



Trading Fast and Slow: Fish Marketing Networks Provide Flexible Livelihood Opportunities on an East African Floodplain

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Domestic marketing networks in inland small-scale fisheries (SSF) provide food and income to millions of the rural poor globally. Yet these contributions remain undervalued, as most trade is informal and unmonitored, and inland fisheries overlooked in research and policy. Taking a commodity chain approach, we provide a case study of access arrangements governing how people come to enter and benefit from the freshwater fish trade on Tanzania's Rufiji River floodplain. We conducted a repeat market survey, interviews, and participant observation with actors at all levels of the district trade over 15 months. Gender, age, and social capital structured participation patterns, with younger men dominating the more lucrative but riskier fresh trade, older men prioritizing steady income from smoked fish, and women culturally constrained to selling a "cooked" product (i.e., fried fish). Nearly all participants were local, with traders drawing on a complex web of relationships to secure supplies. The majority of market vendors cited the trade as their household's most important income source, with women's earnings and consumption of unsold fish likely to have substantial benefits for children's well-being. Our findings reveal a resilient and pro-poor trade system where, starting with small initial investments, people overcame considerable environmental, financial, regulatory, and infrastructural challenges to reliably deliver fish to rural and urban consumers. Preserving the ecological integrity of Rufiji wetlands in the face of hydro-power development and climate change should be a priority to safeguard the livelihoods and well-being of local inhabitants.

Keywords: inland small-scale fisheries, informal fish trade, food and nutrition security, women in fisheries, Rufiji River

INTRODUCTION

Fish are critical to food security in the Global South both directly, by supporting diets and nutrition, and indirectly, by providing a source of cash income for the purchase of staple foods and other essential goods and services (Kawarazuka and Béné, 2010; Béné et al., 2015; Thilsted et al., 2016; Hicks et al., 2019). An estimated two-thirds of fish destined for direct human consumption are caught in small-scale fisheries (SSF), with that estimate rising to 90% for SSF operating in inland waters, supporting the food needs of billions (FAO, 2016). Most consumers in the Global South access fish not via fishing, but through commercial trade (Beveridge et al., 2013). Distribution networks, particularly for processed fish—smoked, dried, or otherwise preserved—can be extensive,

enhancing the nutritional status of distant communities (Kawarazuka and Béné, 2011; Beveridge et al., 2013; Belton and Thilsted, 2014; Steenbergen et al., 2019). Nonetheless, the local and regional trade in SSF products remains largely neglected in global and national analyses (Thilsted et al., 2016).

Inland fisheries—encompassing pre- and post-harvest activities—employ an estimated 58 million people, the majority of whom live in the Global South, and half of whom are women (Funge-Smith and Bennett, 2019). Participants tend to move flexibly in and out of SSF, as just one component of diversified livelihoods (Allison and Ellis, 2001; Smith et al., 2005) or as a safety-net in times of crisis (Béné et al., 2010a). The flexible income and employment provided by SSF can increase households' resilience to risk and shocks, preventing them from slipping deeper into poverty (Béné and Friend, 2011). The need to recognize, support, and enhance the essential welfare functions of SSF is behind the development of Voluntary Guidelines for the sector (FAO, 2015) but the critical importance of inland fisheries for meeting multiple Sustainable Development Goals—including SDG 1 “No Poverty” and SDG 2 “Zero Hunger”—are overlooked on the global development agenda (Lynch et al., 2020).

Refocusing fisheries policy on equity and welfare issues will require better understanding of how SSF work in practice to supply food and income to local communities (Hall et al., 2013; Fabinyi et al., 2017). The nature of SSF—including geographically dispersed landing sites, temporal variability, and informal organization—makes estimating harvest, trade, and consumption patterns challenging, particularly in low-income countries with limited resources (Mills et al., 2011). These challenges are particularly acute for inland fisheries, with official figures found to underestimate global inland fish harvests by over one-third (Fluet-Chouinard et al., 2018). Knowledge gaps mean that the contributions of inland fisheries are undervalued or ignored in policy decisions affecting freshwaters, where powerful interests around the food–water–energy nexus converge (Lynch et al., 2016; Funge-Smith and Bennett, 2019).

In this paper, we describe the functioning of rural inland fish marketing networks on Tanzania's Rufiji River floodplain. We consider who participates and how, illustrating the ways domestic trade provides food, income, and livelihood opportunities in a food insecure and cash-constrained rural society. Local trade systems, operating through informal channels with little support and often under challenging conditions, can deliver reliable benefits to consumers and producers whilst outside interventions to enhance or maintain fisheries' benefits generally fall short (Steenbergen et al., 2019). Accordingly, it is worth asking: what are the features of local trade networks in SSF that allow them to function, and what is the social, economic, and cultural context in which they operate?

The importance of understanding fish trade dynamics is increasingly recognized, as social relations and power differentials among actors in commodity chains have been shown to affect fish availability and access, with implications for food security, poverty alleviation, and biodiversity conservation (Crona et al., 2010; Kittinger et al., 2015; O'Neill et al., 2018b; Steenbergen et al., 2019). The case study presented here, based on 15 months' fieldwork, was modeled on Ribot's (1998) analysis of

a charcoal commodity chain in Senegal, and its later theorisation (Ribot and Peluso, 2003). Their theory of access aims “to facilitate grounded analyses of who actually benefits from things and through what processes they are able to do so,” with an eye to how those patterns of benefit distribution along a commodity chain might be changed. A key insight of access theory is that holding rights to a resource does not necessarily equate to deriving benefits from those rights. Besides legal (*de jure*) rights, Ribot and Peluso (2003) identify various extra-legal (*de facto*) mechanisms that can constrain or enable people's ability (or power) to benefit from resource use, including: social identity or status, coercion and trickery, material wealth (i.e., financial and capital assets), or physical circumstances.

The key contribution of this paper is to set out the prevailing commodity chain structure, livelihood role and access arrangements in the Rufiji fish trade, as these operated in 2008/2009, with the aim of highlighting the trade's value and what stands to be lost through current hydropower plans in the district. Despite long-standing environmental and social concerns (Hoag and Ohman, 2008; Duvail et al., 2014), construction of the Magufuli mega-dam project began in July 2019 on the Rufiji River at Stiegler's Gorge, in the Selous Game Reserve. Given inadequate plans for managed water release, impacts on downstream ecosystems and communities may be severe, and compounded by climate change, deforestation, and other drivers of change (Duvail et al., 2017).

Our analysis of market commodities, dynamics, and participants in an African floodplain fishery is rare in the literature, where most work focuses on coastal (Gibbon, 1997; Walker, 2001; Crona et al., 2010; O'Neill et al., 2018b) or lacustrine trading systems (Chirwa, 1996; Geheb et al., 2008; Fiorella et al., 2014). The inherent variability of floodplain fisheries suggests that these are less likely to be linked to outside systems of production and consumption, or to involve complex trading arrangements (Tvedten, 2002; Jul-Larsen et al., 2003; Abbott et al., 2007). However, this paper provides a counter-example, describing value chains that link floodplain fishers through intermediaries to consumers across southern Tanzania. Our case is also notable in highlighting women's constrained participation in the trade, whereas women predominate in the post-harvest stages of SSF in Africa and globally (Harper et al., 2013; Weeratunge et al., 2014; Kleiber et al., 2015).

We begin by describing our study site and methods. We then introduce the fresh, smoked and fried fish commodity chains in turn, examining the different actors and structures involved. We describe the livelihood role of the trade, and arrangements governing access to trading opportunities.

STUDY SITE

Rufiji District: Geography and Climate

Our case study focuses on the freshwater fish trade supplying Kibiti (population: 15,156) and Ikwiriri (12,200)¹, the two largest market towns in Rufiji District, located within the Pwani Region

¹Tanzania National Bureau of Statistics (2012). *PHC: Population Distribution by Administrative Areas*. Available online at: <https://www.nbs.go.tz/index.php/>



of the United Republic of Tanzania (**Figure 1**). Additional information is drawn from fieldwork at landing sites and villages bordering two lakes on the northern floodplain (**Figure 2A**). The region is one of the country's poorest², with Tanzania ranking among the world's most food insecure countries³.

Inhabitants of Rufiji District are primarily farmers but pursue multiple livelihood activities (Paul et al., 2011; Moreau, 2014). The majority are Muslim (though no official statistics are available), with the Ndengereko the largest of at least eight ethnic groups in the area, together with the Rwingo (a subgroup of the Ndengereko), Matumbi (in the southern hills), Nyagatwa (at the delta), and the Makonde, Ngindo, Ngoni, Pogoro, and Zaramo (whose populations are concentrated outside the district). However, ethnic categories are malleable (Lockwood, 1998) and

district inhabitants will also refer to themselves collectively as Warufiji. A villagization campaign by the national government in the late 1960s forcibly removed inhabitants from the floodplain to the upper terraces, fundamentally disrupting social structure, livelihood strategies, and natural resource management systems (Paul et al., 2015). Swahili is the dominant language spoken, although people born prior to villagization continue to speak their "home language" (*kinyumbani*) regularly, with Kimatumbi and Kindengereko predominant in our study area.

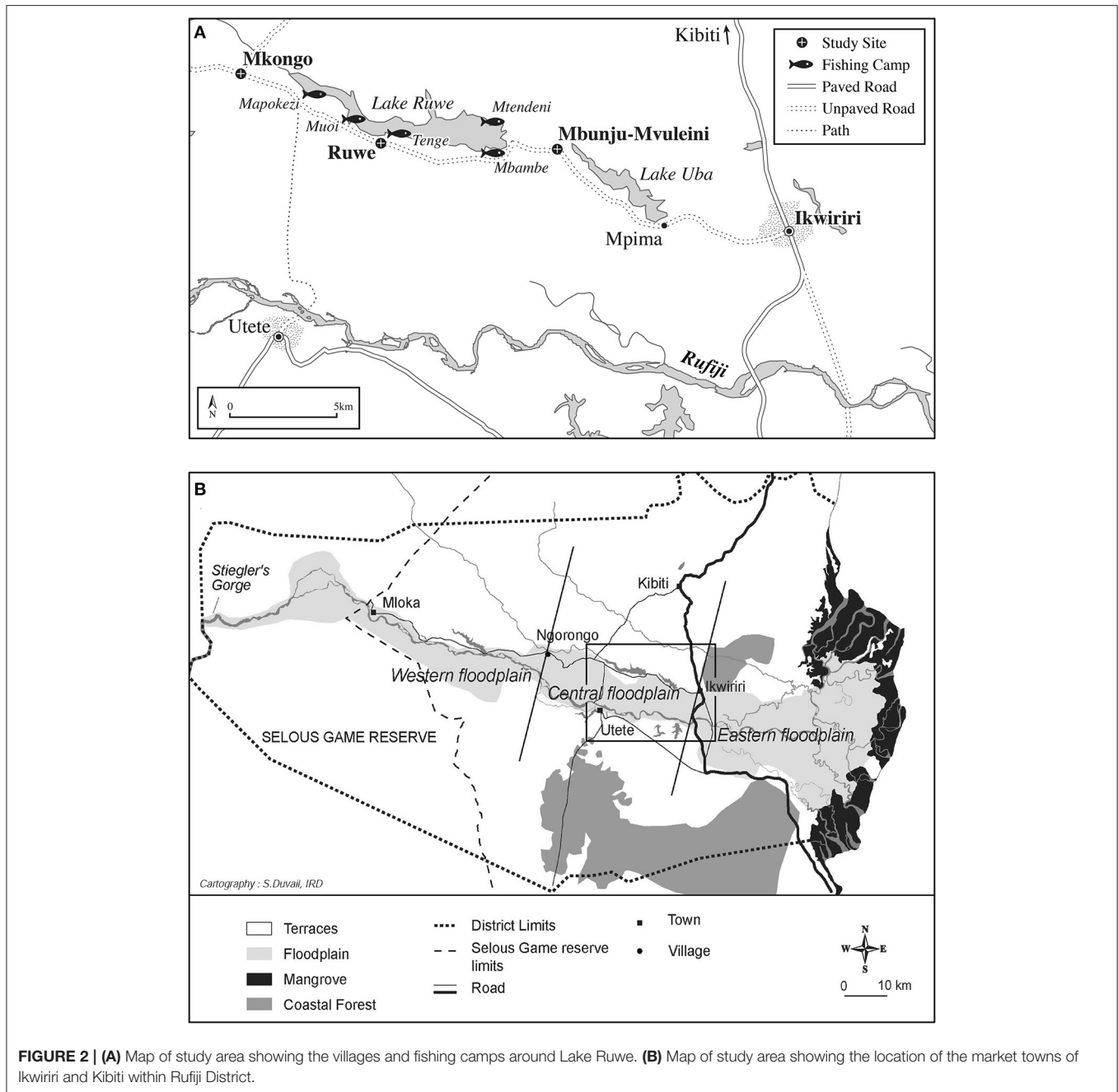
The Rufiji River, the largest in East Africa, bisects the district. Rainfall in this tropical, semi-arid climate is highly variable but generally displays two peaks with the short rains in October–November and the long rains from March to May. The coincidence of the annual peak flood (usually in May) with heavy rains marks the wet season. A vast floodplain occupies the river valley bottom, characterized by a mosaic of former river channels, levees, shallow depressions, and eight permanent lakes (Hamerlynck et al., 2011).

Ikwiriri is located on the north shore of the floodplain and Kibiti is ~25 km to the north, on the valley's shoulder

en/census-surveys/population-and-housing-census/162-2012-phcpopulation-distribution-by-administrative-areas (accessed July 14, 2021).

²Global Data Lab (2020). *Human Development Indices 5.0 – Tanzania*. Available online at: <https://globaldatalab.org/shdi/shdi/TZA/> (accessed July 14, 2021).

³Global Hunger Index (2020). *Tanzania*. Available online at: <https://www.globalhungerindex.org/tanzania.html> (accessed July 14, 2021).



(Figure 2B). Each town is approximately 40 km inland from the Rufiji Delta. Residents of Kibiti farm cassava, coconuts, and oranges, with salaried jobs at the town bank, hospital, and schools. Ikwiriri is the district commercial center, supporting a major road construction project at the time of fieldwork, as well as several saw-mills. Locals grow rice and maize, and fish at nearby lakes.

The Flood Pulse and Local Fisheries

Fish trade in Rufiji is organized to respond to seasonal shifts in fishing activity, driven by the annual flood pulse, and consequent

changes in fish and labor availability (Duvail and Hamerlynck, 2007). The timing, duration, and level of flooding are highly variable but, in general, in years of high flood, riverine fish enter the floodplain to breed, and can be caught in traps. Catch is primarily for subsistence but some buyers will visit accessible parts of the floodplain at this time to buy, primarily, *kambale* (the African catfish, *Clarias gariepinus*). As the dry season progresses and water levels drop, fish become easier to catch, with a peak in production between July and September. Households have more labor available as the rice harvest ends (~July) and preparations for the next year's fields (~October) have yet to begin. As

commercial fishing activity intensifies, camps are established on the shores of the permanent lakes. A second peak in fishery production occurs around December–January, when the lakes have drawn down, juvenile fishes of the year reach marketable size, and better road conditions facilitate transport (Richmond et al., 2002; Hamerlynck et al., 2011).

Lakes with the most recent and long-lasting connections to the river have the best fish supplies, leading commercial fishers and buyers to switch between landing sites over the fishing season and from year to year (Hamerlynck et al., 2011). The commercial lake fisheries are dominated by *pele* (a characin, *Citharinus congicus*), *kumba* (the cichlid *Oreochromis urolepis*), and *ngocho* (a carp, *Labeo congoro*). Residents of lakeside villages use the camps as a base for their fishing activities, setting passive gill nets (*nyavuya kutega*) overnight. Outsiders also use the camps, living in makeshift shelters for weeks at a time. These are mainly buyers stockpiling smoked fish and crew-members of four-man teams working the larger (and illegal, due to their small-mesh size) boat seine nets (*juya*). Lakeside landing sites also attract fresh fish buyers, who come daily, and occasional buyers for the smoked fish. Other fishers work from temporary water bodies on the floodplain proper, using flexible gear such as cast nets (*kimea*) and smaller gill nets.

Aquaculture was largely non-existent in the district at the time of our study, with active resistance to prawn farming at the delta and limited local experimentation with fish ponds inland (Richmond et al., 2002).

Markets: Infrastructure

Ikwiriri and Kibiti are hubs in the district's limited road network, with markets located off the highway linking Dar es Salaam (DSM) and Mozambique. Regional transportation improved with completion in 2003 of the Mkapa bridge and the highway's paving in 2008. Several long-haul buses travel the Mtwara—Lindi—DSM route daily and numerous minibuses (*dala-dalas*) run frequently between the two towns. Passengers can transport luggage, including baskets of fish, on any bus. The two towns are also linked via unpaved roads west toward Mloka giving access to several permanent lakes (Figure 2B). Two buses ran the route but neither was reliable, nor able to use the lower road to Ikwiriri in the wet season. Then, people had to go by foot, bicycle, or motorcycle, and be ferried across flooded road sections in dugouts. Electrical infrastructure was non-existent in the interior and unreliable in town, largely precluding the use of ice in the trade. Mobile phone networks were good near settlements.

Markets: General Trading Arrangements

Ikwiriri market is reached via a side street lined with a dozen small, freestanding shops, leading shoppers to an open area where fresh fish were sold by male traders from ~10 tables before entering the market proper. There, traders of smoked and dried fish and prawn (nearly exclusively male) were set up on ~25 tables under a tin roof. Deep fried fish, sold almost always by women, were traded from small, moveable cabinets in a separate area away from male traders.

All stalls in Kibiti's market were contained under a rectangular roof, with the cooked food stands on one side, vegetable and dry

goods stalls in the middle, and smoked and dried fish vendors (nearly exclusively male) along the far side. The fresh fish vendors (all male) operated a short distance away in an open area, from four wooden tables or gunny sacks and plastic sheeting laid on the ground. There was no dedicated space for fried fish sellers, who sold almost exclusively from the town's backstreets (as did many women in Ikwiriri). Fresh fish vendors appeared at the market for short bouts of trading—in Ikwiriri, ~4–6p.m. (along with the women selling fried fish), and in Kibiti, ~8a.m.–12p.m. Smoked fish traders in both towns were at their stalls by 9a.m. and remained until evening. Vendors estimated that there were 10 fresh fish vendors and 40 smoked fish traders regularly operating in Ikwiriri and six regular fresh fish vendors in Kibiti.

An older, successful smoked fish trader was referred to as “our leader” in Ikwiriri, but there was no formal traders' association. In Kibiti, a dry-goods seller was market chairman.

METHODS

Information derives from a market survey (MS) augmented by semi-structured interviews (SSI), informal conversations, and participant observation conducted among fishers and traders at the study marketplaces and the fishing camps and villages of Lakes Ruwe and Uba over 15 months of fieldwork by the lead author. M-AM (a white, Canadian woman with intermediate Swahili) worked alongside two English-speaking male research assistants, Moshi Bora and Karim Tenge, both local villagers, with MB administering all market surveys, and both assisting separately with SSI. A local female assistant, Idaya Ungando, helped interview village women, with interviews audio recorded. All research was conducted in Swahili (see Moreau, 2014).

Market Survey: Administration and Design

The survey was conducted on two consecutive days (one in Kibiti, one in Ikwiriri) on six occasions at ~6–9 week intervals, spanning the wet and dry seasons between March and November 2008. We aimed to survey all fresh and smoked fish vendors each day.

The first part of the survey collected demographic information on the vendor: name, age, birthplace, current residence, and first language (in lieu of ethnicity). It also asked about their business: whether they were the owner, other markets sold at, which months were best for business, and other livelihood activities. On subsequent survey rounds, if we had previously interviewed the respondent, we asked how business this month compared to last.

The second part collected data on vendor's stock. For each species and size grade sold, we asked: selling price; day brought to market; purchase price; amount purchased (number of fish or total cost); location caught, purchased, and from whom; and for processed fish, if bought fresh. Often there was no clear correspondence between the sale and purchase price. Weighing fish to establish comparable price/kg values across surveys proved difficult, especially for fresh fish where prices fluctuated rapidly in any one trading session. As a result, we do not present price information here except in general terms.

To reflect the availability of other aquatic resources (OAR) in the market, we randomly surveyed: half of fried fish vendors; all *kamba* (smoked penaeid prawns), *uduvi* (sundried, small

sergestid shrimp), and dried marine fish vendors; and a third of dry goods stallholders stocking *dagaa* (small, dried cyprinid fishes typically caught in Lake Victoria), using modified versions of our market survey (see Moreau, 2014). For fried fish vendors, where species were sold mixed and difficult to identify, we asked how many buckets of fresh fish had been purchased, at what price, and expected profit.

Market Survey Sample

We conducted 244 surveys with market vendors (Table 1). Every local freshwater species sold on each survey with a fresh or smoked fish vendor was recorded as a separate entry, giving a total of 147 fresh fish records and 223 smoked fish records. We collected demographic information from 61 of 80 fresh and/or smoked fish vendors surveyed at both markets and from 22 fried fish sellers in Ikwiriri (vendor characteristics described in Table 2). We encountered most vendors once ($N = 50$) or twice ($N = 17$) on our survey.

Additional Data Collection

The market survey data were backed up with 27 SSIs (individual or group) with market vendors, net owners, buyers, and other participants in the Rufiji freshwater fish trade (for details, see Table 3).

Permissions and Compensation

We introduced ourselves to local officials and Kibiti market’s chairman before starting research, and obtained verbal consent from informants prior to surveys or formal interviews. We compensated vendors for disruption to their sales at the rate of 0.40 USD/survey, about twice the amount vendors paid in daily fees. At landing sites, informants were offered gifts of tea and sugar, or cigarettes.

Notes on Analysis and Terms

Survey data were entered in a Microsoft Access database, and interview notes coded using NVIVO. Prices are given using the average interbank exchange rate from 31 January 2008 to 31 March 2009 (0.0008 TZS to 1 USD; www.oanda.com). Species

TABLE 1 | Market survey sample by market vendors’ product type and location.

Survey type	No. of surveys		
	Ikwiriri	Kibiti	Total
Local freshwater fish			
Fresh	42	27	69
Smoked	39	36	75
Subtotal			144
Fried Fish (Freshwater/Marine)	27	5	32
Other aquatic resources (OAR)			
Prawns	15	8	23
Dagaa	18	18	36
Dried (Marine) Fish	2	7	9
Subtotal			68
Total	143	101	244

TABLE 2 | Characteristics of fresh (F) and smoked (S) fish vendors in Ikwiriri and Kibiti, and of fried fish market vendors in Ikwiriri, MS.

Product	Location	(% of vendors)					N
		Male	Lives in town	Born in town	Sells at other markets	Has own field	
Fresh							
	Ikwiriri	100	100	81	52	71	21
	Kibiti	100	67	44	44	44	9
Smoked							
	Ikwiriri	93	93	43	64	100	14
	Kibiti	94	100	59	41	71	17
All F&S vendors		97	82	61	51	73	61
Fried							
	Ikwiriri	0	91	38	43	67	22

TABLE 3 | Semi-structured interviews held with participants in the Rufiji freshwater fish trade, showing informants’ trade position, number of participants per interview, and location.

Interview	Trade position	No.	Location
MARKET VENDORS			
1	Market vendors (F, S)	10	Ikwiriri
2	Vendor (F)	1	
3	Vendor (F, S)	1	
4	Vendor (S)	1	
5	Vendor (S)	1	
6	Vendor (F)— <i>Juma</i>	1	Kibiti
BUYERS (AT LANDING SITES)			
7	Wholesaler (S)— <i>Athumani</i>	1	Floodplain
8	Buyer (F, S)	1	Camp “A”
9	Wholesaler/Retailer (S, M)	1	
10	Wholesaler (S)	1	Camp “B”
11	Wholesaler (S)	1	
12	Fisher/buyer (S)	1	Camp “C”
13	Buyer (S)	1	
14	Buyer (F)— <i>Omari</i>	1	
15*	Buyers (S)	2	
16	Buyer (F)	1	Ruwe
NET OWNERS			
17	Buyer and <i>juya</i> net owner— <i>Ashiru</i>	1	Camp “C”
18	<i>Juya</i> net owner— <i>Kassim</i>	1	
19	Communal <i>juya</i> net owners/fishermen— <i>Tembo clan</i>	5	Ruwe
OFFICIALS			
20	Camp leaders	2	Camp “C”
21	District Fisheries Officials	3	Utete
FRIED FISH SELLERS (VILLAGE-BASED)			
22–27	Women interviewed alone or in pairs	8	Ruwe
Total no. of informants		46	

F, Fresh; S, Smoked; M, Marine Fish. All interviews conducted between June–October 2008, except (*) conducted in March 2009. Names in italics are pseudonyms used in the text, and camps are on Lake Ruwe.

names were assigned based on correspondence with local names (O. Hamerlynck, pers. comm.). All averages are presented as mean ± SD. All personal names are pseudonyms.

RESULTS

Commodity Chains in the Freshwater Fish Trade

Main Actors

There were six main types of actors in Rufiji’s fish commodity chains: fishers, net owners, buyers (i.e., intermediaries), market vendors, fried fish sellers, and customers. Extending outside the district, commodity chains included wholesalers and vendors operating in DSM marketplaces and elsewhere. Actor categories were not mutually exclusive, so that a net-owner may also be a fish buyer, for example, either simultaneously or over a fishing season or lifetime.

Also deriving income from the trade were people working in auxiliary roles such as fish smokers, firewood suppliers, bicycle transporters, porters, and helpers at the market stalls. Indirectly, the trade also provided income to women selling food or alcohol to fishers and buyers away from home.

Who Participates?

Trading networks were highly gendered, with men dominating the fresh and smoked trades, and women the sale of fried fish

(Table 2). Only two surveyed smoked fish traders were female, with one working with her brother.

Market vendors usually lived in the towns they traded in (Table 2). The majority identified as Ndengereko (79%, $N = 53$ men; 54.5%, $N = 22$ women) or Matumbi (7.5% of men; 14% of women). Women in the fried fish trade were more likely to have been born outside Rufiji district, in the coastal towns of Lindi and Mtwara. Fresh fish vendors were younger than smoked fish vendors on average (30 ± 8.5 vs. 44 ± 16 years old, $N = 25$ and 30 , respectively). No one over the age of 45 in our sample was seen to sell fresh fish, whereas several smoked fish vendors were in their seventies. Women surveyed were between 14 and 55 years old (32.5 ± 9 , $N = 22$), but we also occasionally observed younger children working the cabinets alone.

All intermediaries interviewed were born and resided in Rufiji District, with the exception of two smoked fish buyers.

Products and Preferences in the Market

The fresh and smoked trades, and to a large extent the fried fish trade, were based on indigeneous freshwater fish, with 13 species recorded on our survey, all caught within Rufiji district. Three species—*kumba*, *kambale*, and *pele*— were observed most frequently at market (Figure 3). All fried fish sellers observed at Kibiti market sold primarily marine fish ($N = 5$ surveys), sourced from the delta and Lindi province. Additional OAR in the markets were sourced from the delta (prawns, *uduvi*, sundried *mbarata*, i.e., *Hilsa kelee*) or, for *dagaa*, from DSM wholesalers.

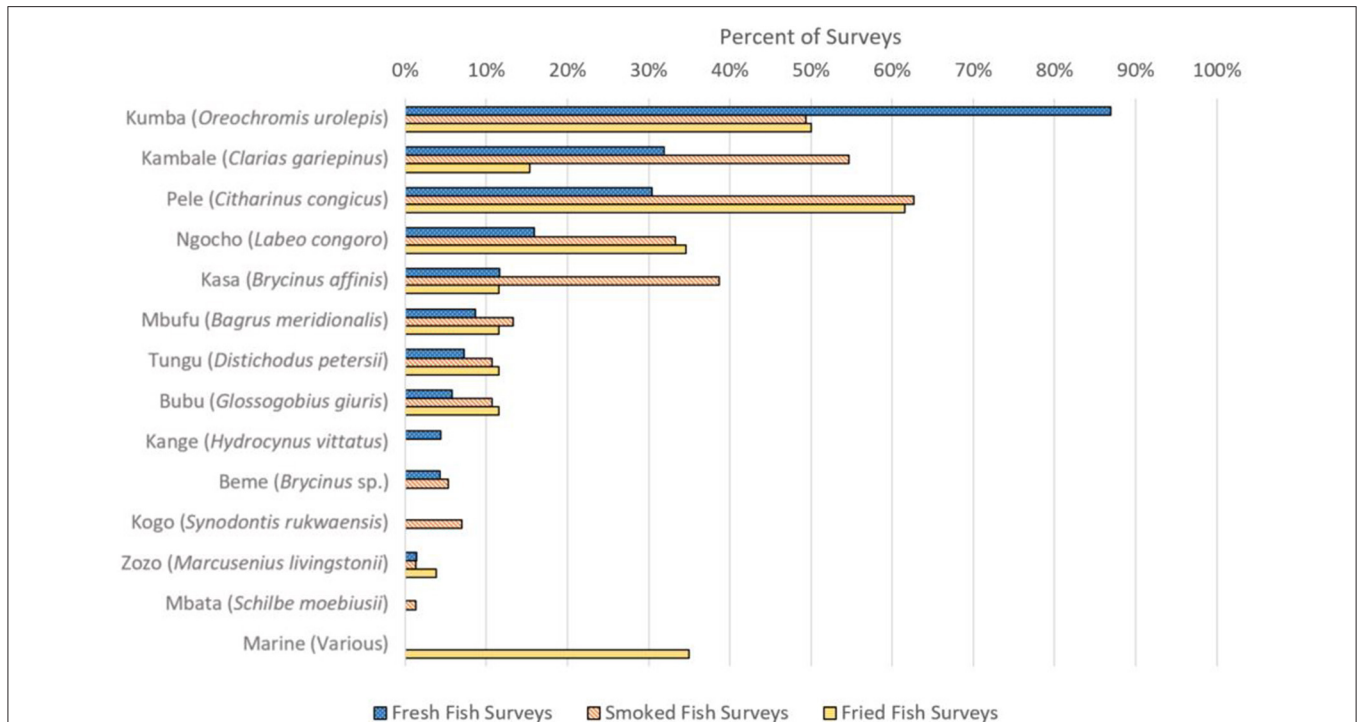


FIGURE 3 | Percentage frequency of indigenous freshwater fish species recorded in the fresh and smoked trades in Ikwiriri and Kibiti ($N = 143$ surveys) and in the fried fish trade in Ikwiriri only ($N = 27$ surveys). For comparison all marine species have been combined in a single bar at the bottom. See note on scientific names in Methods.

Fresh fish, highly perishable, were sourced from the water bodies easiest to access from each town, whereas smoked fish were sourced from up to ~70 km away (Figure 4). Fresh and smoked fish cost more by weight in Kibiti than in Ikwiriri on average for all species and survey rounds combined, likely reflecting longer routes to market, but data were inconsistent (see Methods). Fish were sold in piles (*fungu*), with vendors adjusting fish number and size to maintain a constant price across surveys of either 300 or 500 TSH/pile (0.24–0.40 USD). This represented from 15 to 25% of the minimum daily wage for agricultural labor.

In Ikwiriri, vendors’ main customers were townspeople shopping for their daily *mboga*, the side dish that accompanied staple foods (maize, rice, or cassava) eaten at lunch and dinner. Vendors explained that people liked to eat fish every day and would purchase smoked fish (typically priced at ~80% of fresh fish value) only if fresh weren’t available or too expensive. Other aquatic resources were described as occasional purchases made to save money or for a change. Villagers we spoke with frequently remarked that “any fish was good enough to eat,” while recognizing that the locally popular *kogo* catfish (*Synodontis rukwaensis*) was scorned by outsiders to the district and reporting that

women typically avoided consuming freshwater eels (*mkonga*, *Anguilla* spp.).

Availability fluctuated seasonally and reflected the town’s geographic positions. With fried fish, customers could save twice: on cheaper fish (typically half the cost of fresh fish per portion) and on cooking costs (as fried fish did not require cooking oil or sauce ingredients, such as tomatoes and onions). The largest fresh fish—the most expensive products—were generally bought by salaried workers, by those expecting guests or going visiting, or by restaurants and boarding-house owners. In Kibiti, fresh fish market traders reported that women selling fried fish were their main customers.

Figure 5 shows the number of market traders of fresh, smoked, and fried fish, and OAR, observed at Ikwiriri (A) and Kibiti (B) over the survey. As the dry season set in in August, trading activity in freshwater fish increased in both towns. In Ikwiriri, vendors selling local freshwater fish outnumbered those offering OAR in every month but March, but only in the dry season months in Kibiti (Aug–Nov; Figure 5), consistent with vendors’ self-reported assessment of monthly trading activity (Figure 6) and with seasonal fishery production (see Study Site). However, when asked to explain differences in their monthly trading activity, market traders discounted supply-side issues in

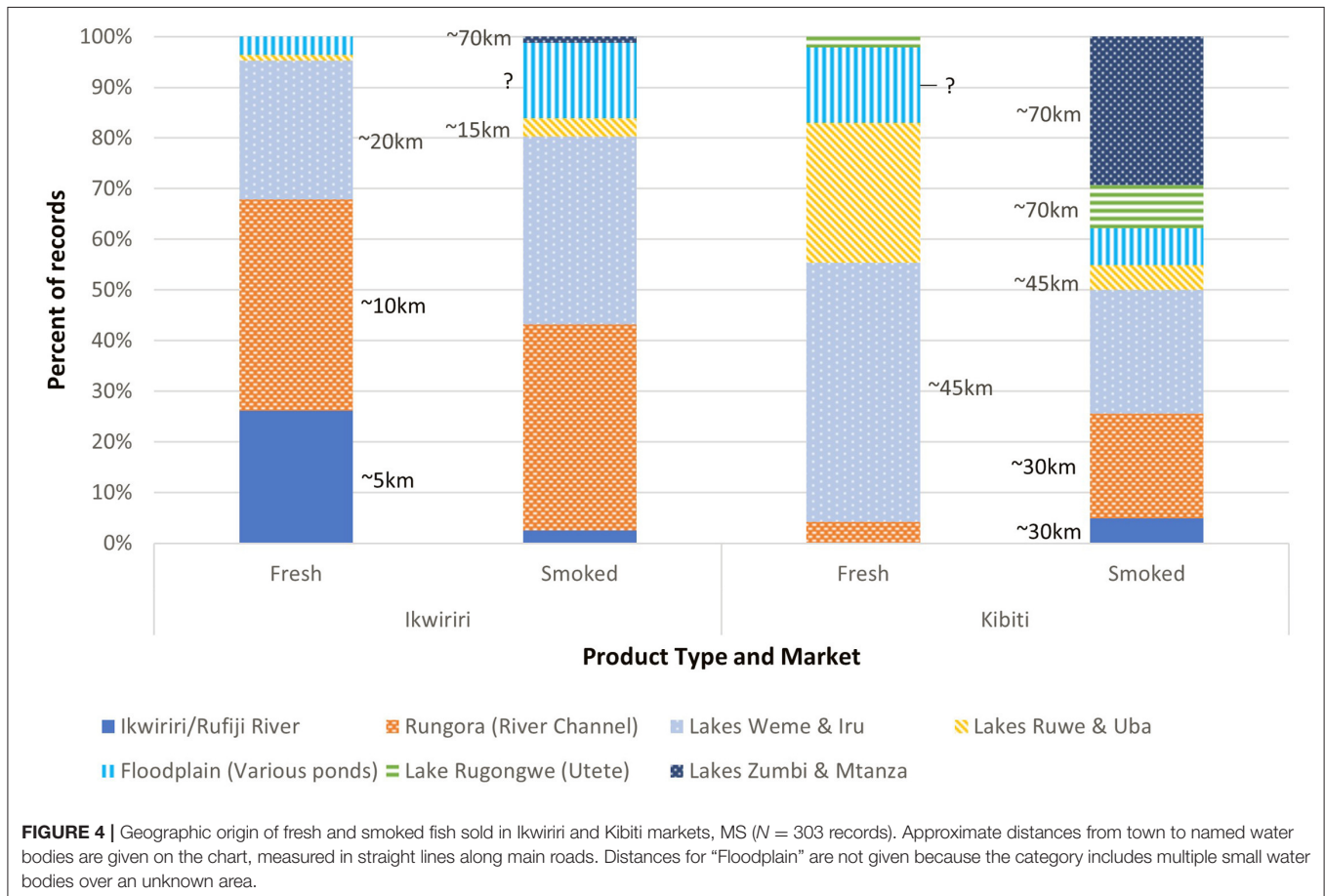


FIGURE 4 | Geographic origin of fresh and smoked fish sold in Ikwiriri and Kibiti markets, MS (N = 303 records). Approximate distances from town to named water bodies are given on the chart, measured in straight lines along main roads. Distances for “Floodplain” are not given because the category includes multiple small water bodies over an unknown area.

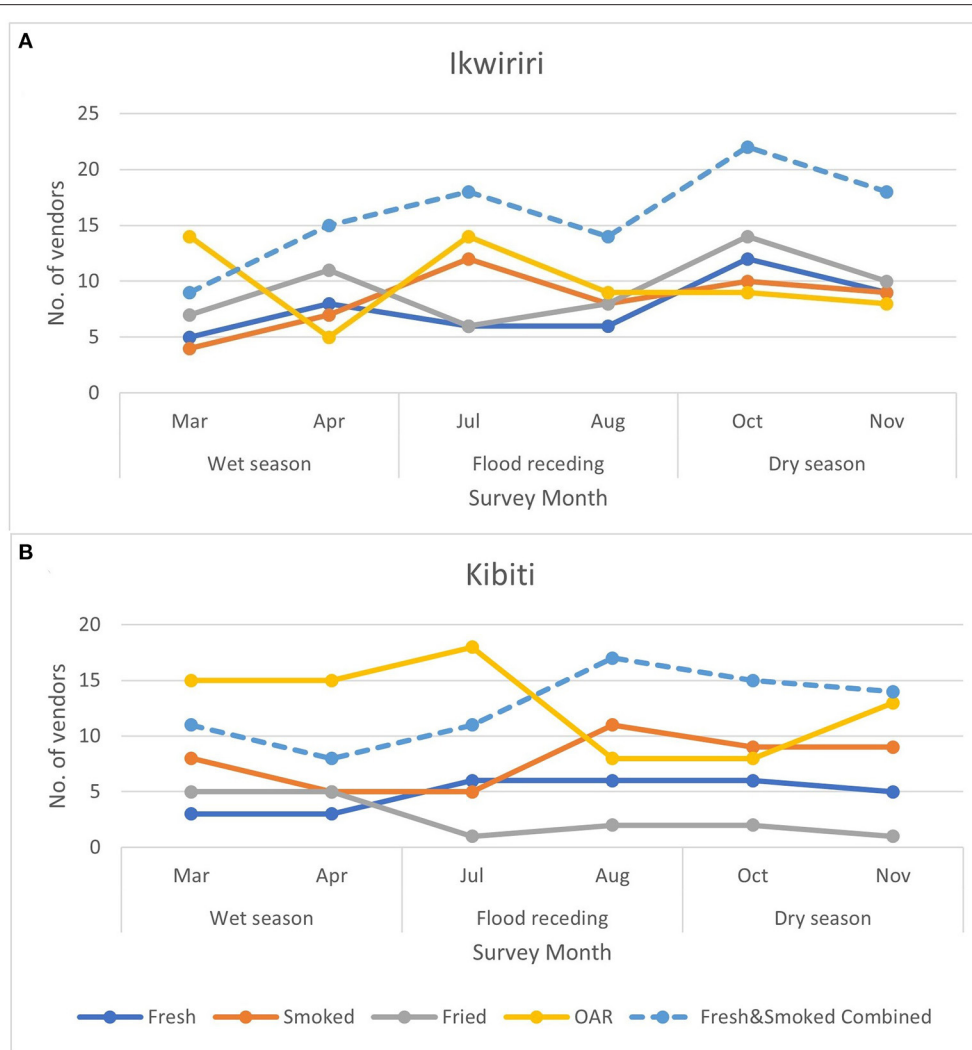


FIGURE 5 | Number of market traders of fresh, smoked, and fried fish, and OAR (i.e., *dagaa*, prawns, *udufi* and *mbarata*) observed in **(A)** Ikwiriri and **(B)** Kibiti markets over the study period, MS.

favor of demand-side factors (i.e., clients being in town rather than at their fields, clients’ cash position before or after the harvest of agricultural crops, changes in eating and spending patterns in the month of Ramadan⁴).

Fresh Fish Commodity Chains

Figure 7 details the fresh fish commodity chains from inland fisheries to the markets. Six different routes (A-F) are described. For participants in the fresh fish trade, the imperative was to sell quickly. With no ice at the landing sites, hot weather ensured that most fish would be past selling fresh within hours. The result was a fast-paced, high-stress business which informants likened to a lottery.

Fishers rarely brought fresh fish to the regional markets themselves, unless they lived locally. This was the case for

fishers based in Ikwiriri who sold directly to fried fish sellers (commodity chain A on **Figure 7**) or market vendors (B). Instead, fishers might sell to visiting buyers who used bicycles and public transport to travel between the market and more accessible water bodies (C). One informant buyer ran a vertically integrated enterprise, hiring one or more waiting bicycle transporters at the landing site to help him carry his baskets of fish (*tenga*) to the main road. There, the men loaded the baskets onto a minibus for delivery to Kibiti, where his team of 2–3 market workers would sell the fish (D). None of these chains involved patronage arrangements.

However, most of the fresh fish destined for the study markets were caught by client-fishers working the boat seine nets (primarily *juya*) at the permanent lakes closest to Ikwiriri, for sale to patron-buyers waiting onshore. Illegal but widely used, *juya* nets brought in high catches but were expensive to buy and run. As a result, *juya* fishers rarely owned the nets they worked on,

⁴In 2008, Ramadan was in September.

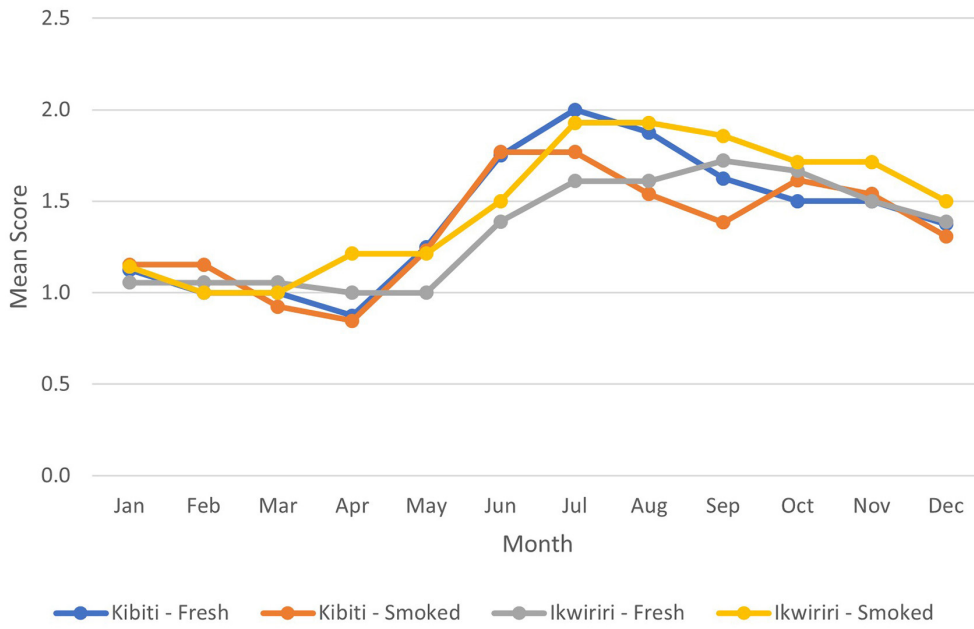


FIGURE 6 | Vendors' own assessment of levels of monthly trading activity across the year, based on mean scores (0 for lowest activity levels, 1 for usual, 2 for highest), MS.

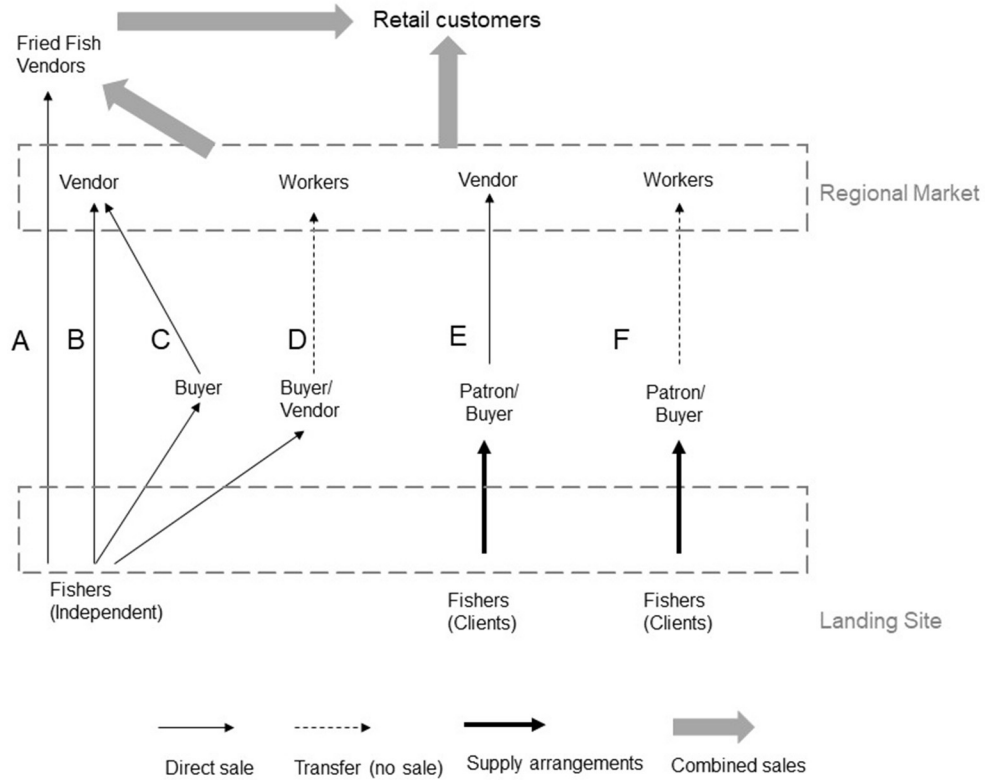


FIGURE 7 | Structure of the fresh fish commodity chains from inland fisheries to Ikwiriri and Kibiti markets, Rufiji District 2008.

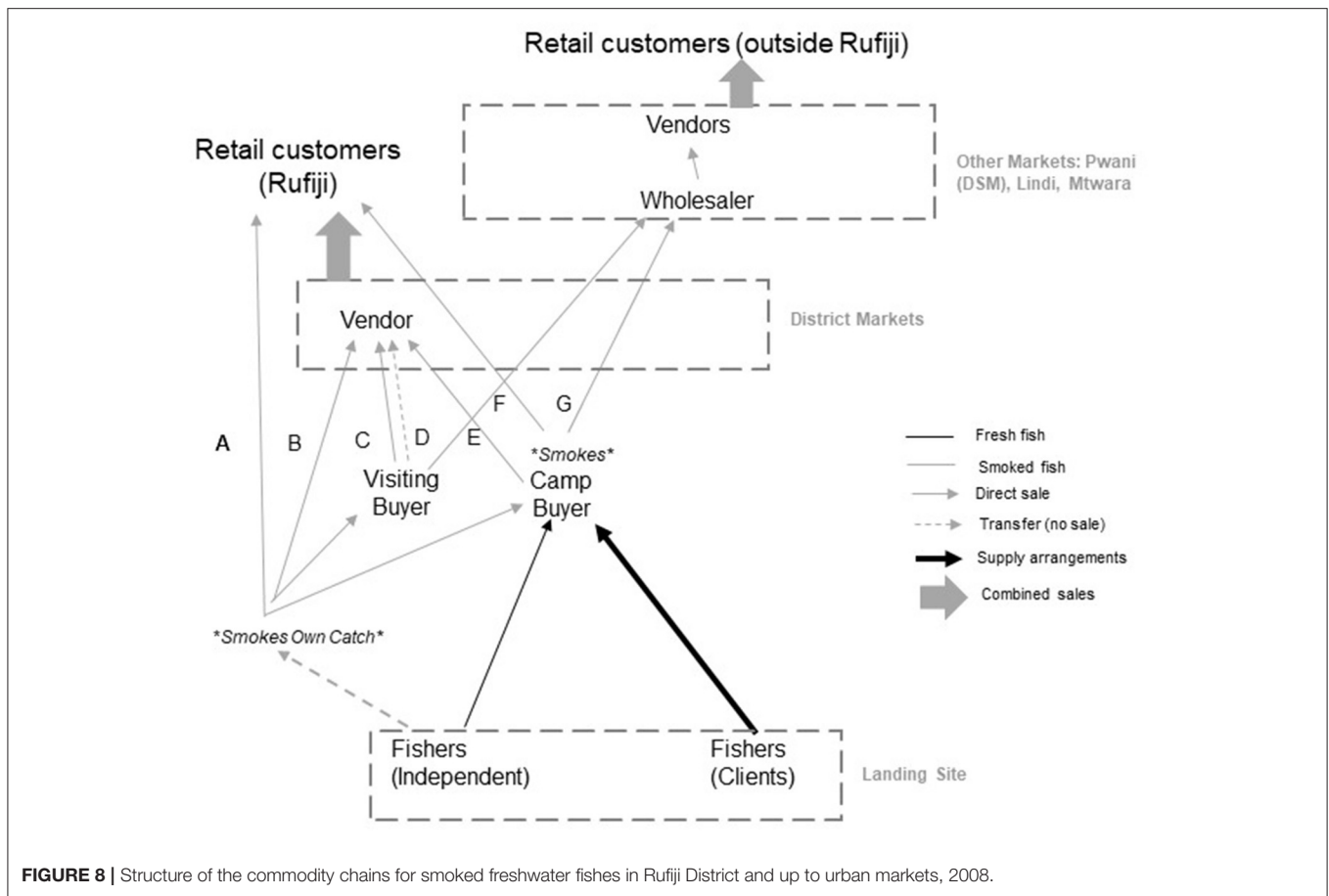


FIGURE 8 | Structure of the commodity chains for smoked freshwater fishes in Rufiji District and up to urban markets, 2008.

paying daily user fees to net and canoe owners. At Lake Ruwe, three main *juya* buyers were active over the study period, each of whom owned a motorcycle (see section Accessing Fish Supplies). Two sold to vendors in Kibiti, though they would sometimes stop at Ikwiriri if prices were good (E). A third, resident in Ruwe, maintained hired workers at Kibiti, explaining that customers preferred to buy from trusted locals (F).

On intermediaries’ arrival to market, vendors would strike a price and hustle to display purchases to advantage. They kept fish looking fresh through frequent rinsing (obvious or surreptitious), shooing flies, and moving fish or mussing up piles to suggest a recent delivery. Prices rose and fell rapidly in a trading period. Any fish left unsold were smoked, eaten at home, or put on ice for sale that evening in the backstreets. There was no significant export of fresh fish outside of the district, according to informants, despite recent highway improvements.

Smoked Fish Commodity Chains

Figure 8 details the smoked fish commodity chains from inland fisheries to the markets. Seven different routes (A-G) are described. Sales in the smoked fish trade took place over days, rather than hours, considerably reducing pressure on sellers. Most processing losses occurred at the smoking stage, with buyers able to distinguish between fish that had been well- or poorly-smoked, and adjusting prices paid accordingly.

Fishers were more likely to sell their own smoked catch at market than fresh, traveling to regional towns to sell at markets or door-to-door themselves (**Figure 8**, commodity chain A) or to market vendors (B). Our village fisher-informants usually bypassed Kibiti or Ikwiriri and traveled further north along the road to DSM, seeking better prices. Village fishers also received buyers to their homes, often by pre-arrangement (C). Most vendors waited for fish to be brought to market, though some worked with a buying partner traveling the interior (D)⁵.

Other buyers established themselves at fishing camps, buying fish from multiple independent or client-fishers. They focused primarily on purchasing fresh fish to smoke themselves, hiring help (a fish smoker, *mchomaji*) at times of high production. Camp buyers sold to vendors at district markets (E), directly to customers (F) or, most commonly, brought fish to DSM by bus for sale to urban wholesalers (G). The latter emphasized the importance of arriving with a well-organized parcel in order to maximize profits, with fish carefully graded by size and quality.

Fish, once smoked, were exported beyond the district. Together, 31 market vendors named 22 places other than Ikwiriri and Kibiti at which they had sold smoked fishes (*N* = 76 mentions), primarily in DSM (40 mentions of eight markets) and

⁵Such buyers did not like to travel far to buy fish. “We go to Mloka (a village ~90 km distant) to find a wife, not fish!,” one joked.

the Pwani region (15 mentions of six towns), but also as far as Lindi, Mtwara, and Zanzibar.

The Fried Fish Trade

The pace of the trade in deep fried fish was moderate, with processed fish losing about a quarter of their value by the third day of sale, and rotting quickly thereafter.

In Ikwiriri, women intercepted fishers and intermediaries where the paths from the floodplain met the highway. As each supplier arrived by bicycle the women descended with plastic buckets and basins to begin negotiations. Of interactions observed, 10 men sold their entire stock of tiny fishes whereas three others, with larger fish, rejected the prices offered, and continued on. In Kibiti, women bought fresh fish at the market for frying at home, gathering from 8a.m. in the marketplace to await the same traders who supplied market vendors.

Despite proscriptions on women’s movements in an Islamic society, traders could travel long distances to source and/or market their fish. Three sellers interviewed at Ikwiriri lived in Somanga and Kilwa (distances 60–120 km), while three of eight women in Ruwe had brought fried fish to the suburbs of DSM (~140 km).

Costs and Revenues

Traders faced four sets of costs in delivering fish to market: purchasing (and any processing); supply arrangements with client-fishers; transport; and fees (see **Supplementary Material**). Economies of scale applied, with those bringing more fish to market experiencing better profit margins. Based on interviews, profit margins on single transactions in the dry season (Oct/Nov) were similar for buyers across fresh and smoked commodity

chains (26–32%) with those bringing smoked fish to DSM making the highest margins (see **Supplementary Material**). However, in reporting costs, informants did not consider their own labor, which was greater in the smoked trade.

In the fried fish trade, fish and cooking supplies were the main costs, as most sellers lived locally and had no travel expenditures. Women could reduce costs by frying larger batches of fishes, buying cooking oil in larger containers, and collecting their own firewood. Overall, women expected to make on average a 28 ± 11% return on the purchase price of their fishes (N = 20 surveys).

Role of the Fish Trade in Local Livelihoods Participation Patterns and Reliance

People’s participation in the trade was flexible. Male and female market vendors were typically active year-round, but described coming to market more often when not busy at their field or when market conditions were good/sales were brisk (as also suggested in **Figures 5, 6**). Buyers at the landing sites worked year-round, spending between 1 or 2 weeks at fishing camps and a similar period back home.

Income from the fish trade was important to vendors’ households. More than 90% of male vendors reported no livelihood activities other than trading fish and farming, and most considered the fish trade more or as important as farming (**Figure 9**; N = 51). The former liked the predictable income of trading compared to farming. The latter explained how trade earnings could make up for crop losses from floods or droughts, but also be invested in farming (e.g., by hiring labor or a tractor). Furthermore, if harvests were good, they explained, fish trading allowed you to stretch your food stores, delaying the need to dip

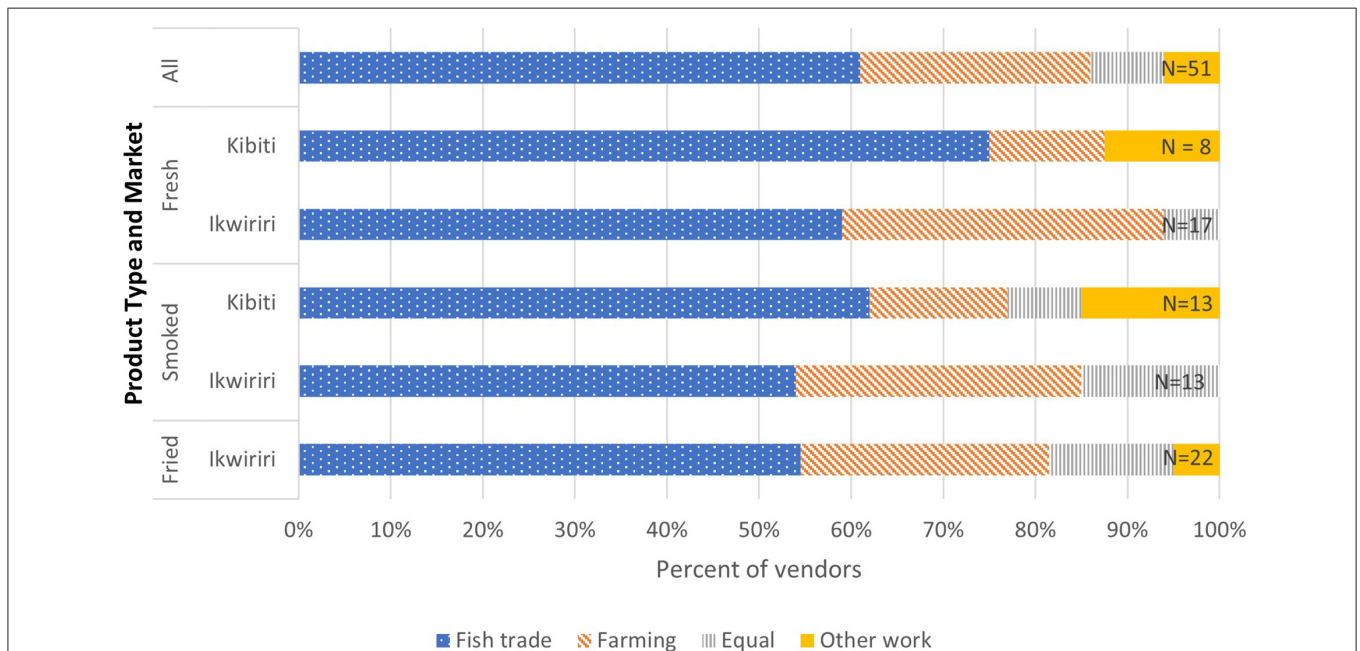


FIGURE 9 | Most important household income source as reported by fresh, smoked and fried fish market vendors, MS. “Equal” means vendors considered fish trade income to be as important to their household as farming income.

into your granary to sell food for cash. Vendors who considered farming as their most important income source emphasized that it was crucial to first put food in the house, as staple foods were expensive to buy, and only then to embark on trading.

Of fried fish vendors in Ikwiriri, 82% cited the trade as their sole occupation, even though most (67%) also had a field (*N* = 22; **Table 2**). This apparent contradiction likely reflected women viewing the fish trade as a proper occupation due to its cash-earning potential. Altogether, 55% of women cited the fish trade as their household's most important income source, or equally important as farming (13.5%; **Figure 9**). Of the women who both farmed and traded, the majority explained how they used trade earnings to invest in their farm (e.g., hire laborers) or to cope with lost harvests.

Estimated Earnings

Rufiji-based fresh fish buyers earned the highest annual incomes from the local trade (up to USD 3,150/year; **Table 4**). Whilst these figures should be treated with caution, resting on numerous assumptions and without estimates of losses (particularly high in the fresh trade), differences between buyers and vendors (fresh, smoked, and fried), and between fresh fish and smoked fish buyers are substantial enough to suggest the higher potential earnings are real.

That said, financial losses—due to fish spoilage, low prices, and/or unexpected costs—could derail traders' prevailing business strategy of steadily building up one's starting capital (or *msingi*) over the fishing season, re-investing a portion of profits to purchase a larger quantity of fish at each transaction to realize economies of scale. As explained by Athumani, a smoked fish buyer selling to DSM wholesalers, he aimed to re-invest ~60%

of profits per sale, to double his *msingi* by the end of 6 months, but unprofitable trips meant starting over regularly.

Defined in Swahili as the base or essence of a thing, the *msingi* (pl. *misingi*) was seen as separate from money for living expenses, although traders would draw on their *msingi* in emergencies or to meet major obligations (e.g., medical costs, school fees). Keeping this fund tied up was an important advantage to traders, who explained how reinvestment in their business protected cash earnings from family and friends' requests for financial assistance.

For market vendors, estimates of annual earnings are lower than for buyers (**Table 4**), but this underplays the trade's importance in wealth accumulation: several informants had built second homes with their earnings, and told us of vendors who had made enough in the trade to move their families to DSM. The trade also served as a safety net activity to generate cash quickly, as in the example of a self-described "retired" elderly vendor whom we met at the market with just enough smoked fish on sale to pay for a family member's emergency medical expenses.

Workers in the market were paid according to the earnings made that day after costs, whereas casual helpers on the stall might only receive fish in payment. The real value in working for a market vendor was in building the connections and knowledge needed to enter the trade oneself (see section Access to the Fish Trade).

Access to the Fish Trade

Entering the Trade

Traders were independent entrepreneurs, with nearly all, male and female, describing themselves as a business owner. Asked how they entered the trade, men focused on how they gathered

TABLE 4 | Estimated annual earnings (USD) of participants in the Rufiji District regional freshwater fish trade, 2008.

Trade position	Smoked		Fresh		Fried	
	Market vendor	Buyer (Chain G)	Buyer/Vendor (Chain D)	Buyer only (Chain E)	Vendor only	Vendor
Selling to	Retail clients, District	Wholesalers, DSM	Retail clients, District	Traders, District	Retail clients, District	Retail clients, District
Starting Capital (USD)	80	120	64	64	16	16
High season						
Length of cycle (d)	7	10	2	2	2	2
Number of cycles	21	15	74	74	74	74
Earnings (USD)/cycle	30	80	36	28	3.50	4.50
Low season						
Length of cycle (days)	14	21	4	4	4	6
Number of cycles	8	5	27	27	27	18
Earnings (USD)/cycle	15	41	18	14	9.60	1.84
Total annual earnings (USD)	750	1,405	3,150	2,450	518	366

Chains refer to **Figure 7** (Fresh) and **Figure 8** (Smoked). This table is built on a number of assumptions and values should be treated with caution. The high season is set at 5 months long, with trade participants working full-time (148 work days). Low season is set at 7 months, with participants working half-time (106 work days). In the low season, turnover is set as slower even for fresh fish sellers, who may continue to work every day, and the earnings/cycle is halved for all. Losses are not estimated, but the assumption of lower earnings in the low season may help to balance this. Finally, estimates provided assume a constant working capital from one transaction to the next, when the goal of many traders was to re-invest profits made in their business and increase the volume of fishes traded at each sale.

their starting capital (*msingi*), with none receiving loans and only a few entering established businesses.

Market vendors accumulated their initial *msingi* most often via their own labor, usually farming or working for a vendor. Acquiring specialized knowledge and social connections were also cited as important, with one worker-turned-vendor explaining that he first had to learn “how to buy and sell at the right prices.” Most intermediaries accumulated starting capital by fishing themselves and/or were from fishing families. Of our three main fresh fish buyer informants, for example, one had started out selling his brother’s catch, while another bought his first *juya* net from the proceeds of fishing with family. Other intermediaries had never fished seriously but moved into the trade with earnings from other sources, namely shopkeeping, timber, charcoal, professional football, and the military.

Amounts needed to enter the trade were low. Vendors in Ikwiriri considered 5.60 USD the minimum needed to begin trading (in fresh or smoked fish), moving from street sales to the market once your *msingi* had built up to 16 USD. Market vendors reported holding stock valued from a few dollars to several hundred. Intermediaries planning to bring fish to DSM needed a starting capital of at least 80 USD to break even, and buyers we spoke with at Lake Ruwe were working with *msingi* between 120 and 160 USD ($N = 3$). Women surveyed selling fried fish in town had spent a median amount of 20 USD (range: 1–52 USD; $N = 26$ surveys). Amounts among village sellers were much lower (~1.60 USD). Most village women were loaned their initial *msingi* by a relative (father, paternal uncle, sister) or lover, but one borrowed from a women’s microcredit group, and another had received fish for free from an enterprising fisher who was now her supplier.

Accessing Fish Supplies

Trading Fast: Close Relationships in the Fresh Trade

Securing fresh fish supplies as a buyer depended on having access to significant material assets, both physical (e.g., gear, motorcycle, mobile phone) and financial (cash), as well as the non-material assets of social connections, skill and knowledge needed to manage relationships along the supply chain.

During our study, three *juya* nets were in constant operation at Lake Ruwe from late August. These were owned by local villagers: Ashiru, with a second net stationed at a neighboring lake; Kassim, a shopkeeper residing in a nearby town; and the Tembo family. Both Ashiru and Kassim were also buyers, purchasing fish landed by their nets, while the Tembo family sold to Omari, a resident of Ikwiriri. Omari did not own nets, buying off the Tembo’s and a second via his agent stationed at a nearby lake, and paying owners a fee for right of first purchase. In October, two more *juya* nets were put into regular operation. Each was owned by a Ruwe villager, but neither had the cash available to run or buy their net’s production, so that Ashiru bought off one and Omari, through his agent, the other. If a net’s regular buyer did not appear or did not have enough cash on hand to purchase their entire catch, fishers could sell to others without penalty.

Kinship mattered, with net-owners entrusting relatives with key roles (e.g., agent). One villager preparing a *juya* net explained that part of the reason was to offer work to family and friends. In addition to familial obligations, buyers (especially if also net owners), had wider social obligations in the community as “rich men” (*matajiri*), including acting as patrons to their fisher-clients. At fishers’ request, patrons did not usually pay the crew for their catch every day, banking their earnings for them while also allotting each a portion of the catch for home consumption. Patrons also provided small daily advances in cash or in kind for staple food, cigarettes, or expenses at home, and larger loans on request. If catches were low, patrons were expected to cover any gear rental fees. Earnings remaining after repayments were split four-ways among crew members.

Managing fishers’ requests for loans was a delicate business, one Kassim, as a novice buyer and non-fisher, struggled with. His demands for daily payment of net fees (regardless of the catch) made him unpopular. His crew also derided his failure to assign a net overseer, meaning repairs were poorly done and the net improperly stored each day, affecting catches. As frustrations grew, crew no longer showed up to sew the net, a daily task, leaving the job to Kassim’s relatives. In response, Kassim took his net to another lake but soon returned, having failed to secure a crew. By then, some of his crew had switched to another *juya* net. When we spoke with them, they were considering whether to go out fishing once more on Kassim’s net, but only to sell the fish to another buyer, planning to purposely tear the net on submerged logs as a way to explain the “poor catch.”

The problem of moral hazard was an issue for other *matajiri* as well. Omari had recently sold his own *juya* net and two canoes because of “poor communication” with his crew, explaining that without a personal stake, fishers had failed to take care of the net. In future, he planned to buy gear for his crew and have them pay off the amount gradually, deducting the advance from their fish sales. Even then, fishers might abscond with the net before paying off their debt, given the lack of an effective legal framework to develop or enforce agreements among crew and *matajiri*⁶. Examples of successful co-ownership of *juya* nets, such as by the Tembo clan, were rare. Informants explained that each person invariably has his own opinion of where to fish, with disagreements usually ending in the owners cutting up the net and taking back their own piece.

Those buyers without special supply arrangements noted that it was sometimes difficult to obtain fish as there was no guarantee of enough people going out to fish each day to supply demand at the landing site. In addition, these buyers were often obliged to purchase fishes in bulk, unlike patrons who had the privilege of counting up and grading the catch by size before deciding on price.

Trading Slow: Accumulating Fish at a Buyer’s Camp

Patronage arrangements existed in the smoked trade among camp buyers seeking to accumulate large quantities of fish. The

⁶In examining all available court records held in the ward, we came across only one case dealing with fisheries, of a net owner suing for the return of an advance to two fishers.

type of support offered to client (or “special”) fishers (*wavuvi maalum*) was similar to that in the fresh trade, though without the focus on running *juya* nets as supplies could be brought in more slowly, with set gill nets and cast nets. The example of Athumani and his partner is illustrative. Set up beside a floodplain pond, they bought from independent fishers living in field houses and two client-fishers sharing their camp. At the start of the season, Athumani had advanced to each client-fisher a *posho*, or maintenance allowance, for use by the fisher’s family in his absence. At the end of a fishing cycle, every 5–7 days, the buyers tallied up the value of the fish, and deducted the *posho* and camp expenses: cigarettes; marijuana; daily canoe rental (which fishers had to repay in full); and food (split four ways). The remainder was owed to the fishers and paid in two parts, half immediately and half once the fish had been sold.

As in the fresh trade, not having dedicated supply arrangements could lead to supply problems. One outside buyer had given up dealing with local fishers in frustration at advancing loans without obtaining promised supplies, and bought instead through a local buyer. He explained that the local, being a friend and neighbor to the fishers, was able to cajole them into meeting their agreements, pursuing them to their homes if necessary, a socially unacceptable move for the buyer.

Risky Trades: Uncertain Supplies for Women

Competition for smaller, cheaper fishes to fry was intense, with more women seen waiting for fish on survey mornings than departing with any. Women might avoid competition at the trading site by paying fishers in advance to deliver fish to their homes, but several reported losing such advances. Alternatively, women could go directly to the landing sites. This was a common strategy for village informants, who preferred buying directly from fishers rather than providing advances (unless it was to a trusted kinsman). However, unless women could stay with relatives in villages with easy access to landing sites, traveling to source fish was seen as disreputable, and living at fishing camps more so. Of the three women traders we encountered living at one camp, one was there with her lover (*mchumba*), an important camp buyer, and the others were her sisters.

Enabling Environment

Regulations and Enforcement

Rufiji’s inland fisheries are *de facto* open access. Few inland fishers at Lake Ruwe bothered obtaining fishing or boat licenses, but they did dread the possibility of unexpected patrols to enforce *de jure* rules and regulations, as officials were known to confiscate and burn small-mesh nets, or demand bribes. Transporting fish any distance without a trading license was more risky. If caught, the person faced confiscation of their fish or a fine (8–240 USD, depending on basket size). Unlicensed fishers brought their smoked fish to regional markets by bicycle on backcountry paths, avoiding the main roads, or passed off their fish on buses as the property of a licensed traveling companion.

All people transporting fish additionally had to pay a district tax (*ushuru*) on each basket. Although set by basket size, amounts paid varied at officials’ discretion. Buses were meant to stop for inspection at five checkpoints along the district’s main roads, and

traders either pay or show a valid receipt. In our afternoon at one checkpoint, we did not observe any officials inspecting buses’ cargo, and witnessed several traders asking the person on desk duty to “help them,” suggesting opportunities for tax avoidance.

Market vendors did not need a license, but paid a tax to the district as well as fees for stall rental and market cleaning daily (see **Supplementary Material** for USD amounts of all fees and taxes).

Access to Credit

Small loans between buyers and fishers were an important part of supply arrangements, but credit was absent at higher levels of the commodity chain. No intermediaries or vendors had received loans, and informants stated that it was not possible to get one, informal or formal. Furthermore, informants explained that wholesalers in DSM did not always pay on delivery, forcing traders to cover expenses in the city while awaiting payment.

To overcome the lack of outside financial support, participants cooperated with peers. Several buyers in the smoked fish trade worked with an equal partner, as did several market vendors. In the latter partnerships, one individual sold fish at the market while the other sourced fish inland. Cooperation in the fresh fish trade seemed less structured but widespread. Although the three fresh buyers on the *juya* nets we interviewed worked independently, the major buyer in Kibiti (Juma) had an equal business partner. Market vendors often pooled their cash to buy up large fish deliveries as these arrived to market, making spur-of-the-moment agreements several times, with different partners, over the course of a single trading period. A similar camaraderie existed among smoked fish vendors, who would entrust others to sell their product when temporarily leaving their stall.

DISCUSSION

Our study of a rural, informal freshwater fish trade demonstrates the ability of local inhabitants to overcome considerable environmental, financial, and infrastructural challenges to reliably deliver fish to rural and urban consumers, and illustrates the unique position SSF hold in supporting the nutritional and economic needs of those who need it most (Cohen et al., 2019). Locals aimed to eat fish—whether fresh, smoked or deep fried—every day, and most species in the trade were sold in small quantities at a low price, making a nutrient-rich product affordable to the poor. Indigenous freshwater fish dominated the trade, from the large, oily and nutritious *Clarias gariepinus* African catfish (Hamerlynck et al., 2017) to many small-sized, pelagic species of the type increasingly recognized as critical to achieving food security (Thilsted et al., 2016), particularly among children who suffer the most severe consequences from micronutrient deficiencies (Bogard et al., 2015; O’Meara et al., 2021). Once smoked, fish were traded long distances, up to DSM and across southern Tanzania, supporting food security far beyond source communities, recognized as a key contribution of SSF (Beveridge et al., 2013). The combined activities of trade participants—hiring helpers, purchasing supplies, renting gear, eating at food stands, using local transport—had multiplier

effects in the local economy, further illustrating the value of inland fisheries to rural communities (Welcomme et al., 2010).

The flexibility of the fish trade, in terms of how participants were able to combine it with other activities, further underscores its important livelihood role. Trade income provided a safety net for when harvests were lost, husbands left, or emergency expenses arose (Paul et al., 2011; see also Hamerlynck et al., 2017). It also offered opportunities for investments (e.g., in farming inputs, children's education, or in the fish business itself) and asset purchases (e.g., houses, motorcycles). People entered and left the trade as needed, switching between farming (primarily) and trade over the course of the year, and over their lifetimes. Buying and selling fresh fish was seen as a young man's game, borne out by the age profile of surveyed vendors. It was high-risk and fast-paced, "a lottery" as traders often told us, bringing in potentially higher earnings each day but at higher risk. Several market vendors explained how they had given up selling fresh fish to concentrate on smoked fish as they got older, appreciating the more leisurely pace and predictable earnings (see also Abbott et al., 2007).

The inland fish trade serviced local rather than global markets and involved nearly exclusively participants born and living in Rufiji, thereby ensuring that much of the economic value remained within the district⁷. This is in marked contrast to the situation in the Rufiji Delta, where local communities have engaged in struggles against multinational corporations intent on prawn fishing and aquaculture (Gibbon, 1997), and now outside conservation initiatives restricting fishing and other livelihood activities (Beymer-Farris and Bassett, 2012). Despite a focus in fisheries policy on value-creation via exports to distant markets, any gains generated do not appear to trickle down to local producers, and may introduce new vulnerabilities (Béné et al., 2010b; Cohen et al., 2019). As such, the local, small-scale, under-the-radar nature of the Rufiji fish trade should not be seen as a problem to solve, but rather as key to food and livelihood security in the region. Below we identify the key features of Rufiji's local informal fish trade networks and how these support, or hamper, its livelihood function.

First, the informal trade is robust: well-developed, historical, and providing an arena for locals' entrepreneurial ability. The links described here between a thriving local production system and a wide network of rural and urban markets are very different from the situation described for the Zambezi-Chobe floodplain fishery in Namibia, where the lack of intermediaries and regional markets meant that consumption was nearly entirely local at the time (Abbott et al., 2007). These authors' description of an "involved market" (as per Geertz, 1963) can be explained in part by the nature of the floodplain, where changing water levels affect the location of landing sites, labor demands, and the availability of economic activities besides fishing (Jul-Larsen et al., 2003). This makes it difficult for traders to know when and where fish will be landed, and to access sites. However, Rufiji district, by combining an environment of permanent lakes with temporary

water bodies provides a hybrid example of an inland trade, offering opportunities for developing both geographically stable, year-round trading routes and seasonally shifting ones, with mobile phones facilitating information flows (pers. obs.). Indeed, the sudden emergence of a new lake and productive fishery on the Zambezi-Chobe floodplain, together with increased demand for fish and improved transportation and mobile phone networks, has entirely transformed and complicated local fish marketing systems (Abbott et al., 2015).

The people of Rufiji have a long history of looking outwards, engaging in commercial trade through centuries of interaction with the Arab world (Beymer-Farris and Bassett, 2012). The orientation of the freshwater fishery in particular toward urban markets is long-standing, with Bantje (1982) describing the daily export of smoked fish up to the city by bus even then, when travel times were considerably longer. It may be for this reason that informants did not consider the recent improvements in the road network to have had much effect on their business at the time of our study.

The entrepreneurial drive of Rufiji traders was evident in people's narratives of how they came to enter the trade. Starting with relatively small investments, acquired through their own labor or cooperation with friends and relatives, and taking calculated risks, the fish trade offered an important means for local people to earn income and accumulate savings in a cash-poor rural society, where formal employment opportunities were virtually nil (Paul et al., 2011). Although certain buyers might dominate at the landing sites (particularly in the fresh fish trade) there were ample opportunities for less well-resourced individuals to enter the trade, including by selling their own catch. As found also by Richmond et al. (2002), most buyers were small-scale traders who made regular visits to landing sites, buying from fishers without owning nets themselves or offering patronage. Village-based traders had the extra advantage of being able to source fish from the floodplain, where *juya* nets could not be deployed and where non-residents struggled to locate supplies within the seasonally shifting landscape.

A second key feature of the local fish trade was the importance of social relations in structuring who could participate, and how. Gender norms and relations severely constrained women's participation (Lawless et al., 2019). In Rufiji, women dealt only in fried fish, and were relegated to the spatial and temporal margins of the marketplace⁸. This is in marked contrast to wider trends in African inland fisheries where women are reported to comprise 69% of fish processors for countries studied (De Graaf and Garibaldi, 2014) and for SSF globally, where women dominate the post-harvest stage numerically if not always economically (Weeratunge et al., 2010; Harper et al., 2013; Kleiber et al., 2015). In sub-Saharan Africa, women are often the main intermediaries in low-value fisheries (Abbott et al., 2007; Fiorella et al., 2014; Manyungwa et al., 2019); but can also occupy positions of power as traders, gear owners and credit providers in higher-value marine fisheries (Walker, 2001; O'Neill et al., 2018a).

⁷We expect that urban wholesalers were predominantly Rufiji natives as well, on the basis of informants' anecdotes of local traders who had made good and moved to the city, and wider patterns of Rufiji men's migration to DSM (Lockwood, 1998).

⁸Women did occasionally fish for home consumption however; see Moreau and Garaway (2018).

The constrained role of women within the Rufiji fish trade reflected their ambiguous position in society, entitled to their own field and earnings, and allowed some independence of movement (if traveling in groups, and/or staying with relatives), but also confronting men's desire, often justified on religious grounds, to maintain control. While Rufiji district is the most uniformly Islamic part of Tanzania today, local practice remains highly syncretic and heterodox (Lockwood, 1998, p. 74) and patriarchal norms sit uneasily over the earlier matrilineal system Islam displaced⁹. By dealing in fried fish, a cooked item that could be prepared at home while caring for children, traders are operating within the female domain, satisfying gender norms while successfully opening space for some agency in their livelihood choices (see also Wamukota, 2009). In Rufiji, selling other "domestic" products—donuts, chapattis, cooked meals, homebrew—offered accessible alternatives to the fried fish trade, and were of higher status than the remaining options available to women for earning cash income (e.g., day labor, charcoal making). Nonetheless, the practical need to fulfill their reproductive responsibilities (e.g., caring for children and the elderly, household chores) limited opportunities to travel, accumulate assets, or gain experience in the fish trade (Frocklin et al., 2013).

The constraints placed on participation should not obscure the trade's importance to local women, as most informants considered the activity to be more or as important to their household as any other activity, a similar finding to Abbott et al. (2007) (but see Matsue et al., 2014). The fact that women kept their own earnings from the trade—where income controlled by women in developing countries is more likely to benefit household nutrition (Smith et al., 2003)—and reported eating unsold fish at home suggests particular benefits for the well-being of children in fish sellers' households (Manyungwa et al., 2019). In addition, further study might reveal that women are more influential in local marketing networks than appears here, with several fresh fish traders in Kibiti citing fried fish sellers as their most important clients, and traders in Ikwiriri complaining of their effect in driving up fish prices.

Social relations were important in structuring male traders' participation in fish value-chains as well, alongside age and economic status which mattered to an extent not observed among female traders. Fresh fish buyers were estimated to earn the highest annual income from the freshwater trade, and were also different from most other trade participants in having access to greater fixed capital. The three major buyers on Lake Ruwe each owned a motorcycle and two owned a *juya* net. However, capital holdings alone did not explain how people reached their position as major fresh fish buyers. Several local villagers owned *juya* nets but lacked the cash to buy fish produced every day from their nets, for instance. Other individuals had access to cash, but did not own nets or a motorcycle.

Critical to success in the fresh fish trade were holdings of social capital. The most successful fresh fish buyers we encountered

had to exercise extreme diplomacy in securing supplies from fishers, combining social skills and deep-rooted local connections with entrepreneurial drive, as well as obvious charisma. Although several smoked fish buyers at the landing sites came from outside the district, fresh fish buyers we encountered were all Rufiji natives. Resident buyers were regularly called upon to broker deals when outsiders failed to enforce agreements made with local fishers. Similarly, it was local villagers who operated from floodplain water bodies, as these were adjacent to people's fields and subject to weakened, but persistent, customary rights and norms of access (Moreau, 2014). Although most fishers and trade participants encountered were Ndengereko, we would suggest that this reflected the group's numerical dominance in the area, with little evidence of ethno-professional categorisations operating in local fisheries today.

A third feature of the local trade, related to social relations, was its cooperative nature, at least among male participants at the same level in the commodity chain. Whilst there were undoubtedly less obvious power dynamics in play, relations appeared supportive. Market vendors minded each other's stalls, maintained long-term partnerships, and pooled their money for spontaneous purchases in trading periods. Fresh fish buyers were seen to transport each other's catch if they had extra room on the motorcycle, and lend each other gas. A key motivation for investing in fishing gear was to provide work to friends and family.

For women traders, however, competition over supplies could be intense, and any cooperation highly personalized. Informants reported physically fighting with one another to get fish from roadside sellers in Ikwiriri, and we observed much jostling there and in Kibiti market. Paying fishers in advance could backfire when men failed to appear with fish, and women reported having difficulty recouping these losses. Although village women did not report any significant competition for supplies, most relied on kinship ties. Women living at the fishing camp likely secured supplies through the kind of sex-for-fish transactions described elsewhere in Africa (Merten and Haller, 2007; Béné and Merten, 2008; Fiorella et al., 2014), as reported by fishers and village women. However, such transactions were not necessarily perceived as shameful, with village women expecting fish as gifts from lovers. In Rufiji, the association of fish with sex was long-standing, with elders recounting how men from the high terrace used to "lend" their wife overnight to visitors from the floodplain arriving with smoked fish to sell (see also Bantje, 1982; Lockwood, 1998, p. 67 on transactional sex in Rufiji District).

Fourth, although differences in annual earnings at different trade levels could be substantial, trading relations were not necessarily exploitative, given the costs and risks incurred by traders relative to fishers. The role of intermediaries in SSF, and the nature of their relationships with fishers, is a subject of much study (Platteau, 1989; Crona et al., 2010), and determining the precise level of exploitation here would require closer accounting of the financial and non-financial benefits involved (Drury O'Neill and Crona, 2017). In our case, fishers might choose or be forced to deal with intermediaries because of factors such as: lack of gear, licenses, and transport; limited connections

⁹Away from Rufiji, women may experience greater freedom to trade: Richmond et al. (2002) noted that both male and female wholesalers for Rufiji finfish operate at Kariakoo, the main DSM market.

within the marketplace, including poor price information; higher risk aversion; and competing demands on their time from farming. The ability of traders to set prices would explain why villagers brought their smoked fish directly to market when they could, and suggests that price squeezing occurred in the fresh trade, where fishers had little option but to sell their catch quickly.

Yet relationships between fishers and intermediaries were complex and multiple. Relations were mediated by cultural expectations of how a “rich man” should behave (i.e., with generosity and compassion) and embedded in social networks of kinship and residency. Outside buyers struggled to cajole or pressure clients into meeting agreed terms, often relying instead on residents to broker transactions. Fishers on *juya* crews resisted unwelcome treatment, not showing up for work or quitting, selling to other buyers, or wilfully damaging gear. The fact that patronage arrangements were more common and well-developed on the active nets (e.g., *juya*) supplying the fresh fish trade, and which were understood to bring in the highest catches, underscores the need to better understand the role of intermediaries in driving resource exploitation patterns and sustainability (Crona et al., 2010; Miñarro et al., 2016).

A final key feature to highlight is the lack of official support to trade participants. Together, burdensome regulation, a lack of public services in return for tax payment, and the regular mistreatment of locals by officials would have contributed to locals’ non-compliance with controls (Ali et al., 2014), and encouraged the trade’s informal nature. Only those regulations that extracted money from fishers and traders were regularly enforced, with the licensing system serving primarily to criminalize the rural poor (see also Paul et al., 2011). The transport of one’s own fishes for sale in the highlands is a practice that has supported regional food security for generations (Moreau and Garaway, 2018), but unlicensed locals now must avoid patrols or risk fines and confiscations. None of the taxes or fees collected from the fish trade were earmarked for the sector, and there were no extension services or financial aid available to trade participants.

In conclusion, we would argue that the freshwater fish marketing system described here is resilient and pro-poor, offering flexible food and income opportunities to a range of local actors where these are limited. As such, the priority for government should be to recognize the important livelihood functions played by local inland fisheries, to consider how best to safeguard and enhance these, and to involve trade participants as equals in any planning given the social complexities governing access and exploitation patterns. Most fundamental, the ecological viability of Rufiji’s wetlands on which productive fisheries depend must be preserved, but this is no small endeavor given the political enthusiasm for the controversial Magufuli mega-dam project at Stiegler’s Gorge¹⁰ and the growing climate emergency.

¹⁰<https://www.theelephant.info/long-reads/2021/06/11/tanzania-the-dialectics-of-maguphilia-and-maguphobia/>

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the UCL Anthropology Department Research Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements. Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

M-AM designed the study, conducted data collection and analysis, and wrote a thesis chapter on which this article is based, advised throughout by CG as doctoral supervisor. M-AM and CG co-wrote the article and approved the submitted version. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2021.742803/full#supplementary-material>

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