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Using fish landing sites and markets information towards quantification of the blue economy to enhance fisheries management

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Abstract

Fisheries management uses important fish market information and information from Communication Technology (ICT) to improve fish trade by identifying inefficiencies, inequity and post-harvest losses. The current study reports fisheries output using ICT at major landing sites and markets in Kenya and Uganda from the Kenya Marine and Fisheries Research Institute (KMFRI) Enhanced Fish Market Information Service (EFMIS) database for 2009 – 2017. Catch assessment survey data validated the use of market data in drawing conclusions. Regional Frame Survey data provided information before EFMIS, enabling comparisons of fish trade costings. The average quantity of fish traded in Kenya depended on seasons of active lake fishing, which occurs in January – March and August – October, while Uganda had an irregular pattern associated with fish trade throughout the year. The quantity of fish traded weekly depended on the average price of fish. Lower sales margins during the EFMIS project showed the merits of information sharing using ICT platforms for efficient and equitable fish trade. Such evaluation of fish market information is useful in fish trade policy formulation and for fisheries management and ecological sustainability in rural and peri-urban communities.

KEYWORDS

blue economy, fisheries, information and communication technology, landing site, management, market

1 | INTRODUCTION

Fisheries occupy a significant place in the socio-economic development of many countries (Aura et al., 2018; Njiru, Aura & Okechi, 2018; Woodhead, Abernethy, Szaboova & Turner, 2018). For example, Kenya's fisheries sector contributes about 4.7% of the country's Gross Domestic Product (GDP) (Mulatu, Oel, Odongo & van der Veen, 2018). Total fishery and aquaculture production is about 186,700 t, with 83% coming from inland capture fisheries (FAO, 2016). The marine sub-sectors have an annual potential of between 150,000 and 300,000 t (KMFRI, unpublished data). The marine capture fisheries are composed of coastal and nearshore artisanal, semi-industrial and offshore industrial fisheries. The local coastal communities exploit artisanal and semi-industrial fisheries while the industrial fisheries are exploited by foreign fishing companies (Fisheries Bulletin, 2016). Uganda's major fishery is from Lake Victoria located in its 43% portion of the entire lake, whereas Kenya has only 6% and Tanzania 51% (Njiru et al., 2012). Uganda's total

annual production is about 217,000 t valued at US$ 72,468 million (http://www.fao.org/fi/oldsite/FCP/en/UGA/body.htm). Lakes and reservoirs are recognised as important income and employment generators in both nations, as they stimulate the growth of a number of subsidiary industries, and are a source of cheap and nutritious food besides being a foreign exchange earner. More importantly, fisheries are a source of livelihoods for a large section of an economically backward population in rural and peri-urban communities (Gangadhar, 2011; Njiru et al., 2018).

Inland and marine ecosystems sustain more than 70 million people in most parts of Kenya, Uganda and Tanzania through fisheries, transport, water for domestic, agricultural and industrial uses. The endowment of the East African region with rich fisheries resources presents myriad opportunities for economic and social transformation of the local people. The majority of this target population is from rural communities who rely mainly on mobile phones to access market information (Abila et al., 2012; Aura et al., 2017, 2018). Market information is a key factor influencing sellers and buyers' decisions and choices in the market regarding what, quantity, price, and when and where to sell or buy, which could help further quantify the actual value of aquatic resources under the "Blue Economy" concept. Communication facilities and relevant knowledge such as market information are vital to the initiation of policies to support fair competition in local and global markets (Aura et al., 2018). Information on prices and availability can be shared across fisheries value chains, diminishing the exploitation of smaller or otherwise disadvantaged rural populations, such as women, who play a dominant role in post-harvest fisheries trade and processing by middlemen, while reducing wastage and volatility of fish prices (Gangadhar, 2011).

However, such market information is not readily available to most small-scale producers in both coastal and inland fisheries, thus giving undue advantage to those with access to information (Agboola, Azizul, Rasidi & Said, 2018). Intermediaries higher up the fish value chain tend to have greater access to market information, consequently taking advantage of producers at the lower end (Kambewa, van Tilburg & Abila, 2007). Globally, fisheries market information loopholes and the resulting inequities in the commodity value chain are being addressed through Information and Communication Technology (ICT) systems.

For example, in many countries such as Sri Lanka, Japan and The Netherlands, ICT is widely used in applications relevant to fisheries such as Global Positioning Systems (GPS) for navigation and location finding, mobile phones for trading, information exchange and emergencies, Satellite Remote Sensing (RS) for fishery forecasting and culture site selection, and radio for communication with fishers (Wimalasena, Dahanayaka & Amaralal, 2016). Currently, NetFish is a worldwide programme for development of a mobile phone application for fisheries data collection (http://netfish.org/). ABALOBI is a mobile application suite and programme that is aimed at social justice and poverty alleviation in the small-scale fisheries chain (http://abalobi.info/). It has transformed South Africa in the way knowledge is produced, improved stewardship of marine resources, and resilience in the wake of climate change. Additionally, in South Africa, the Blue Venture programme has been applied to nurture and sustain locally led marine conservation (https://blueventures.org/).

In East Africa, the Enhanced Fish Market Information Service (EFMIS) project has been ongoing since 2009. EFMIS is an ICT pilot project based on mobile phones, which is being implemented in Kenya and Uganda and with possibilities of upscaling to other East African countries. It is a system for generating, packaging and disseminating essential market information from fish landing sites around the lakes and marine sources and markets in major urban areas across the participating countries. Currently, through mobile phones, the aim of EFMIS programme is to indicate the landings in terms of species and prices at beaches and markets. This is to ensure that fishers can locate where wholesalers are paying the best prices and boat crews can cut deals while at sea.

Thus, to realise sustainable socio-economic development under the "Blue Economy" concept in fisheries rural communities in East Africa and other global artisanal fishing regions, there is need to evaluate policies for accessing and quantification of fish marketing information by rural communities using ICT. The assessment will help in determining the benefits and the lessons to be learnt from ICT projects such as the EFMIS in artisanal fishing communities as a decision support tool in fisheries marketing, management and policy formulation. Therefore, the current study aimed at highlighting values needed for quantification of fisheries output using fish market information in East Africa, to identify gaps for fish food and by-products for policy formulations from the major fisheries in lead landing and market sites as a case study. This information will be useful in driving the "Blue Economy" concept for fisheries management and ecological sustainability.

2 | METHODS

2.1 | Study area

The major landing sites and markets in Kenya and Uganda involved in the EFMIS project are shown in Figure 1. Unlike Kenya, Uganda mainly relies on inland fisheries because it is land-locked. Natural water bodies cover some 42,000 km^2, or about 18% of Uganda's total area, and fisheries play a critical role as a foundation of subsistence and commercial livelihoods. Lake Victoria is by far the largest and economically most important of the national fisheries. However, other large lakes, including George, Edward, Albert, and Kyoga, along with the River Nile and a great variety of minor lakes around each of the large lakes, swamps and streams, also contribute to the annual national catch (http://www.fao.org/fi/oldsite/FCP/en/UGA/body.htm).

Inland fisheries are the most important fisheries in Kenya, with L. Victoria dominating fish production, contributing over 80% of the total fish landings (KMFRI, unpublished data). Besides Lake Victoria, other freshwater fish sources include lakes Turkana, Baringo, Jipe, Naivasha, several dams and rivers spread across the country collectively producing 3% of total fish production and with a surface area of 18,029 km^2. Marine and aquaculture fisheries constitute 4% and 1%, respectively, of the fish landed (FAO, 2016). Kenya's Exclusive Economic Zone (EEZ) covers 200 nautical miles from the coastline

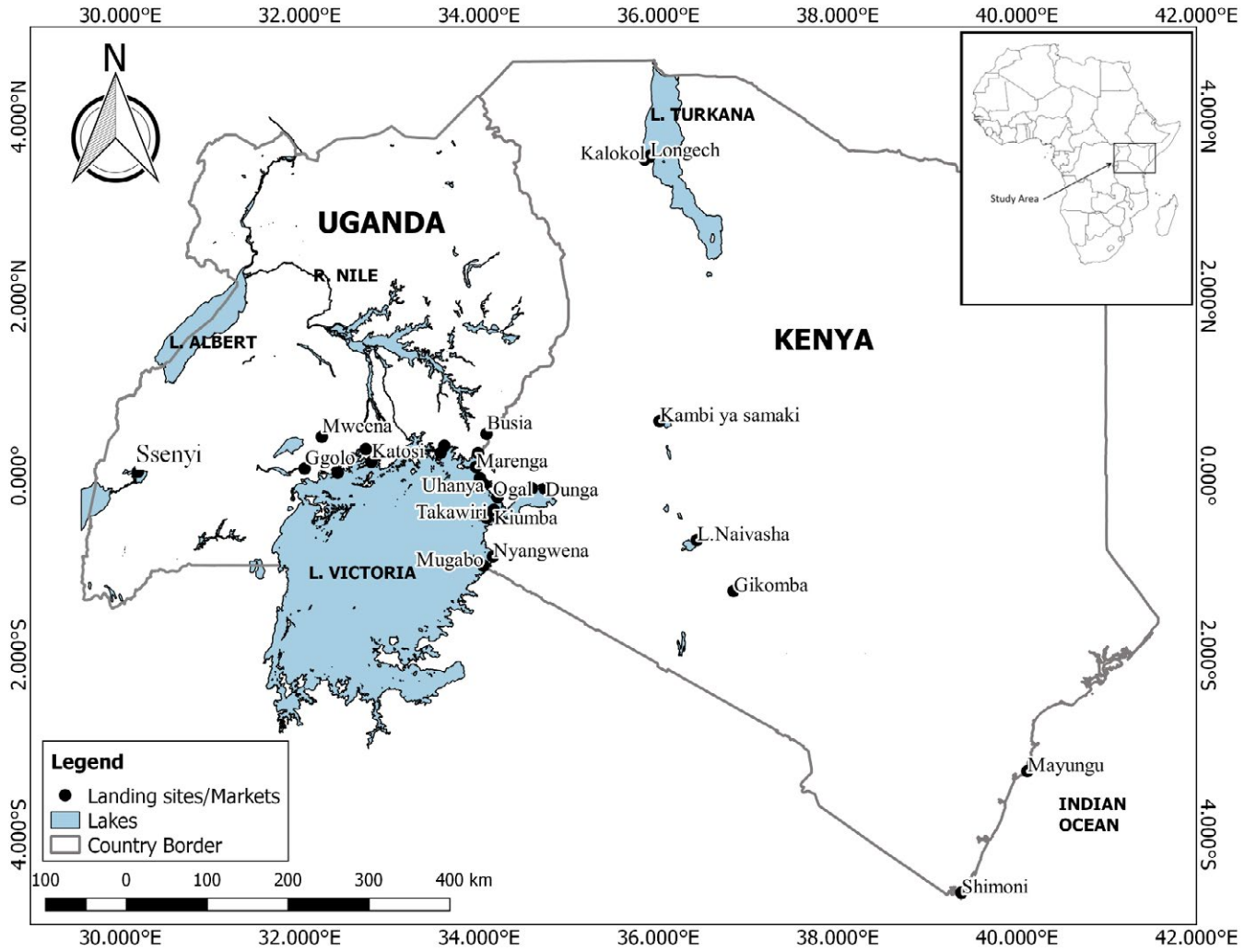

FIGURE 1 Major fish landing sites and markets in Kenya and Uganda in East Africa under the ICT project, Enhanced Fish Market Information Service (EFMIS) [Colour figure can be viewed at wileyonlinelibrary.com]

(FAO, 2009). The marine fishery mostly operates within a narrow continental shelf confined to a small strip of 2.5 to 3.0 nautical miles (Samoilys, Maina & Osuka, 2011). Kenya's marine coastline is about 640 km long covering an area of about 83,603 km^2 (Newell, 1959). The coastal region of Kenya has approximately 3.3 million inhabitants. The economy of these communities depends mainly on artisanal fishing, small-scale farming, livestock husbandry, subsistence forestry and small businesses. Although the inland and marine resources provide many opportunities for economic growth and reduction of poverty, their unsustainable management has contributed to the degradation of the resource base as a result of high human population pressure (Government of Kenya Report, 2012). The small-scale fisheries of Kenya and Uganda contribute the greatest proportion of the catches and employ the highest number of fishers.

2.2 | Sourcing of data

Data spanning 2009–2017 were sourced from catch assessment surveys as well as from the EFMIS database of Kenya and Uganda. Both countries use similar standard operating procedures (SOPs) for various data platforms, such as EFMIS, catch assessment and frame surveys. The EFMIS system consists of three broad phases: data recording, coding and transmission from landing sites and markets to the data centre; a central database for recording the information; and an automated query response system (Figure 2). Data are recorded once or twice a day at each of the landing sites and markets and relayed by phone Short Message Service (SMS) in a coded format to a data centre based at KMFRI in Kisumu County, Kenya. The data are then synthesised and packaged into a database in a format that fishers, fish traders, cooperatives and other consumers can access them in real time (daily, by the hour), whenever needed. To obtain the information, a user has to send a query by SMS to the data centre from a mobile phone through a dedicated number (short code) and gets an automatic response within 10 s. The system is active for 24 hours every day and can be accessed from any part of the region where there is a cellular network.

EFMIS aims to enhance fish trade and incomes for the fisher community through improved access to market information (Abila et al., 2011, 2013). Market information is also disseminated through monthly electronic bulletins, posters, brochures and pamphlets. The EFMIS model offers the potential to be adapted for application in other

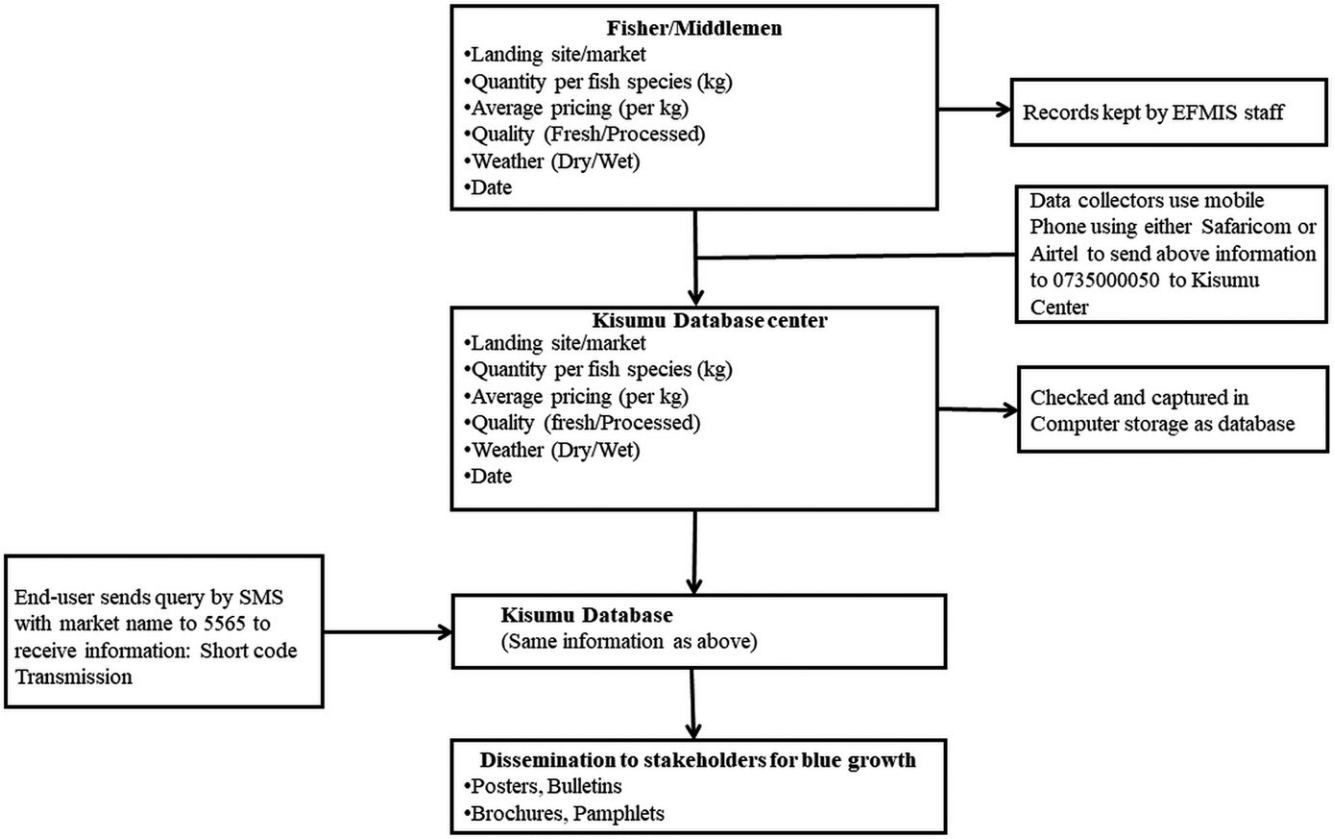

FIGURE 2 Schematic representation of the flow of fish market information implemented under the Enhanced Fish Market Information Service (EFMIS) project in Kenya and Uganda. Data centre is at Kenya Marine and Fisheries Research Institute (KMFRI), Kisumu, Kenya

small-scale fisheries for effective relaying of fish marketing information to potential clients and thus aiding "Blue Economic Growth."

Lake Victoria Fisheries Frame Surveys cost data were corroborated in the study to enhance the fish market information. Frame surveys provide information on the facilities and services at landing sites and the composition, magnitude and distribution of fishing effort to guide development and management of the fisheries resources of Lake Victoria. The survey is a complete census of craft, gear, costs and fishers operating in the lake and all landing sites facilities and services. The activity is coordinated by the Lake Victoria Fisheries Organization (LFVO) secretariat together with a Regional Working Group (RWG) on Frame Surveys and by National Working Groups (NWG) at the national level. Trained enumerators undertake data collection using standardised questionnaires. Data are archived in the East African fish database.

2.3 | Data analyses

Microsoft Excel, SPSS version 21.0 (SPSS Inc., Chicago, IL, USA) and R version 3.5.1 (R Core Team) software were used for statistical analyses. Data were entered and cleaned in Microsoft Excel 2016, then exported to SPSS version 25 and R (packages psych and doBy) for analysis and development of tables and graphs. Measures of proportion and variation were used to evaluate the fish prices at landing sites and inland markets and compared per country. Cost of marketing fish and the quantities of fish landed and sold at landing sites were also assessed through frequency measures, averages (means per annum or per month) and central tendencies, and comparisons and relationships gauged using regression analysis. Unevenly distributed data were log-transformed to achieve normality. Lake Victoria Frame Surveys and catch assessment data were incorporated with EFMIS data to estimate the effect of EFMIS data in Kenya and Uganda.

3 | RESULTS

Nile perch *Lates niloticus* L., (21 major markets) and Nile tilapia *Oreochromis niloticus* L. (18 major markets) were dominant in most markets (Table 1).

In both Kenya and Uganda, there was no significant difference ($p > 0.05$; $r^2 < 0.50$) between the catch assessment survey data (Non-EFMIS CAS) and market data (EFMIS CAS) during the EFMIS period (Figure 3). The average quantity of fish traded in Kenya had two annual peaks in January – March and August – October (Figure 4). The average quantity traded in Uganda had an irregular peak-pattern with most quantity traded occurring in 2016 in February – May and July – October. However, there was a significant weak correlation ($p = 0.01$; $r^2 < 0.50$) between the quantity of fish traded versus the price of fish per kg (Figure 5).

Mayungu at the Kenya coast ($ 4.93/kg), Homa Bay Market, Kenya ($ 3.98/kg), Gikomba market, Kenya ($ 3.48/kg) and Kigungu,

TABLE 1 Overview of the major fish markets in Uganda and Kenya indicating the year EFMIS started collecting data and the major type of fish traded

Country	County	Beach/Market	Initial year of survey	Fish traded							
				Dagaa	King Fish	Lobster	Nile perch	Octopus	Rabbit Fish	Scavenger	Tilapia
Kenya	Busia	Bukoma	2009				*				*
		Busia Market	2010				*				*
		Marenga	2009				*				*
	Homa bay	Homa Bay Market	2009								*
		Kiumba	2009				*				
		Mainuga	2010				*				*
	Kilifi	Mayungu	2012		*	*		*	*	*	
	Kisumu	Dunga	2009	*			*				*
		Kisumu Market	2009	*			*				*
		Kobudho	2009			*					
	Kwale	Shimoni	2013		*	*		*	*	*	
	Migori	Got Kachola	2010				*				
		Migori Market	2013	*			*				*
		Sori	2009	*			*				
	Nairobi	Gikomba Market	2010				*				*
	Siaya	Luanda Kotieno	2009				*				*
		Mahanga	2009				*				*
		Siaya Market	2009	*			*				*
Uganda	Busia	Busia MKT UG	2015								*
		Majanji	2015	*			*				*
	Kalangala	Mweena	2015				*				*
		Nakatiba	2015				*				
	Kampala	Bugoto	2015	*			*				*
	Mukono	Katosi	2015				*				
		Ssenyi	2015	*			*				*
	Wakiso	Kigungu	2015				*				*

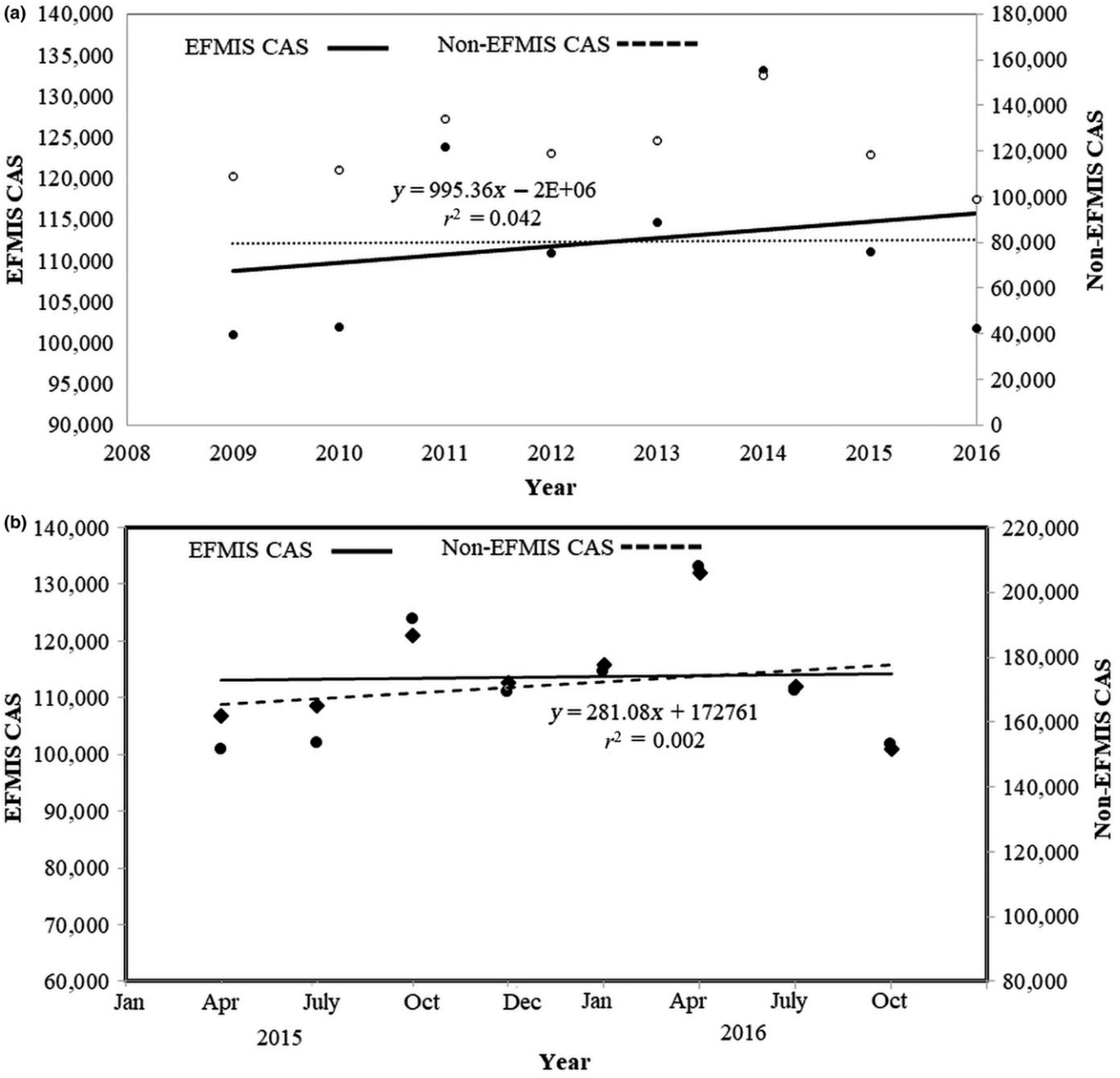

FIGURE 3 Relationship between total quantity of catch assessment survey data (Non-EFMIS CAS) and market data (EFMIS) in t/yr in (a) Kenya, and (b) Uganda

Uganda ($ 3.13/kg) exhibited the highest average prices of fish (Figure 6a). Markets or landing sites with the lowest fish prices per kg included Dunga, Sori (Kenya) and Bugoto (Uganda). Fish traders and factory agents' sale prices for small-sized fish were between $ 2.26/kg and $ 2.40/kg with factory agents receiving the highest prices in Uganda and fish traders received the highest prices in Kenya (Figure 6b). Prices of medium-sized fish ranged between $ 2.92/kg and $ 3.47/kg, with factory agents receiving higher prices than fish traders, and highest prices being in Kenya. Prices of large-sized fish were on average $ 4.50/kg in Kenya and $ 3.99/kg in Uganda.

The average quantity of fish traded was highest in Ssenyi (Uganda, 7.7 t), Busia Market (Uganda, 2.5 t), Gikomba market (1.5 t) and Kigungu (Uganda, 1.4 t) (Figure 7). The lowest quantities traded were in non-transition and non-consumer market zones and landing sites.

In Kenya, lobster ($ 11.06/kg) emerged as the most expensive item traded, followed by kingfish ($ 3.02/kg), both marine (Figure 8a). Tilapia and Nile perch were the most expensive fish in Uganda (Figure 8b) as well as the most expensive inland fish in Kenya. Although *Rastrineobola argentea* (Pellegrin), locally known as dagaa, was the least valued fish traded in both countries, it was the most abundant by quantity (163.70 t), followed by tilapia (42.62 tons) and Nile perch (20.72 t).

The proportion of fresh fish traded in both Kenya (83.5%) and Uganda (79.9%) was higher than processed products (< 21.0%) (Table 2a). Additionally, the sales margin for the processing agent

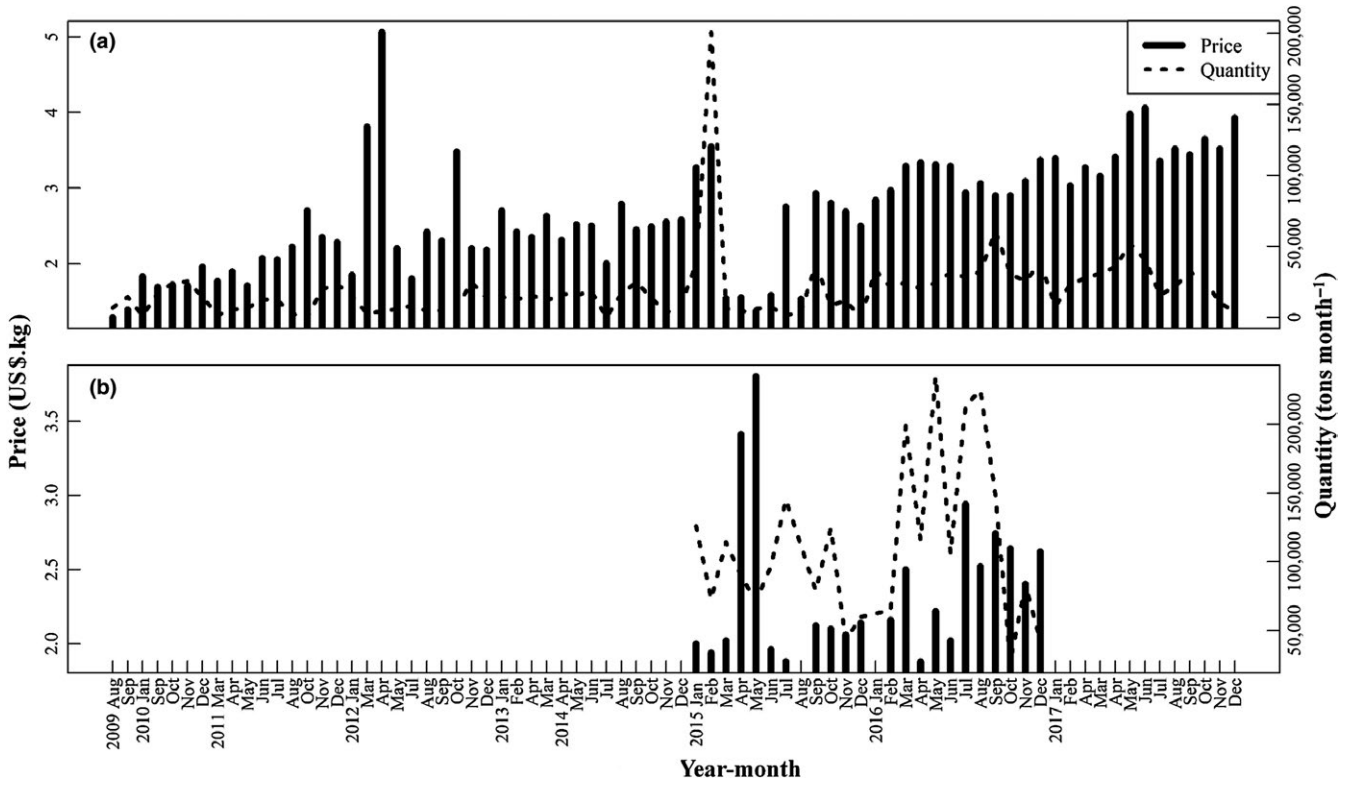

FIGURE 4 Relationship between the average monthly price of fish (US$/kg), average quantity of fish traded (t/month) from August 2009 (start of EFMIS) until December 2016 in (a) Kenya, and (b) Uganda

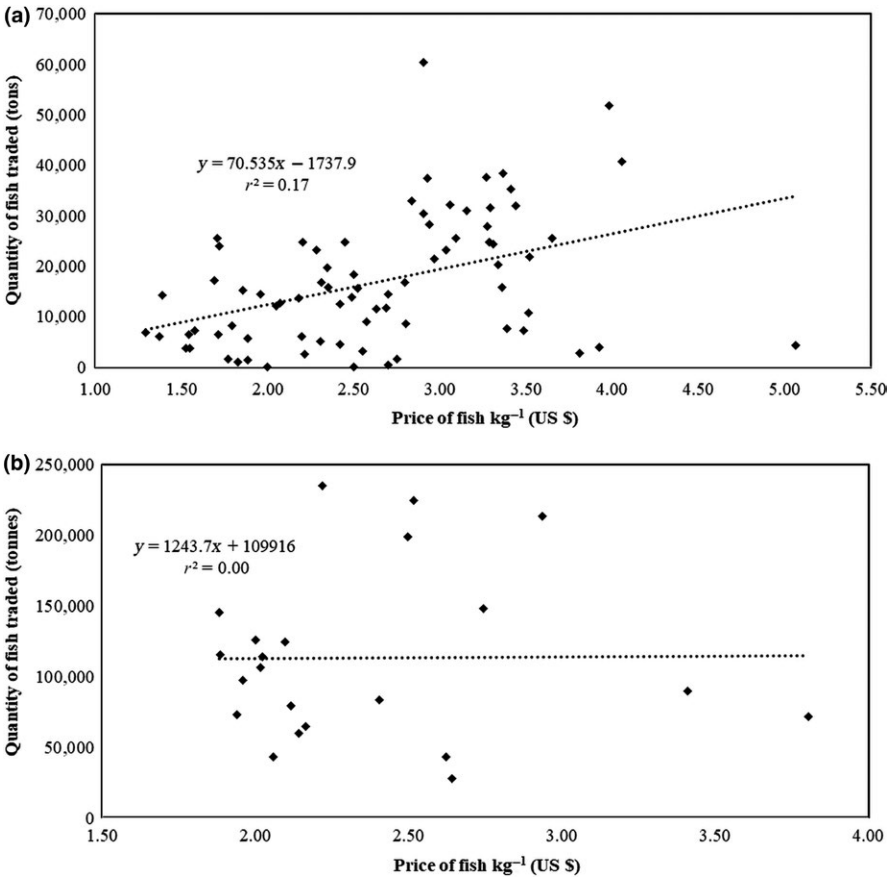

FIGURE 5 Scatter plots showing the relationship between price of fish per kg and quantity of fish traded in the landing sites and markets in (a) Kenya, and (b) Uganda

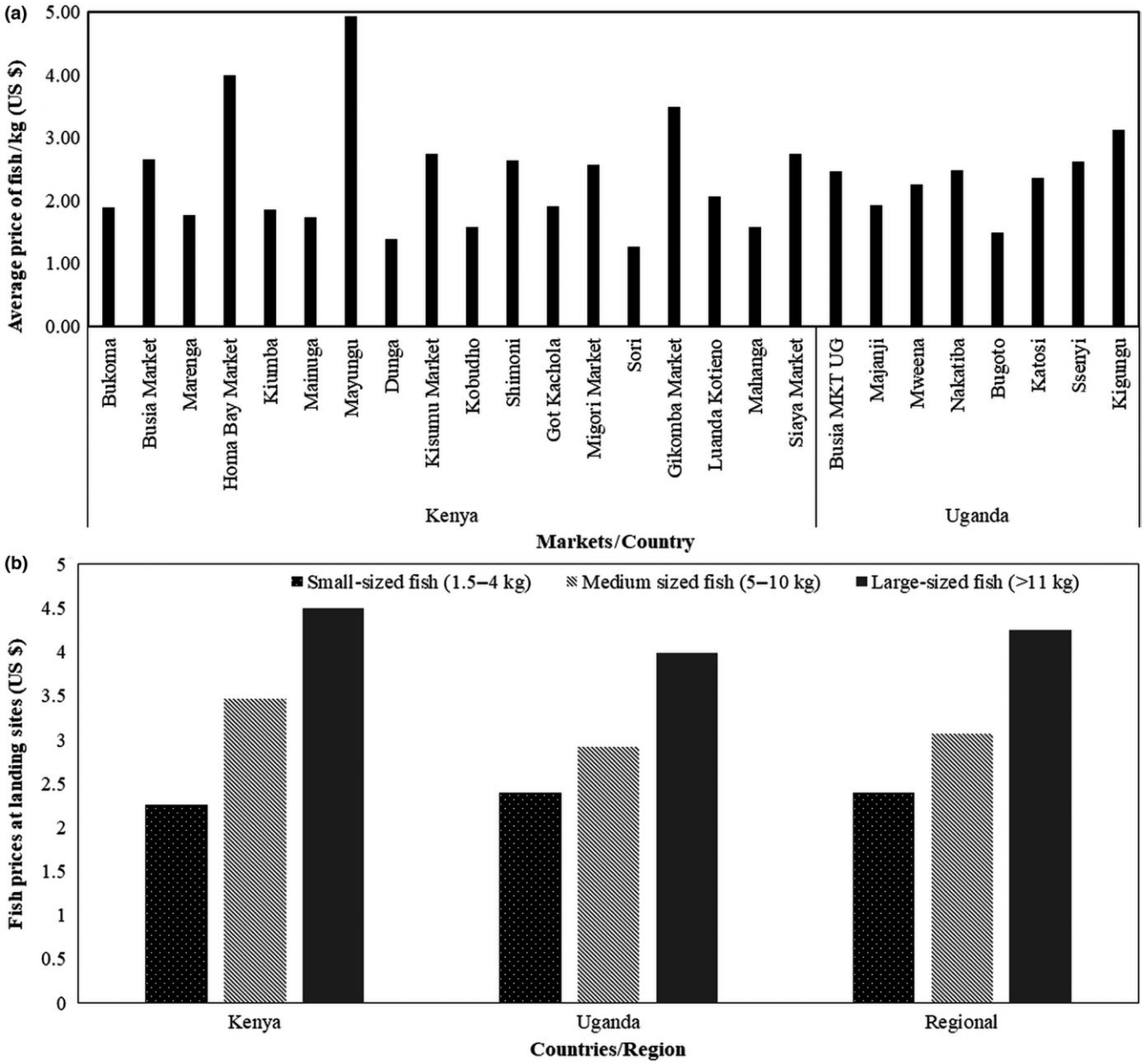

FIGURE 6 Relationships between the Kenyan and Ugandan prices of fish for (a) landing sites and markets, and the average price per fish, (b) landing sites and markets according to fish sizes (1US$ ≡ 100 Kshs ≡ 3731 Ushs)

and fish trader before the EFMIS project was lower than after the project across Kenya and Uganda and at the regional level (Table 2b).

4 | DISCUSSION

The perfectly competitive market model which is traditionally used in economics to attain efficiency and equity (Roberts, 1987) was tested. The model presupposes and entails an economically efficient allocation of resources (Rezaei, Mianaji & Ganjloo, 2018). In this case, each trader maximises profits by equating the given price to its marginal cost. This is based on the assumption that competitive prices correctly reflect both consumer demand and the cost of resources. Thus, large variations in sales margins could reflect exploitation of the fishers in rural communities by middlemen. An efficient market will establish prices that relate transport, processing and storage costs, respectively, to the provision of services in space, form and time (Mulatu et al., 2018). For the blue economy and investment in fisheries to thrive, and for improved policy formulation for management, competition should ensure that prices and marketing margins fully reflect the costs of resources used (McNulty, 1967).

It is hypothesised that ICT systems should aim to ensure that market information is a key factor influencing sellers and buyers' decisions and choices in the market. However, such information is not readily available for rural communities in agriculture and fisheries, thus giving undue advantage to those with access to information (Kambewa

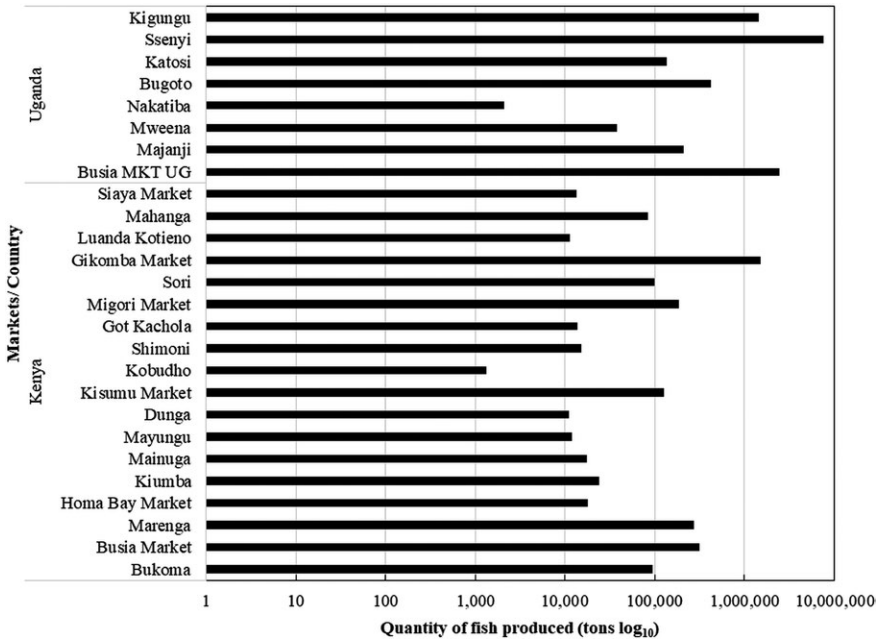

FIGURE 7 The average quantity of fish traded in the major landing sites and markets in Kenya and Uganda between the conception of EFMIS in August 2009 to January 2017

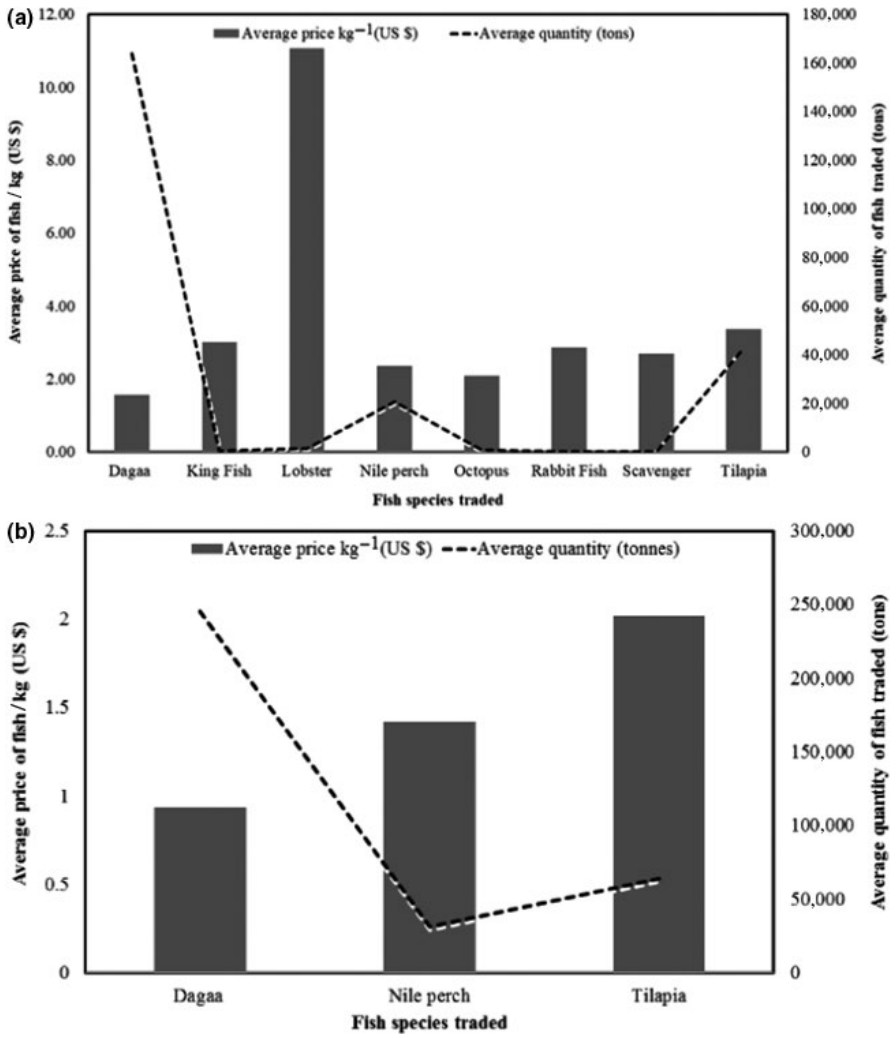

FIGURE 8 The relationship between fish species traded and the average price per kg and the average quantity traded (tonnes) in (a) Kenyan, and (b) Ugandan major fish landing sites and markets

TABLE 2 The Kenyan and Ugandan landing sites/market indicating (a) the state at which fish is sold in quantity (tonnes) and proportion (in brackets), and (b) average monthly sales margin of a processing agent and fish trader (in USD $) before (2002–2008) and during (2009–2017) EFMIS project period. Margins for 2002-2008 were calculated based on Frame Survey data that is conducted bi-annually in the lake region

(a)

State	Kenya	Uganda	Regional
Processed [Proportion (%)]	1062377 (16.5)	13794869 (20.09)	(18.30)
Fresh [Proportion (%)]	1062377 (83.5)	13794869 (79.91)	(81.71)

(b)

Actor type	Before	After	Before	After	Before	After
Processing agent	0.7	0.5	0.6	0.4	1	0.4
Fish trader	0.9	0.8	0.5	0.3	1.15	0.5

et al., 2007). The use of mobile phones comes in handy to complement traditional ICTs, such as radio, television and newspapers and face to face extension services in rural communities. Notably, Africa has the fastest-growing mobile phone market worldwide, which is already being applied in many ways for profitable and non-profitable ventures. The penetration of the mobile phone is far greater than that of the Internet in Africa, especially in rural areas, making it one of the most accessible communication tools for fish trade (Abila et al., 2012).

The existing gaps in fish trade are identified with the need for the development of policies geared towards sustainable use of fisheries resources among rural populations. It is vital that fishers should adopt practices that are consistent with their existing principles, values and beliefs. To overcome this gap, it is suggested that future studies and implementation approaches could focus on fish trade policy formulations.

Lack of significant variations ($p > 0.05$; $r^2 = 0.50$) in both countries between the catch assessment survey data (Non-EFMIS CAS) and market data (EFMIS CAS) during the period studied validated the use of EFMIS data in drawing conclusions in the current study. Inland fish species were the most traded in Kenya and Uganda markets, which could be attributed to freshwater fish species dominating the East African markets, of which Lake Victoria accounts for over 80% of production. These figures indicate that the fisheries resources of Lake Victoria make significant contributions to the local and national economies of the Partner States (Marshall & Mkumbo, 2011). Moreover, freshwater biodiversity plays a substantial role in supporting the livelihoods of rural and poor communities. Fifty-six million people in the developing world are involved in small-scale freshwater fisheries and in Sub-Saharan Africa, fish are a key source of nutrition and income for much of the rural population (Béné, Lawton & Allison, 2010).

Nile perch (21 major markets) was the most traded fish. Much of the lake's economic contribution to the region's fisheries comes from the Nile perch. It generates significant foreign exchange, estimated at over 60% of the total fisheries contribution in the lake, and provides employment and income for millions of people within and outside the region. The 2016 frame survey report indicated that over 50% of fishing craft and people in Lake Victoria target Nile perch (LVFO, 2015). This makes this species the single most significant driver of Lake Victoria's fisheries. This is evident from the various efforts and measures taken to address threats posed to the fishery (LVFO, 2016). Nile tilapia emerged as the second most traded fish with 18 major markets symptomatic of consumer preference for it (Musa, Aura & Kundu, 2014; Obiero et al., 2014). Lack of infrastructure and professionalism along such dominant fish value chains as those of Nile perch and Nile tilapia reduce the product quality and increase risk and operating costs, as well as fish bio-wastes and discards (Kolding, van Zwieten, Marttin & Poulain, 2017). Notably, it is the lack of drive and innovation on fish bio-wastes that has caused the fisheries sector to be under-estimated and under-valued; necessitating a policy of low investment by rural populations and industry (KMFRI, 2018).

The two annual peaks in January–March and August–October (Figure 4) experienced during fish trade in Kenya correspond to rainy and dry seasons in Lake Victoria, which constitute the bulk of the regional fishery (LVFO, 2016; Njiru et al., 2018). Thus, the quantity of fish traded may depend strongly on fish production rather than the price of fish at the landing site or market, which could account for the weak dependency between quantities of fish traded versus the price of fish per kg (Figure 5). The continuous fish trade in Uganda and across the border with Kenya may have caused the fish trade to be active throughout the year (LVFO, 2016). In this case, fish trader's and factory agent's sales prices for small-sized fish ($ 2.26 and $ 2.40) enabled factory agents to receive the highest prices in Uganda, and fish traders received the highest prices in Kenya (Figure 6b). This adds credence to fishers' information that factory prices in Kenya were low, leading to factory agents to sell fish in Uganda where factory prices were higher. Medium-sized fish prices ($ 2.92–$ 3.47) enabled factory agents to receive the highest prices compared with fish traders, with the highest prices being in Kenya. A similar scenario was noted for large-sized fish prices that prompted increased fish trade in Uganda throughout the year.

The study noted that transitional and consumer markets for goods and services recorded high fish prices per kg. Such areas include Mayungu at the Kenya coast ($ 4.93/kg), Homa Bay Market, Kenya ($ 3.98/kg), Gikomba market, Kenya ($ 3.48/kg) and Kigungu, Uganda ($ 3.13/kg). Similarly, the average quantity of fish traded was highest in such zones which included Ssenyi (Uganda, 7.7 t), Busia Market (Uganda, 2.5 t), Gikomba market (1.5 t) and Kigungu (Uganda, 1.4 t). Transitional and consumer market zones are known to have a history of business transactions whose sales margins tend to benefit go-betweens due to their proximity to external markets and influence (KMFRI, 2018; Lovell, Gray & Boucher, 2018). The opposite is true for non-transitional and non-consumer markets or landing sites

which included Dunga, Sori (Kenya) and Bugoto (Uganda) that recorded the lowest fish prices per kg.

Tilapia and Nile perch emerged as the most expensive inland fish in both Kenya and Uganda. Catches are sold and traded in both domestic and export markets (Geheb et al., 2008). Dagaa was the least valued fish but leads in terms of weight of landed fish. Dagaa is fished for both domestic and regional markets, and the driver of the harvest is for production of animal feeds and human food. This species is primarily harvested for human food but quality is often reduced due to post-harvest conditions and as a result much of the catch ends up being used in animal feed factories (LVFO, 2016). Dagaa is now considered an essential staple for food and nutritional security. When used for animal feed, it is primarily in average to rich households, as these have the equipment for agriculture or aquaculture. However, harvesting of this species is at night by men from poorer households and provides employment for women in fish processing and trade in rural and marginalised communities (Taabu-Munyaho, Marshall, Tomasson & Marteinsdottir, 2016). Small indigenous fish species such as dagaa, although more abundant and productive, are viewed as a low-value commodity that is mostly reduced to fishmeal, oil and used in animal feed (Garcia et al., 2012). Policy information and implementation should focus on innovative rethinking of the food security discourse by focusing on the nutritional value of dagaa and other small indigenous fish species.

The proportion of fresh fish traded in both Kenya (83.5%) and Uganda (79.9%) was higher than processed fish (<21.0%) (Table 2a). This is linked, at present, to many fishers operating on behalf of fish processing factories and agents that supply them with equipment, such as nets and outboard engines that allows them to fish further afield. As a result, these fishermen are obliged to sell their catches to the factories (at a market price fixed by the factory traders) to pay back for the equipment. This creates an unequal relationship between fishers and factories and results in an unequal distribution of income (Geheb et al., 2008). Therefore, the sales margin for the processing agent and fish trader experiences variations. The current study noted lower sales margins during EFMIS project than before; a situation accorded to the merits of information sharing using ICT platforms in fish trade to enhance fisheries management and ecological sustainability.

5 | CONCLUSIONS

The aim of this paper was to examine pre-requisites for quantification of fisheries output using fish market information in East Africa to draw lessons for policy formulations from the major fisheries landing and market sites to enhance fisheries management and rural blue economies. The use of market information data herein was validated by comparison with catch assessment survey data. Inland fishes were the traded more than marine products, with Nile perch and tilapia leading in the trade due to high catches and importance of the fishery. Both fishes dominate the fishery in terms of livelihoods value. Dagaa was the least valued fish in both countries though it is now considered an essential staple for food and nutritional security. The study noted that the quantity of fish traded depended more strongly on fish production than the price of fish at the landing site or market. Therefore, policy reviews should target social, economic and legal barriers that often inhibit sustainable fish production for improved small-scale fishers' livelihoods, which limit their food and income security. At the same time, the guidelines could streamline fish trade in non-transitional, transitional and consumer market zones, for the equity of the fish traders, agents and middlemen. The current study noted lower sales margins during EFMIS project than before the project which was indicative of the advantages of ICT platforms in rural communities for use in fish trade. Furthermore, the study recommends the application of EFMIS in catch and stock assessment surveys due to closer linkages in data collection methodologies.

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