

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

2

3

4 Abstract

5

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

24

25 **Keywords:** Sierra Leone; inland aquaculture; marine capture fisheries; wealth creation;
26 social welfare; alternative and supplementary livelihoods

27

28 Introduction

29

30 Globally, 90% of fish stocks monitored by the United Nations Food and Agriculture Organisation (FAO) are
31 fully or overexploited (FAO, 2018). Aquaculture is highlighted as one option to address food insecurity where
32 appropriate. Estimates suggest that up to six times more food can be produced from aquaculture than
33 from the ocean (Costello et al., 2020). In 1974, aquaculture provided only 7% of global fish consumption,
34 increasing to 26% in 1994 and to 39% in 2004 (FAO, 2016). Ten years later, “the aquaculture sector’s
35 contribution to the supply of fish for human consumption overtook that of wild-caught fish for the first
36 time” (FAO, 2018; see also Nadarajah and Flaaten 2017). In 2016, aquaculture production (including edible
37 sea plants) was 110.2 million metric tonnes valued at USD 243.5 billion (FAO, 2018). In total, close to 600
38 species are now farmed globally with current production including 54 million metric tonnes of finfish, 17 million
39 m e t r i c tonnes of molluscs, eight million metric tonnes of crustaceans, and one million metric tonnes of
40 assorted aquatic animals (FAO, 2018).

41

42 These figures reflect the wealth creation approach to aquaculture as a major source of income from exports
43 which contributes to national economic revenue rather than the social welfare approach which focuses on
44 satisfying the basic nutritional and employment needs of domestic populations. The distinction between the
45 wealth creation approach and the social welfare approach in coastal fisheries management is explained in
46 Okeke-Ogbuafor & Gray (2021). The Peoples Republic of China, the largest aquaculture producer in the
47 world, exemplifies the wealth creation approach in that aquaculture is exploited on an industrial scale for
48 national revenue generation. In 2016, China’s production outweighed the combined production of the rest of
49 the world (FAO, 2018). The expansion of China’s aquaculture industry was facilitated by the free-
50 market economic strategy it adopted in 1978 as well as significant government support and regulation
51 (FAO, nd). In 1991, the Chinese government introduced monitoring of hatchery for the quality
52 production of juveniles and fingerlings through the creation of the National Fish Protogenetic and Fine Seed
53 Certification Committee and promoted the diversification of species that could be farmed. In addition,
54 economic incentives were introduced by the Chinese government for expansion of the fish feed sector (FAO,
55 nd). Other countries such as India, Indonesia, Vietnam, Bangladesh and Norway have also adopted the wealth
56 creation approach and are now leading players in the production of farmed fish (Nadarajah and Flaaten, 2017,
57 FAO, 2016). In Africa, Egypt stands out as a major farm fish producer, with an annual total of more than
58 750,000t (James, 2018). Several other African countries, including Benin, Côte d'Ivoire, Guinea, Kenya,
59 Madagascar, Malawi, Nigeria, South Africa, Tanzania, Togo and Uganda have developed substantial

60 aquaculture industries (AUC-NEPAD, 2014; Bolman, et al 2018).

61

62 However, proceeds from commercial aquaculture do not always trickle down to communities (Campbell et al
63 2020). In Myanmar, Filipinski and Belton (2018, p.1) compared the benefits of small-scale and large-scale
64 aquaculture to host communities, and their findings revealed that small-scale indigenous aquaculture served
65 communities better than did large-scale commercial operations: ‘small fish farms generate more spillovers than
66 large fish farms’. Similar studies carried out in parts of Africa, including Tanzania, Zambia and Nigeria,
67 highlight the social welfare role of small-scale aquaculture for food security and poverty alleviation (Mulokozi
68 et al, 2020; Aba, 2020; Namonje- Kapembwa, 2020; Adeleke et al, 2020; FAO, 2010).

69

70 In Sierra Leone, the coastal areas of the country are experiencing a decline in marine fish stocks which make it
71 imperative to find additional, or in some places, alternative sources of fish protein. But attempts at
72 establishing commercial inland aquaculture enterprises to help reduce the pressure on fish stocks have not
73 always been successful. Sankoh et al (2018), report that subsistence inland aquaculture has been successful
74 in Tonkolili District in the Northern Province of Sierra Leone where there were more than 1,500 active
75 fishponds farming Nile tilapia (*Oreochromis niloticus*) producing an approximate 82 tonnes annually. The
76 reason for their success is that the farmers in Tonkolil who were trained by the Peace Corps on how to
77 construct and manage fishponds adopted the technology and have since continued to train others (Sankoh et al,
78 2018). Considering the pressure on declining fish stocks, the current study explores the possibility of
79 emulating the experience of Tonkolili District by assessing the potential for the development of small-
80 scale subsistence inland aquaculture enterprises in two of Sierra Leone’s big fishing communities - Tombo and
81 Goderich.

82

83 **Sierra Leone’s coastal fisheries and aquaculture projects**

84

85 Sierra Leone is one of the poorest and least developed nations in the world. In 2020, the United Nations Human
86 Development Index ranked Sierra Leone 182 out of 189 countries. In 2017, nearly 60% of its seven million people
87 experienced multidimensional poverty, including lack of access to basic facilities such as clean water and
88 education (UNDP, 2020).. Sierra Leone also has one of the world’s highest rates of maternal mortality
89 (Treacy et al, 2018), and general life expectancy is below 45 years (Mondal et al, 2015; Islam et al, 2017).
90 Sierra Leone continues to suffer from the after-effects of a civil war that lasted from 1991-2002 and killed an
91 estimated 70,000 people (United Nations, 2006) and destroyed properties and infrastructure (Voors et al,
92 2016). The civil war led to the displacement of approximately 2.6 million people with many people moving from
93 inland areas to coastal areas (United Nations, 2006). This huge influx of migrants has increased pressure on
94 marine fish stocks in many coastal areas of Sierra Leone (Davis, 2015; Menard, 2017; Okeke-Ogbuafor et al,
95 2018; Okeke-Ogbuafor et al, 2019). The 2014 Ebola epidemic was another setback to Sierra Leone’s
96 development as imports and exports dried up and household incomes plummeted when fisheries, farming
97 and local craft industries collapsed (Kevany et al, 2019). In 2017, Sierra Leone was hit by natural disasters
98 resulting in heavy mudslides and flooding in which over 500 people were killed and nearly 6,000 people remain
99 missing, and hundreds of families were further displaced (Harris, 2018).

100

101 Sierra Leone is highly dependent on its marine capture fisheries because fish is the main source of animal
102 protein for about three quarters of the population (Teh et al, 2016, Okeke-Ogbuafor et al, 2019; Vakily et al,
103 2012; Belhabib et al, 2018; Okeke-Ogbuafor and Gray, 2021). However, many of the targeted fish stocks are
104 considered to be in decline, and Bonga (*Ethlamosa fimbriata*), Snappers (*Lutjanidae*), Groupers
105 (*Epinephelinae*), Shrimp (*Carideawithin*) and Herring (*Clupea harengus*) stocks are fully exploited and need to
106 be managed with care (Baio and Sei, 2017: 33; Belhabib et al, 2019).

107

108 Sierra Leone has been described as a failed state for fishing (Thorpe et al., 2008). For decades, international
109 organizations have provided interventions to boost Sierra Leone’s capture fisheries but these have failed to
110 eliminate poverty and hunger in coastal areas (Finch, 2016; Joaque, 2017; Okeke-Ogbuafor et al, 2018). Sierra
111 Leone’s marine fisheries suffer from ‘wicked’ problems (i.e., multi-faceted problems for which feasible
112 solutions may not be easily identifiable) including illegal, unreported and unregulated (IUU) fishing, over-
113 fishing by industrial vessels, and the use of unsustainable fishing methods by artisanal fishers (Okeke-
114 Ogbuafor et al 2019; Okeke-Ogbuafor and Gray 2021; Khan and Neis 2010; Jentoft and Chuenpagdee, 2009).
115 However, one potentially promising strategy to offer supplementary or alternative sources of food and/or
116 income is inland aquaculture. Development partners from the European Union (EU), non-governmental
117 organizations (NGOs) and the FAO have encouraged the development of aquaculture in developing countries
118 to support livelihoods through the creation of jobs and to provide nutrition (Sankoh et al, 2018; FAO, nd;
119 Kassam et al, 2017). However, attention to understanding the local context, particularly socio-economic

120 constraints, cultures, values and the willingness of fishers to consider aquaculture as a livelihood
121 is often overlooked by well-intentioned initiatives aimed at eradicating poverty and food insecurity
122 (Stead, 2005; Slater et al., 2013; Genschick et al, 2018; Limuwa, 2018; Stead 2019b).

123

124 Very little research has been conducted on Sierra Leone's aquaculture sector (Kassam et al, 2017) and there
125 is uncertainty about when it was first introduced into the country. The Food and Agriculture Organization
126 (FAO nd) reports that coastal aquaculture began with the culture of mangrove oyster (*Crassostrea tulipa*) which
127 is thought to have been introduced during 1974 by the government of Sierra Leone with assistance from
128 the Canadian International Development Research Centre. This project, according to FAO (nd), provided a
129 biological basis for the development of the oyster but the extension of this project to farmers failed and it
130 was discontinued after eleven years due to inadequate financial and technical support. Another account by
131 Sankoh et al (2018) claims inland aquaculture began in 1976, when the Sierra Leonean government
132 established a fish breeding station in Tonkolili District in the Northern Province. In 1984, a
133 government inland aquaculture experimental station was established in the Bo District in the Southern Province
134 (FAO, nd; Sankoh et al, 2018). During the 1990s and 2000s, several further inland aquaculture initiatives were
135 developed in Tonkolili and Bo Districts. Another oyster farming project was developed during 2014 to 2018
136 around Bonthe, a coastal town located on Shebro Island (Murray et al, 2019).

137

138 In a bid to continue promoting the expansion of aquaculture in Sierra Leone, WorldFish developed a
139 private-public partnership initiative which was a shift from their previous top-down aid programmes
140 (CGIAR, nd). It was a USD 3.5 million project developed to test a business model aimed at increasing fish
141 production, consumption and incomes of small-scale fish farmers (CGIAR, nd). While this private-public
142 partnership initiative looked promising, to ensure sustainability, Sankoh et al (2018) pointed to the need to
143 factor into its design local circumstances and needs because the poor understanding of local needs contributes
144 to the poor performance of commercial aquaculture in Sierra Leone: 'Catfish command a high price. However,
145 to date all foreign experts have been advising on growing *tilapia* a species we did not encounter in the markets
146 and which we would infer are not very desirable' (Sankoh et al, 2009, p.13). Sankoh raises an important issue
147 here – that the development of inland aquaculture in Sierra Leone has been mainly pushed by foreign agencies
148 within the international donor agenda rather than by indigenous or bottom up initiatives. As a result, some of
149 the projects have lacked local knowledge and contextual understanding. Other factors that have hindered the
150 commercial development of aquaculture include poor site selection, natural predators, poachers, a lack of
151 technical know-how, low quality feed and seed, poor labour inputs, fluctuating environmental
152 conditions (e.g., floods and droughts), and expensive fishpond facilities.

153

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

159

160 **Methods**

161

162 Our study makes use of both qualitative and quantitative data collected in Tombo and Goderich communities
163 during April and May 2017. The choice of Tombo and Goderich was because they are among Sierra Leone's
164 biggest fishing communities with the highest number of full-time fishers. Together, Tombo and Goderich
165 host over 60% of the fishers in the Western region of Sierra Leone which include many migrant fishers or
166 'internally displaced' people who continue to move into these communities, thereby increasing pressure on
167 marine fish stocks (Thorpe et al, 2009; Teh et al, 2016).

168

169 Twenty-six semi-structured key informant (KI) interviews and 100 survey questionnaires (SQs) were
170 administered in Tombo, whilst in Goderich, 25 KIs and 99 SQs were conducted. KI interviewees from Tombo
171 and Goderich were recruited through snowball sampling, which is a convenient selection method
172 whereby existing participants are used to recruit future participants (Naderifar et al, 2017). To avoid
173 bias and to obtain a variety of perspectives, efforts were made to recruit and interview a wide range of KI
174 respondents. For example, respondents were asked to recommend participants who held contrary views to their
175 own. KI interviewees included staff of the Ministry of Fisheries and Marine Resources (MFMR), fishers who
176 were mostly men, women fish sellers, academics, executives of fishers' organizations including the Sierra
177 Leone Artisanal Fisher's Union (SLAFU), and local councillors. Like the KI interviewees, SQ participants
178 were recruited through snowball sampling. The SQs were mostly fishers who were heads of their households.
179 There was no attempt to select a representative sample of the populations apart from ensuring an equal

180 number of KIs and an equal number of SQ respondents from Tombo and Goderich. Both KI interview questions
181 and open-ended SQ questions centred on three main themes: (1) the value of aquaculture and willingness of
182 respondents to get involved in it; 2) the perceptions of obstacles to fish farming; and 3) suggested solutions to
183 these problems. The semi-structured interviewing and open-ended questionnaire format encouraged participants
184 to reflect deeply in their responses. This meant they answered questions in their own ways, sometimes by using
185 life examples, opening up further issues. Qualitative data from the 51 KI interviews were thematically analysed.
186 Themes were read, re-read, scrutinized and threaded together. Quantitative data from the 199 SQs were analysed
187 and the frequency of themes were expressed in percentages.

188 189 **Results**

190
191 The results are divided into three sections: 1) respondents' understanding about aquaculture and its value;
192 2) views of the difficulties of practising it; and 3) opinions on how to overcome these difficulties.

193 194 **Perceptions of the value of aquaculture**

195
196 Although the word 'aquaculture' was unfamiliar to a third of the SQ respondents in both Tombo and Goderich,
197 the activity of fish farming was known to most of them (60% in Tombo and 57% in Goderich respectively) as a
198 recreational enterprise. Two KIs who were academics perceived that commercial aquaculture projects developed for
199 wealth creation in Sierra Leone have not always been successful, and they were convinced that introducing small-scale
200 aquaculture into two of Sierra Leone's leading marine fishing communities, Tombo and Goderich might be more
201 successful. This is because it has the potential to alleviate poverty, improve food security and reduce pressure
202 on marine fisheries. One of these two KIs who is also Sierra Leone's leading aquaculture scholar, said:
203 "aquaculture can reduce pressure on our fisheries" (KI-6)

204
205 Another academic KI-16, pointed out that while marine fishing may be adequate today in Tombo and
206 Goderich, tomorrow may be a very different story:

207
208 *"Yes, these fishermen get enough fish today, but the question as far as I am aware should be, is the size
209 and quantity of catch same as yesterday? Are species changing? If authorities are concerned, then they
210 will see the need to encourage aquaculture for its full benefit. The time for this may be now, otherwise very
211 soon these fishermen and their families will have nothing left".*

212
213 Another KI-4 who was a SLAFU executive noted that inland aquaculture will be particularly valuable during
214 the rainy season when marine capture fishing is poor:

215
216 *"Aquaculture is good when there is a very poor season like around the raining season, August, September
217 when fish are very scarce because of the weather. During this time, the catch is always small and fish is
218 always expensive. So if we have a pond, that will be the season that we target to harvest our fish".*

219
220 Three fishers (KI-28, 32, 46) accepted that aquaculture can alleviate poverty: *aquaculture can help us out of
221 poverty... we need it now* (KI-28).

222
223 From these statements, it is suggested that aquaculture could indeed alleviate pressure from reliance on marine
224 capture fisheries for both protein and employment. The assumption was that if access to farmed fish was adequate
225 to meet demand, there would be a reduction in catching juvenile and small marine fish, and this would help
226 sustain fish stocks.

227
228 The SLAFU Chief Executive (KI-2) said he had tried to persuade the government to recruit an NGO to
229 help SLAFU set up inland aquaculture plants:

230
231 *"Aquaculture was one of our objectives, we had gone to MFMR and asked them to search for any NGO
232 that would work with us on aquaculture because many families are poor. If we set up aquaculture, this
233 will take care of the scarcity of fish and also provide money for these families".*

234
235 With regard to their willingness to get involved in inland aquaculture, some respondents expressed their
236 opinions about their desired level of involvement after researchers had explained that aquaculture meant the
237 farming of fish and marine plants. In Tombo, 54% of respondents and in Goderich, 44% were willing to be
238 involved in inland aquaculture, though not as an alternative to marine fishing but as a supplementary
239 livelihood. In Tombo and Goderich, 14 and eight respondents, respectively, were unsure about whether or not

240 they wanted to be involved in aquaculture.

241

242 **Perceived obstacles to the development of aquaculture in Tombo and Goderich**

243

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

251

252 *“When you hear people talking about ‘the sea never dries’ and we like ‘our country fish’, and when you see*
253 *how they organize themselves to catch marine fish so easily and how it provides employment and food to poor*
254 *families, then you will understand why people do not pay attention to aquaculture. If you are living in a*
255 *coastal settlement and you have your mosquito net, then you can just use it to catch your fish for soup, it is*
256 *very easy. You catch what you need for the whole day. If you go to the beach and stand for a few minutes you*
257 *will see boats coming with very cheap fish. These are the situations in the coastal communities, these are the*
258 *reasons why aquaculture is a very distant option”.*

259

260 Likewise, another KI-5 academic, said

261

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

267

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

272

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

274

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

278

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

289

290 *“If you don’t teach people to quantify what they do, how much they take out from their purse for business,*
291 *then how can you estimate production? How can you prove to the local man that what he is doing is*
292 *profitable? If you just come in to help them to dig holes and put fish there and feed the fish, they grow to some*
293 *size, and then you harvest. If you think this is sustainable then it is not. The aquaculture people do not weigh*
294 *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*
295 *much was the input and how much was the output so that you can organise things properly. They don’t do*
296 *that. They only organize seminars and workshops on how to dig holes. What is needed is to teach a man to*
297 *be diligent, to watch his input against his production, to see how much he is getting out of it, to make him take*
298 *it seriously”.*

299

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

304
305 Land issues were flagged up by 85% and 99% of SQ respondents in Tombo and Goderich, respectively.
306 One SQ-5 from Tombo asked: *“Where is the land to farm the fish? Land is the problem”*. Land was
307 scarce and therefore expensive. With the increasing cost of marine fishing in terms of engine oil, engine
308 repairs, licence fees, ice blocks, and fish bait), 61% of SQs from Tombo and 87% of SQs from Goderich
309 reported they were in debt and lacked capital to purchase land for fish farming: *“Every fisherman in our
310 community is a debtor, there is no money to buy land and start this business”* (SQ-47 fisherman from
311 Goderich). Land was also a problem because of gender discrimination. According to KI-16, a researcher:
312 *“Land tenure is in fact a serious problem here...most fish traders and business people are women and
313 the culture here is such that women do not own land. If a man dies, his land is given to his sons or his
314 brothers rather than his widow”*. Few women go out to catch fish and looking after aquaculture ponds
315 would be a practicable accompaniment or extension to their marketing and processing roles.

316
317 A researcher KI-6 suggested that taste could have also contributed to the underdevelopment of
318 aquaculture in Tombo and Goderich: *“We did a fish consumption survey and I noted that up to 50 miles from
319 the shorelines, all these people like eating marine fish, because they are used to it”*.

320

321 **Proposed solutions for the development of fish farming in Sierra Leone**

322

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

329

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

340

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

348

349 **Discussion**

350

351 Four key issues emerged from the analysis of the survey responses. First, the concept of aquaculture
352 was not well understood by respondents. A substantial number of respondents were not familiar with the word
353 and some were not familiar with what fish farming actually involved. This finding, which is in line with results
354 from other studies (e.g., Stead, 2019; Bolton, 2017; Brummett et al, 2008; Akpabio et al, 2007) suggests that
355 much work needs to be done to inform the public about the nature of aquaculture activities. It is encouraging
356 to note that when respondents were informed about the meaning of aquaculture, most of them viewed it as
357 offering potential benefits. This emphasizes the importance of effective engagement with locals to explain
358 the pros and cons of aquaculture (Kaiser and Stead, 2002; Stead, 2019).

359

360 Second, informed respondents generally saw aquaculture as a practical activity for poverty alleviation and
361 for food security rather than as means of generating wealth through farmed fish exports (Ndamu, 2016;
362 Toufique and Belton, 2014; Allison, 2011; Cunningham; 2005). Some respondents viewed inland
363 aquaculture as an essential development in supporting marine ecosystem health, arguing that the decline in
364 coastal capture fisheries made the development of aquaculture urgent. This is also in line with the
365 literature on the benefits sustainable aquaculture can offer in terms of providing an alternative source
366 of protein and/or livelihood to locals to reduce dependency on declining coastal fish stocks (Stead, 2019;
367 Gouvello, 2017; Blythe, 2013; Diana, 2009). However, some respondents were unconvinced of the necessity
368 to switch from marine capture fishing to aquaculture, because they perceived there was no decline in fish
369 stock populations.

370
371 Third, the views expressed by many respondents that they were willing to be involved in aquaculture
372 was conditional on this being only a supplementary activity, not an alternative to capture fishing.
373 Respondents of both Tombo and Goderich were not willing to adopt aquaculture as a main source of income,
374 they were only prepared to consider it as a supplement to their main activity of catching fish. Part-time
375 aquaculture would enable fish farmers to rely on their marine fish catches during the time-lag between early
376 development phases whilst they waited for finfish grow to harvestable size.

377
378 Fourth, the likelihood of success of inland aquaculture ventures, whether full-time or part-time, was considered
379 dependent on three crucial factors: 1) government support and regulation; 2) education and training of potential
380 fish famers; and 3) a reform of land tenure laws. On government support and regulation, if communities
381 like Tombo and Goderich are to embrace inland aquaculture, the government must be prepared to provide the
382 infrastructure necessary for its establishment as well as to provide suitable financing mechanisms to allow
383 interested fish farmers to rent or buy land and obtain equipment, seed capital and fish feed. Another
384 suggestion was to assist education and training by involving Aquaculture Extension Workers
385 (trained experts) in undertaking solutions that are socially relevant and adapted to the aspirations
386 and limitations of participating communities (Atukunde et al., 2018; AUC-NEPAD, 2017; Brummett et al,
387 2011). Tailored education and training programmes should be co-developed with communities so that local
388 cultures and values were embedded in the aquaculture practices required for sustainable enterprises. For
389 regulatory purposes, there is the need to develop a new policy that integrates existing marine fisheries with an
390 emerging aquaculture sector (Stead, 2019). This synergy will control the pressure on marine fisheries as well as
391 oversee the takeoff of aquaculture as supplementary livelihood by fishers (Free et al, 2020; Muir and James,
392 1998). With regards to land issues, the government must revisit the laws in Sierra Leone which forbid
393 women from owning land as this deprives women who already exhibit strong entrepreneurial skills in
394 marketing from trying aquaculture (Daley and Englert, 2010; Ajala, 2017; Akinola, 2018). This requires a
395 larger scale change in public policy to encourage greater equality, diversity, and inclusion at local and
396 national levels.

397 398 **Conclusion**

399
400 In conclusion, there are no substantial difference in perceptions towards willingness to develop aquaculture
401 between residents in Tombo and Goderich. In both communities, the major obstacle to the sustainable
402 development of aquaculture identified from interviewees was the reluctance of coastal fishers to consider
403 switching from their familiar and perceived easier open access approach to marine fishing in contrast with
404 the unfamiliarity and potential risks of being involved in aquaculture. The lack of infrastructural, support
405 from government, the unavailability of suitable financing mechanisms, the lack of technical knowledge of
406 fish farming, fingerlings and feeds, land tenure issues, and limited educational levels of fishers are further
407 factors that currently hinder the development of inland aquaculture in Sierra Leone. A starting point for the
408 introduction of inland aquaculture in communities at Tombo and Goderich would, therefore, be to assess
409 community needs and identify the most marginal fishers who would have a greater
410 willingness to consider aquaculture as a supplementary livelihood activity to marine capture fisheries.

411
412 Supplementary livelihoods, especially those introduced by external agents, are usually perceived as a means to
413 diversify income generating opportunities. The question arises, however, whether the aim of aquaculture in
414 Sierra Leone is wealth creation or social welfare. If the former, important issues such as ensuring market access
415 to export opportunities and obtaining suitable strains of tilapia and the right kind feed need to be addressed by
416 further research. If the latter, care must be taken to monitor the progress of new fish farmers, because if the
417 livelihood benefits are not realized, abandonment of aquaculture activities is common with fish farmers shifting
418 their focus to more economically viable alternatives such as concentrating more on catching marine fish. Since
419 marine fishing will undoubtedly maintain its place as the most important activity by fishers in Tombo and

420 Goderich, the real test for the government is to dovetail aquaculture and capture fisheries together in a symbiotic
421 or complementary relationship. One cannot survive without the other.

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