



Is inland aquaculture the panacea for Sierra Leone's decline in marine fish stocks?

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ABSTRACT

The literature on fisheries for developing countries often cites inland aquaculture as a promising source of wealth creation for a nation in terms of revenue generation from export products. However, in this paper we argue that inland aquaculture has a greater prospect of success if it focuses on social welfare – i.e. alleviating food insecurity and poverty in coastal fishing communities, particularly those that are experiencing increased and unsustainable fishing pressure on marine fish. Nevertheless, promoting inland aquaculture in coastal areas faces many challenges, including financial, legal, political, environmental, logistical, educational, and attitudinal obstacles. Our study investigates these challenges in two coastal communities in Sierra Leone – Tombo and Goderich – where declining levels of marine fish catches are intensifying efforts to provide alternative or supplementary forms of employment for artisanal fishers, but where knowledge and experience of, and enthusiasm and funding for, inland aquaculture are limited. The research is based on the perceptions of 51 key informant interviewees and 199 survey questionnaire respondents. The main findings of the fieldwork are as follows. (1) Few local fishers were familiar with inland aquaculture and its potential benefits. (2) There were land tenure problems (for example, women were excluded from ownership of land). (3) There was little funding to buy/rent land and equipment. (4) Despite declining fish stocks, respondents were reluctant to take up full-time fish farming because of the easier option of fishing. Our findings suggest that greater uptake of inland aquaculture is more likely if presented to local fishers as a supplementary livelihood activity rather than an alternative occupation to marine capture fishing. Our study reinforces the importance of understanding local fishers' cultures, values, and preferences before introducing a new livelihood activity.

1. Introduction

Globally, 90% of fish stocks monitored by the United Nations Food and Agriculture Organisation (FAO) are fully or overexploited [28]. Aquaculture is highlighted as one option to address food insecurity where appropriate. Estimates suggest that up to six times more food can be produced from aquaculture than from the ocean (Costello et al., [74]). In 1974, aquaculture provided only 7% of global fish consumption, increasing to 26% in 1994 and to 39% in 2004 [29]. Ten years later, “the aquaculture sector's contribution to the supply of fish for human consumption overtook that of wild-caught fish for the first time” ([28]; see also Ref. [53]). In 2016, aquaculture production (including edible sea plants) was 110.2 million metric tonnes valued at USD 243.5 billion [28]. In total, close to 600 species are now farmed globally with current production including 54 million metric tonnes of finfish, 17

million metric tonnes of molluscs, eight million metric tonnes of crustaceans, and one million metric tonnes of assorted aquatic animals [28].

These figures reflect the wealth creation approach to aquaculture as a major source of income from exports which contributes to national economic revenue rather than the social welfare approach which focuses on satisfying the basic nutritional and employment needs of domestic populations. The distinction between the wealth creation approach and the social welfare approach in coastal fisheries management is explained in Okeke-Ogbuafor & Gray [57]. The Peoples Republic of China, the largest aquaculture producer in the world, exemplifies the wealth creation approach in that aquaculture is exploited on an industrial scale for national revenue generation. In 2016, China's production outweighed the combined production of the rest of the world [28]. The expansion of China's aquaculture industry was facilitated by the free-market economic strategy it adopted in 1978 as well as significant government

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support and regulation [30]. In 1991, the Chinese government introduced monitoring of hatchery for the quality production of juveniles and fingerlings through the creation of the National Fish Protogenic and Fine Seed Certification Committee and promoted the diversification of species that could be farmed. In addition, economic incentives were introduced by the Chinese government for expansion of the fish feed sector [30]. Other countries such as India, Indonesia, Vietnam, Bangladesh and Norway have also adopted the wealth creation approach and are now leading players in the production of farmed fish [29,53]. In Africa, Egypt stands out as a major farm fish producer, with an annual total of more than 750,000 t. Several African countries, including Benin, Côte d'Ivoire, Guinea, Kenya, Madagascar, Malawi, Nigeria, South Africa, Tanzania, Togo and Uganda have developed substantial aquaculture industries [8,13].

However, proceeds from commercial aquaculture do not always trickle down to communities [18]. In Myanmar, Filipinski and Belton [19, p. 1] compared the benefits of small-scale and large-scale aquaculture to host communities, and their findings revealed that small-scale indigenous aquaculture served communities better than did large-scale commercial operations: 'small fish farms generate more spillovers than large fish farms'. Similar studies carried out in parts of Africa, including Tanzania, Zambia and Nigeria, highlight the social welfare role of small-scale aquaculture for food security and poverty alleviation ([49, 54]; [1,31]).

In Sierra Leone, the coastal areas of the country are experiencing a decline in marine fish stocks which make it imperative to find additional, or in some places, alternative sources of fish protein. But attempts at establishing commercial inland aquaculture enterprises to help reduce the pressure on fish stocks have not always been successful. Sankoh et al. [60], report that subsistence inland aquaculture has been successful in Tonkolili District in the Northern Province of Sierra Leone where there were more than 1500 active fishponds farming Nile tilapia (*Oreochromis niloticus*) producing an approximate 82 tonnes annually. The reason for their success is that the farmers in Tonkolili who were trained by the Peace Corps on how to construct and manage fishponds adopted the technology and have since continued to train others [60]. Considering the pressure on declining fish stocks, the current study explores the possibility of emulating the experience of Tonkolili District by assessing the potential for the development of small-scale subsistence inland aquaculture enterprises in two of Sierra Leone's big fishing communities – Tombo and Goderich.

2. Sierra Leone's coastal fisheries and aquaculture projects

Sierra Leone is one of the poorest and least developed nations in the world. In 2020, the United Nations Human Development Index ranked Sierra Leone 182 out of 189 countries. In 2017, nearly 60% of its seven million people experienced multidimensional poverty, including lack of access to basic facilities such as clean water and education [70]. Sierra Leone also has one of the world's highest rates of maternal mortality [67], and general life expectancy is below 45 years ([48]; Islam et al., [38]). Sierra Leone continues to suffer from the after-effects of a civil war that lasted from 1991 to 2002 and killed an estimated 70,000 people (United Nations, [75]) and destroyed properties and infrastructure [73]. The civil war led to the displacement of approximately 2.6 million people with many people moving from inland areas to coastal areas (United Nations, [75]). This huge influx of migrants has increased pressure on marine fish stocks in many coastal areas of Sierra Leone (Ménard, [76]; [58,59]). The 2014 Ebola epidemic was another setback to Sierra Leone's development as imports and exports dried up and household incomes plummeted when fisheries, farming and local craft industries collapsed [42]. In 2017, Sierra Leone was hit natural disasters resulting in heavy mudslides and flooding in which over 500 people were killed and hundreds of families were further displaced (Dale-Harris, [83]).

Sierra Leone is highly dependent on its marine capture fisheries

because fish is the main source of animal protein for about three quarters of the population [10,57,59,64,72]. However, many of the targeted fish stocks are considered to be in decline, and Bonga (*Ethlamosa fimbriata*), Snappers (*Lutjanidae*), Groupers (*Epinephelinae*), Shrimp (*Carideawithin*) and Herring (*Clupea harengus*) stocks are fully exploited and need to be managed with care (Baio and Sei, [84]: 33; [11]).

Sierra Leone has been described as a failed state for fishing (Thorpe et al., [65]). For decades, international organizations have provided interventions to boost Sierra Leone's capture fisheries but these have failed to eliminate poverty and hunger in coastal areas ([32,58]). Sierra Leone's marine fisheries suffer from 'wicked' problems (i.e., multi-faceted problems for which feasible solutions may not be easily identifiable) including illegal, unreported and unregulated (IUU) fishing, over-fishing by industrial vessels, and the use of unsustainable fishing methods by artisanal fishers [40,43,57,59]. However, one potentially promising strategy to offer supplementary or alternative sources of food and/or income is inland aquaculture. Development partners from the European Union (EU), non-governmental organizations (NGOs) and the FAO have encouraged the development of aquaculture in developing countries to support livelihoods through the creation of jobs and to provide nutrition [30,41,60]. However, attention to understanding the local context, particularly socio-economic constraints, cultures, values and the willingness of fishers to consider aquaculture as a livelihood is often overlooked by well-intentioned initiatives aimed at eradicating poverty and food insecurity (Stead, [82]; Slater et al., [81]; [34,44,63]).

Very little research has been conducted on Sierra Leone's aquaculture sector [41] and there is uncertainty about when it was first introduced into the country. The Food and Agriculture Organization [30] reports that coastal aquaculture began with the culture of mangrove oyster (*Crassostrea tulipa*) which is thought to have been introduced during 1974 by the government of Sierra Leone with assistance from the Canadian International Development Research Centre. This project, according to FAO (nd), provided a biological basis for the development of the oyster but the extension of this project to farmers failed and it was discontinued after eleven years due to inadequate financial and technical support. Another account by Sankoh et al. [60] claims inland aquaculture began in 1976, when the Sierra Leonean government established a fish breeding station in Tonkolili District in the Northern Province. In 1984, a government inland aquaculture experimental station was established in the Bo District in the Southern Province [30,60]. During the 1990s and 2000s, several further inland aquaculture initiatives were developed in Tonkolili and Bo Districts. Another oyster farming project was developed during 2014–2018 around Bonthe, a coastal town located on Shebro Island [52].

In a bid to continue promoting the expansion of aquaculture in Sierra Leone, WorldFish developed a private-public partnership initiative which was a shift from their previous top-down aid programmes [20]. It was a USD 3.5 million project developed to test a business model aimed at increasing fish production, consumption and incomes of small-scale fish farmers [20]. While this private-public partnership initiative looked promising, to ensure sustainability, Sankoh et al. [60] pointed to the need to factor into its design local circumstances and needs because the poor understanding of local needs contributes to the poor performance of commercial aquaculture in Sierra Leone: 'Catfish command a high price. However, to date all foreign experts have been advising on growing *tilapia* a species we did not encounter in the markets and which we would infer are not very desirable' ([61], p.13). Sankoh raises an important issue here – that the development of inland aquaculture in Sierra Leone has been mainly pushed by foreign agencies within the international donor agenda rather than by indigenous or bottom up initiatives. As a result, some of the projects have lacked local knowledge and contextual understanding. Other factors that have hindered the commercial development of aquaculture include poor site selection, natural predators, poachers, a lack of technical know-how, low quality feed and seed, poor labour inputs, fluctuating environmental conditions

(e.g., floods and droughts), and expensive fishpond facilities.

This study is one of the few that aims to explore conversations about these factors affecting the sustainable development of inland aquaculture in coastal areas in Sub-Saharan African countries like Sierra Leone. To achieve this, we explored the perceptions of residents in two coastal communities – Tombo and Goderich – about inland aquaculture, focusing particularly on the extent to which they valued its contribution to their livelihoods and their willingness to adopt it.

3. Methods

Our study makes use of both qualitative and quantitative data collected in Tombo and Goderich communities during April and May 2017. The choice of Tombo and Goderich was because they are among Sierra Leone's biggest fishing communities with the highest number of full-time fishers. Together, Tombo and Goderich host over 60% of the fishers in the Western region of Sierra Leone which include many migrant fishers or 'internally displaced' people who continue to move into these communities, thereby increasing pressure on marine fish stocks [64,65].

Twenty-six semi-structured key informant (KI) interviews and 100 survey questionnaires (SQs) were administered in Tombo, whilst in Goderich, 25 KIs and 99 SQs were conducted. KI interviewees from Tombo and Goderich were recruited through snowball sampling, which is a convenient selection method whereby existing participants are used to recruit future participants (Nadarajah et al., [53]). To avoid bias and to obtain a variety of perspectives, efforts were made to recruit and interview a wide range of KI respondents. For example, respondents were asked to recommend participants who held contrary views to their own. KI interviewees included staff of the Ministry of Fisheries and Marine Resources (MFMR), fishers who were mostly men, women fish sellers, academics, executives of fishers' organizations including the Sierra Leone Artisanal Fisher's Union (SLAFU), and local councillors. Like the KI interviewees, SQ participants were recruited through snowball sampling. The SQs were mostly fishers who were heads of their households. There was no attempt to select a representative sample of the populations apart from ensuring an equal number of KIs and an equal number of SQ respondents from Tombo and Goderich. Both KI interview questions and open-ended SQ questions centred on three main themes: (1) the value of aquaculture and willingness of respondents to get involved in it; (2) the perceptions of obstacles to fish farming; and (3) suggested solutions to these problems. The semi-structured interviewing and open-ended questionnaire format encouraged participants to reflect deeply in their responses. This meant they answered questions in their own ways, sometimes by using life examples, opening up further issues. Qualitative data from the 51 KI interviews were thematically analysed. Themes were read, re-read, scrutinized and threaded together. Quantitative data from the 199 SQs were analysed and the frequency of themes were expressed in percentages.

4. Results

The results are divided into three sections: 1) respondents' understanding about aquaculture and its value; 2) views of the difficulties of practising it; and 3) opinions on how to overcome these difficulties.

5. Perceptions of the value of aquaculture

Although the word 'aquaculture' was unfamiliar to a third of the SQ respondents in both Tombo and Goderich, the activity of fish farming was known to most of them (60% in Tombo and 57% in Goderich respectively) as a recreational enterprise. Two KIs who were academics perceived that commercial aquaculture projects developed for wealth creation in Sierra Leone have not always been successful, and they were convinced that introducing small-scale aquaculture into two of Sierra Leone's leading marine fishing communities, Tombo and Goderich

might be more successful. This is because it has the potential to alleviate poverty, improve food security and reduce pressure on marine fisheries. One of these two KIs who is also Sierra Leone's leading aquaculture scholar, said: "aquaculture can reduce pressure on our fisheries" (KI-6)

Another academic KI-16, pointed out that while marine fishing may be adequate today in Tombo and Goderich, tomorrow may be a very different story:

"Yes, these fishermen get enough fish today, but the question as far as I am aware should be, is the size and quantity of catch same as yesterday? Are species changing? If authorities are concerned, then they will see the need to encourage aquaculture for its full benefit. The time for this may be now, otherwise very soon these fishermen and their families will have nothing left".

Another KI-4 who was a SLAFU executive noted that inland aquaculture will be particularly valuable during the rainy season when marine capture fishing is poor:

"Aquaculture is good when there is a very poor season like around the raining season, August, September when fish are very scarce because of the weather. During this time, the catch is always small and fish is always expensive. So if we have a pond, that will be the season that we target to harvest our fish".

Three fishers (KI-28, 32, 46) accepted that aquaculture can alleviate poverty: *aquaculture can help us out of poverty... we need it now* (KI-28).

From these statements, it is suggested that aquaculture could indeed alleviate pressure from reliance on marine capture fisheries for both protein and employment. The assumption was that if access to farmed fish was adequate to meet demand, there would be a reduction in catching juvenile and small marine fish, and this would help sustain fish stocks.

The SLAFU Chief Executive (KI-2) said he had tried to persuade the government to recruit an NGO to help SLAFU set up inland aquaculture plants:

"Aquaculture was one of our objectives, we had gone to MFMR and asked them to search for any NGO that would work with us on aquaculture because many families are poor. If we set up aquaculture, this will take care of the scarcity of fish and also provide money for these families".

With regard to their willingness to get involved in inland aquaculture, some respondents expressed their opinions about their desired level of involvement after researchers had explained that aquaculture meant the farming of fish and marine plants. In Tombo, 54% of respondents and in Goderich, 44% were willing to be involved in inland aquaculture, though not as an alternative to marine fishing but as a supplementary livelihood. In Tombo and Goderich, 14 and eight respondents, respectively, were unsure about whether or not they wanted to be involved in aquaculture.

6. Perceived obstacles to the development of aquaculture in Tombo and Goderich

According to 98% of SQs from Tombo, 81% of SQs from Goderich, and 41 KIs (academics, fishers, researchers) stated that the tradition of 'open access' fishing in Tombo and Goderich posed an important obstacle to the development of aquaculture in both communities. This is because anyone can fish in the sea at comparatively little cost and immediately obtain fish to eat, or purchase fish cheaply on the beaches from the hundreds of fishing boats landing fish. KI-14, an academic, reported that families in these two fishing communities had for generations relied on capture fishing and they assumed that fishing would continue to meet their needs:

"When you hear people talking about 'the sea never dries' and we like 'our country fish', and when you see how they organize themselves to catch

marine fish so easily and how it provides employment and food to poor families, then you will understand why people do not pay attention to aquaculture. If you are living in a coastal settlement and you have your mosquito net, then you can just use it to catch your fish for soup, it is very easy. You catch what you need for the whole day. If you go to the beach and stand for a few minutes you will see boats coming with very cheap fish. These are the situations in the coastal communities, these are the reasons why aquaculture is a very distant option”.

Likewise, another KI-5 academic, said

“Aquaculture is important, but you know that aquaculture has never taken off in Africa and especially Sierra Leone. Maybe some countries like Ghana, but for as long as the marine supplies a lot of fish in a coastal country, it will be difficult for aquaculture to come into prominence. With wild fishing, you see the readiness of people to buy as you are landing the fish. If you go to our beaches, you will see fishmongers in their thousands waiting for fishermen to land fish so they can buy”.

Despite evidence of declining stocks, one KI-9 (fisher) expressed strong optimism about the sufficiency of their marine fisheries: “we have enough fish in our water”. By contrast to marine capture fishing, in aquaculture there was a long time-lag between input and output. Another fisher (KI-20) said: “if you want us to farm fish, we cannot stay hungry and wait for the fish to grow”.

A KI-30 researcher and former employee of the Environmental Justice Foundation, asked:

“How do they sustain themselves during the waiting period? Is this a feasible step, how will you maintain this man who was formerly working and getting money every day? You cannot prevent this man from going to fish”.

Another important obstacle to the expansion of aquaculture in Sierra Leone is the lack of education among fishers. In Tombo and Goderich, 31% and 21% of respondents respectively had received no education at all, while only 11% and 5%, respectively had acquired secondary education. These low levels of education help explain why residents in the two communities were heavily dependent on marine fisheries as full-time jobs - because artisanal marine fishing does not require a high level of education. One fisher KI-35 said: “Everybody here is a fisherman, You do not need a certificate to catch fish”. Fish farming is more complicated than capture fishing and requires training for some of its activities. According to one of the KI academics, the failure of commercial aquaculture (wealth creation) in Tonkolili and Bo Districts was partly because fish farmers were not educated and trained sufficiently to carry out complex calculations of inputs (e.g., fish feed) and outputs (grading market sized fish):

“If you don’t teach people to quantify what they do, how much they take out from their purse for business, then how can you estimate production? How can you prove to the local man that what he is doing is profitable? If you just come in to help them to dig holes and put fish there and feed the fish, they grow to some size, and then you harvest. If you think this is sustainable then it is not. The aquaculture people do not weigh the fish, they don’t pay attention to this, you teach the man to farm fish, but you don’t teach him to quantify how much was the input and how much was the output so that you can organise things properly. They don’t do that. They only organize seminars and workshops on how to dig holes. What is needed is to teach a man to be diligent, to watch his input against his production, to see how much he is getting out of it, to make him take it seriously”.

The above statement is a criticism of the simplistic way in which government and international organizations introduced aquaculture into rural communities in Sierra Leone: “People get funding from different places to help poor countries like Sierra Leone. Then they come in and tell people to dig up ponds and this is the aquaculture” (KI-14 academic).

Land issues were flagged up by 85% and 99% of SQ respondents in Tombo and Goderich, respectively. One SQ-5 from Tombo asked: “Where is the land to farm the fish? Land is the problem”. Land was scarce and therefore expensive. With the increasing cost of marine fishing in terms of engine oil, engine repairs, licence fees, ice blocks, and fish bait), 61% of SQs from Tombo and 87% of SQs from Goderich reported they were in debt and lacked capital to purchase land for fish farming: “Every fisherman in our community is a debtor, there is no money to buy land and start this business” (SQ-47 fisherman from Goderich). Land was also a problem because of gender discrimination. According to KI-16, a researcher:

“Land tenure is in fact a serious problem here...most fish traders and business people are women and the culture here is such that women do not own land. If a man dies, his land is given to his sons or his brothers rather than his widow”. Few women go out to catch fish and looking after aquaculture ponds would be a practicable accompaniment or extension to their marketing and processing roles.

A researcher KI-6 suggested that taste could have also contributed to the underdevelopment of aquaculture in Tombo and Goderich: “We did a fish consumption survey and I noted that up to 50 miles from the shorelines, all these people like eating marine fish, because they are used to it”.

7. Proposed solutions for the development of fish farming in Sierra Leone

Solutions suggested by respondents for overcoming the obstacles described in the previous sections centered around the need for greater control over the aquaculture sector. For example, one recommendation was for stricter governmental licensing and regulation of Sierra Leone’s inland aquaculture industry. KI -14, an academic, stated that: “China regulates aquaculture, we need to copy best practice, if we really want aquaculture to work for us. We have not done any regulation. There is no regulation. They just build ponds they don’t register them so they can be licensed”.

Another recommendation was for integration of the management of aquaculture and marine capture fisheries to optimise food security. KI-5, an academic, said “You cannot say you are planning development when marine fisheries is working on their own without the aquaculture guys. You cannot separate aquaculture from marine, if we are serious about food security and household income.”. KI-6, another academic, argued that an integrated approach involved recognition of fishers’ dependence on marine capture fisheries: “Planning to introduce fish farming will mean that we have to understand the extent to which our people depend on marine fisheries. To plan properly we need to understand their level of education and what they depend on to survive. We need to know whether they have other sources of income”. Many fishers indicated they would prefer to engage in aquaculture on a part-time basis whilst continuing to practice marine capture fishing.

Another recommendation was for community participation in government decisions about inland aquaculture development. Seven KIs said Sierra Leone’s MFMR cannot be relied upon by itself to ensure that inland aquaculture will develop in Tombo and Goderich communities or elsewhere in Sierra Leone. The Secretary of a fishers’ organization union said: “Planning for aquaculture is planning for community development” (KI-2). Community engagement would facilitate the transfer of good aquaculture practice from one fish farmer to another – e.g. the copying of more efficient techniques. According to 20% of KIs and three SQs, this would involve training fishers to learn such aquaculture skills.

8. Discussion

Four key issues emerged from the analysis of the survey responses. First, the concept of aquaculture was not well understood by respondents. A substantial number of respondents were not familiar with the word and some were not familiar with what fish farming actually

involved. This finding, which is in line with results from other studies (e.g., [5,14,16,63]) suggests that much work needs to be done to inform the public about the nature of aquaculture activities. It is encouraging to note that when respondents were informed about the meaning of aquaculture, most of them viewed it as offering potential benefits. This emphasizes the importance of effective engagement with locals to explain the pros and cons of aquaculture (Kaiser and Stead, [77]; [63]).

Second, informed respondents generally saw aquaculture as a practical activity for poverty alleviation and for food security rather than as means of generating wealth through farmed fish exports [4,21,55,66]. Some respondents viewed inland aquaculture as an essential development in supporting marine ecosystem health, arguing that the decline in coastal capture fisheries made the development of aquaculture urgent. This is also in line with the literature on the benefits sustainable aquaculture can offer in terms of providing an alternative source of protein and/or livelihood to locals to reduce dependency on declining coastal fish stocks ([63]; Gouvello et al., [78]; Blythe et al., [80]; [25]). However, some respondents were unconvinced of the necessity to switch from marine capture fishing to aquaculture, because they perceived there was no decline in fish stock populations.

Third, the views expressed by many respondents that they were willing to be involved in aquaculture was conditional on this being only a supplementary activity, not an alternative to capture fishing. Respondents of both Tombo and Goderich were not willing to adopt aquaculture as a main source of income, they were only prepared to consider it as a supplement to their main activity of catching fish. Part-time aquaculture would enable fish farmers to rely on their marine fish catches during the time-lag between early development phases whilst they waited for finfish growth to harvestable size.

Fourth, the likelihood of success of inland aquaculture ventures, whether full-time or part-time, was considered dependent on three crucial factors: 1) government support and regulation; 2) education and training of potential fish farmers; and 3) a reform of land tenure laws. On government support and regulation, if communities like Tombo and Goderich are to embrace inland aquaculture, the government must be prepared to provide the infrastructure necessary for its establishment as well as to provide suitable financing mechanisms to allow interested fish farmers to rent or buy land and obtain equipment, seed capital and fish feed. Another suggestion was to assist education and training by involving Aquaculture Extension Workers (trained experts) in undertaking solutions that are socially relevant and adapted to the aspirations and limitations of participating communities (Atukunda et al., [79]; AUC-NEPAD, [8]; [15]). Tailored education and training programmes should be co-developed with communities so that local cultures and values were embedded in the aquaculture practices required for sustainable enterprises. For regulatory purposes, there is the need to develop a new policy that integrates existing marine fisheries with an emerging aquaculture sector [63]. This synergy will control the pressure on marine fisheries as well as oversee the takeoff of aquaculture as supplementary livelihood by fishers [33,50,54]. With regards to land issues, the government must revisit the laws in Sierra Leone which forbid women from owning land as this deprives women who already exhibit strong entrepreneurial skills in marketing from trying aquaculture [2,3,22]. This requires a larger scale change in public policy to encourage greater equality, diversity, and inclusion at local and national levels.

9. Conclusion

In conclusion, there are no substantial difference in perceptions towards willingness to develop aquaculture between residents in Tombo and Goderich. In both communities, the major obstacle to the sustainable development of aquaculture identified from interviewees was the reluctance of coastal fishers to consider switching from their familiar and perceived easier open access approach to marine fishing in contrast with the unfamiliarity and potential risks of being involved in

aquaculture. The lack of infrastructural, support from government, the unavailability of suitable financing mechanisms, the lack of technical knowledge of fish farming, fingerlings and feeds, land tenure issues, and limited educational levels of fishers are further factors that currently hinder the development of inland aquaculture in Sierra Leone. A starting point for the introduction of inland aquaculture in communities at Tombo and Goderich would, therefore, be to assess community needs and identify the most marginal fishers who would have a greater willingness to consider aquaculture as a supplementary livelihood activity to marine capture fisheries.

Supplementary livelihoods, especially those introduced by external agents, are usually perceived as a means to diversify income generating opportunities. The question arises, however, whether the aim of aquaculture in Sierra Leone is wealth creation or social welfare. If the former, important issues such as ensuring market access to export opportunities and obtaining suitable strains of tilapia and the right kind feed need to be addressed by further research. If the latter, care must be taken to monitor the progress of new fish farmers, because if the livelihood benefits are not realized, abandonment of aquaculture activities is common with fish farmers shifting their focus to more economically viable alternatives such as concentrating more on catching marine fish. Since marine fishing will undoubtedly maintain its place as the most important activity by fishers in Tombo and Goderich, the real test for the government is to dovetail aquaculture and capture fisheries together in a symbiotic or complementary relationship. One cannot survive without the other.

CRedit authorship contribution statement

All persons who contributed to this paper have been mentioned as authors. Below is the list of each author's contribution: Dr Nwamaka Okeke-Ogbuafor-conducted the fieldwork in Sierra Leone. Prof Selina Stead-developed the concept and research questions. Prof Tim Gray-framed the research and paper. The three authors contributed to writing and revising the paper.

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