certain products, such as the importation of endangered or protected species.
  - Liberia is a member of regional fisheries management organizations, such as the Fisheries Committee for the West Central Gulf of Guinea (FCWC) and the Sub-Regional Fisheries Commission (SRFC). These organisations collaborate on fisheries management, conservation, and regional cooperation initiatives. Liberia also adheres to international agreements and standards, such as those set by the Food and Agriculture Organization (FAO) and the World Trade Organization (WTO).

- In 2021, Liberia imported $4.21M in Processed Fish, becoming the 146th largest importer of Processed Fish in the world[3]. At the same year, Processed Fish was the 99th most imported product in Liberia. Liberia imports Processed Fish primarily from Morocco ($3.04M), Indonesia ($566k), United Arab Emirates ($290k), Thailand ($117k), and Lebanon ($85k).
- The fastest growing import markets in Processed Fish for Liberia between 2020 and 2021 were Indonesia ($389k), United Arab Emirates ($276k), and Morocco($147k).

4.1.5 Import duty

- Liberia's Revenue Code provides the legal and regulatory basis for customs duties and standards.
- Imports are subject to tariff duties that vary according to product type, category, and volume and constitute a major source of government income. Import duties are specific (based on volume) for some commodities, and ad valorem (based on cost, insurance, and freight value) for others. .
- GST is imposed at the manufacturing stage on several goods and services specifically listed in the Liberia Revenue Code. It is levied at the rates of 7 percent (for goods) and 10 percent (for services), except for communication services which are set at 15 percent.
- The National Port Authority (NPA) implements the Cargo Tracking Note/Advanced Cargo Declaration (CTN/ACD) system for shipments to any destination port, including transit through Liberia.
- This system is mandatory. Shipments without a valid CTN number will not be loaded or discharged. Therefore, shippers, exporters, and forwarders at various ports of loading around the world are required to obtain a validated Cargo Tracking Number (CTN) using the online platform and to submit the required shipping documents. Failure to obtain the CTN could result in additional fines in accordance with the NPA regulation, plus additional costs.
- The NPA also requires inspection through the exclusive pre-shipment provider Bureau Veritas or BIVAC, with such services costing 1.5 percent of the shipment's value.
- Pre-shipment inspections are required for goods valued at US$3,500 and above.
- The penalty for importers who fail to complete the BIVAC pre-shipment inspection ranges from 10 percent to 30 percent of the shipment's value.

[3] https://oec.world/en/profile/bilateral-product/processed-fish/reporter/lbr?flowCompetitor=buttonImports&yearGrowth2=exportYear4&yearGrowth=exportYear2

- After clearing customs, importers present cost information to MOCI for price approval. Note: In July 2021, the government switched from pre-shipment to destination inspections and proposed to use a new contractor named Medtech to carry out the inspections. Medtech was planning to use BIVAC as a sub-contractor who would continue to conduct the actual inspections. However, this arrangement was suspended due to strong public pushback over the lack of transparency and the higher fees. This suspension is still in effect.
- BIVAC lists the following products as items exempt from import (customs) duties:
  - Goods with a value below the threshold of US$1,000 free on board (FOB).
  - A reasonable number of personal effects and household items.
  - Supplies for diplomatic missions and United Nations organizations.
  - Gold, precious stones, objects of art.
  - Explosives, pyrotechnic products, arms, ammunition, weapons and implements of war imported by the Liberian Armed Forces and other security or law enforcement entities.
  - Fresh fish caught by local Liberian fishermen.
  - Goods imported by parcel post not exceeding US$1,000.

4.1.6 Local fish markets and fish prices

- The prices of fish in Liberia range from US$1.04/kg for *Sardinella Spp*. (Bonny) to US$3.97/kg of snapper fish and more for Barakuda fish. Supprisingly, fish was recorded to be more expensive than pork and chicken in Liberia. Fish importers justified the relatively high prices of fish as due to taxes paid at the port for on importation of fish and other frozen foods. The local fishermen blame the prices of fuel and other fishing inputs for the high cost of fish in the market.

4.1.7 Current status of the Liberian Artisanal Fisheries

The artisanal fishery operations in the Monrovia region is conducted by local communities and Ghanian settlers (Fantis) using traditional or low-technology fishing methods. The fishers typically operate smaller vessels, such as canoes or small boats, and employ simple gear like handlines, traps, or gillnets.

The fishers in the artisanal sector target a variety of fish species based on local preferences and availability. Common target species include various types of coastal fish, such as snappers, groupers, bonga (Ethmalosa fimbriata), or herrings.

The artisanal catch from the Monrovia region serves both local consumption and small-scale commercial purposes. It is sold in local markets or directly to local communities, contributing to the food security and livelihoods of coastal communities.

4.1.8 Future Needs:

- There is an increasing emphasis on promoting sustainable fishing practices in artisanal fisheries. Future needs may include initiatives to raise awareness about sustainable fishing techniques, reducing bycatch, and minimizing the impact on vulnerable species and habitats.

- Other needs may include enhancing fishery infrastructure, such as improving landing sites, storage facilities, and processing facilities to support the artisanal fishery's growth and improve the quality and value of the catch.

- Ensuring equitable access to fishing resources, such as fishing grounds and gear, can be important for sustaining artisanal fishing communities. Future needs may include policies and measures to address potential conflicts over resource access and promote fair distribution of fishing opportunities.

- Providing training and capacity-building programs to artisanal fishers can enhance their skills and knowledge in areas such as fishing techniques, post-harvest handling, value addition, and business management. These initiatives can contribute to improved livelihoods and the sustainable development of the artisanal fishery.

- Supporting market linkages and improving market access for artisanal fishers can create economic opportunities and increase the value of their catch. Future needs may include initiatives to strengthen market channels, improve product quality, and promote value-added products.

- Artisanal fishers in all 3 landing sites visited indicated that the river mouths in their landing sites need dredging to make them deep enough for their boats to pass through to safe anchorage. They also all requested for marine store, where they can buy their fishing inputs. Some of them complained that fishing inputs like nets, ropes, floats and leads (sinkers) are by far cheaper in Guinea and Ghana compared to Liberia, so they would want government to set up a store where these supplies are sold at reasonable price

- They also all wanted gas stations in their communities where they can buy fuel for their boats
- They wanted cold stores and Ice making machines (flake ice) in their communities. They however admitted that they do not have the technical knowhow to operate and service these equipment, so better to get private investors to provide these facilities in the various locations (landing sites) at the disposal of the fishermen, who will in turn pay for the services and goods.

- They also all complained that their boats cannot go far in the rainy season, so their catches are low in the rainy season. They boats currently used are small and unsafe to use in rough seas. Project Coordinator has indicated that NaFAA has plans to introduce fiberglass boats for use by artisanal fishers. These are considered to be safer and more fuel efficient. These boats can also be built with provisions for ice boxes, so fish caught can be preserved at sea in ice and brough to port in good condition
- With ice at sea, the fishermen can spend longer time at sea until they have appreciable catch before returning to port, whereas if they don't have ice, the can only make daily trips, as they have to rush home with the fish caught, so it will not spoil.

- All fishermen and women reported that in the dry season, they can sometimes catch so much fish that they needed to dig and burry some of the fish as they would not get buyers and even when they give the fish on loan to the women, the women will always come back from the market with stories of not being able to sell the fish.

- The smoking oven seen in most of the areas visited are traditional ovens (see photo). FAO Improved smoke oven and water sanitation and hygiene facility and community centre were recorded in Marchal fishing village

- Fish supply in the dry season is reported to be higher than the demand within the communities, but in the rainy season, the demand is higher than the supply, so women transport their fish to markets in Monrovia using taxis, motor bikes or tricycles (Kekes)

4.1.9 Vessels Characteristics

The characteristics of fishing vessels in Liberia can vary depending on the scale of fishing operations, the fishing method, and the targeted species. The general characteristics of fishing vessels are:

1. **Artisanal and Small-Scale Fishing**: The majority of fishing vessels in Liberia are small Kru canoe, carved from trees. These boats are typically small operated by one or two fishermen and are used for inshore or nearshore fishing activities. They are often equipped with basic fishing gear, such as handlines, gillnets, and traps and make day trips lasting for at most six hours within the 6 NM IEZ. These traditional wooden canoes have been used for fishing for generations. These

canoes are often powered by paddles, poles or sails. There are over 3000 of these kinds of boat in the Liberian fisheries.

2. **Medium-Sized Vessels**: Some medium-sized fishing vessels can be found in Liberia, primarily used by small-scale commercial fishers. These vessels are larger than traditional kru canoes, often made larger by extending the wooden canoes with additional wooden planks. They are powered by outboard engines, ranging from 15 to 40 HP depending on the size of the boat, and may have slightly more advanced equipment and technology for fishing. There are less than 1000 of these boats in the fisheries

3. **Longliners**: In the offshore waters of Liberia, there may be some longline fishing vessels. Longliners use long lines with multiple hooks to target species like tuna and swordfish. There are both artisanal and industrial scale long liners. Industrial Long Liners are Mostly Tuna vessels and the artisanal long liners are mostly kru canoes, targeting inshore shallow demersal species

4. **Industrial Vessels**: Liberia's fishing industry also includes some larger industrial fishing vessels that target pelagic species like tuna. These vessels are typically equipped with advanced fishing gear and processing facilities on board.

5. **Landing Craft**: For transporting fish from fishing grounds to shore, landing craft or fish carriers may be used. These vessels are designed to carry large quantities of fish to shore for processing and distribution.

6. **Fish Aggregating Devices (FADs)**: These are mostly used by tuna purse seiners to attract fish. FADs are floating structures that provide shelter and food for fish, making it easier for fishermen to catch them.

The Fanti and Kru operating in the artisanal fishery use motorized and non-motorized canoes. All the motorized canoes are operate by Fanti, the non-motorized canoes are mostly used by the Kru. There were six industrial trawlers that are owned and operated by a Chinese businessman, who also own a cold room

4.1.10 Fishing Gears used

Different types of fishing gears used in the Liberian fisheries are based on the target species, fishing method, and fishing location. Common fishing gear used in Liberia's coastal and offshore fisheries include:

- **Bottom Trawls**, used to catch demersal species living near or on the seafloor. Trawling involves dragging a net along the seabed to capture fish and other bottom-dwelling organisms like shrimps, lobsters and snails.
- **Longlines,** consisting of a mainline with baited hooks attached at intervals. Longlines are used to catch pelagic and demersal species such as tuna, swordfish, snappers groupers, etc.
- **Handlines**, which are simple fishing lines with hooks that are operated manually. Handlines are commonly used by the Kru fishermen in the artisanal and small-scale fishing, targeting various species near the surface or bottom.
- **Gillnets**, consisting of vertical panels of netting that are set in the water column to entangle fish by their gills. Gillnets are used to target a range of species, including pelagic and demersal fish.
- **Fish Traps and Pots**, used to capture fish by attracting them into the trap or pot through bait. These gears are often used for specific target species such as lobsters, crabs, or reef fish.

The Fanti and Kru were recorded to use different fishing gears. The Fanti employ nets, either set nets, ring nets, gillnets or bottom set gillnets, while the Kru employ mostly hook and line or long line.

Table 10: The contributions of gears types to the total fishing effort (source: Jueseah et al. 2021)

Fishing Gear Type	Contribution to the fishing effort
Set Net	47%
Ring Net	27%
Gillnets	18%
Bottom Gillnets	8%
Hook &Line	0%
Longline	0%
Trap Line	0%

4.1.11 Fishing Ground

The fishing grounds were categorized as either inshore or deep sea, where inshore is defined as all fishing grounds within the 6 nm inshore exclusive zone (IEZ), while the deep sea refers to all fishing grounds further out. As shown in Figure 4 , the Fanti canoes all fish in the IEZ and deep sea beyond the IEZ, while the Kru fish within the (IEZ).

Table 11: Distance travelled by Canoes (Source: Dumbar, 2017)

	Kru		Fanti			
Sea Distance	Frequency	Percent	Frequency	Percent	Overall Freq	Overall Percentage
0 -3NM	30	37%	23	10%	53	17.5%
4 -6 NM	43	37%	77	53%	120	39.60%
7 – 8 NM	8	10%	104	47%	112	37%
Above 8 NM	0	0%	18	8%	18	5.90%
Total	81	100%	222	100%	303	100%

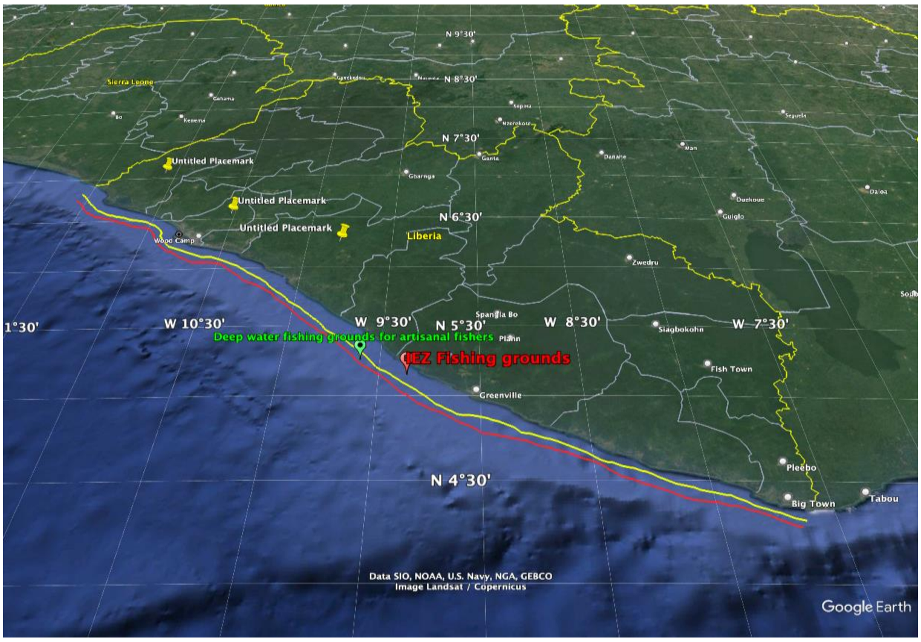

Figure 2: Fishing grounds accessed by artisanal fisheries operators (the Fanti fish in both inshore and deep water fishing grounds, whereas the Kru fish in the IEZ)

4.1.12 Current Licenses regimes and fisheries revenue streams for NaFAA

Fieldwork inwquiries recorded that Kru Canoes are required by law to pay US$50/year as license fees, motorised boats using 1 to 15 HP outboard engine are required to pay US$250/year and others using 16 to 40 HP outboard engines pay US$475/year as license fees to NaFAA. However, the Fanti fishermen disclosed that they had requested NaFAA to reduce the license fees for the following categories of fishing vessels to half its current price, i.e. boats propelled by 1 to 15HP outboard engines to pay US$125/year instead of US$250/year and the 16 to 40HP to pay US$250/year instead of US$475/year. Based on this request, the expected revenue from the artisanal fishers from licensing fishing boats is US$273,650.

Industrial fishing boats on the other are required to pay 10% of the equivalence of the total value of fish they catch for the year, and that NaFAA alocates fish quotas to fishing unit operators in the Industrial fisheries sector. Tables 4 and 5 provides an insight into estimated revenue streams to government from harvest volumes and value of fish.

The agent for the six fishing trawlers currently licensed to fish in Liberian waters reported that in addition to registration fees, license fees, each month, they pay US$251.50 for use of the jetty which is owned by a private company. Assuming NaFAA will charge same rate for use of the proposed fishing port, and that all fishing vessels are required to land their catch in the port before local distribution, processing and export, one vessel would be paying an additional US$3018/year.

If these fees are paid according to ther legal priscriptions, NaFAA would have made on average US$2,889,119.61 per year from license fees from the Industrial fishing operations. The tuna vessels whould have paid on average an additional US$2,734,652.56/annum in License fees to NaFAA for the reported period.

Table 12: Total industrial fisheries production and expected revenue, based on legislated license fees schedule

Year	**Volumr (tons)**	**Actual Cost(USD)**	Expected 10% fees from operators
2015	25,940.34	24,643,318.25	2, 464,331.83
2016	51,267.74	48,704,355.85	4, 870, 435.59
2017	44,300.00	42,085,000.00	4, 208, 500
2018	29,847.93	28,355,537.30	2, 835, 553.73
2019	33,701.76	32,016,668.96	3, 201, 666.9
2020	30,215.75	28,704,962.50	2, 870, 496.25
2021	14,468.64	13,745,210.19	1, 374, 521.02
2022	13,552.12	12,874,515.43	1, 287, 451.54

Table 13: Tuna Production 2016-2022 and expected revenue based on legislation

YEAR	*PROD (KG)*	*VALUE(USD)*	Expected 10% license fees from the Tuna vessels operators
2016	*2,878,190.00*	*7,063,475.00*	706,347.5
2017	*10,640,150.00*	*25,943,015.00*	2,594,301.5
2018	*10,259,815.00*	*25,646,777.50*	2,564,677.75
2019	*9,691,330.00*	*23,907,525.00*	2,390,752.5

2020	*15,218,780.00*	*37,543,181.72*	3,754,318.17
2021	*10,290,100.00*	*25,533,150.00*	2,553, 31
2022	*17,724,780.00*	*43,975,179.18*	4,397,517.92

Table 14: Numbers of Registered/Licensed Fishing Boats/Canoes in the Liberian Fisheries for the period 2004 to 2021 and expected revenue

Year	No of non-motorised boats	Expected revenue from non-motorised boats (US$)	No of Motorised boats	Expected revenue from Motorised boats (US$)	Total annual Revenue from Artisanal boat license (US$)
2004	331	16550	168	8400	**24950**
2005	348	17400	217	10850	**28250**
2006	612	30600	278	13900	**44500**
2007	879	43950	360	18000	**61950**
2008	1238	61900	471	23550	**85450**
2009	1714	85700	602	30100	**115800**
2010	2459	122950	737	36850	**159800**
2011	2517	125850	752	37600	**163450**
2012	2515	125750	760	38000	**163750**
2013	2615	130750	814	40700	**171450**
2014	2748	137400	827	41350	**178750**
2015	3163	158150	685	34250	**192400**
2016	3163	158150	685	34250	**192400**
2017	3552	177600	702	35100	**212700**
2018	3615	180750	740	37000	**217750**
2019	3815	190750	774	38700	**229450**
2020	3815	190750	774	38700	**229450**
2021	3815	190750	774	38700	**229450**
Total		**2145700**		**556000**	**2701700**

4.2 Maximum sustainable yields of the fisheries

Catch and effort data for the artisanal and industrial fleet used to compute the MSY using the Schaefer Surplus production model estimated the maximum sustainable yield for all the shallow water pelagic and demersal stocks at 14,870 tons and an FMSY value of 86,136 tonnes. Estimates for the deep water pelagic and demersal stocks targeted by the industrial fleet are MSY = 4, 820 tons and FMSY = 31, 848 tonnes

It is noted that despite the increase in the number of fishing boats from 3, 196 in 2010 to 4, 589 boats in 2021 (implying an increase in fishing effort), the catch per unit of effort of the small-scale fishers had generally increased, suggesting that whilst some species are already showing some signs of growth and recruitment overfishing and other are fully exploited, there are still a few species that are still healthy, but the data. It has been difficult to estimate the MSY at species level and for specific standard fishing boats and fishing gears, as the efficiency of each fishing gear differ (ie the catchability of each fishing gears is different). Available data provided a single figure for the whole year for the shallow water fish stocks (small scale fisheries) and another annual figure for the industrial fisheries (large scale) considered as deep-water fish stocks, as the law provides that the industrial fleet are to fish at 3 or 6 NM offshore.

Table 15: Trends in the numbers and composition of artisanal fishing fleet in Liberia for the period 2010 to 2021

Year	No of unmotorised boats	No of motorised boats	Total no of artisanal boats
2010	2459	737	3196
2011	2517	752	3269
2012	2515	760	3275
2013	2615	814	3429
2014	2748	827	3575
2015	3163	685	3848
2016	3163	685	3848
2017	3552	702	4254
2018	3615	740	4355
2019	3815	774	4589
2020	3815	774	4589
2021	3815	774	4589

Table 16: Total fish landings for the artisanal and industrial fishing fleet in Liberia

Yr.	*Small Scale (Artisanal)*	*SmallScale (CPUE)KG*	*Large Scale (Industrial)*	*Large Scale (CPUE)KG*
2010	*10,153.00*	*14.84*	*1,959.94*	*390.12*
2011	*10,869.00*	*15.54*	*1,050.28*	*477.83*
2012	*10,824.00*	*15.44*	*1,021.81*	*1,084.72*
2013	*13,149.00*	*17.92*	*1,737.55*	*1,383.40*
2014	*12,744.00*	*16.66*	*609.36*	*1,940.64*
2015	*13,727.00*	*16.67*	*688.22*	*313.11*
2016	*13,914.90*	*16.90*	*972.00*	*773.89*
2017	*13,160.43*	*14.46*	*339.42*	*108.10*
2018	*10,780.60*	*14.17*	*3,232.95*	*1,716.00*
2019	*18,237.95*	*18.56*	*5,816.25*	*2,385.88*
2020	*18,340.42*	*18.68*	*5,038.61*	*2,713.75*
2021	*21,051.53*	*21.39*	*4,442.94*	*2,278.18*
2022	*23,734.72*	*24.15*	*4,904.61*	*2,725.02*

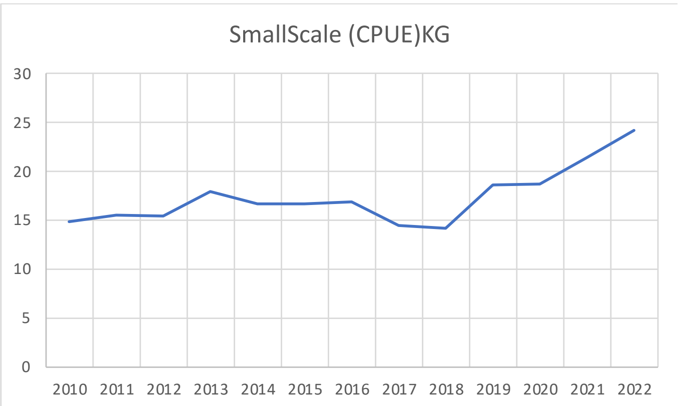

Figure 3: Trends in the Catch (kg) per unit of fishing effort (boat days) by the artisanal fishing fleet for the period 2010 to 2022

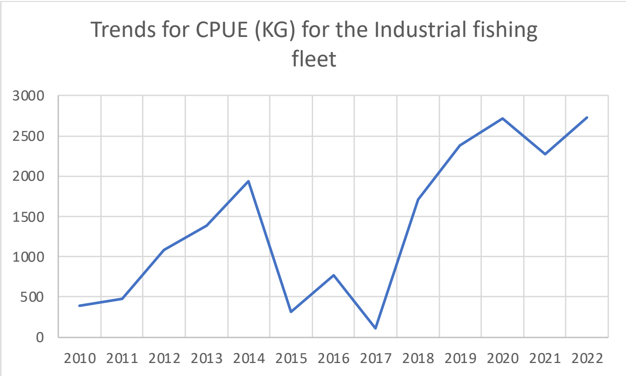

Figure 4: Trends in the Catch (kg) per unit of fishing effort (boat days) for the industrial fishing fleet for the period 2010 to 2022

4.3 Catch composition and Length frequency distribution

The composition of fish species in the catch reported for the period 2010 to 2021 and the length frequency distribution of the 20 most abundant species in the catch reported for 2020 to 2022 were analysed. From this analysis, it is noted that the small pelagic assemblages dominated the catch between 2010 and 2016. From 2017 to 2019, the large pelagics were more dominant in the catches. 2020 and 2021 saw a dominance of the small pelagics again and this trend have continued to date particularly with the artisanal fisheries landing mostly flat and round Bonny (*S. maderensis and S. aurita*) and Gbakpelleh (*illisha Africana*) (Fig 5)

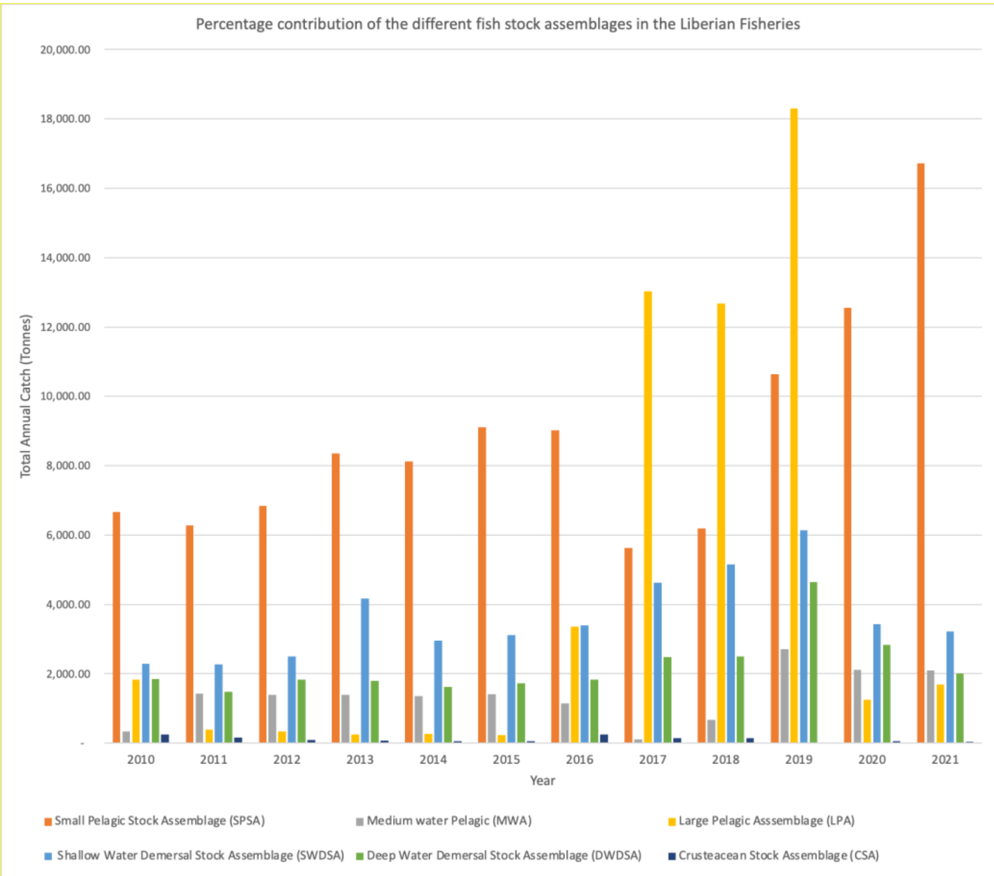

Figure 5: Trends in the catch composition of the different fish stock assemblages for the period 2010 to 2021

The large pelagics had steadily increased in the total catch from 2010 to 2019, with a slight drop in 2014 and 2015 and in 2020 and 2021. Many of the small pelagics that dominate the catch are not high value species, but are reported to be very popular in the local markets in Liberia, because of the price.

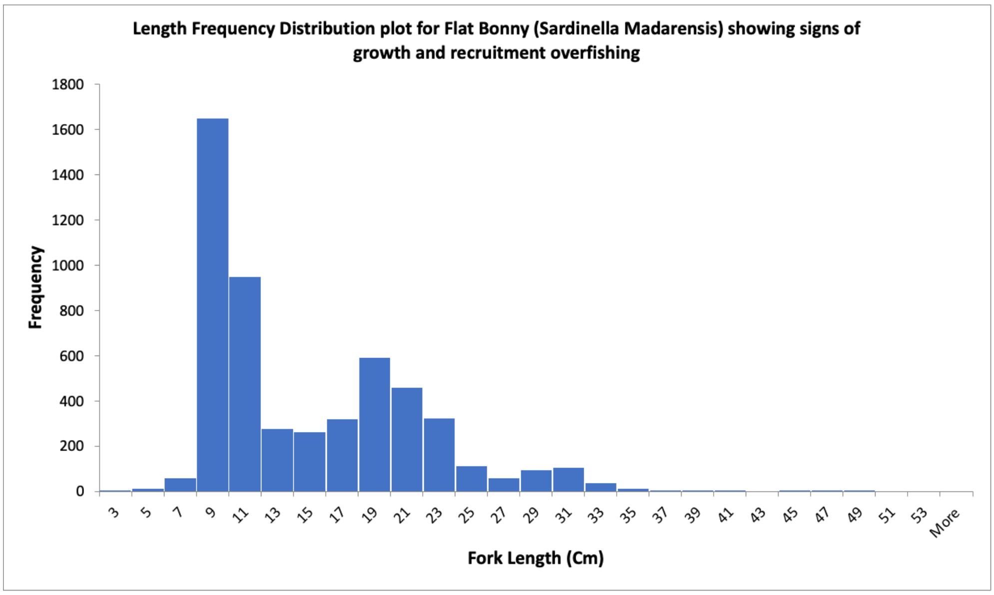

Figure 6: Length frequency distribution for flat Bonny (*S. maderesis*)

The length at first capture (Lc50 = 9 cm) was lower than the length at first maturity (Lm50 = 29.75 cm) estimated by Wehye et al (2017), an indication that most of the harvested stock were juveniles.

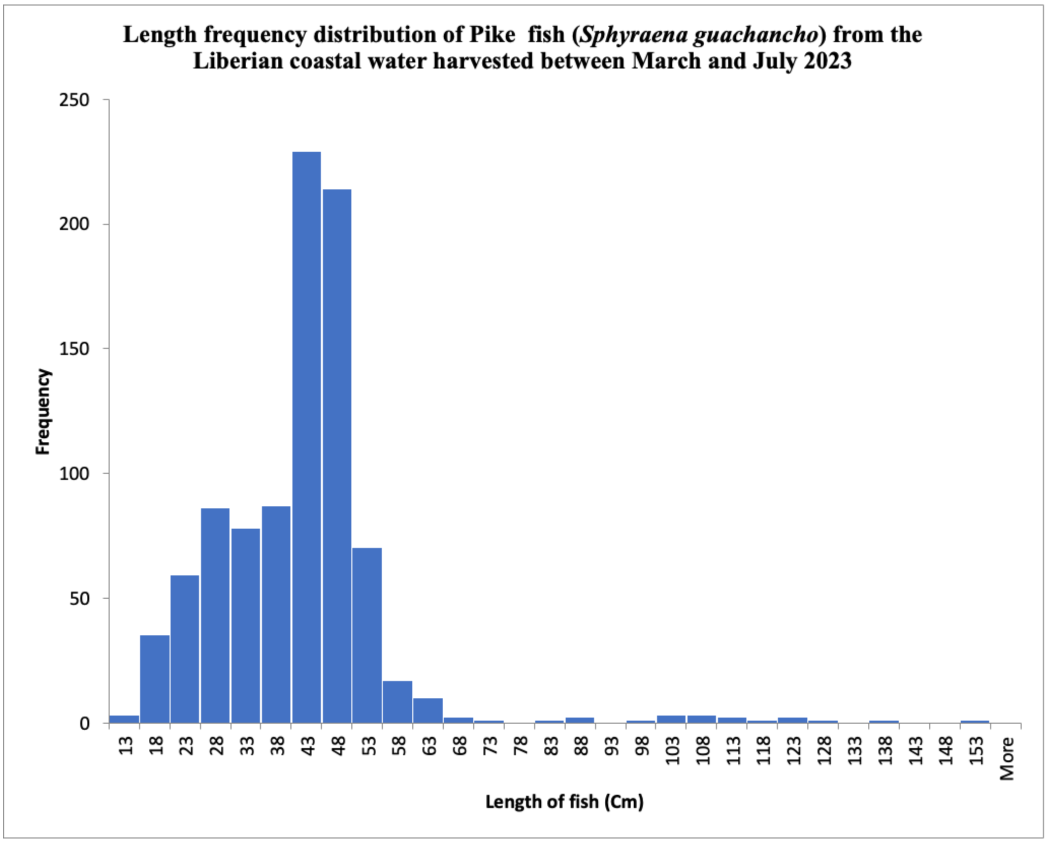

Figure 7: Length frequency distribution of Pike fish (*Sphyraena guachancho*). Maximum length of this fish according to fish base is 200cm and common length is 70 cm, meaning length at first capture 18cm is far below the length at maturity- growth and recruitment overfishing.

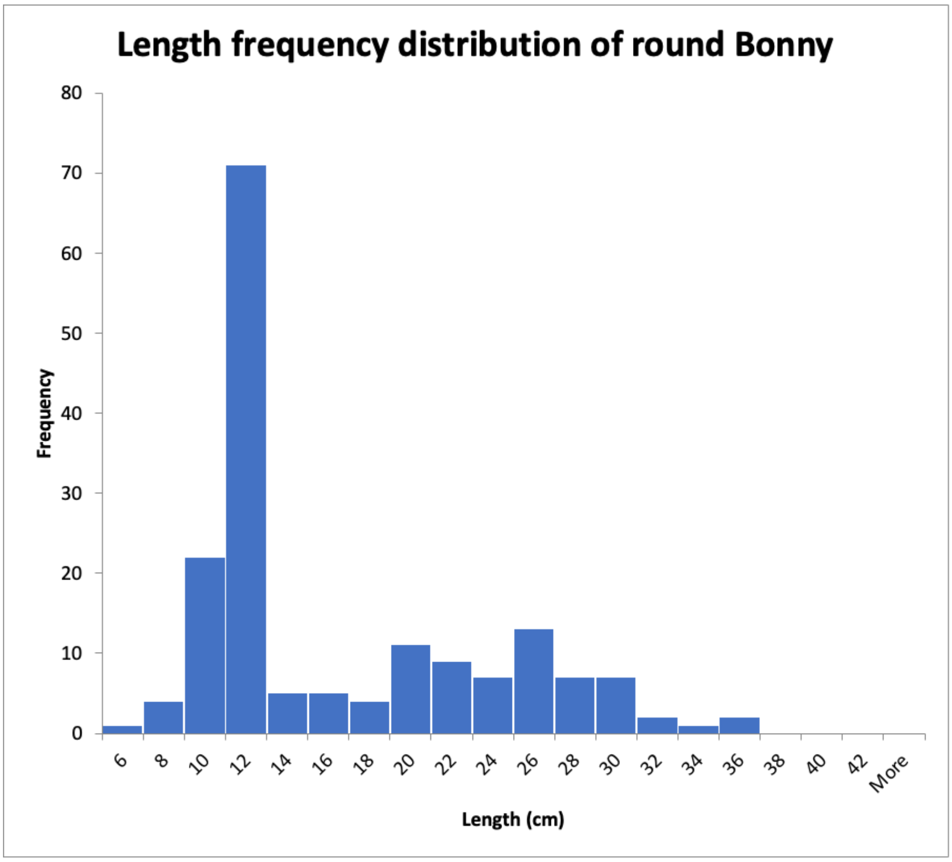

Figure 8: Length frequency distribution of round Bonny fish (S. aurita).

Length of S. aurity at maturity: Lm 18.8 (range 13 - 25 cm) depending on environmental conditions and fishing pressure. Max length of the species 41.0 cm TL; common length: 25.0 cm; max. published weight: 420.00 g; max. reported age: 7 years (FishBase). This means that a high percentage of the s. aurita catch comprised of fish below the length at first maturity

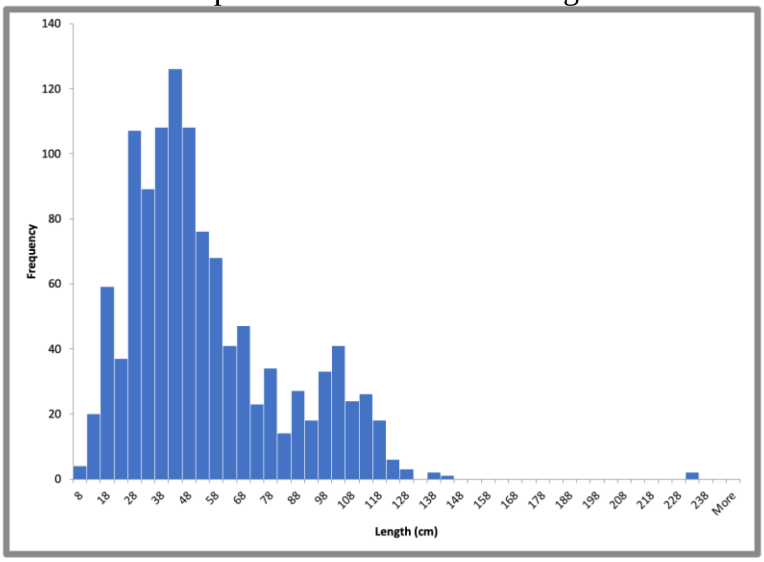

Figure 9: Length frequency distribution of Long neck cassava fish

Length at first maturity of this fish is 48.3 cm. Max length is 140 cm; common length: 50.0 cm; max. published weight: 15.0 kg. length at first capture in the Liberian waters is about 10 cm and the dominant sizes in the catch reported range from 18 to 70 cm. there is an outlier length of 233cm which is probably an error in the data entry process. Again, a good percentage of the catch are below the length at first maturity of 48.3 cm (https://fishbase.mnhn.fr/summary/Pseudotolithus-typus.html)

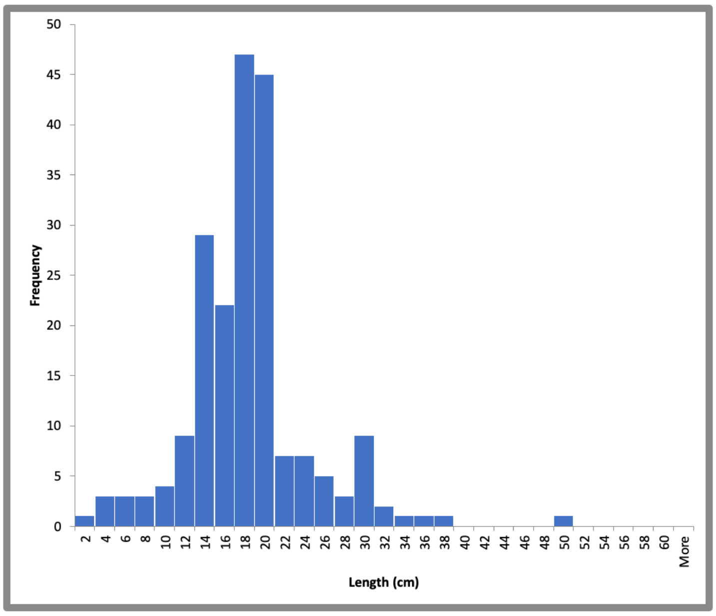

Figure 10: Length frequency distribution of Gbekpelleh fish (Illisha africana)

Length *of Illisha africana* at maturity (Lm = 13.0), (range 13 - 18 cm). Maximum length recorded in the shared data set is 30.0 cm and correspond with maximum length suggested in the FishBase database. The common length recorded range from 14 to 20 cm which also corresponded with the common length reorted in the FishBase (common length: 16.0 cm) (https://www.fishbase.se/summary/SpeciesSummary.php?id=1625&lang=scchinese). This suggest that the species is still healthy as most of the harvested fish are above the length at first maturity, ie the fish are allowed to spawn before harvested (

5 Recommendations

1. Enforce mesh size regulations particularly for the Fanti fleet targeting small pelagics to ensure that juvenile fish that have not reached spawning age/size can escape capture by gill nets.
2. Train and deploy trusted and well-motivated enumerators and at sea observers to be able to effectively monitor and report catch accurately.
3. Monitor catch and effort for different fishing gears and crafts and record separately as lumping catch by different crafts and fishing gears is difficult to standardise and predict yields, especially for a multi species fisheries, whereby a gill net and sein net can catch 10 to 50 different species in one fishing trip.
4. Refine the unit of effort in recording catch and effort. Many of the artisanal fishing crafts do not spend a whole day fishing, rather they spend 4 to 6 hours at sea fishing at a time and have to ruch home with the catch to minimise fish spoilage. Number of hours spent at sea, instead of fishing days would make more sense. Some artisanal fishers in other countries like Sierra Leone go out fishing 2 times in in 24 hours (based on semi-diurnal tide cycle). They spent most

of their time traveling to the fishing grounds or locating schools of fish. Once they locate a school of fish, they spend at most 2 hours to encircle the school and fish it out and then travel back to port, so using fishing boat days as a unit of effort could be misleading, because this assumes 24 hour day, when in actual fact actual fishing period is 6 hours (ie 2 hours to travel to fishing ground, 2 hours actual fishing and 2 hours traveling back to port. At sea observer in Sierra Leone are now recording net shooting time and hauling time, so that exact number of trawling ours can be calculated and used as a unit of fishing effort, so when we calculate a CPUE of 500kg of fish per hour, such a CPUE will not sound ridiculous, as compared to 500kg of fish per day for a fishing trawler

5. Unless you can effectively monitor the fishing vessels, enforcing a quota system in the country may present its challenges that are difficult to address.
6. Current vessels used in the artisanal fisheries would not permit them to effectively use the facilities in the proposed fishing port at Messurado. Improving the fishing craft of the artisanal fishers to allow them to take ice to sea in their fishing trips and be able to take longer at sea would facilitate landing better quality and larger quantities at the proposed port.
7. Not all current artisanal fishers can afford the proposed improved fishing boats, so Liberia would still continue to have the Kru and Fanti boats for the foreseeable future, but a micro-credit scheme set up by fish importers who would loan the fishermen these improved and efficient fiberglass boats and fishing gears and in turn buy the fish from the fishermen, whilst also recovering their loans. A micro-credit loan scheme study was conducted in Sierra Leone funded by the government of Iceland and they had recommended setting up fishers groups as a criteria for accessing the loans. The goup members will put resources together and pay for a boat to be used by one of its members at time until all members have acquired the technology, although the study was for the construction of fish processing facilities (Matis ovens), which are much easier to acquire in terms of cost, the fishers groups concept will all work well for acquiring fishing boats, fishing gears and accessories.
8. Encourage business people to invest in the improvement of small-scale landing sites and infrastructures, provision of goods and services to coastal fishing communities such as fuel supply (gas stations), fishing inputs (marine store supplying/selling different fishing inputs), cold stores and ice making machines to supply ice to fishermen. These business entities can also buy, process, distribute and market the fish landed by these fishermen and employ the women fish processors and marketers in these landing sites, so as to develop and improve the fish value chain and create onshore job opportunities in the sector.

6 Conclusion

Liberia has a high level of species diversity in their fishery waters. The fishery is a multi-species fishery with over 100 commercially exploited species. However, of the 52 species landed in 2020 to 2022, with a total landing of 14, 386.2 metric tonnes, 20 species contributed 94.92% of total landings on the industrial catch.

The data gaps and data quality in the data shared presented challenges for rigorous estimation of the Maximum sustainable yields of the fisheries at species level. The estimated maximum sustainable yield (MSY) for the fisheries from the total annual catch and effort data, using different fishing crafts and gears all grouped into small-scale and large scale was the Schaefer model, which uses certain assumptions to simplify the complexities of fisheries dynamics and make it more tractable. The model assumes that:

1. the population growth of the fish follows a logistic growth pattern. In this model, the rate of population increase is proportional to the size of the population and is limited by the carrying

capacity of the environment (K). This implies that as the fish population approaches its carrying capacity, its growth rate slows down.
2. the fish population is uniformly distributed and well mixed throughout the fishing area, without accounting for spatial or age structure differences within the population.
3. the parameters influencing fish population dynamics, such as intrinsic growth rate (r) and carrying capacity (K), remain constant over time. In reality, these parameters can vary due to various factors like environmental changes and fishing pressure.
4. there is no density-dependent regulation of population growth, meaning that the population growth rate does not depend on the current population size.
5. It does not explicitly consider environmental variability and assumes that the carrying capacity (K) remains constant over time.
6. the fish population is closed, meaning there is no migration or emigration of individuals into or out of the population.

It's important to note that while the Schaefer model is a valuable tool for estimating MSY, its assumptions might not always hold true for real-world fisheries. Consequently, caution should be exercised when interpreting the results and making management decisions based solely on the model's outputs. Fisheries are complex systems, and a comprehensive understanding of the ecology and dynamics of the target species is crucial for effective and sustainable management.

Similarly, the industrial data set used in this assessment seem to suggest that the deep water pelagic and demersal stocks are already fully exploited in the Liberian waters and therefore expanding the industrial fishing fleet from its current level could lead to a decline of the fish stocks. The reported catch of the Tuna vessels are however suggesting promising signs, although this data set do not have the effort. It is also noteworthy that Tuna are highly migratory and cannot in the strictest sense be considered to belong to any one country’s fishery waters. However, tuna feed on other small fish like bonny, bonga, and mackerel. If a lot of tuna are caught in Liberian waters, like the reported this could mean that there are a lot of prey fish for the tuna to feed on. It could also mean that the Tuna were just passing through the Liberian waters when they were caught.

Despite the above assumptions and limitation of the model, Predictions/projections in the Bioeconomic models developed by Jueseah et al (2020), had an MSY of 9,500 tonnes per year for the small pelagics, whilst our estimates for the shallow water pelagics and demersal species targeted by the artisanal fishers is 14,870 tonnes per year. The deep water large pelagics and demersal targeted by the industrial fleet are still in healthy condition, as shown in the percentage contributions in the catch in the period 2010 to 20221

Wehye et al (2017) in their assessment of the technical efficiency of the Kru, Fanti and industrial fishing boats concluded that the Kru and Fanti boats are inefficient, can only go out to 8 NM and do day trips. However, their profitability is recorded in same paper to be higher than the industrial vessel. Boats are also reported to encounter lots of accidents at sea, so using semi-industrial vessels that can go farther out to sea, stay loner at sea, because they have ice onboard and targeting large pelagics and deep water demarsals and crustaceans will increase their profitability, increase the contribution of fisheries to the local economy of Liberia as all the fish will be landed and most of it sold in Liberia. Low value small pelagics like the sardines can be processed by canning (value addition) and the Millions of US$ used to import fish into the Liberian market can be used in some other areas of the economy

Anticipated users/beneficiaries of the proposed fishing port identified during the one week field vist are:

1. Current importers of fish in Liberia
2. Current industrial fishing fleet operators in Liberia, including tuna vessels if the port is deep enough to accommodate these large tuna vessels.
3. Many Fanti fishermen who may be able to afford the semi-industrial vessels and will be landing and selling fish to buyers at the port for processing or cold storage
4. Local fish traders, who will buy fish from the cold rooms at the port and sell in the local markets in Liberia
5. Government agencies (including NaFAA), ports authorities (NPA) Customs Agency Liberia Revenue Authority, BIVAC, etc

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10. Appendices

Appendix III: Terms of Reference

Section 7. Terms of Reference

Consulting services to conduct Economic Feasibility Study for expansion/construction of the Mesurado industrial facility and other fisheries infrastructure

1.0 Introduction

The government of Liberia through the National Fisheries and Aquaculture Authority (NaFAA) has received support from the World Bank Group toward the preparation and implementation of the, "Liberia Sustainable Management of Fisheries Project (LSMFP)", and desires to apply part of the proceeds towards eligible payment of the services of a consultant for the conduct of a feasibility study for expansion of the Industrial Fishing Port and Artisanal Landing facility at the Mesurado Pier, Freeport of Monrovia. The purpose of this terms of reference is to solicit the interest of qualified consultants to conduct an economic analysis of the proposed investment.

2.0 Background

Liberia has a coastline of some 590 km, a relatively narrow shelf with an average width of 31 km, and a total Economic Exclusion Zone (EEZ) of around 18,400 km^2. The coastline of Liberia is dotted with about 114 fish landing sites but, from North to South, four large clusters are located around the large towns of Robertsport, Monrovia, Buchanan and Harper. The key landing sites include: Kru & Fanti Town in Robertsport; West Point, New Kru town, Banjor, King Gray and ELWA in Monrovia; Marshall, Little Bassa, Small & Big Fanti Town in Bassa and Margibi counties; Cestos city; Greenville; Sasstown and Grandcess in Grand Kru; and Cavalla & Harper in Maryland County.

The main oceanic pelagic resources are tuna and tuna-like species such as bonito and marlin, and the sardinella stocks; *S. aurita and S. maderensis*. The shelf is slightly narrower in northern waters and rather broader in the south, where it is the starting point for the Gulf of Guinea. Unlike the coastal regions to the north such as Sierra Leone and Guinea, Liberia is not affected by the upwelling effects of the Canary Current, which therefore limits its productivity, although it does receive heavy seasonal discharges from the numerous rivers and their estuaries; these provide productive conditions for shrimp fisheries. The lack of upwelling does not favour the production of the small pelagic sardine-like species so plentiful further north but, nevertheless, they are sufficiently prolific as to provide a significant element in the fishery.

The artisanal fishery is estimated to provide a means of livelihood for about 33,120 full-time fisher folk and processors in both marine and inland waters. The Liberian fishing communities are mainly indigenous Kru and others are Fanti and Popoe fishers who migrated to Liberia from Benin, Ghana and Cote D'Ivoire, with recent additions of Gambian and Senegalese fishermen in Cape Mount County. Grand Kru County with 35 landing sites and Sinoe County with 30 have the largest number of landing sites and are dominated by indigenous fisher folk, but land substantially less fish annually than Grand Cape Mount County with 14 sites and Grand Bassa County with 18 sites; a reflection of the smaller boats used by indigenous fisher folk.

The government of Liberia, with support from the World Bank through the closed West Africa Regional Fisheries Program (WARFP), has rebuilt the fish stocks to recovery status thus significantly increasing landings by artisan fishers. In order to further harness the benefit from the resources to increase revenues, improve income and food security, the Government of Liberia is seeking further assistance from the World Bank Group to support 'Sustainable Management of Fisheries in Liberia', with the objective to improve the management and utilization of selected fisheries.

The overall project consists of: (i) procurement of fishing equipment and gears, including fiber glass semi-industrial vessels for piloting in selected counties; (ii) expansion of the NaFAA office to create additional work space for project and NaFAA staff; (iii) construction/expansion of the fishery hub at the Mesurado pier in Monrovia, to provide for a semi industrial and artisanal fish landing site with shore facilities for fish auction, processing and marketing; (iv) provision for private sector investment in ice production and chill storage; (v) construction of a quay, central fish market, processing area, landing pontoons, ice plant, chill stores etc.; (vi) financing of fisheries landing site improvements planned at Buchanan, Greenville, Grandcess and Harper; (vii) other basic infrastructure construction or rehabilitation to provide better landing sites, markets, toilets, water, wastewater and solid waste handling and treatment facilities and post-harvest processing facilities in selected communities; (viii) training and skills upgrading, and provision of financial and technical assistance to fishers, fish producers, handlers and processors, fishmongers and exporters on basic hygiene practices and sanitary procedures; (ix) value-addition to enhance market access and shelf-life; (x) product branding and certifications to adhere to standards and sustainability requirements; (xi) assistance with procurement of legal fishing materials through private business people; and (xii) identifying needs, feasibility and development for suitable landing sites, ice making and cold storage facilities in selected fishing communities.

Considerable funds have already been invested in fisheries infrastructure in Liberia, particularly at Mesurado. The benefits of this investment have not yet been fully realized. A further investment program is now being developed, that to date has not benefitted from detailed analysis of the likely volumes, types of fish, fishing vessels and fish buyers/markets, that this fish is aimed for. It is crucial for long term success of these investments, that they meet the needs of users, attract fishing activity within fisheries management plans and generate sufficient income to support and successfully maintain sustainable operations towards attaining food security and economic benefits.

3. Objective of the assignment

The Government of Liberia through NaFAA is soliciting the services of a qualified Consultant Firm or Consultant Consortia for an economic Analysis which will inform the scale of investment needed for development of fisheries port infrastructure to be supported with funds from the World Bank. Specifically, the economic Analysis (EA) will provide the decision makers in the GoL and the World Bank Group with the necessary baseline and information to justify the proposed investment, including the proposed financing and implementation modalities and coordination with the National Ports Authority. To this end, a key component of the study is to determine economic and financial feasibility based on projections of financing, operating costs, coordination with Freeport Authority on revenues and profitability, as well as sensitivity analyses in relation to key internal and external parameters and constraints and the investment's impacts on the economic objectives of the country. Financial feasibility will be informed by analyses of the economic, operational, environmental, social and technical aspects, analysis of the availability of fish stocks taking into consideration climate change, and fishing methods for a future sustainable fishery will inform the overall feasibility. The FA will inform the choice of design, and scale of the Mesurado industrial fisheries port and Mesurado artisanal landing site by providing detailed analysis for scenario/option/concept 5 provided in consultant Mr J Sciortino's report.[1] This is establishing the future needs of the fisheries sector for infrastructure and the business case for construction, including forecasting the anticipated economic benefits of the Mesurado Industrial Fishing Port and Mesurado Artisanal Fish Landing Site investments.

4.0 Scope of Feasibility Analysis/Study

The firm will undertake an economic analysis/study of the proposed Mesurado Industrial Fisheries Port and Mesurado Artisanal Fish Landing Site, comprising financial, economic, fish stocks, operational, social and technical components.

The studies will be conducted in close collaboration with local stakeholders and take into consideration the previous work done at the Mesurado pier by local and international experts. The consultants will compile and review all relevant background information[2] to the feasibility study and collect additional information, including holding meetings with NaFAA and the Freeport Authority, stakeholders to the fisheries sector (e.g., fishers, community members, retailers, processors, fishing boat operators, Government authorities and Port managers, etc.) to obtain their input.

The scope of the proposed consultancy will include the following tasks:

1. Assess the current situation and identify the current and future fisheries resources based on the existing data and estimate likely sustainable yields for each fish catch/species taking into consideration the impact of IUU fishing and climate change. Estimate the resulting shore and marine infrastructure requirements.
2. Collect, analyze and describe the most current technical and socio-economic information available on the project's geographic location and the project beneficiaries;
3. Evaluate the national and potential international markets and revenues and identify where each of the fish resource groups may best be targeted.
4. Assess the types of fishing and support vessels needed to support each fishery, and estimate the investment costs, potential profitability and financial returns on the port infrastructure investments taking into consideration social and environmental costs.

[1] Sciortino, J. A. (2020) Investment Concept for Mesurado, Liberia

[2] Review "Feasibility Study of the Mesurado Deep water Berth" and "Infrastructure Needs Assessment" by J. A. Sciortino, and previous work done under WARFP I

5. Analyze past trends in fish imports and exports to estimate future port use by vessels responding to demand by fish importers and exporters and estimate potential revenue for the port infrastructure.
6. Identify data gaps and specialized studies which need to be undertaken.
7. Assess the current status and future needs of the artisanal fishery for Monrovia region including the proposals for a fishing basin, provision of a new fish market, space for development of the processing facilities, size of these facilities, support services and amenities.
8. Assess the infrastructure concept 5 identified in the Sciortino report (Investment Concepts for Mesurado, Oct 2020) and test concept 5 against other proposed concepts to demonstrate which is of the most economic benefits to Liberia.
9. Estimate operating costs and potential revenues from the most suitable infrastructure investment.
10. Construct a financial model for the proposed concept that enables both economic and financial forecasting of cash flow, revenue and profitability requirements against current and incremental operating costs, debt repayments and dividends over a period of at least 10-years. The model should provide for cost overruns and other contingencies; This model should enable benefit-cost analysis (BCA) and investment appraisal of the proposed project.
11. Apply the financial model for sensitivity analysis with respect to key operating and financial and economic parameters, including volumes of landings, fish prices on domestic and export markets, labour and utility costs, and variation in sales volumes.
12. Assess the skills gaps within Liberia and particularly in the project area to operate the infrastructure.

13. Carry out initial consultations with key project stakeholder and beneficiaries of the proposed investment. Provide record of stakeholder consultations.
14. Prepare an economic assessment report on the, financial, economic and institutional, feasibility of the proposed infrastructure investment.

5.0 Methodology

To carry out the above tasks, the Consultant will be required to adopt the Fisheries Infrastructure Assessment Tools[3] (FIAT) which provides a framework and checklist as the core methodological guide to implement the assignment. Additionally, the Consultant should apply methodologies that incorporate the following so as to meet the objective of this consultancy:

A. Feasibility Assessment

a. Assess gender needs, roles, and dynamics with attention to constraints, risks, and opportunities for women, youth and those with disabilities. Identify sectors where action should be taken and recommend activities to enhance inclusive economic participation of gender in decision-making and in the operations and management of the proposed facility.

[3] Fisheries Infrastructure Assessment Tools (FIAT), World Bank

b. Assess marine traffic flows for fish products import and export, illegal fishing, vessel types and dimensions, volume of import and export, changes in revenues to Nation Ports Authority (NPA) over the past 10 years and future forecast over the same period.
c. Assess current usage of the NPA facilities, including the implementation status of the Freeport Master Plans and relationship between fisheries and other port users, to identify alternative & existing berthing for fishing vessels, or lack thereof, and therefore the need for construction of a dedicated fisheries specific facility.
d. Consult with NPA and NaFAA to identify the long-term structure of partnership in the operation of fisheries facilities within the Freeport Zone.

B. Economic and Financial Feasibility Assessment

In accordance with guidelines acceptable to the client and the World Bank and as per good international industry practices (GIIP), the consultant will carry out an economic and financial assessment of the proposed investments to be supported by the project at the Mesurado pier. The Consultant will do so by using economic and financial valuation methods that can best demonstrate all expected outcomes in costs and positive effects between the interventions and project beneficiaries within a time horizon which is long enough to justify the project interventions and derive development impacts. The Consultant will create a baseline scenario that allows comparison with “project investments” scenarios including:

- Identification of all assets to be financed by the world Bank, including all initial costs (infrastructure, equipment, marketing, training, institutional strengthening, etc.) required to commence operation (i.e., total estimated project cost)
- Development of fully allocated operating models (including employment) according to the proposed option for the Mesurado facility and alternative operational options.
- Construction of a financial model for the proposed concept/option that enables forecasting of cash flow, revenue and profitability requirements against current and incremental operating costs, debt repayments and dividends over a period of at least 10-years. The model should provide for cost overruns and other contingencies, and the financial values and financial model maybe used as basis for further follow-on economic analysis, using economic values.
- Application of the financial model for sensitivity analyses with respect to key operating and financial parameters, based on volumes of fish landings, fish prices on domestic and export markets, labour and utility costs, and variation in sales volumes, for which the following parameters will be finalized:

i. The financial and economic analysis and use of specific performance metrics (NPV,ROI,IRR etc) will be conducted using an appropriate discount rate and a sensitivity analysis may also be applied to consider the impact of a range of DR.

C. Institutional and management feasibility assessment

a. Assess the capacity and capacity building needs at NaFAA for the planning, operations, management and maintenance of the proposed infrastructure.

b. Assess institutional capacity for overall gender awareness and particularly in fisheries governance and management. Identify gender gaps and recommend relevant measures for filling the gaps including gender integration and capacity building and suggest optimum levels of female participation and staffing in the operations, management and maintenance of the proposed infrastructure.

c. Develop an outline of the capacity building plan for NaFAA with a timeline that meets the management and operational needs of the port infrastructure.

6.0 Project Area

The economic analysis will cover the Mesurado Industrial Fishing Pier area located along the Northern Breakwaters of the Freeport of Monrovia, and the adjoining Mesurado Artisanal Fish Landing Site.

7.0 Qualification Requirements and Composition of Study Team: The minimum requirements for the firm are (i) extensive and proven experience in conducting economic analyses for establishing fisheries harbors and post-harvest infrastructures, including landing sites and processing facilities in different parts of the world, especially in developing countries; (ii) It is preferred that the firm has a recent and solid experience in preparing economic analyses for donor-financed fisheries infrastructure projects, and must have successfully implemented at least 1 similar projects in the past 10 years; (iii) considering the current COVID 19 pandemic, the firm is expected to work with a qualified local firm/consultant to perform needed services to ensure timely completion of the assignment and limit the number of international travel.

In order to complete the assignment, the firm will assemble a multi-disciplinary team of port engineering and operations, financial and economic analysts, fisheries operations and stock assessment specialists with substantial experience (no less than 8 years) and adequate educational backgrounds (Master's degree and higher) who will ensure the services are carried out in a professional and timely manner. The team leader shall have at least 15 years of experience, and 10 years of experience for other key staff in similar fisheries infrastructure development or related projects. The team is expected to have the following:

- Strong analytical and report writing skills
- Strong communication and facilitation skills
- High computer literacy, and
- Full proficiency in English

The team will include, but may not be limited to:

Description of Input (list only core responsibilities)	Position and experience
Lead and manage inputs of consultant team; responsible for overall product delivery and for timely and quality execution of services; primary contact point for contract execution	Team Leader (Key Position) *- 15 years: A civil engineer with experience in marine construction and dredging/reclamation.
Financial and Economic Analysis	Fisheries Economist (Key Position) * - 10 years
Identification of available fish stocks and determination of maximum sustainable yields to sustain viable operation of facility to ensure optimum economic and social benefits.	Fisheries Biologist (Key position) * 10 years
Fisheries Operations specialists to analyze fishing methods and vessels for the optimum exploitation of each fishery	Fisheries Management Specialist (Key Position) * - 10 years
Institutional and capacity needs assessment; contribute to interviews for capacity needs assessment; contribute to definition of training needs and methods for management, operations and maintenance of port infrastructure & services	Institutional Development and Capacity-Building Specialist (Key Position) * – 8 years

(*) Key Positions that will be included in the technical proposal evaluation (based on the detailed CVs of the proposed respective team members).

8. Deliverables, Schedule of Deliverables

I. Deliverables.

The Consultant will produce the following deliverables (described further below):

1. Inception Report for Feasibility Assessment;
2. Draft Economic analysis Report;
3. Final Economic Analysis Report

The preparation and delivery of the above documents will be organized as outlined in Annex 1, and presented in three steps, as follows:

1. Inception Report submitted within **four weeks** of contract signing: The Consultant will submit an Inception Report detailing the methodological approach for the entire assignment covering all items under" Scope of Services" and "Methodology" as outlined in this Terms of Reference. The Inception Report will inter alia describe the method of data collection including field work plan, verification, field work with project

stakeholders and beneficiaries, and analysis. The Inception Report will provide an outline of the team tasks and team members' inputs and deliverables. The Inception Report will provide a list of the available/collected information, identify studies to be carried out and timeline to fill in the gaps. It will comment on the TOR and propose changes / clarification (if any) to the TOR. This Inception Report will be subject to review and comment by the NaFAA and the World Bank. The Consultant will revise the inception report based on those comments. The final Inception Report will be submitted to the NaFAA after incorporation of comments.

2. Draft Economic Analysis (EA) Report submitted **10 weeks** after contract signing: The Consultant will prepare a Draft FA Report covering all tasks under the assignment with specific recommendations on the feasibility of project interventions. It will be accompanied by a draft executive summary. After submission of the draft reports, a presentation shall be disseminated to the Client for obtaining feedback. The Client's comments on the draft final report will be incorporated in the final report.
3. Final Economic Analysis Report submitted **15 weeks** after contract signing: This deliverable should include all the review comments and suggestions by the client, World Bank and other relevant stakeholders. It will include all relevant data in a tabulated format used by the Consultant for the baseline, raw and processed data, toolkits and questionnaires used for the social-cultural assessment, and other supplemental information that will constitute the project file. The Report will be prepared in the English language following the format outlined in annex 1.

The total duration of the consultancy services will be **15 weeks** from the date of contract signing.

9. Institutional Arrangements

NaFAA is the implementing agency of the project hence the Consultant will work under the direct supervision of the Project Coordinator, Sustainable Management of Fisheries Project, NaFAA, Monrovia. NaFAA will assist the study team as required, particularly with regard to fisheries data and information on the fisheries in the study area.

As the lead implementing agency of the project, NaFAA represents the Client for this assignment including key stakeholder such as National Ports Authority (NPA). However, prior to contract signing, NaFAA will obtain in writing the agreement of the National Ports Authority that the scope of the assignment and its possible outcomes is acceptable to the NPA as the government designated Authority for the port area within which the infrastructure is proposed. The agreement would include Freeport Authority requirements for leases for any area proposed, user charges due to the Freeport for the use of any constructed infrastructure, compliance with NPA regulations for security and health and safety, compliance with Port Marine safety codes and Port State Measures.

Prior to contract signing, NaFAA will also obtain in writing agreement from Monrovia City Council for the scope of works and its compliance with city urban and traffic planning for the shore-based infrastructure, designation of any land outside the Freeport but needed for the successful implementation of the proposed artisanal port.

The LSMF Project Coordinator will support the Consultants to ensure the objective of the study, as detailed in the ToR, would be achieved within the agreed time schedule, and that the contents of the report are acceptable to the client and the World Bank; He will support the execution of the feasibility study and will monitor progress according to the objectives set in the ToR.

The Project Coordinator will facilitate meetings between the consultants and NaFAA professional staffs to discuss technical issues. Any unresolved issues, either technical or otherwise, will be taken up with NaFAA's senior technical personnel or other GoL agencies as required.

Payments against approved deliverables will be authorized by the NaFAA. The NaFAA-designated counterparts will make all possible efforts to make available the following data, services and facilities to the Consultant as per the existing rules at NaFAA:

- All available fisheries data and records for the different sectors of the fisheries;
- Available reports and study related documents;
- Any other services, available with NaFAA to help the consultants carry out the data collection as per the ToR.

10. Consultant Responsibilities

Data, personnel, facilities and services will be provided by the Consultant as detailed in this ToR. The Consultant will mobilize the necessary expertise for the effective delivery of the services as stipulated in the scope of works and ToR. The Consultant will carry out the services in the best interest of the Client, the GoL represented by NaFAA, with reasonable care, skills and diligence in line with sound professional, administrative and financial practices. Field surveys and field data collection will be carried out in coordination with Division of Statistics & Research, NaFAA. The Consultant will be responsible to the client for the execution of the contract according to the terms and conditions spelled out therein. Consultant will organize presentations and dissemination events to enable the monitoring of progress and study results by the relevant NaFAA personnel.

11.0 Client's Responsibility

The client, NaFAA, will provide access to available data, reports and information, and to relevant personnel of NaFAA and officials of government institutions with important roles in achieving the objectives of this terms of reference. NaFAA will also provide a favorable work environment and logistical support for the consultant, and support/facilitate stakeholder consultations. NaFAA will review all draft reports and provide comments and suggestions to enable the consultant finalize the feasibility report.

12.0 Payment Schedule

Payment will be made according to the following schedule:

(i) 5% after signing the Contract

(ii) 25% after submitting the Inception report
(ii) 40% after submitting the draft economic report
(iii) 30% after submitting the final report

All the payments will be made only after acceptance of the reports and deliverables by the Client.

13.0 Selection method will be through Consultant Qualification Selection (CQS)

Appendix

ANNEX 1: Feasibility Assessment Report Outline

The Economic Analysis Report will include at a minimum the following elements:

i. Summary
ii. Sector background
    1. Policy, legal and administrative framework
    2. Socio-economic status of fishing communities in project area
iii. Project design description
iv. Methodology
v. Description of data used for the assessment and data validation
vi. Results of the assessment
    1. Financial Feasibility
    2. Economic Feasibility
    3. Institutional and Management Feasibility
vii. Recommendations
    1. Make a clear decision to accept or not accept the investment proposed for design Concept 5.
    2. Project implementation arrangements and flow of funds
    3. Risks Assessment
    4. Project coverage and selection of targeted locations for all activities as specified, and criteria used for selection;
    5. Any further actions needed to secure project financing and implementation, such as tender documents for consultancy services;
    6. Sustainability of project results;
    7. Monitoring and Evaluation of Project results;
viii. Summary of results of public consultations
ix. Conclusions
x. Annexes

The Pearl in the Shell

Unlocking Value in the
Maritime & Transport Industry

Maritime & Transport Business Solutions

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