Scientific Research Publishing

Agricultural Sciences, 2026, 17(9), 993-1012
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

Socioeconomic and Environmental Study of Artisanal Fishing and Its Impacts on Fish Stocks and Aquatic Biodiversity at the Bonfi Artisanal Landing Stage

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How to cite this paper: Sidimé, N., Konaté, D., Sakho, A.M., Sakouvogui, A., Camara, K. and Bangoura, K. (2026) Socioeconomic and Environmental Study of Artisanal Fishing and Its Impacts on Fish Stocks and Aquatic Biodiversity at the Bonfi Artisanal Landing Stage. *Agricultural Sciences*, **17**, 993-1012.
https://doi.org/10.4236/as.2026.179056

Received: August 24, 2026
Accepted: September 21, 2026
Published: September 24, 2026

Abstract

The study conducted in this work shows the important role played by the Bonfi landing stage in the economy coastal towns, through many activities that develop there, such as artisanal fishing, ice sales, fuel distribution, trade in fishery products, transport, supply of fishing equipment. The study also reveals that the volume of landings of fishery products has decreased significantly in recent years. However, the management model applied at this landing stage is a mixed management that is both community-character and informal. Decisions and tax payments are handled in a largely informal manner. The trade surpluses from fishing activities in the landing stage show that generate that they bring in more they spend, despite the decline in the volume of landed fishery products. The observed environmental impacts and the analysis of certain physicochemical and microbiological parameters of the samples water and soil samples from the site, show signs of environmental pollution.

Keywords

Impacts, Soci-Economics, Environmental, Fish Stocks, Bonfi Artisanal Landing Stage

1. Introduction

The small-scale fishing sector plays a crucial role in the economies of coastal coun-

tries, particularly in West Africa [1]. In Conakry, the Bonfi artisanal landing stage, located in the Bonfi district, plays a multi-function role in intermunicipal fishery products supply of fish products, municipal, job creation, transport, fishing, etc. [2] This massive sale of seafood products toward other exterior markets to the municipality gives to this activity a territorial open, marked by an outing considerable outflow of seafood products and a significant inflow of inputs. [3]. In this context, a purely microeconomic interpretation based on the profitability of the main production units (dugout canoes, fish-processing boats, etc.) is not sufficient to understand the economic impacts of economic activity on the region. Indeed, the activity is embedded in value chains that involve various stakeholders and generate income and livelihoods beyond the units directly involved in fish capture [4]. Therefore, establishing a link between individual performance and the spatial organization of economic exchanges makes it possible to borrow a macroeconomic a vision through an adaptation of notion of the local trade balance. Furthermore, the intensification of small-scale fishing activities can place significant pressure on marine resources, leading to a drop in fish stocks and the degradation or destruction of marine biodiversity. These environmental concerns show the need to assess the impacts of these fishing activities in order to propose solutions for the sustainable management of fishery resources. ***This study therefore aims to analyze the current state of this very important landing site, while identifying the environmental constraints and their consequences, as well as the socioeconomic and technical constraints responsible for its poor performance, in order to propose sustainable solutions for its improvement, because this site faces numerous challenges, particularly in terms of organization, infrastructure, and environmental management.*** It will also help highlight the important role of the landing stage in local development and in improving the living conditions of the target populations. He will also discuss the small-scale fishing carried out at this landing stage, which primarily targets fish, crustaceans, and cephalopods, a sector that once accounted for about 60 to 70 percent of the total volume of fishery product landings and is now reportedly facing enormous challenges.

2. Materials and Methods

2.1. Overview of the Study Area

This study was conducted at the Bonfi landing stage in the urban commune of Matam (Conakry) (**Figure 1**). It extends towards the eastern shore of the Kaloum Peninsula. The neighboring communes of Matam are as follows: Dixinn, Matoto, Kaloum and Ratoma. It was founded in 1991, at the same time as certain communes of the city of Conakry, replacing the three former prefectures. The latest general census of population and habitat (February 25, 2026) showed that since 2016, its population saw a 48% increase, resulting in a male population of 85,990 and a female population of 91,281, representing a rate of 51.5% [5]. The Bonfi landing stage is one of the main landing sites for artisanal fishing in Guinea. Before 2015, it operated in a largely informal format. Before 2015, it operated in a

format informal manner, with precarious or non-existent infrastructure. In 2015, as part of a national policy for the development of the fisheries sector, avast program to modernize and improve infrastructure in the artisanal landing stage has been launched [6]. Despite these efforts, our observations in this landing stage remain deplorable (**Figure 1**).

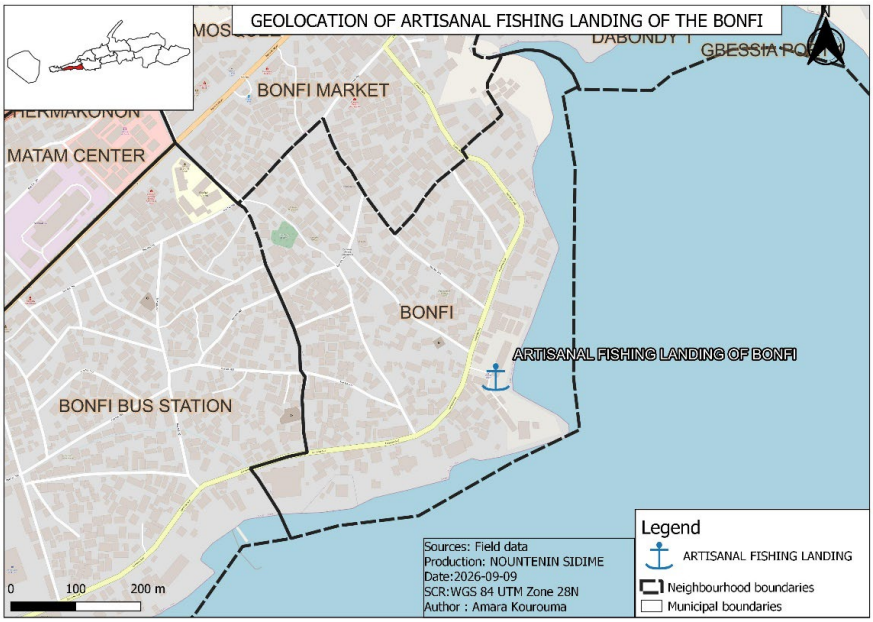

Figure 1. Showing the map of the commune of Bonfi.

The operation of the landing stage relies on a multitude of actors with complementary roles. The main producers in the landing stage are: the fishermen, fishmonger women, female smokers, without forgetting transport the products towards urban markets, handlers and small traders who participate in the value chain.

2.2. Survey Data Collection Methods

Using predefined questionnaires, a purposive sample of 90 respondents in total—selected based on their involvement in fishing activities (100%)—namely: fishermen, female fishmongers, fish smokers, merchants, transporters, local authorities, and administrative staff, were interviewed. Among the respondents, fishermen were the largest group, comprising 60 fishermen (66.7%) (age range: 15 to 60 years), followed by 10 female fish wholesalers (11.1%), 7 female fish smokers (7.8%), 4 small-scale traders (4.4%), 3 transporters (3.3%), 3 local representatives (3.3%), and 3 administrative staff members (3.3%) (age range: 10 to 55 years). Overall, these categories accounted for 100% of the 90 respondents. Direct observation of the site and interviews allowed us to assess the condition of the infrastructure, environmental practices, socioeconomic dynamics, and the reasons for the decline in fish catches. The data were collected between April and May 2026, focusing on three main types of evaluation.

2.3. Ecological Assessment

Based on simple observation, made it possible to identify types of pollution at the site, water quality, soil, biodiversity, sanitary conditions and waste management.

Methods used:

Observations of environmental practices (discharges, waste, odor, noise, what people say, etc.).

2.4. Evaluation Based on Physicochemical Analyses of Seawater and Soil Samples

For better visibility on the environmental condition of the site, to ensure on the quality of the water and soil (habitat of fishery ressources) an essential factor qualifying the commercial value of these fish sold and intended for consumption, these parameters must be considered as support for the sustainable management of the site.

2.4.1. Methods Used

Three independent water and soil samples (E1, E2, and E3) were collected at different points within each sampling site. The samples were not pooled; instead, they were analyzed separately (individually). The labels E1, E2, and E3 represent independent field samples rather than analytical replicates derived from a single sample. For each parameter analyzed, the mean value reported represents the arithmetic mean of the three independent measurements (E1, E2, and E3), and the standard deviation (SD) was calculated using the sample standard deviation formula (n-1). Results are presented as mean ± SD, with n = 3 independent samples per sampling site. L'analysis were based on the parameters: (pH, COD, NPK, heavy metals (Pb, Cd, Hg, etc.), temperature, conductivity, turbidity, BOD) and (texture, structure, moisture content, soil organic matter), CEC, etc. The water samples were packaged in sterilized 500 mL polyethylene bottles, then kept in an insulated cooler equipped with a control thermometer and transported to the laboratory. The transportation did not exceed six hours to ensure the integrity of the analyzed parameters. The geographic coordinates of the sites were obtained by estimation from available map data and not using data recorded by a GPS. The analysis of physicochemical parameters was conducted in accordance with the following standards: ISO 10523:2008; ISO 6060:1989; ISO 5815-1:2003; ISO 7890-3. The method used for heavy metals (Pb, Hg) in soil was ICP-MS in accordance with ISO 17294-2:2016. Calibration was performed using a multipoint calibration curve ($R^2 \geq 0.995$) in accordance with the reference standards for validity. The limits of detection and quantification were determined as 3σ and 10σ of the blank, respectively.

2.4.2. Water Sample

Was collected at a depth of 20 to 30 cm, far from visible sources of Pollution.

Site 1. Seafood landing points: Latitude: 9.5503˚N; Longitude: 13.6459˚W; **Site 2.** Landing site for canoës: Latitude: 9.55031˚N; Longitude: −13.64592˚W et **Site**

3. at 50 meters from the quay: the estimated coordinates are: 50 m towards the north: 9.55076˚N, −13.64592˚W; 50 m towards the south: 9.54986˚N, −13.64592˚W; 50 m towards the east: 9.55031˚N, −13.64546˚W; 50 m towards the west: 9.55031˚N, −13.64638˚W.

Soil sample: was collected at a depth of 10 to 20 cm in a staggered pattern using a trowel and on-site : Canoe dock. They all took place on Monday, May 25, 2026, at 11 :25 a.m., at the moment the gradual rise in water level between low and high tide (during the rising tide phase). The recorded tide levels this day were: low tide at 09:38 (≈ 1.23 m) and high tide at 15:55 (≈ 3.07 m).

2.5. Sampling (Water and Soil)

2.5.1. Equipment *Used*

Sterile bottles (500 ml); gloves, labels, cooler containing a thermometer; stainless steel trowel and a digging bar; polyethylene bags.

2.5.2. Protocol (Water Sampling)

Collect the sample at a depth of 20 to 30 cm below the water surface. Rinse the bottle twice with the water to be sampled. Seal tightly and label with the location, date, and time. Keep cool (4˚C) and transport to the laboratory within 6 hours.

2.5.3. Protocol (Soil Sampling)

Scrape away the top 2 - 5 cm. Collect samples at a depth of 10 - 20 cm. Use in zigzag or composite sampling pattern (mixing samples from several points). Allow to air dry if not analyzed immediately.

2.6. Assessment of the Physical Condition and Functioning Status of the Existing Infrastructures and Equipments

Methods used:

Direct observation of existing infrastructure infrastructure such as: buildings, ice-making units, Fish smoking and preservation of seafood, docks, conveyors, cranes, toilets, latrines, garbage bins, Storage warehouse, fishing gear, outboard motor repair workshop, and potable water supply, availability of equipment (gloves, tables, hairnets, etc.), presence of a fuel station, surfacing of site areas, etc.

2.7. Socioeconomic Assessment

Goals:

Identify the key economic actors (fishermen, women female fish smokers and fish traders, small businesses, etc.) and the activities de: (fishing, processing, trade, etc.), measure the value added by landing site activities and assess their impacts on living conditions of the populations, employment, income, food security, easy access to infrastructure, etc. For this purpose, precise interview-based questionnaires were asked to respondents from the various groups, according to a reasoned sampling method on: revenue collection, collection methods, income analysis, landing rates, fish prices, etc**.** Direct observations also enabled us to assess envi-

ronmental practices and socioeconomic dynamics.

Fishermen were the most numerous group, accounting for 70%, followed by female fish traders (15%), female fish smokers (12%), and small-scale traders and transporters (3%).

3. Results and Discussion

3.1. Results

The findings of this study reveal the main socioeconomic distinctive features and environmental features of artisanal fisheries at the Bonfi landing stage. Data collected from fishermen and other stakeholders in the small-scale fishing sector indicate that this activity is a good source of income and employment and plays an important role in supplying markets with seafood products. However, the intensification and observed shortcomings in fishing activities may impact the sustainable management of the landing stage. The results obtained are presented and discussed successively from socioeconomic and environmental perspectives. According to literature on the development of artisanal fisheries in Guinea, the Bonfi landing stage underwent initial development work between 1985 and 1992 as part of the ODEPAG project (Office for the Development of Artisanal Fisheries and Aquaculture) [7]. Despite these efforts, the users and authorities of the landing stage were unable to sustain these achievements for years, so much so that today this landing stage is now characterized by a severe state of unsanitary very pronounced. Thus, our observations on this landing stage in the urban commune of Matam (Republic of Guinea) produced the followings results.

Current Status of Places

1. Ecological Assessment

The observed sources of pollution were of human origin:

Discharge of domestic wastewater; presence of solid waste (household garbage and plastics); Poorly regulated human activities; haphazard installation of equipment facilities and business activities, presence of inadequate infrastructure for informal-sector activities [8].

2. Assessment of the Condition of Infrastructure and Equipment

3. Absence or Insufficiency

Sanitation systems, waste management equipment, sanitary control, fishing equipment repair workshop, conveyors, cranes, cold room, signage, Hygienic processing tables or equipment, shops or treatment, warehouse, kiosks or retail markets, weighing and packaging equipment, waste disposal facilities are absent, insufficient outboard motor maintenance workshops, lack of electric fish smoking facilities, toilets or latrines; docks or access ramps for canoes, absent, circulation area, presence two ice-making units for preserving seafood products, supplied by a borehole located 100 meters from the landing stage (***very insufficient for the 200 fishing canoes***), of a fuel supply station (a single pump), of a traditional fish-

smoking shed using wood as fuel, a non-operational refrigerated vehicle (Figure 2). Presence of a police station providing security services. The site exhibits alarming levels of poor sanitation.

1) Quay and Landing Site (Observation of His Condition)

Presence of numerous cracks, concrete erosion, subsidence observed in certain areas, lack of regular maintenance with a risk of users slipping and difficulties for fishing canoes in accessing the landing site.

2) Access (by Road)

Congested or damaged roads, stagnant rainwater, frequent traffic jams caused by commercial activities of the landing stage, a pirogue access ramp littered overrun with garbage, the presence of a fuel supply station.

3) Areas for Sales and Storage for Seafood Products or other Fishing Equipment

Undeveloped speaces; no: workshop for fishing equipement; fishery products exposed to the open air (health risks); shops or warehouses; sales hall; kiosks or retail market area; weighing and packaging equipment; absence of a waste disposal area.

4) Hygiene Infrastructure

Latrines, sanitation systems, and waste management, generally inadequate or even non-existent, visible pollution (solid waste and wastewater).

4. Available Equipements

1) Equipements of Conservation

Presence: of a functional ice-making supplied by a borehole located located by a well located 100 meters from the site; a refrigerated truck that is out of service (Figure 2).

2) Fishing Equipment

Presence of numerous artisanal canoes, outboard motors (often broken down), and worn-out or unconventional fishing nets.

3) Materials Handling Equipment and Other Small Equipment

Presence of basins (baskets as the dominant means of transport), lack of conveyors, cranes, hygienic treatment tables or equipment.

4) Safety

Lack of road signage, night lighting; presence of a police station for security services. The site exhibits an alarming level of unsanitary conditions.

5. Economic Difficulties

Drop in users' income (high expenses for sea trips and in the taxes).

1) Tendency Traffic and Circulation in the Landing Stage

The observation results showed an average of nearly 200 pirogues in operation, with regular traffic of economic operators at the site transporting their products. Goods are transported on foot, by motorcycle, by taxi, or by tricycle. During periods of high visitor volume at the site, the spaces within the landing site become overcrowded, which slightly disrupts operations. This demonstrates that the existing port reception infrastructure are inadequate.

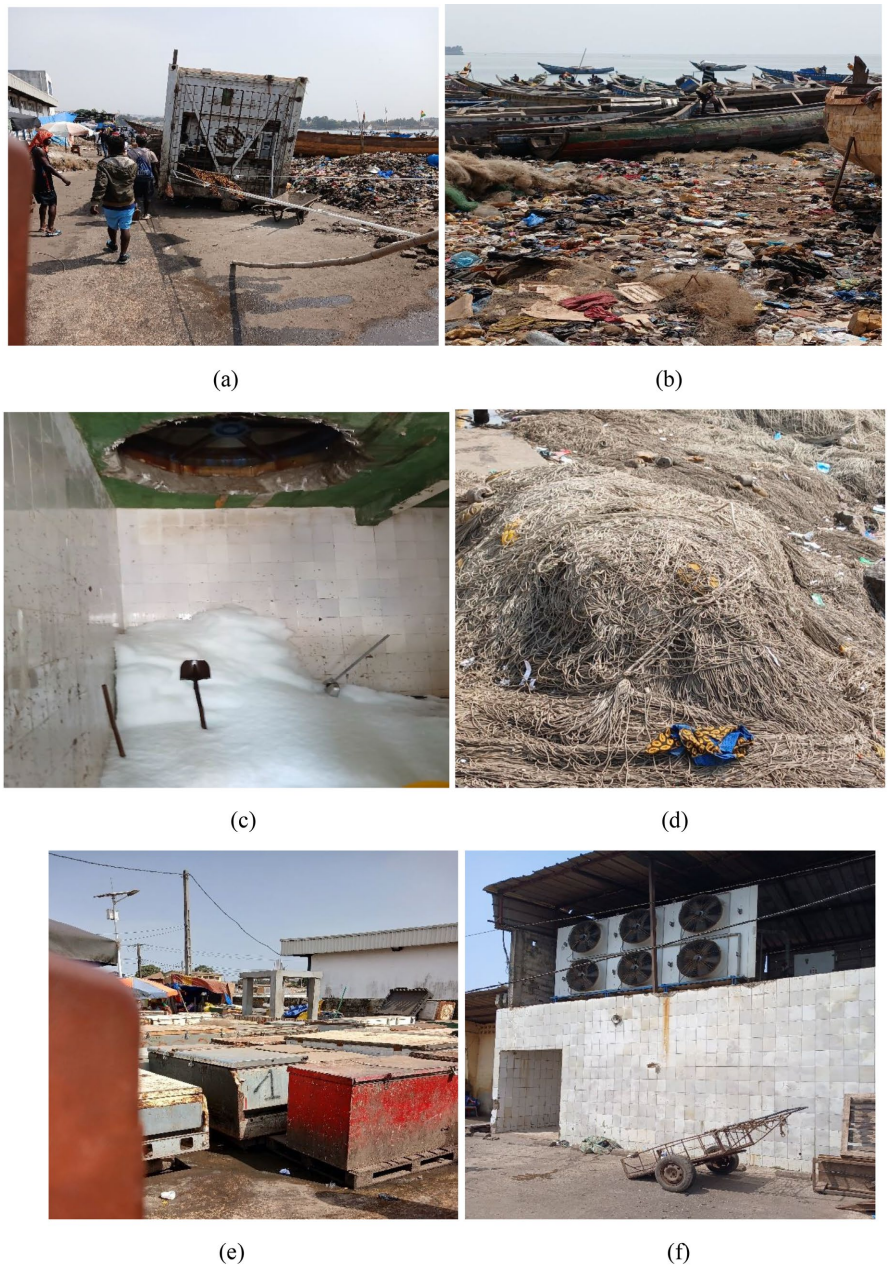

Figure 2. Showing some illustrative images: (a) decommissioned refrigerated vehicle; (b) garbage dump on the access ramps for pirogues; (c) ice stalactites or ice formations extending downwards from the ceiling; (d) fishing equipment or a fishing net placed on the ground; (e) mix of decommissioned and functional refrigerators; (f) Exterior view of the ice manufacturing plant.

6. Evolution of the Fishing Canoe Fleet and Fish Species Most Frequently Landed at the Site

A significant increase in the fishing canoe fleet between 2019 and 2024 and in the species of fish landed was observed at the Bonfi site. The species landed are predominantly small pelagic fish. The results found are as shown in Figure 3 and Table 1.

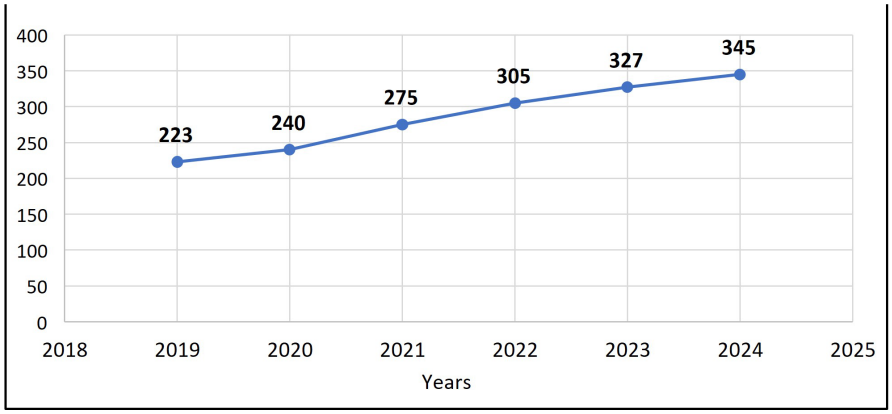

Figure 3. Changes in the fishing Canoeat the Bonfi Artisanal Landing Site, 2019-2024.

The main species and quantity of fishery resources frequently landed at the small-scale fishing port of Bonfi are shown in **Table 1** and **Figure 4**.

Table 1. Showing the main species of fishery resources frequently landed at the small-scale fishing port of Bonfi.

Families	Scientific Names	French Names	Soussou Names (en Guinea)
Clupeidae	*Ethmalosa fimbriata*	Ethmalose	Bonga
Sparidae	*Pogellus belloti*	Daurade	Sinapa
Scianidae	*Pseudotolithus typus* (spp)	Otholites	Sossoé
Sphyraenidae	*Sphyraena barracuda*	Barracuda	Kouta
Carangidae	*Trachurus trachurus*	Chinchard	Bologui
Claroteidae	*Arius heudolotii*	Mâchoirons	Konkoé
Cynoglossidae	*Cynoglossus monodi* (spp)	Sole	Fagba
Polynemidae	*Pentanemus quinquarius*	Capitaine royal	Gbalakassa
Clupeidae	*Sardinella maderensis*	Sardinelle	Bonga Série

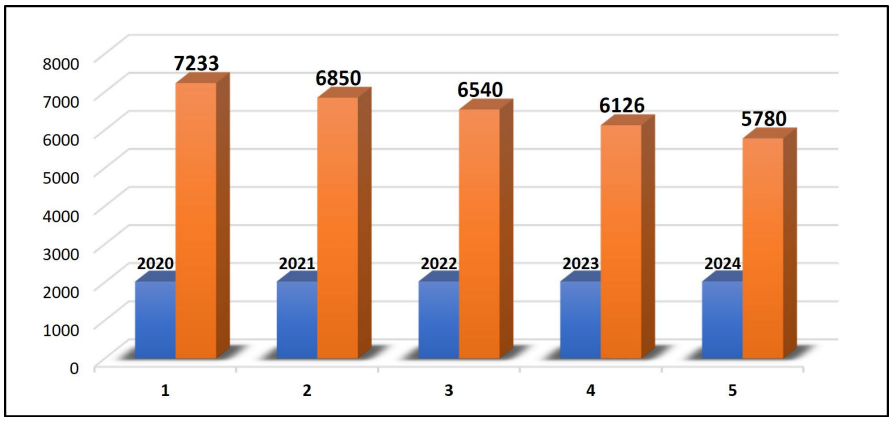

Figure 4. Showing the landing rate of fishery resources at the Bonfi artisanal landing stage from 2020 to 2024.

Figure 4 shows that the landing rate of fishery resources at the Bonfi landing

site decreases each year. It went from 7,233 tonnes in 2020 to 5,780 tonnes in 2024—a reduction of nearly 1,453 tonnes over five (5) years. This difference could be due to several factors: increase fishing intensity, destruction of fish breeding habitats, etc.

7. Policies, Regulations, and Operations

Applies on: capture of certain species during the breeding season, types of nets used, workplace safety, hygiene, possession of a fishing license, dumping of waste into the water, haphazard parking of canoes. However, the application is inadequate. The rules that are enforced are a mix of local practices + national port regulations + interventions by the authorities. The site is operated by a port chief (appointed by the authorities and recognized by the community).

8. Existence of a Professional or Trade Union Structure

Composed of: In addition of a chief of port, who is assisted by achairperson of the landing stage development committee (CDD), which is responsible to ensure the coordination of the user community, organize and oversee the arrival of pirogues and commercial activities, manage conflicts between users, and enforce local principles. However, there are other small entities that are associations or groupings of Fishermen, women fishmongers and smokers, carpenters and mechanics, and outboard motors that play a role in union organizing. These groups are sometimes more powerful than the administration. Thus, these management structures can be described as empirical, relying on local practices (the experience of the actors) rather than on a modern or formal organization. Example: The canoes dock wherever there is space. Decisions are made by the chief or according habits.

1) Types of fishing encountered

2) There are two types of fishing

"Lou Radier" pirogues (using fish hook) for 10 days of fishing.

Canoes (using nets) for 7 days of fishing Among the fishermen surveyed, 62% use the encircling gillnet, 20% use the net bottom-set gillnet; 13% use drift gillnets and 5% use seine nets (Figure 5) net specifications used: (mesh size) 25 - 40; 80 - 220; 40 - 70; 16 - 28 (mm); (depth) 6 - 8; 6 - 25; 5 - 15; 3 - 6 (m); and (length) 500 - 800; 600 - 1000; 300 - 1000; and 400 - 500 m, respectively.

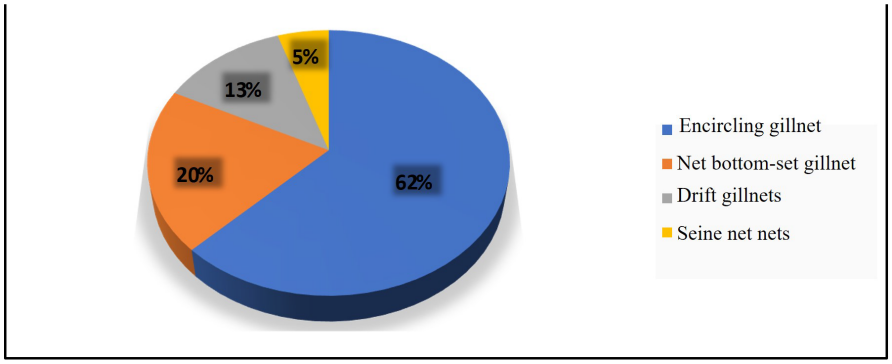

Figure 5. Showing the percentage of use of different fishing nets by fishermen.

9. Governance

1) Based on numerous unwritten rules.

2) Decisions are often made through negotiation (for example: in the distribution of sales space, access to the docks and conflict management) taking seniority into account, the Influence of local those responsible in the Landing stage and Social Relations.

3) The State is only present than in cases of insecurity, unauthorized urbanization, and in eviction and supervision operations. There are many practices that work also informally (no strict regulations). The governance of the landing stage is disorganized and flexible.

a) Economic Aspects

The **taxation** system at the Bonfi landing stage is a combination of informal and formal (parafiscal levies), involving several collectors. The amounts paid vary depending on the actors involved.

b) Taxable Activities

Regarding permits (fishing permits, canoe operating permits, etc.), instead of these permits we find daily or informal payments, tickets for access to the landing stage, local permits.

c) Types of Tax Collection Practices Observed in This Landing Stage

Informal or parafiscal tax collection.

4) Who Is Responsible for Collecting Taxes?

There are several informal and formal structures representing various services (local governments, unions, port authorities, sanitation services, environment, municipalities, fisheries, etc.), who collect fees simultaneously each day and for each activity at the landing stage, undetermined amount that is not strictly regulated by the state formal state tax collection system shown in Table 2.

5) Method of Collection

Direct payment in cash by users (fishermen, fish wholesalers, fish cutters, merchants, etc.) without using banking or digital systems, sometimes accompanied by informal payment receipts. The taxes paid are individual, numerous, and paid daily to largely informal entities. The vast majority of this revenue eludes the government.

Table 2. Showing a summary of taxation at the Bonfi landing stage.

Activity	Type of tax	Average Estimated Amount (GNF)	Frequency	Who Collects?
canoe docking	Docking fee	15,000	Per landing (day)	chief of the port/Fisheries department
Transport of passagers	Transport tax	4.000/passenger	Per trip	Municipality/union/safety
Artisanal fishing (capture)	Fishing fee	8,000	Per outing or per day	Fisheries department/local agents
Fish sales	Market fee	1500 /basin: the contents of one (1) basin is about between: (15 - 30 kg)	Per sale (day)	Municipality (market)

Continued

Processing (smoking, drying)	activity tax	2,500	Per day or per kiln	Municipality/Environment
Space occupancy	Stall fee	8,000	Per day or month	Municipality
Miscellaneous trade	Business license tax	4,500	Per day	Municipality/informal agents
Ice/Storage	Service tax	2,500	By usage	Site Management/Private
Fishing license or fishing permit	Local levy	50,000	Per year	Landing stage management committee + harbor chief (under state supervision)
Unloading of goods or passengers	Landing tax/month	400,000	Per landing (day) 20,000 GNF/day × 20 days of activity = 400,000 GNF	The landing site is not modern or well-organized. Collection is sometimes delegated to the landing site managers, and sometimes to locally appointed agents (official or semi-official).
Local (informal) contribution	Social fee	200,000	Per year	To trade unions/local groups

Notes: The amounts paid depend on the activities carried out. Passenger transport taxes from the islands and the Republic of Sierra Leone. Several local actors are informally involved in the collection of these taxes. However, due to the low level of official fishing permit ownership, some fees are collected through daily ticket payments by various local actors.

Respondents stated that nearly 70% of residents in the neighborhoods surrounding the landing stage derive their income from activities at the site Approximately 270 direct jobs have been identified (landing-site activities), along with 100 indirect jobs linked to related activities: small businesses, transport, food service, etc.

6) Economic Estimation Methodology

The estimated economic values were derived from approximations based on observations and supplemented by surveys conducted using structured questionnaires, in the form of semi-structured interviews with economic stakeholders (fishermen, fish smokers, fish vendors, traders, etc.). The information collected covered: number of weekly trips, duration of trips (hours), Total quantity caught (kg), main species caught, average daily sales (kg)/day, average selling price (GNF/kg), sales locations, as well as the main expenses incurred by the users, namely (fuel, ice, labor, fresh fish for women who smoke, and other expenses). Thus, we considered the following: an average fisherman makes 20 fishing trips per month, with each trip being a daily round trip using a traditional canoe operated by a small crew, along with the sale of smoked fish, etc. Fishermen reported an average unit price of GNF 20,000/kg, with an average daily sale of 30kg/day of fresh fish and 20 days of activity per month. About 30 female smokers reported a selling price of 850,000 GNF for a dozen smoked fish, including the purchase price of fresh fish (400 GNF), smoking wood, and transportation costs over 15 days of activity shown in Table 3.

Table 3. Estimated economic revenues from canoe fishing activities and smoked fish sales at the landing site.

Products	Number of days of activity at sea, average quantity sold in kg/day, or calculation assumption.	Monthly gross revenue per actor (GNF)	Number of actors	Total monthly gross revenue (GNF/month)
Fresh fish (canoes)	20 days × 30 kg/days × 20.000 GNF = 12,000,000 GNF/canoe.	12,000,000	200 canoes	2,400,000,000 GNF
Smoked Fish	15 days × 400,000 GNF (Estimated potential profit without expenses) = 6,000,000 GNF/Female fish smoker.	6,000,000	30	180,000,000 GNF
Total gross revenue				**2,580,000,000 GNF/monthly**

Notes: Average selling price of fresh fish: **20,000 GNF/kg**. Each fishing canoe is assumed to sell an average of 30 kg of fish per day, for 20 days of activity per month. Based on this, the estimated monthly revenue per canoe is: **12,000,000 GNF** either **2,400,000,000 GNF/**month **for 200 canoes**. For smoked fish, the estimated gross recipe value is **400,000 GNF/day and by Female smoker** in 15 days activity by month either e**stimated monthly gross revenue of: 6,000,000 GNF/Female smoker**. For 30 **Females smokers**, **the total estimated monthly gross revenue is 180,000,000 GNF. The costs associated with this smoking activity** (15 days activity) are: **purchase of fresh fish** (**150,000 GNF on average**) + wood 10 stere (cubic meters of stacked wood) × 3,000 GNF/stere (cubic meters of stacked wood) = **30,000 GNF/10 steres; 123,000 GNF** (transport + other small expenses) This results in a total cost of 303,000 GNF for the 15 days either: 150 000 + 30 000 + 123 000 = **303,000 GNF**. Given these estimated revenues and expenses, the fish-smoking activity at the Bonfi landing stage has significant economic potential. With an estimated monthly gross margin of **5 697,000 GNF**/woman, either: Estimated monthly gross sales = 6,000,000 **GNF/**woman the costs associated with the fish-smoking activity over a 15-day operating period = **303,000 GNF**, and of: (**170,910,000 GNF)** For all 30 women beneficiaries, representing a total of: **5,697,000 GNFx 30** women fish smokers = **170,910,000 GNF**. This activity helps improve the income and economic independence of these women who smoke, It also contributes to reducing post-harvest losses and enhancing the value of locally caught fish.

Table 4. showing the segmentation and monthly *reviews* of 26 days of activity of female fish trader at the Bonfi artisanal landing site.

Profile of female fish trader	Type of fish	Quantity per basin/day	Gross income/day (GNF)	Estimated net income/day (GNF)	Net income/month (26 days) (GNF)
Female fish traders dealing in commonly traded fish species	Sardine, bonga, horse mackerel	2	400.000 GNF	50.000	1.300.000 GNF
Female fish trader specializing in high-value fish species.	Sea bream, threadfin, shrimp	2	1300.000	1000.000	26. 000.000 GNF/month

Notes: Female fish traders dealing in commonly traded fish species: Ret income/day (all the revenue the Female fish traders receives from customers, without deducting any expenses) = 2 basin × **200,000 GNF unit price of a basin** = **400,000 GNF Gross income/day;** Estimated net income/day (actual profit) of the female fish trader = 400.000 **– 350,000 GNF (expenses)** = **50,000 GNF/day n**et profit; estimated net income/month = 50,000 × **26 days**= **1,300,000 GNF/month; Female fish trader specializing in high-value fish species:** Gross income/day ((actual profit) of the female fish trader) = (2) basins x **650,000 unit price of a basin = 1,300,000 /jour;** Estimated net income/day (actual profit) Female fish trader specializing in high-value fish species after expenses =1,300,000 – **300,000 GNF (expenses)** = **1,000,000 GNF/jour**, estimated net income/month = 1,000,000 × 26 days = **26,000,000 GNF/month**, The fish basin, usually made of plastic is the container in which fish are placed; it is widely used by female fish traders dealing to sell their fresh fish.

7) Economic Analysis of Fish Trading Activities at Bonfi

This activity is based on an economic segmentation system divided as follows: the common fish segment, characterized by low unit prices and high volumes, and the high-quality fish segment, characterized by high market value (high-end products) but low volume. This diversity in the structure of the activity results in varying monthly incomes. The details are shown in Table 4.

Table 5. Showing the approximate economic expenses per day of the 200 Canoes.

Expenses	Amount over 20 days of activity	Amount (GNF)
Fuel (litres) per canoe	150.000 GNF × 20 days	3.000.000
Ice/preservation	50 000 GNF × 20 days	1.000.000
Canoe/engine maintenance	It's a flat rate, and it's monthly	500.000
Nets and Equipment	Depreciation (spreading the value or cost of equipment over several days or over its useful life)	300.000/canoe
Labor (assistant or helper)	50 000 GNF × 20 days	1.000.000
Fishing Permit or License		100.000/year
Miscellaneous (transportation, unforeseen expenses)	-	300.000
Landing/Port Tax	20 000 × 20 days	400.000
Informal local contribution	-	200.000
Totals expenses		**6.800.000 GNF/**canoe

Table 6. Showing the approximate economic expenses of women fish smokers based on 15 days of activity.

Inputs	Estimated quantity purchased in kg/day	Number of days	Unit price in GNF	Total Amount (GNF)
Purchase of fresh fish	15 kg	15	20.000	4500.000
Ice/preservation	5 kg	15	5000	375000
Transport (cart)		15	1000	15000
Wood	2 stere (2 cubic metres of stacked wood)	15	3000/stere	90000
Total expenses			**GNF**	**4.920.000**

8) Quick Analysis of the Model with 200 Canoes

Total estimated monthly gross income from the 200 canoes (GNF/month) = **2,400,000,000 GNF/month or** sales revenue **(**Table 3**),** expenses for 200 canoes as shown in **(**Table 5**)** = 6.800.000 GNF/month × 200 canoes = **1,360,000,000 GNF,** Monthly net income of the 200 canoes = sales revenue - expenses = **2,400,000,000 GNF/month – 1,360,000,000 GNF = 1,040,000,000 GNF,** Net Margin = (Net income ÷ Gross Income) × 100 = **1,040,000,000 GNF** ÷ **2,400,000,000** = 0,4333 = 43,33%.

9) A Quick Review of the Canoe Model

Sales revenue = 12,000,000 GNF/month shown in Table 3.

Expenses = 6,800,000 GNF/month

Net income = 12,000,000 GNF - 6,800,000 = **5,200,000 GNF/month**, ...of a pirogue can be considered profitable and consistent with the performance of a well-managed artisanal pirogue, despite environmental constraints and their consequences, as well as constraints linked to the still-imperfect management of the Bonfi landing site.

10) Brief Overview of the Model Involving 30 Female Smokers

Total monthly gross income of the 30 women smoke in GNF/month = **180,000,000 GNF/month or Sales revenue (Table 3).** For the expenses incurred, due to the lack of official statistical data, the amounts for the various purchases made (the price of fresh fish, transportation, and smoking wood) were estimated based on the costs observed in the field shown in Table 6. However, it should be noted that the activities of the 30 women smokers are carried out every two days, corresponding to an estimated: 30 days/2 = 15 days of activity. Thus, the estimated monthly expenditure (15 days of activity) amounts to: **4,920,000 GNF/15 days activity**.

10. Trade Balance of the Activities of the 30 Women Fish Smokers

1) Total monthly gross income of the 30 women who smoke = **180,000,000 GNF/month.**

2) Monthly expenses = 149,400,000 GNF for 15 days of activity of the 30 women smoke.

3) Calculation of the Trade Balance (TB)

TB = Income - Expenses Balance

TB = 180,000,000 GNF - 149.400.000 GNF = **30,600,000 GNF**

Since the value of the balance is positive, this indicates that the activity is profitable after all expenses have been deducted. However, for each woman smoker we will have:

30,600,000 GNF ÷ 30 = **1,020,000 GNF/woman smoker /month**

4) Socioeconomic Analysis of Fishing at the Bonfi Landing Stage

This analysis shows that this activity is the main source of income for fishermen, women smoke, and and female fish trader. Data from our surveys showed that: a pirogue producing an average of 30 kg of fish per day over 20 days of operation, with an average selling price of 20,000 GNF per kilogram shown in Table 3, produces approximately 12,000,000 GNF in monthly revenue. After deducting operating expenses, estimated at 6,800,000 GNF, the resulting monthly net income is approximately: 5,200,000 GNF, which indicates that the activity is economically viable and profitable. In addition to its profitability, the Bonfi landing stage plays an important role in the marketing of fishery products by supplying other markets in Conakry and other localities through the activities of women smokers, female fish traders, wholesalers, and retailers. However, this economic benefit may increase pressure on fishery resources as demand rises, potentially leading to the overexploitation of fish stocks. Results of the analysis and interpre-

tation of water samples and physicochemical Parameters of the Soil Sample and Interpretation collected at three sampling points (E1, E2 and E3). Given the advanced state of visible unsanitary conditions at the Bonfi landing site, prompted us to conduct these three sampling operations, the mean values of which are presented in are presented in Tables 7-8.

Table 7. Showing physicochemical parameters of the water at the landing stage and interpretation.

Parameters	Average ± SD	Recommended Limit Values	Compliance	Synthetic Interpretation
pH	**7.32**	6.5 - 8.5	Compliant	Slightly neutral water, conducive to aquatic life and the stability of chemical balances.
Temperature (˚C)	**26.67** ± 0.15	<30	Compliant	A normal average temperature, with no thermal impact on marine wildlife.
Conductivity (µS/cm)	**50600** ± 8 214.62	<5000	Not applicable with regard to potability standards.	A very high value, reflecting the high salinity of the coastal waters. This value must be interpreted within two contexts—the marine environment and the natural salinity of the setting—rather than against drinking water standards.
Turbidity (FTU)	**58,00** ± 1.00	<100	Compliant	The water is relatively clear. However, the site warrants monitoring.
Total dissolved salts (mg/L)	**43,031.85** ± 4 123.89	<3000	Not applicable with regard to potability standards.	High dissolved salt content, consistent with the marine characteristics of the waters studied. The variations observed between stations may be attributed to hydrological conditions and the natural salinity of the environment.
DBO_5 (mg) (O_2/L)	**4.53** ± 0.06	≤5	Compliant	The water shows low levels of biodegradable and oxidizable organic pollution.
DCO (mg) (O_2/L)	**24.33** ± 0.06	≤40	Compliant	
Nitrates (mg/L)	**12.63** ± 0.06	≤50	Compliant	The concentrations of nutrients and trace elements remain within the recommended limits, indicating good chemical water quality and limited anthropogenic influence.

Table 8. Showing physicochemical parameters of the soil sample and interpretation.

Parameters	Resultats	Criteria	Compliance	Synthetic Interpretation
Texture	Sandy silty			The texture indicates a sedimentary depositional environment, reflecting moderate transport of particles by water, which are subsequently carried and deposited along the coast.
Structure	Granular Stable			Structured soil that promotes infiltration and good water and air circulation. Soil that is relatively resistant to erosion.

Continued

Moisture Content (%)	19.35 ± 0.13			This value indicates moderately moist soil, neither excessively water-saturated nor too dry.
pH	7.85 ± 0.08	6.5 - 8.5	Compliant	Shows a moderately alkaline soil, favorable to biological processes and nutrients.
Organic matter (%)	2.95 ± 0.05	>2%	Compliant	High organic matter content; this reflects the influence of human activities at the landing site.
Total nitrogen (%)	0.22 ± 0.03	0.1 - 0.3%	Compliant	The determined total nitrogen content of 0.20% falls well within the 0.1 - 0.3% range. This indicates that the nitrogen level in the soil is normal.
Phosphorus (P_2O_5) (mg/kg)	27.78± 0.13	15 - 40	Conforme	
Potassium (K_2O) (mg/kg)	142.60 ± 0.00	**142.6**	Compliant	All values for the indicated parameters: (K_2O), Lead (Pb), Cadmium (Cd), Mercury (Hg), and CEC (cation exchange capacity) are normal.
Lead (Pb) (mg/kg)	21.75 ± 0.05	**21.8**		
Cadmium (Cd) (mg/kg)	0.39 ± 0.00	**0.39**		
Mercury (Hg) (mg/kg)	0.06 ± 0.00	**0.06**		
CEC (cmol(+)/kg)	15.87 ± 5.70	10 - 25		

3.2. Discussion

The results of the physicochemical parameters reported in **Tables 7-8**, indicate that, in general, many parameters meet the quality assessment criteria (compliance) established for evaluating the sites studied. However, these analytical results must be interpreted in light of the observations made in the field. Indeed, despite the compliance of several physicochemical parameters, visual observations reveal a high level of unsanitary conditions, characterized by the accumulation of waste, out-of-service equipment, and organic matter resulting from human activities at the landing stage. These conditions may pose risks to the environment and public health. The results were compared to the World Health Organization's recommended standards for drinking water and the EPA's international guidelines for soil, in the absence of specific, detailed standards in the Republic of Guinea [7]. **Figures 1-3** show the geographical location (**Figure 1**) and some illustrative images shown in (**Figure 3**), including: (**a**) a decommissioned refrigerated vehicle; and (**b**) a waste dump on the access ramps for canoes; **(c)** icicle-like ice formations hanging from the ceiling; **(d)** fishing gear or fishing net lying on the ground, **(e)** mix of refrigerators out of service and operational refrigerators; **(f)** Exterior view of the ice-making plant and the evolution of the fishing canoe fleet at the Bonfi artisanal fishing port 2019-202 (**Figure 3**). Although many physicochemical parameters meet the criteria, visual observations in the field reveal a high level of unsanitary conditions due to the accumulation of waste, decommissioned equipment and organic matter associated with human activities at the landing site, which are potential health risk factors [9]. **Figure 3** shows that the number of ca-

noes in Bonfi has grown year after year by 223 in 2019 at 345 in 2024 According to our surveys based on our field surveys conducted among users and local managers of the landing site (latest available data) on a total of 7.450, estimated Guinean fishing canoe fleet.[10]. This result shows an increase of 122 canoes over six (6) years between 2019 and 2024 and a significant decrease in fishery product landings during the same period, amounting to 1453 tonnes shown in **Figure 4**. This trend may be linked to a number of factors, such as environmental conditions, fishing effort, and socioeconomic factors [11]. However, in the absence of standardized data on fishing effort and other information identifying the causes of this decline, it cannot be directly attributed to overfishing. This decline in landings has economic consequences for the profitability of the landing stage, such as, for example: the decrease in the volume of fish marketed, a decrease in the income of fisheries stakeholders, human pressure on the site's infrastructure, resulting in generation, the accumulation and mismanagement of waste. By comparison, with a total of 345 canoes in 2024, the Bonfi landing site exceeds the threshold of 200 canoes used as a criterion for classifying major landing sites in the Atlas. However, the canoe fleet at Bonfi remains smaller than that of some major Senegalese landing sites, such as Joal and Kayar, which can accommodate 500 canoes or more [12]. **Figure 5** shows the percentage of users of the various fishing nets at the Bonfi landing stage which are: 62% use encircling gillnets, 20% use set gillnets, 13% use drift gillnets, and 5% use seines. Our results differ from those reported by [10], who indicate that in Côte d'Ivoire, the gear primarily used to harvest fishery resources by Fanti fishermen an Akan ethnic group originating from the central coast of Ghana are: purse seines and encircling gillnets. However, if this overfishing trend is not reversed, it could seriously jeopardize the economic viability of the landing stage.

3.3. Analysis of the Management Model and the Trade Surplus

The management model observed at the Bonfi landing stage is a mixed management system**,** primarily based on a community-based and informal management model, involving public authorities, namely: Ministry of Fisherie, port authorities, security services, and local stakeholders: Fishermen, female fish traders, trade unions, tax collectors, and landing site committees. Many decisions and payments are made informally, without clearly defined procedures. A management model applied in the Ampiyacu Basin in northeastern Peru within the framework of community-based forest enterprises (CSFEs) engaged in timber harvesting [13]. The activities at the landing stage generate more revenue than they incur in expenses, as the trade surpluses generated by the landing site's activities are positive and contribute significantly to the local economy.

4. Conclusion and Recommendations

This study made it possible to assess the socioeconomic importance of artisanal fishing activities at the Bonfi landing stage, which constitute an important source

of income and employment for the various stakeholders. The results indicate that fishing and related activities, such as the sale and smoking of fish, they can still generate appreciable profitability when the operating conditions are adequate and properly respected, although this economic contribution is accompanied by significant pressure on fishery resources, related to the growth of fishing activities and the constraints associated with the management of the site. Thus, the sustainability of this sector requires the implementation of appropriate measures to promote the long-term sustainable exploitation of fish stocks, better organization of stakeholders, and the strengthening of landing and fish preservation infrastructure.

Author Contributions

Conceptualization: Author Nounténin Sidimé, Author Daouda Konaté, Author Adama Moussa Sakho and Author Kandet Bangoura; Methodology: Author Nounténin Sidimé, Daouda Konaté, Adama Moussa Sakho and Kandet Bangoura; Software: Author Ansoumane Sakouvogui; Validation: Authors, Nounténin Sidimé, Daouda Konaté, Adama Moussa Sakho and Kandet Bangoura; Formal Analysis: Author Adama Moussa Sakho and Ansoumane Sakouvogui; Investigation: Author Nounténin Sidimé, Daouda Konaté and Adama Moussa Sakho; Resources: Author Nounténin Sidimé, Daouda Konaté and Adama Moussa Sakho; Data Curation: Author Nounténin Sidimé, Daouda Konaté and Adama Moussa Sakho; writing—original draft preparation, Nounténin Sidimé, Daouda Konaté and Adama Moussa Sakho; writing—review and editing, Nounténin Sidimé, Daouda Konaté, Adama Moussa Sakho and Kandet Bangoura; visualization, Author Adama Moussa Sakho, Ansoumane Sakouvogui and Kandet Bangoura; supervision, Author Kandet Bangoura, Nounténin Sidimé, and Adama Moussa Sakho; project administration, Kandet Bangoura and Adama Moussa Sakho; funding acquisition, Nounténin Sidimé and Adama Moussa Sakho. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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