Social Sciences & Humanities Open 7 (2023) 100377

Contents lists available at ScienceDirect

Social Sciences & Humanities Open

journal homepage: www.sciencedirect.com/journal/social-sciences-and-humanities-open

Regular Article

How the pre and post COVID-19 era have shaped system understanding of the socioeconomic impact of small-scale inland fisheries

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ARTICLE INFO

Keywords:
Resilience
COVID-19
Pandemic
Small-scale
Blue economy
Fish-food systems

ABSTRACT

The current study provided a socioeconomic quantification of small-scale inland fisheries in East Africa using fish market information data for major markets in the pre (2009–2017) and post COVID-19 containment (Jan–May 2022) eras. The socioeconomic status index (SEI) incorporated 6 dimensions: access to fresh fish, access to market, available fish processing (drying) infrastructure, favourable price range, high quantity range traded, and high seasonal profit margins; using three major commercial fishes (Nile perch, Tilapia and Dagaa) and the season (pre and post COVID-19) as the main independent variables. The SEI was calculated using a segmented sociometric scale interval as: $\geq$ 4.21Very High $\leq$5.00; $\geq$3.41 High $\leq$4.20; $\geq$2.61 Moderate $\leq$3.40; $\geq$1.81 Low $\leq$2.60; and $\leq$1.00 Very Low $\leq$1.80. The socioeconomic quantification was highly dependent on COVID-19 containment periods that reflected very high (pre COVID-19 = 4.67, post COVID-19 = 4.06) impacts on small-scale inland fisheries. This suggested a negative impact of COVID-19 on small-scale inland fisheries attributed to various factors such as disrupted value chains, reduced purchasing power among the customers, struggles by businesses to compensate for losses incurred during the pandemic, and diversion of economic focus. The impact had a lower proportion on Dagaa, given its low value compared to the other two major commercial species. The quantification of fish data during a pandemic is useful to provide mitigation measures for shocks that could be anticipated in the sector for sustainable fish-food systems.

1. Introduction

Fisheries serve an important role in the economic progress of many countries (Njiru et al., 2018). More than 40 million people worldwide rely on small-scale inland fisheries for subsistence, accounting for roughly half of the total catch in developing countries (FAO, 2018). As a relatively inexpensive source of animal protein, it is difficult to overstate the relevance of fish for people living in tropical regions, notably the most vulnerable populations (Woodhead et al., 2018). The East African region has plenteous fishery resources which offer countless opportunities for the native community to spur economic and social transformation (Schubert et al., 2021). For Kenya and Uganda, small-scale inland fisheries comprise the majority of catches and employ the most fishers.

In Kenya, for example, the fisheries sector supports the national Gross Domestic Product (GDP) by contributing a proportion of 4.7% (Mulatu et al., 2018). Inland capture fisheries account for 83% of total fishery and aquaculture production, which is expected to be around 186, 700 tons (FAO, 2016). Thus, the most important Kenyan fisheries are those undertaken inland, with Lake Victoria dominating fish production and accounting for more than 80% of total fish landings (KMFRI, 2018, p. 33).

Similar to Kenya, Lake Victoria is also Uganda's major source of fish. Uganda's sector of the Lake is 43% in contrast to Kenya's 6% and Tanzania's 51% (Njiru et al., 2012). The country produces an estimated 217,000 metric tons of fish annually amounting to an estimated US $ 72, 468 million (FAO, 2020). The Lake Victoria catchment area is also important in supporting a variety of agricultural industries, provision of cheap and nutritious food stockpile, and creation of export earnings (Aura et al., 2022a). Besides, small-scale fishing offers a great portion of income for rural and peri-urban residents who are economically disadvantaged in the Lake Victoria Basin (Gangadhar, 2011).

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https://doi.org/10.1016/j.ssaho.2022.100377
Received 14 July 2022; Received in revised form 13 November 2022; Accepted 16 November 2022
Available online 28 November 2022

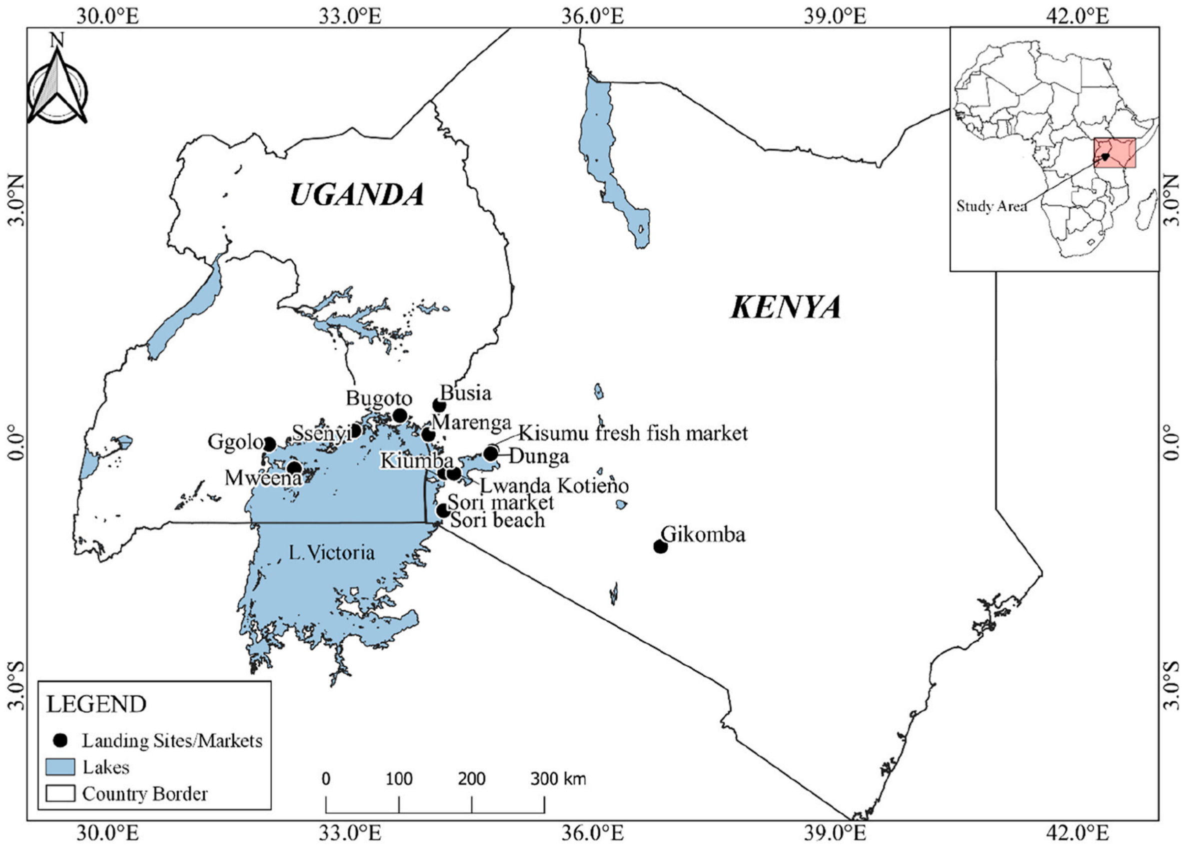

Fig. 1. Major markets and landing sites (beaches) involved in the Enhanced Fish Market Information System (EFMIS) in Kenya and Uganda.

Uganda, as opposed to Kenya, is land-locked and gets most of its food from inland fishing (Njiru et al., 2012). Natural water bodies account for 18% of Uganda's land area (or 42,000 km^2), and the fishing industry is a major source of food and income for the country and its citizens. Furthermore, several smaller lakes, swamps, and streams such as Edward, Albert, George, Kyoga and the River Nile, contribute to the annual national catch in a substantial proportion (FAO, 2016).

Among the issues emerging in the Lake Victoria eco-region are the increase in fishing pressure, emergence of invasive species, dwindling of biodiversity, degradation of the environment, conflicts due to access and ownership, ecological shifts, climate change, lack of information, and inconsistencies in policy (Nyamweya et al., 2020). Currently, fisheries production has also been impacted by COVID-19 effects in East Africa (Aura et al., 2020). However, current and upcoming mitigation and adaptation actions may not be properly guided due to limited information available on the impact of COVID-19 on fishery-based livelihoods (FAO, 2020).

The outbreak of COVID-19 was first discovered in Wuhan, China, in December 2019, and then spread to other countries (Aura et al., 2020). On January 30, 2020, and March 11, 2020, the World Health Organization (WHO) issued pandemic declarations for the situation (UN News, 2020). In Kenya, the first case of COVID-19 was discovered on March 12, 2020 and by June 9, 2020, about 2989 people had been infected across the country (Anadolu Agency News, 2020; MoOdende & pers. comm, H Anadolu Agency News, 2020).

The pandemic impacted every step of the fisheries' value chain. Curfews, for example, implemented in developing countries, reduced fishing time and the number of fishing trips on the production node (Aura et al., 2020; Isingoma, 2020). Capacity for fish processing and export has therefore reduced, as well as quantities processed and trade nodes (Sustainable Fisheries Partnership, 2020). As a result, vulnerable fishing communities have struggled to find markets for their catch and adequate storage facilities for their excess catch (FAO, 2020).

The Kenyan government implemented policies to stop the spread of COVID-19 and minimize casualties (Fiorella et al., 2021). Among these measures were curfews, social isolation, the closure of places for congregational worship and schools, and dusk to dawn curfews (Aura et al., 2020). Travel restrictions to major fish markets and curfews affected how long fishers could stay out at sea and how much money they could make selling their catch (Fiorella et al., 2021). When COVID-19 arrived in Uganda in early March, the Government of Uganda quickly put in place several measures drawing from their similar experience with other contagious diseases such as Ebola. Among the measures taken were closure of entry points into the country, prohibition of public gatherings and the use of public transportation, closure of schools and places of worship, and the declaration of a national lockdown and curfew (Margini et al., 2020).

An innovative Information and Communication Technology (ICT) project based on mobile phones was created and tested in June 2009 to overcome market information gaps in the Lake Victoria region's markets. This system continued to provide data even during the COVID-19 containment period (Aura et al., 2020; Margini et al., 2020). Named the Enhanced Fish Market Information System (EFMIS), the project has equipped the fishing community with essential fish market information to strengthen their bargaining position and increase their market share. It was intended to increase fish trading and the earnings of the fishing community and has continued to provide data for the Kenya Marine and Fisheries Research Institute (KMFRI) in the pre and post COVID-19 containment eras (Margini et al., 2020).

The digitalization of fisheries data has thus become crucial for assisting KMFRI in understanding the fish market trends in the pre and post COVID-19 containment periods. This is based on the premise and guarantees that sellers and purchasers are linked, resulting in consistent market access. However, there is still insufficient knowledge about how

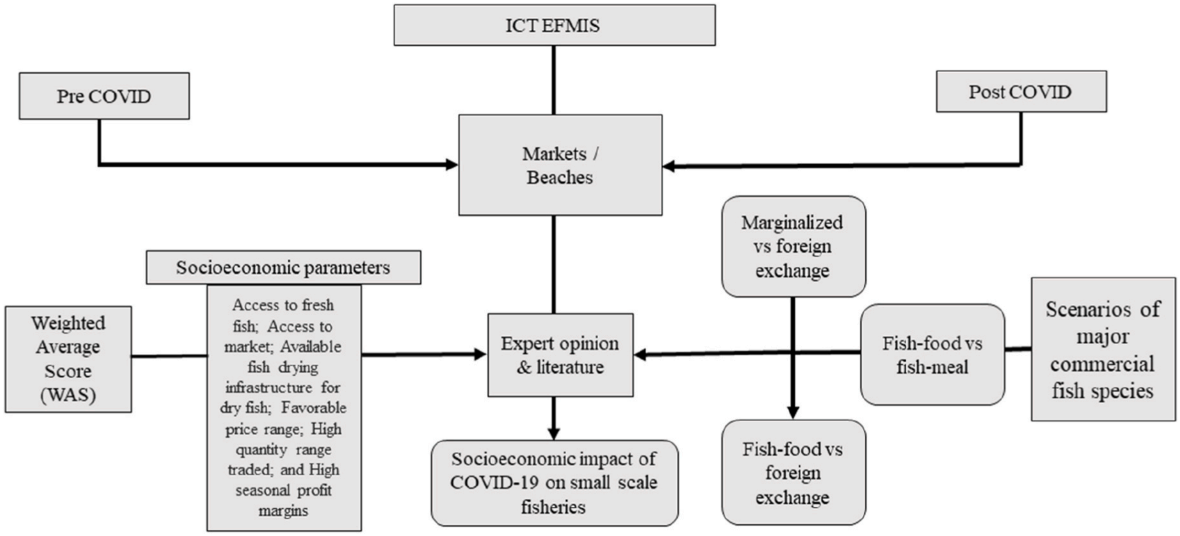

Fig. 2. Schematic representation towards building an understanding of the socioeconomic impact of COVID-19 containment measures on small-scale inland fisheries.

disasters like COVID-19 have affected the socioeconomic status of small-scale inland fisheries to aid in developing strategies and interventions for resilience in the industry. Our study evaluated the socioeconomic impact of the pre and post COVID-19 containment eras on small-scale inland fisheries to guide the governance and productivity of the sector for blue growth.

2. Materials and methods

2.1. Study area and sample selection

Uganda had 15 landing sites spread in 10 districts while Kenya had 205 landing sites spread across 21 counties in the pre COVID-19 era. A myriad of factors, including transfers, redeployments, and retirement of staff, led to the closure of some landing sites and markets in the post COVID-19 era. In Uganda, all sites were closed during the COVID-19 era rendering a comparison between the two-eras undoable, thus excluded from analysis. In Kenya operational markets during the COVID-19 era were 16, spread cross 11 counties. The markets were purposively sampled based on five criteria, namely (a) marketing potential indicated by proximity to densely populated towns (b) dominance of fisheries and fisheries related activities reflected by presence of large number of producers, processors and traders and (c) existing infrastructure for fish processing and marketing. The study was restricted to the same markets in the pre and post COVID-19 era in Kenya. In Kenya, the sites included Busia, Marenga, Kiumba, Dunga, Kisumu Fresh Fish Market, Luanda Kotieno, Gikomba and Sori. (Fig. 1).

2.2. Data sourcing and processing

Fig. 2 shows the schematic diagram employed in sourcing and processing data and information towards understanding the socioeconomic impact of COVID-19 containment eras on the small-scale inland fisheries. The EFMIS database hosted by KMFRI, Kisumu, served as the source of data covering the pre COVID-19 containment era from 2009 to 2017 and the post COVID-19 containment era from January–May 2022. By January 2022, the Kenyan government had lifted all COVID-19 restrictions that limited the movement of people and goods, and the COVID-19 positivity rate was very low at 1%. This provided a useful reference point for a post-pandemic market comparison. We monitored the market situation for the next five months (until May) in order to give a well-balanced comparison. It was during this period that Kenya was on its economic recovery path.

Given that fish market conditions face a lot of uncertainties from seasonal effects, longitudinal data covering a longer time span is usually better in capturing an accurate trend, hence we preferred a longer data duration (2009–2017) for the pre-pandemic era. Data collection using the EFMIS system faced some transmission and scope challenges between 2017 and 2019. This was due to limited funding. The project was however buoyed by government support in late 2019 and was restored to expected operations. Overall, we saw no point of limiting the pre-COVID-19 duration to five months to smoothen any seasonality, whereas we did not have any data into the future for the duration after COVID-19 regulations were lifted in January 2022, hence we compared to only 5 months of data. The EFMIS data platform uses comparable standard operating procedures (SOPs) in both Kenya and Uganda (Margini et al., 2020).

Data processing was guided by the scenarios affecting the socioeconomic status of the major commercial fishes i.e., Dagaa (DA), Tilapia (TL) and Nile perch (NP) using the "What if" function in Microsoft Excel, as well as deriving weighted average scores for the socioeconomic parameters used to quantify the impacts of COVID-19 on small-scale inland fisheries. First, the average monthly weights and prices of the three commercial fish species were computed from the original data. To capture the impact of quantity-price relationship of major commercial fish species of a small-scale fishery in the face of a pandemic, the study leverages on expert opinion, theoretical and empirical evidence to develop six (6) relationships for analysis. This is premised on the fact that the three commercial species i.e., dagaa, Nile perch and tilapia differ in economic potential and impact on the stakeholders in the value chain. As such, high quantity/catch of dagaa does not translate to a higher economic impact than the lower quantity of Tilapia or Nile perch. The latter species may be lower in quantity but with significant economic impact due to their high prices. The same scenario is evident between Nile perch and Tilapia, where a higher quantity of Tilapia does not imply a higher socio-economic impact than low quantity Nile perch since the latter has a higher price.

When building the scenarios, quantities were varied while prices of the three major commercial species were held constant. The quantity of one species is assumed to be higher than another followed by another in ascending order. The study includes six scenarios:

(i) Scenario M vs FE (DA > NP > TL) in this scenario, that is, Marginalized (M) verses Fish Export (FE); it is assumed that dagaa which is perceived as food for the marginalized/poor is higher in volume than Nile perch and tilapia respectively

Table 1
Quantitative interpretation of 5-Point Likert Scale measurements employed in the study.

Mean descriptive equivalent	Numeric scale	Weighted mean interval scale
Very Low	1	1.00–1.80
Low	2	1.81–2.60
Moderate	3	2.61–3.40
High	4	3.41–4.20
Very High	5	4.21–5.00

(ii) Scenario M vs FF (DA > TL > NP) comprising Marginalized (M) verses Fish Food (FF) assumes that dagaa which is perceived as food for the marginalized/poor is assumed to be higher in volume Tilapia and Nile perch respectively
(iii) Scenario FE vs FF (NP > TL > DA) implying Fish for Export (FE) against fish food (FF). In this scenario, the volume of Nile perch generally perceived as fish for export/rich due to its high economic potential is assumed to be higher than tilapia and dagaa, respectively
(iv) Scenario FE vs M (NP > DA > TL) implying Fish for export (FE) against fish for the marginalized (M). In this scenario, the volume of Nile perch is assumed to higher than dagaa and tilapia respectively.
(v) Scenario FF vs FE (TL > NP > DA) comprising Fish food (FF) against fish for export (FE). In this scenario, Tilapia volumes are assumed to be higher than Nile perch and dagaa respectively.
(vi) Scenario FF vs FM (TL > DA > NP) comprising Fish food (FF) against fish meal (FM). In this scenario, Tilapia is assumed to be higher in volume than dagaa and Nile perch respectively.

The scenarios were categorized into three main groups: the perceived status of the three major commercial fishes (Aura et al., 2019; Margini et al., 2020) in terms of marginalized versus foreign exchange; fish-food versus fishmeal; and fish-food versus foreign exchange. The scenarios formed six rated combinations in form of DA > NP > TL; DA > TL > NP; NP > TL > DA; NP > DA > TL; TL > NP > DA; and TL > DA > NP. The Busia and Gikomba markets were the most representative since they had information for both pre and post COVID-19 containment eras, hence they were used in the computation of the rates. The attributes were used to provide an impression of the general socioeconomic impact of small-scale fisheries on communities between the two periods regarding COVID-19 pandemic. A one-way ANOVA statistical technique was conducted to compare quantities of the pre and post covid-19 periods in Gikomba market in Nairobi region.

A socio-economic status index (SEI) was computed as a measure of the impact of COVID-19 on small-scale inland fisheries. The score was computed from weighted averages of the specific ordinal scores subject to the Likert rating (1 = Very Low; to 5 = Very High). The index incorporated 6 socioeconomic dimensions related to fish trade: access to fresh fish; access to markets; available fish drying infrastructure; favourable price range; high quantity range traded; and high seasonal profit margins. The choice of the variables for the index construction was based on expert knowledge and empirical studies (e.g., Abobi and Wolf, 2019; Aura et al., 2019). The overall sociometric scale was segmented as: $\geq$ 4.21Very High $\leq$5.00; $\geq$3.41 High $\leq$4.20; $\geq$2.61 Moderate $\leq$3.40; $\geq$1.81 Low $\leq$2.60; and $\leq$1.00 Very Low $\leq$1.80 (Table 1). To determine the Likert scale rank for each factor, equation (1) was used (Aura et al., 2022b).

$$\mathbf{WAS} = \frac{\mathbf{TWS}\ [(\mathbf{5xVH}) + (\mathbf{4xH}) + (\mathbf{3xM}) + (\mathbf{2xL}) + (\mathbf{1xVL})]}{\mathbf{Total\ number\ of\ observations}} \tag{1}$$

Where; WAS = Weighted Average Score; TWS = Total Weighted Score; VH = Very High; H = High; M = Moderate; L = Low; and VL = Very Low.

The Sociometric scale interval (SMS) was calculated using equation (2) (Aura et al., 2022b).

$$\mathrm{SMS} = \frac{\mathrm{Max} - \mathrm{Min}}{\mathrm{N}} \tag{2}$$

$$\mathrm{SMS} = \frac{5 - 1}{5}$$

All the EFMIS data were sourced as Microsoft Excel spreadsheets and eventually analyzed using Microsoft Excel and R statistical software version 3.6.0.

2.2.1. *Study limitations*

The current study focuses solely in Kenya in comparing the pre and post COVID-19 period. This is attributable to the fact that Uganda only used EFMIS in the pre COVID-19 era. Transfer, redeployments and retirement of staff led to some of the landing sites and markets being closed down. As a system, while EFMIS is most useful as a pioneer fish market data collection tool for the east African region, its initial dependance on donor funding led to sustainability challenges at the end of the project in 2017.

The scope of data collection was impacted in Kenya between 2018 and 2019 to accommodate for reduced funding from the central government, and it was not until late 2019 when the system was fully restored to paperless operations. Besides, since the system largely covers the trade dynamics of capture fisheries, other systems which integrate aquaculture systems could provide additional prospects in fish market assessments. The magnitude of the observed results and the interpretations are influenced by the indicators used in SEI. As a result, the indicator chosen should be theoretically or empirically guided. Patterns can vary. More research is needed to confirm the validity of these findings and to investigate the causal mechanisms underlying the associations between various aspects of the socioeconomic status index.

3. Results and discussion

According to the study, dagaa showed a 78% increase in an average price from 1.80 to 3.20 USD during the pre to post COVID-19 periods in the surveyed landing/market sites. It was found that Dagaa was consumed more frequently by small-scale fishing households in the face of COVID-19 period. Increased income levels have been found to affect the consumption of Dagaa (Garcia et al., 2012). This implies that the price of dagaa may have risen due to an increase in demand. The primary use of the dagaa is to make animal feed and food for humans (Odoli et al., 2019). This species is generally targeted for human consumption, but post-harvest conditions frequently result in quality reductions. Therefore, a large portion of the catch is used by animal feed manufacturers (Aura et al., 2022b). Today, dagaa is a necessary staple for food and nutrition security (Margini et al., 2020). Although more numerous and productive, small native fish species like dagaa are considered low-value commodities primarily reduced to use in animal feed, fishmeal and oil (LVFO, 2016).

Therefore, dissemination of policy information and its implementation should emphasize on a creative reinterpretation of the conversation about food security and pandemic scenarios by highlighting the nutritional, price and value of the three major commercial species. Nile perch recorded a 31.6% increase (2.66–3.50 USD) in average price from pre to post COVID-19 periods, whereas, Nile tilapia had a paltry 7.73% increase (3.62–3.90 USD) from pre to post COVID-19 containment eras. Higher fish costs have a positive impact on consumer preference and Nile tilapia consumers prefer to pay more for better quality and provenance, such as avoiding cheap Chinese fish, which is mass-produced (Odoli et al., 2019). It has been found that higher household income increased the demand for expensive fish varieties such as Nile tilapia (Ayuya et al., 2021). The European Union is the current significant market for Nile perch fillets with the primary purpose being for export (Aura et al., 2020; Chikowi et al., 2020); where the lift of travel restrictions for the post COVID-19 season made trade in the fish to be

Table 2
The ranked socioeconomic dimensions during the pre and post COVID-19 era in the Lake Victoria region. WAS = Weighted Average Score; and TWS = Total Weighted Score. The sociometric scale was segmented as: ≥ 4.21Very High ≤5.00; ≥3.41 High ≤4.20; ≥2.61 Moderate ≤3.40; ≥1.81 Low ≤2.60; and ≤1.00 Very Low ≤1.80.

Pre COVID-19 attribute	Very High	High	Moderate	Low	Very Low	Total	TWS	WAS	Rank
Access to fresh fish	9	3	0	0	0	12	57	4.75	2
Access to market	8	4	0	0	0	12	56	4.67	4
Available fish drying infrastructure	8	4	0	0	0	12	56	4.67	4
Favourable price range	7	2	3	0	0	12	52	4.33	7
High quantity range traded	9	3	0	0	0	12	57	4.75	2
High seasonal profit margins	10	2	0	0	0	12	58	4.83	1
Socioeconomic status index (SEI)								**4.67**	
Post COVID-19 attribute	**Very High**	**High**	**Moderate**	**Low**	**Very Low**	**Total**	**TWS**	**WAS**	**Rank**
Access to fresh fish	1	2	0	0	0	3	13	4.33	2
Access to market	1	1	1	0	0	3	12	4.00	3
Available fish drying infrastructure	2	1	0	0	0	3	14	4.67	1
Favourable price range	1	1	1	0	0	3	12	4.00	3
High quantity range traded	1	1	0	1	0	3	11	3.67	5
High seasonal profit margins	1	1	0	1	0	3	11	3.67	5
Socioeconomic status index (SEI)								**4.06**	

Table 3
Scenario ratings and categorizations of the three major commercial fisheries in Gikomba markets in the Nairobi region. Marginalized (M); fish-food (FF); foreign exchange (FE); fish-meal (FM). The "Current Values" column represents changing cell values at the time the scenario report was being computed. 1 USD = KES 100; data estimation was per month (i.e., 20 days of EFMIS data during the collection period.

Scenario Summary	Current Values:	M vs FE	M vs FF	FE vs FF	FE vs M	FF vs FE	FF vs FM
		DA > NP > TL	DA > TL > NP	NP > TL > DA	NP > DA > TL	TL > NP > DA	TL > DA > NP
Pre COVID (A)	Changing cell						
	Quantity (kg)						
Dagaa	3972.22	220401.8	220401.8	3972.22	15270.46	3972.22	15270.46
Nile perch	15270.46	15270.46	3972.22	220401.8	220401.8	15270.46	3972.22
Tilapia	220401.8	3972.22	15270.46	15270.46	3972.22	220401.8	220401.8
	Prices (USD)						
Dagaa	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Nile perch	2.66	2.66	2.66	2.66	2.66	2.66	2.66
Tilapia	3.62	3.62	3.62	3.62	3.62	3.62	3.62
Value (USD)	845623.94	451722.10	462568.41	648697.85	628135.05	845623.94	835907.45
Post COVID (B)	Changing cell						
	Quantity (kg)						
Dagaa	8457.40	70510.00	70510.00	8457.40	18980.00	8457.40	18980.00
Nile perch	18980.00	18980.00	8457.40	70510.00	70510.00	18980.00	8457.40
Tilapia	70510.00	8457.40	18980.00	18980.00	8457.40	70510.00	70510.00
	Prices (USD)						
Dagaa	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Nile perch	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Tilapia	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Value (USD)	368482.68	325045.86	329254.90	347870.68	340504.86	368482.68	365325.90
Difference (B–A)	−477141.26	−126676.24	−133313.51	−300827.17	−287630.19	−477141.26	−470581.55

lucrative.

The study found that small scale fisheries impacted very highly (SEI = 4.67) on actors in the fisheries value chain in the pre COVID era while the impact was high (SEI = 4.06) in the post COVID-19 era indicating a 13.1% change in the reference period (Table 2). During the pre COVID-19 season, the players in the fish value chain considered a high seasonal profit margin to be the most valuable factor in fisheries. Because of COVID-19 countermeasures, changes in fish demand and prices, selection stresses, or interplay among these significant developments, probably decreased engagement in livelihood activities. Global market ties and local economic output can influence fish prices and availability in a variety of ways, affecting livelihoods and consumption in numerous and complex ways (Fiorella et al., 2021). In the Kenya's culture, economy, and food security, the capture fisheries sector was valued at 440 million US dollars in 2018, directly or indirectly employing 1.2 million people (Daniel et al., 2021). In correlation to Kenya's catches, many other areas around the world's fisheries are distinctive in how most of the total reported fish catch originates from the freshwater fishing industry (Daniel et al., 2021). In the transitory and end-user market economies, fish production costs per kilogram have been substantial. Historically, the transitional and consumer market zones are known to benefit from business transactions because of the proximity and influence of external markets (Kimani et al., 2018; KMFRI, 2018, p. 33).

Fish market access, access to fresh fish and infrastructure for drying fish were ranked very high (Ranked 1–3) and taken into account by all actors in the fisheries value chain at the same time during the post COVID-19 containment era. Access to fresh fish and infrastructure for drying fish were rated highly by traders during the post COVID-19 era. These could imply that consumers are willing to pay a premium price for quality fish. None the less, it is highly likely that good market infrastructure will increase fish quality, add value, and draw customers, especially the more affluent ones who are safety-conscious. This will lead to better prices and higher incomes for traders (Odoli et al., 2019).

The pre COVID-19 period recorded the highest trading value of USD 0.85 million as compared to USD 0.37 million in the post COVID-19 era in Gikomba market; which could be attributed to the fact that the current era is still ongoing and it may surpass the former period (Table 3). Due to a change in income, some households opted for less expensive

Table 4
Scenario ratings and categorizations of the three major commercial fisheries in Busia markets in Lake Victoria region. Marginalized (M); fish-food (FF); foreign exchange (FE); fish-meal (FM). The "Current Values" column represents values of changing cells at the time the scenario report was being computed. The changing cells for each scenario are represented in grey. 1 USD = KES 100; data estimation was per month (i.e., 20 days of EFMIS data during the collection period.

Scenario Summary	Current Values:	M vs FE	M vs FF	FE vs FF	FE vs M	FF vs FE	FF vs FM
		DA > NP > TL	DA > TL > NP	NP > TL > DA	NP > DA > TL	TL > NP > DA	TL > DA > NP
Pre COVID (A)							
	Quantity (kg)						
Dagaa	580.74	36290.00	36290.00	580.74	11067.10	580.74	11067.10
Nile perch	11067.10	11067.10	580.74	36290.00	36290.00	11067.10	580.74
Tilapia	36290.00	580.74	11067.10	11067.10	580.74	36290.00	36290.00
	Prices (USD)						
Dagaa	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Nile perch	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tilapia	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Value (USD)	**139487.632**	**100207.446**	**99158.81**	**142009.922**	**130474.926**	**139487.632**	**126904**
Post COVID (B)							
	Quantity (kg)						
Dagaa	311.67	58826.25	58826.25	311.67	6419.00	311.67	6419.00
Nile perch	58826.25	6419.00	311.67	58826.25	58826.25	6419.00	311.67
Tilapia	6419.00	311.67	6419.00	6419.00	311.67	58826.25	58826.25
	Prices (USD)						
Dagaa	2.35	2.35	2.35	2.35	2.35	2.35	2.35
Nile perch	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Tilapia	3.21	3.21	3.21	3.21	3.21	3.21	3.21
Value (USD)	**227229.29**	**161708.65**	**159937.52**	**227229.29**	**221976.99**	**212031.19**	**205007.76**
Difference (B–A)	**87741.66**	**61501.20**	**60778.71**	**85219.37**	**91502.06**	**72543.56**	**78103.76**

fish foods, such as Dagaa, resulting in a shift from 3.97 tons (pre COVID) to 8.46 tons (post COVID-19). The quantity of Nile perch species increased significantly from 1.53 tons (pre COVID-19) to 18.98 tons (post COVID-19). COVID-19 containment measures such as lockdowns in and out of Nairobi and its environs and curfews had an impact on tilapia trade and consumption, a species which is typically favored for its sweet flavor and perceived as expensive (Aura et al., 2020). This greatly reduced its quantity from 220.40 tons in the pre COVID-19 to 70.51 tons during the post COVID-19 period. The prohibition on movement to Nairobi that is one of the largest fish markets, curfews, and social distancing, affected the frequency and duration of fishing trips, disrupted the fish value chain, and negatively impacted the fishers' ability to make a living (Fiorella et al., 2021). Presently, the trade is in a gradual recovery path.

Fish-food versus foreign exchange (FF vs FE) scenario of TL > NP > DA (USD -477,141.26) and fish-food versus fishmeal scenario of TL > DA > NP (USD -470581.55) combinations had the highest negative socioeconomic impact in the Gikomba environments (Table 3). The FE versus FF at NP > TL > DA (USD -300,827.17) and FE versus M at NP > DA > TL had a moderate socioeconomic impact on the Gikomba economy (USD -287,630.19). Fish perceived to be marginalized against foreign exchange (M versus FE, DA > NP > TL) and M versus FF (DA > TL > NP) were found to have the lowest socioeconomic monetary impact to the Gikomba market environments, at USD -126,676.24 and USD -133,313.51, respectively. The study reaffirmed that the COVID-19 periods were affected by the status of the three major commercial fishes which was influenced by the socioeconomic impact. For example, according to (Odoli et al., 2019), Dagaa could have been the most preferred for low-income households in informal settlements during the pandemic, where the majority of households are low-income earners.

Unlike Gikomba markets, the post COVID-19 period recorded nearly double the value (USD 0.23 million) in relation to the trading level experienced in Busia markets and during the pre COVID-19 era (USD 0.14 million) despite the current post COVID containment era still ongoing (Table 4). Small-scale inland fisheries were impacted very highly in Busia market during the post COVID-19 period. This was largely as a result of the overall price variation, which increased dramatically from pre to post COVID-19 periods for the three major commercial species, namely dagaa (USD 0.55 = 30.6%), Tilapia (USD 0.31 = 10.7%), and Nile perch (USD 0.50 = 16.7%). However, both dagaa and tilapia decreased in quantity from the pre COVID era to the post COVID era, whereas the quantity of Nile perch increased from 11.07 tons to 58.83 tons between the same periods.

Foreign exchange versus marginalized (FE versus M) scenario of NP > DA > TL (USD 91,502.06), FE versus FF of NP > TL > DA (USD 85,219.37) and FF versus FM of TL > DA > NP (USD 78,103.76) combinations had the lowest variations and hence the highest socioeconomic impact in the Busia environments. Fish trade is a significant socioeconomic driver in Busia County. Since the establishment of a favourable business environment and regulatory framework, Busia market has remained the top county for fish commerce, production and export (Margini et al., 2020). Fishermen from various countries come to Busia's cross-border market to buy and sell their catch. Aquaculture farms, Lake Victoria, Turkana, and Kyoga supply the market, then fish is distributed to urban centers in Kenya, the Democratic Republic of the Congo, Uganda, and Rwanda. Since the Ugandan border was opened and inter-county travel restrictions were eased, trade has been relatively easy due to a steady supply of fish (Mitchell et al., 2018).

In terms of differences in value, Nile perch scenarios were ranked first. Fish processing companies target Nile perch for the export market with a small portion of the fish for local consumption (Njiru et al., 2018). For high income earners, Nile tilapia and Nile perch are preferred over other fish species (Fiorella et al., 2021). Nile tilapia was ranked the second due to its relative abundance in the market in line with locals' preference of its taste, despite it being expensive (Odende & pers. comm.,).

The M versus FF at DA > TL > NP (USD 60,778.71) and M versus FE at DA > NP > TL (USD 61,501.20) had the lowest socioeconomic value to the Busia market environments (Table 4). As a result of fluctuating prices and low selling prices, dagaa is considered seasonal. The lower cost of dagaa appeals to larger household sizes, which frequently prefer it (Musa et al., 2021). According to (Owiti et al., 2021), Dagaa consumption is influenced by availability and cost. On the other hand, the preference for Nile perch (the main foreign exchange fish) decreases due to increased knowledge of nutrition (Aura et al., 2020). Being at the top of the food pyramid and being a predatory fish, Nile perch would have

Table 5
ANOVA for pre COVID era to the post COVID era in Gikomba market in Nairobi region.

	Source of Variation	SS	df	MS	F	P-value	F crit
Post-Covid	Between Groups	608.34	3	305.67	0.6589	0.539	3.8143
	Within Groups	6123	14	423.67			
	Total	6731.34	20				
Pre-Covid	Between Groups	6.10352E-05	6	1.02E-05	6.85416E-16	1	2.8477
	Within Groups	2.07779E+11	14	1.48E+10			
	Total	2.07779E+11	20				

much less nutritional value than its prey, such as dagaa and Nile tilapia (Odoli et al., 2019). Consumers who are aware of the nutritional worth of fish could rank dagaa as having a high nutritional value, followed by Nile tilapia (*Oreochromis niloticus*) and Nile perch (Kariuki, 2011). It has been known that people who live close to each other may have a chance to learn about each other's cultural norms, which may influence their food choices. Consequently, household preferences for fish species are affected by the opinions of their neighbors, with the majority choosing fish that are given a favourable review by neighbors (Esilaba et al., 2017).

The F value of 0.6589 is less than the F critical value of 3.8477, so the null hypothesis of no difference between the quantities in the pre covid-19 period is not rejected (Table 5). On the contrary, the F value of 6.85416E-16 is greater than the F critical value of 2.847, so the null hypothesis of no difference between the quantities in the postcovid-19 period is reject.

4. Conclusion and recommendations

The current study found that small scale fisheries impacted very highly (SEI 4.67) on actors in the fisheries value chain in the pre COVID-19 era while the impact was high at 4.06 in the post COVID-19 containment era; indicating a 13.1% change in the reference period. The perceived status of the three major commercial fishes influenced the socioeconomic impact to the value chain actors. Dagaa seems to show a lot of potential due its demand, affordability, availability and ability to boost food and nutrition security. To mitigate on pandemics such as COVID-19, future investments in blue economy could focus on good market facilities which will increase fish quality, add value, and attract customers, especially the more affluent ones who are safety-conscious. This will lead to better prices and higher incomes for traders. Furthermore, a mechanism for gathering and making available marketing data and information to fish traders should be reviewed and maintained. The data may include details such as the availability and cost of fish in the target and source markets, fish prices, the types and sizes of fish, the number of traders and suppliers.

Data availability

The data used in the current study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declaration of competing interest

There is no conflict of interest among the authors and their affiliations.

CRediT authorship contribution statement

Christopher Mulanda Aura: Draft development. **Fonda Jane Awuor:** Results & Discussion development. **Hezron Awandu:** Methodology development. **Horace Owiti:** Data analysis. **Safina Musa:** Introduction development. **Winnie Owoko:** GIS and map development and methodology development. **James M. Njiru:** Results & Discussion development.

Acknowledgements

Kenya Marine and Fisheries Research Institute (KMFRI) funded the logistics and data sourcing of the current paper.

References

Anadolu Agency News. (2020). In *Kenya confirms first Coronavirus case*. https://www.aa.com.tr/en/africa/kenya-confirms-first-coronavirus-case/1764717.

Aura, M. C., Mwarabu, R. L., Nyamweya, C. S., Owiti, H., Ongore, C. O., Guya, F., Musa, S., Owili, M., Macaria, S., & Abila, R. O. (2022a). Exploring the potential of small water bodies as an integrative management tool for fisheries production. *Fisheries Management and Ecology, 29*, 254–268. https://doi.org/10.1111/fme.12529

Aura, M. C., Nyamweya, C. S., Njiru, J. M., Odoli, C., Musa, S., Ogari, Z., Abila, R., Okeyo, R., & Oketch, R. (2019). Using fish landing sites and markets information towards quantification of the blue economy to enhance fisheries management. *Fisheries Management and Ecology, 26*, 141–152.

Aura, M. C., Nyamweya, C., Odoli, Owiti, H., Njiru, J. M., Outo, P., Waithaka, E., & Malala, J. (2020). Consequences of calamities and their management: The case of COVID-19 pandemic and flooding on inland capture fisheries in Kenya. *Journal of Great Lakes Research, 46*, 1767–1775. https://doi.org/10.1016/j.jglr.2020.09.007

Aura, M. C., Owiti, H., Nyamweya, C., Odoli, C., Obuya, A. J., Ogari, Z., & Njiru, J. M. (2022b). Aligning Small Indigenous Fish Species (SIS) in policy and management for enhanced food security and nutrition - the case of Dagaa fishery in Lake Victoria, Kenya. *Lakes & Reservoirs: Sci. Pol. Mana. Sustain. Use, 27*(1), Article e12399. https://doi.org/10.1111/lre.12399

Ayuya, O. I., Soma, K., & Obwanga, B. (2021). Socioeconomic drivers of fish species consumption preferences in Kenya's urban informal food system. *Sustainability, 13*(9), 5278.

Chikowi, C. T., Ochieng, D. O., & Jumbe, C. B. (2020). Consumer choices and demand for tilapia in urban Malawi: What are the complementarities and trade-offs? *Aquaculture, 530*, 735–755.

Daniel, L., Mbilingi, B., Mutambala, M., & Arayo, E. (2021). *Effects of COVID-19 on the fisheries value chain: A case for Uganda and Tanzania*.

Esilaba, F. A., Moturi, W. N., & Mokua, M. A. (2017). Urban consumers' fish preferences and the determinants influencing fish selection and consumption: Case study of Nakuru Town, Kenya. *Int. J. Fish. Aquat. Stud., 5*, 356–360.

FAO. (2016). *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all.* Rome: Italy.

FAO. (2018). *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all.* Rome: Italy.

FAO. (2020). *The impact of COVID-19 on fisheries and aquaculture - a global assessment from the perspective of regional fisheries bodies*. https://doi.org/10.4060/ca9279en. Initial assessment [No. 1]. Rome.

Fiorella, K., Bageant, E., Mojica, L., Obuya, J. A., Ochieng, J., Outo, P. W., Onyango, H. O., Aura, M. C., & Okronipa, H. (2021). Small-scale fishing households amid COVID-19: The case of Lake Victoria, Kenya. *Fisheries Research, 237*, Article 105856.

Gangadhar, N. (2011). The role and relevance of ICT use in fisheries sector in India: Emerging policy implications. *Int. J. Adv. Res. Manag. Tech., 1*(1), 1–14.

Garcia, S. M., Kolding, J., Rice, J., Rochet, M.-J., Zhou, S., Arimoto, T., & Smith, A. D. M. (2012). Reconsidering the consequences of selective fisheries. *Science, 335*, 1045–1047.

Isingoma, T. (2020). In *How COVID-19 health responses impact displaced fishing communities in Uganda*. Retrieved from: https://blogs.lse.ac.uk/africaatlse/2020/07/16/covid19-health-impact-displaced-fishing-communitiesuganda-lake-albert/.

Kariuki, M. B. J. (2011). *Analysis of market performance: A case of 'dagaa' fish in selected outlets in Kenya; No. 634-2016-41486*. Egerton, Kenya: Egerton University Graduate School.

Kimani, E. N., Aura, M. C., & Okemwa, G. M. (2018). *The status of Kenya fisheries: Towards the sustainable exploitation of fisheries resources for food security and economic development* (p. 154). Mombasa, Kenya: Kenya Marine and Fisheries Research Institute.

KMFRI. (2018). *Implementation of economic and financial impact assessment (EFIA) in Lake Victoria, Kenya* (p. 33). Kisumu: Kenya Marine and Fisheries Research Institute (KMFRI).

LVFO. (2016). *Technical report: Stock assessment regional working group* (p. 17). Jinja, Uganda: Lake Victoria Fisheries Organization.

Margini, F., Pattnaik, A., Jordanwood, T., Nakyanzi, A., & Byakika, S. (2020). *Case study: The initial Covid-19 response in Uganda*. Washington, DC: ThinkWell and Ministry of Health Uganda.

Mitchell, D. M., Lovel, A. G., & Stenkamp, D. L. (2018). Dynamic changes in microglial and macrophage characteristics during degeneration and regeneration of the zebrafish retina. *Journal of Neuroinflammation, 15*(1), 1–20.

Mulatu, D. W., vanOel, P. R., Odongo, V., & van der Veen, A. (2018). Fishing community preferences and willingness to pay for alternative developments of ecosystem-based fisheries management (EBFM) for Lake Naivasha, Kenya. *Lakes & Reservoirs: Sci. Pol. Mana. Sustain. Use*. https://doi.org/10.1111/lre.12225

Musa, S., Aura, M. C., & Okechi, J. K. (2021). Economic analysis of tilapia cage culture in Lake Victoria using different cage volumes. *Journal of Applied Aquaculture*. https://doi.org/10.1080/10454438.2021.1884632

Njiru, J. M., Aura, M. C., & Okechi, J. K. (2018). Cage fish culture in Lake Victoria: A boon or a disaster in waiting? *Fisheries Management and Ecology, 26*, 426–434.

Njiru, M., Sitoki, L., Nyamweya, C. S., Jembe, T., Aura, C., Waithaka, E., & Masese, F. (2012). Habitat degradation and changes in Lake Victoria fisheries. In W. A. Adoyo, & C. I. Wangai (Eds.), *Environmental degradation: Causes issues and management* (pp. 1–34). New York: NOVA Science Publishers Inc.

Nyamweya, C. S., Natugonza, V., Taabu-munyaho, A., Aura, M. C., Njiru, M., Ongore, C., Mangeni, R., Kashindye, B. B., Odoli, C. O., & Kayanda, R. (2020). A century of change: Induced revolution of Lake Victoria fisheries and ecology. *Fisheries Research, 230*. https://doi.org/10.1016/j.fishres.2020.105564 105564

Odende T. pers. comm. Busia County Fisheries Department, Busia, Kenya.

Odoli, C., Owiti, H., Kobingi, N., Obiero, M., Ogari, Z., Mugo, J., Nyamweya, C., & Aura, M. C. (2019). Post-harvest interventions in small-scale fisheries: A boon or a bane to food and nutritional security in Kenya? *Journal of Food Security, 11*, 855–868. https://doi.org/10.1007/s12571-019-00950-x

Owiti, H. O., Ochiewo, J. O., Aura, M. C., Kayanda, R., Sunil, S. S., Otuo, P. W., Obuya, J. A., & Njiru, J. M. (2021). The Lost Coin: Redefining the economic and financial value of small-scale fisheries, the case of Lake Victoria, Kenya. *Social Sciences & Humanities Open, 4*, Article 100221. https://doi.org/10.1016/j.ssaho.2021.100221

Schubert, A., Nyingi, W., Tuda, P., Aura, M. C., Obiero, K., Manyala, J., Cowx, I. G., Vianna, G. M., Ansell, M., Meeuwig, J. J., & Zeller, D. (2021). Reconstructing Kenya's total freshwater fisheries catches: 1950-2027. *Marine and Freshwater Research*. https://doi.org/10.1071/MF21189

Sustainable Fisheries Partnership. (2020). https://www.congalsa.com/en/commitments/sustainability-and-enviroment/sustainable-fisheries-partnership-sfp Accessed on 11th July 2022.

UN News. (2020). In *UN working to avert dual crises as COVID-19 hits hunger hotspots*. United Nations, 2020 https://www.un.org/en/uncoronavirus-communications-team/un-working-avertdual-crises-COVID-19- hits-hunger-hotspots.

Woodhead, A. J., Abernethy, K. E., Szaboova, L., & Turner, R. A. (2018). Health in fishing communities: A global perspective. *Fish and Fisheries*. https://doi/epdf/10.1111/faf.12295.