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The Utility of Water Hyacinth in Communities Along River Tano and Abby-Tano Lagoon, Ghana

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Abstract

Water hyacinth invasion has proven to be a source of problem to riverine communities. Studies have shown that the dense mats of water hyacinth obstruct agriculture, transportation and fishing, but also serve as raw materials for the making of fertilizer, biofuel and artefacts. This study assesses the utility of water hyacinth in the Jomoro District of Ghana. Multi-stage sampling procedures were adopted in the study. In the first stage, five communities along the River Tano and Abby-Tano Lagoon were purposively selected, based on their proximity to the water bodies. In the second stage, 305 respondents including fishermen, fish traders, farmers and boat operators were sampled using snowballing non-probability sampling technique. Data was collected using questionnaire administration and Focus Group Discussions (FGDs). While descriptive statistics, including the use of cross-tabulations and stacked bar charts were used to analyse quantitative data, direct quotations from respondents were used as qualitative data to support the quantitative data. The principal uses of water hyacinth identified in the study area were its uses in the making of fertiliser and animal feed. However, the utility of water hyacinth was at a very low level among respondents, mainly because of the lack of knowledge about its usefulness. Water hyacinth was therefore not perceived to be a resource in the study area. We suggest that any future interventions should focus on training the people in the study communities to duly utilise the water hyacinth. This will turn the water hyacinth into a valuable resource.

Keywords

Water Hyacinth, Utility, Resource, Knowledge, Technology, Jomoro District

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1. Introduction

Water hyacinth *(Eichhornia crassipes),* like other invasive species, has become a major invader of aquatic habitats in many parts of the world [1]. Studies have indicated that water hyacinth serves as micro habitat for disease vectors; clogs fresh waterways; affects agriculture and aquaculture by obstructing fishing leading to reduction in fish catch and income; and hampers shipping by choking off navigational routes [2-6].

Some countries in Africa have particularly been affected by the invasion of water hyacinth, partly due to a lack of naturally occurring 'enemies' and predators [7, 8] such as Warner *(Neochetina eichhorniae)* and Hustache *(Neochetina*

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bruchi) [9] to control them. In Nigeria (West Africa), the Ologe Lagoon, Agbara and Badagry Creeks, have been infested by water hyacinth [10]. In addition, the Zambezi (Zambia), Congo and Nile (Egypt) Rivers have also been invaded by water hyacinth [2, 11]. In Ghana, the River Volta, River Tano, and Abby-Tano Lagoon have been invaded by water hyacinth, posing challenges to socio-economic activities on them [12, 13].

Despite the adverse effects associated with these weeds, studies have shown that water hyacinth could be used for the production of items and products like paper, biogas, ethanol, methane, fertilizer, human food and animal feed [3, 14, 15]. In countries like Java and the Philippines, the dried petioles are being used to craft items such as coasters, mats, shoes, sandals, bags, wallets and vases [2].

Invasive species in the Tano River and the Abby-Tano Lagoon include water hyacinth, Kariba weed, water lettuce and hippo grass. These weeds present challenges to water transportation of goods and people, and negatively affect fishing and farming on and along these water bodies [16, 13]. Communities including Adusuazo, Ellenda Wharf and Takinta Wharf along the River Tano; and Jaway Wharf and Asukro along the Abby-Tano lagoon have been negatively affected by water hyacinth invasion [17, 13].

2. Research Significance

Various aspects of water hyacinth invasion have been studied such as its ecological and socio-economic utilisation [18], the impact of water hyacinth on fish stock [4, 6], the control of water hyacinth including the using of microbial agents [1, 19], the allelopathic effects of water hyacinth [20], as well as its distribution, socio-economic importance and management [21]. In Ghana, a few studies have investigated into different aspects of water hyacinth invasion [17, 13, 16, 12, 22]. However, none of the existing researches in Ghana, particularly, focuses on the utility of water hyacinth. However, the utility of water hyacinth as a resource needs to be carefully assessed for a complete intervention strategy to convert weeds that have until now been a menace to one that can become a blessing and serve as a complementing activity to support rural livelihoods. The non-existence of solid evidence to explain the level of utility of water hyacinth in Ghana in general and in the study communities in particular, makes this study relevant. Results of the study adds to the literature on the usefulness of the water hyacinth, particularly in Ghana, and calls for the needs to research and undertake more investment in utilising the copiously available water hyacinth especially in an era when climate change is negatively affecting many plant species.

3. Profile of Study Area

The Jomoro District lies in the Western Region of Ghana, with a land area of 1, 344 km^2. It is located between latitude 04°55′–05°15′N and longitude 02°15′ – 02°45′W, with an extensive rainforest and high rainfall which falls in two wet seasons, and a uniformly high temperature [23]. The tropical nature of the district's climate promotes the copious growth of the water hyacinth. This is because water hyacinth is a heliophyte, growing best in warm waters rich in macronutrients [24, 18]. The Tano Basin is one of the main south-western river basin systems of Ghana, located between latitudes 5º 00′ N and 7°40′ N, and longitudes 2°00′W and 3°15′ W [25]. The basin is transboundary since the last 100 km of its downstream flows across the international boundary between Ghana and La Côte d' Ivoire before entering the Aby-Tano-Ehy lagoon system [26]. The Abby-Tano Lagoon also lies in the south-western part of the district. While the Abby Lagoon lies approximately between 05°05′18.1″ N and 002°56′42.8″ W, the Tano Lagoon lies between 05°05′38.1″N and 002°05′30.9″W but both are interconnected to form a lagoon complex with the Ehy Lagoon in La Cote d' Ivoire [27]. Like the Tano Basin, the Abby-Tano Lagoon is transboundary between Ghana and La Côte d' Ivoire, but a larger part of it is located in La Côte d' Ivoire where it discharges into the sea [26].

4. Materials and Methods

4.1. Study Design

This study made use of a cross-sectional study design, which finds out the prevalence of a problem among a cross-section of a population [28]. The utility of water hyacinth in the Jomoro District was assessed using data gathered from cross-sections of people in the selected communities. The study adopted a mixed method, which involved the use of both quantitative and qualitative data. According to Creswell [29], this approach gives a better understanding of a research problem than the use of one aspect on its own. The Quantitative data gathered using questionnaire, included whether respondents had ever used the water hyacinth, what respondents used water hyacinth for, whether respondents had formal training regarding the uses of water hyacinth, potential economic opportunities associated with water hyacinth and knowledge about products that could be derived from water hyacinth. The qualitative aspect of the research design, including respondents' normative quotes, was appropriate because it enabled the researcher to engage respondents' experiences regarding the uses of water hyacinth. This would not have been feasible using only a quantitative research approach.

4.2. Sampling Procedure

Purposive sampling was used to select five riparian communities close to the Tano River and Abby-Tano Lagoon. These communities had been affected by water hyacinth invasion of the two water bodies so it was necessary to assess whether the affected people were able to turn some of the weeds into a resource. Besides, it was anticipated that their proximity to the two invaded water bodies would enable the researcher obtain information regarding any uses of the water hyacinth. According to the first law of geography by Tobler [30], everything is related to everything else but near things are more related than distant things. Hence, the closer communities which had been affected by water hyacinth invasion were in a better position to provide information regarding the utilisation of the water hyacinth. The five communities included Jaway Wharf and Asukro along the Abby-Tano Lagoon, and Ellenda Wharf, Takinta Wharf and Adusuazo along the River Tano (Figure 1).

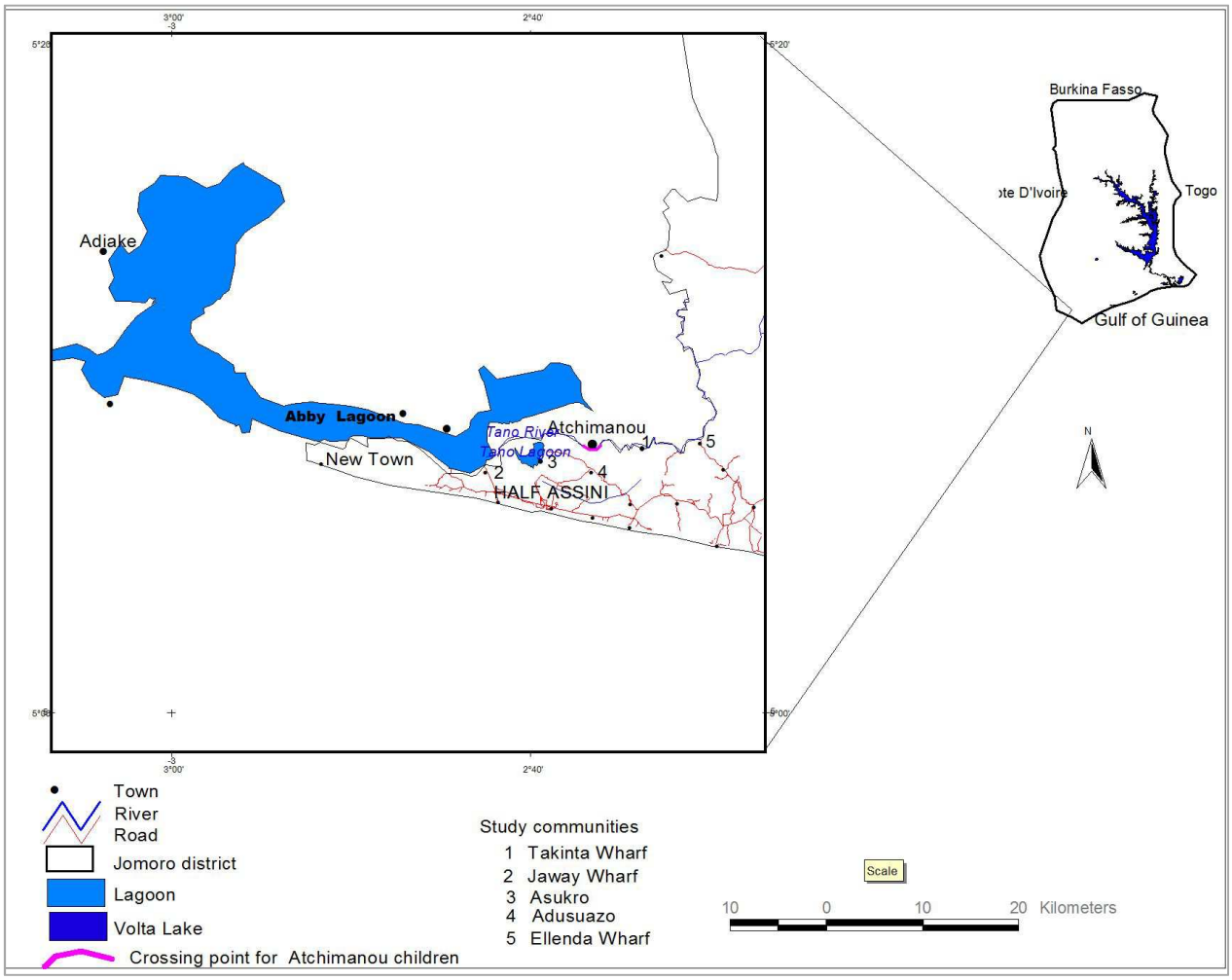

Figure 1. Map of Jomoro District showing the study areas and water bodies.

A total of 305 respondents, shown in Table 1, were selected from the populations of the study communities. Due to the lack of data on the number of people in the communities who had been affected by water hyacinth invasion, 5% (0.05) of the population of each community was selected and distributed among the various categories of respondents. However the application of this approach to the population of Jaway Wharf would have made the sample for that community too large hence a sample of 140 respondents was selected for it.

Table 1. Population and sample characteristics of the selected communities.

Community	Population	Sample Selected from the Community
Asukro	314	16
Takinta Wharf	163	8
Jaway Wharf	3,626	140
Ellenda Wharf	197	10
Adusuazo	2, 627	131
Total	6, 927	305

Source: Jomoro District Assembly, 2010.

In order to focus on people whose livelihood activities were

connected to the invaded water bodies, 126 fishermen, 84 fish traders, 55 farmers and 40 boat operators were selected to compose of the 305 sample size. These respondents were to represent people in the same occupations in presenting information on the utility of water hyacinth. In each community, respondents were traced personally through the application of the snowballing sampling technique [28], in which only the people within the targeted occupational groups were contacted for data collection. The snowballing sampling method was adopted because the researcher had no records of the number of people in the various occupational categories at his disposal.

4.3. Data Collection Methods and Tools

Method triangulation approach [31] was adopted in the study. This involved the use of both partially pre-coded questionnaires and Focus Group Discussions. The aim of the partially pre-coded questionnaires was to enable respondents contribute adequate information through the open questions since the close questions might have limited them in contributing detailed information to the study.

The interviews of respondents were conducted in their homes and landing beaches along the two water bodies. Questions were translated into two local languages (Nzema and Twi) in order to serve the linguistic needs of all participants, including migrants. Respondents were briefed on the purpose of this study and what was expected of them prior to the interviews. Participation was voluntary. Respondents were assured of confidentiality and anonymity of their responses hence their names or other identifying features were not collected. Eight focus group discussions (FDGs) were conducted for two of the selected communities, namely; Adusuazo along the River Tano and Asukro along the Abby-Tano Lagoon. Each group had a minimum of eight and maximum of twelve people. Group numbers were limited to allow for effective group management. In order to prevent interruptions from potential third parties, the FGDs were held in enclosed places [32]. The selection of the participants was based on gender (men and women) and occupation (fishermen, fish traders and farmers). This was to allow respondents in each gender category to freely contribute to the discussions without intimidation.

The FGDs were carried out in the local dialect (Nzema) in order to serve the language needs of the participants and to enable them contribute eloquently to the discussions. Each group discussion lasted for about 60 minutes. The researcher facilitated the discussions with the aid of a research assistant. An interview guide, which was developed after a critical review of literature on the utility of water hyacinth, was used as a checklist during the discussions. A digital audio recorder was also used to record the responses from the discussions. This occurred after seeking the informed consent of participants. The recordings enabled the researcher to capture participants' own words and examine them afterwards, in order to avoid the loss of viable information in the course of the note taking. Based on the objective of the study, questions posed to both the 305 respondents and the FGD participants included: have you used the water hyacinth before; what did you use the water hyacinth for; have you had any formal training regarding the use of the water hyacinth; which institution provided you with the training on the use of the water hyacinth; what do you think are some of the economic opportunities that are associated with the use of the water hyacinth; and name any product that you think could be made from water hyacinth.

4.4. Data Analysis

Cross-tabulations, frequency tables, pie charts and stacked bar charts in the statistical package for social sciences (SPSS, Version 16.0) and Microsoft Excel were used to analyse quantitative data. Qualitative data, on the other hand, were recorded, transcribed, analysed, and integrated into the text. The audio records taken during the FGDs were translated into English. Some of respondents' normative quotes were directly reported to support the quantitative data.

5. Analysis and Discussion of Results

5.1. Uses of Water Hyacinth Among Respondents in the Jomoro District

Even though it is widely reported that water hyacinth could be put to many uses, results of the study show a low level of its usage in the study communities. Figure 2 presents data on the extent of the usage.

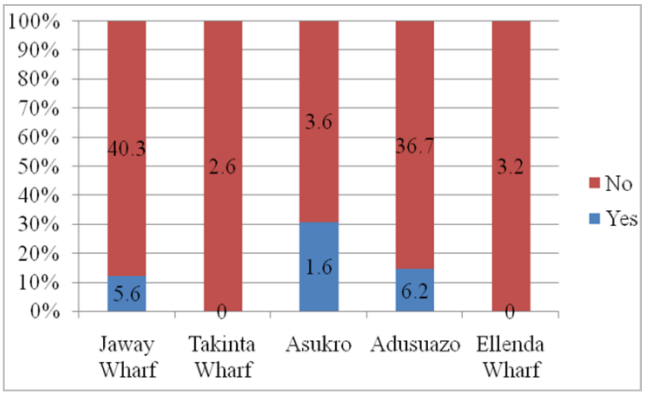

Figure 2. Level of utility of water hyacinth in the Jomoro District.

The Results displayed in Figure 2 show that majority of the respondents (86.6%) had not put water hyacinth to any use prior to the data collection, compared to only 13.4%

who had used it. While Asukro recorded a proportionally high percentage among the communities whose respondents had used the water hyacinth, no respondent from Takinta Wharf and Ellenda Wharf had put the water hyacinth to any use.

5.2. Uses of Water Hyacinth in the Jomoro District

The few respondents who reported they had utilised the water hyacinth indicated they put them into various uses. These uses have been presented in Table 2.

Table 2. Uses of water hyacinth in the Jomoro district.

Uses	Jaway Wharf	Takinta Wharf	Asukro	Adusuazo	Ellenda Wharf	Total
Animal feed	1 (0.3%)	-	-	12 (4.0%)	-	13 (4.3%)
Human food	-	-	-	1 (0.3%)	-	1 (0.3%)
As shade in fish trap	8 (2.6%)	-	-	4 (1.3%)	-	12 (3.9%)
Production of fertilizer	6 (2.0%)	-	5 (1.6%)	-	-	11 (3.6%)
Other	2 (0.7%)	-	-	2 (0.7%)	-	4 (1.4%)
None	123 (40.3%)	8 (2.6%)	11 (3.6%)	112 (36.7%)	10 (3.2%)	264 (86.6%)
Total	140 (45.9%)	8 (2.6%)	16 (5.2%)	131 (42.9%)	10 (3.2%)	305 (100%)

The results of the study presented in Table 2 show that 4.3% of the respondents had used the water hyacinth as animal feed, with the significant majority coming from Adusuazo. The study revealed that the animals involved were mainly pigs, reflecting Jafari [18], that pig farmers in China use water hyacinth to feed their animals. Besides, in the findings of Onyango and Ondeng [7], majority of the respondents reported that the price of feedstock for fish, poultry, and pigs had reduced, thus reducing the cost of input, due to the cheap feed from water hyacinth. In this study, 3.9% of the respondents had used water hyacinth to provide shade in fish traps (Figure 3), a usage which was only reported at Jaway Wharf and Adusuazo.

Figure 3. Water hyacinth used in fish traps on the Abby Lagoon.

The results also indicate that 3.6% of the respondents had used water hyacinth in the production of fertilizer. These respondents came from Jaway Wharf and Asukro. The following comments illustrate the use of water hyacinth in the fertilizer project:

*"We were trained by the Agric officers to use the water hyacinth to make fertilizer. We added chicken manure, cow dung, ash, soil, saw dust and water. We were able to make the fertilizer and used it to plant vegetables. We even taught people in other communities like Apolonu. We sold a lot of green pepper to generate profit" (*A 42-year old boat operator at Jaway Wharf during an in-depth interview; August, 2016).

"The District Agric Officers taught us how to use the water hyacinth to make fertilizer. The process was successful and we even planted vegetables with the fertilizer. However, some of us did not continue with the project because farming was not our main work" (A 52-year old fisherman at Asukro during a FGD; July, 2016)

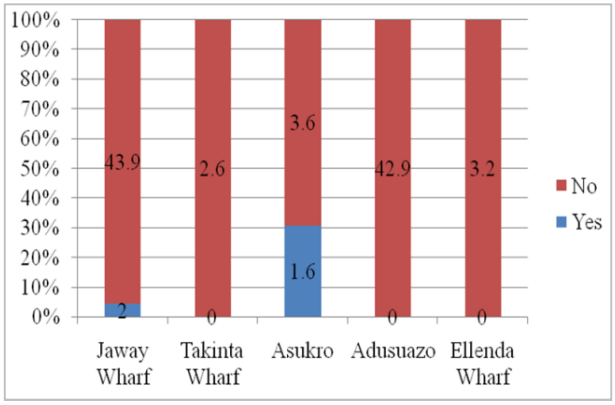

Figure 4. Percentage of respondents who had been formally trained on the use of the water hyacinth in the Jomoro District.

The other uses of water hyacinth identified in the study included its use by fish traders as hand sanitizers after fish processing while others covered smoking fish with water hyacinth. The study results presented in Figure 4 also indicate that the 3.6% respondents from Jaway Wharf and Asukro were the only category of people who had been formally trained by the District Agriculture Officers to turn water hyacinth into fertilizer. The others acquired their ideas about the use of water hyacinth either from friends or through their own ingenuity. According to Barokini and Babalola [10], one way of controlling invasive species is to move from their total destruction to their socio-economic utilisation. In the view of Onyango and Ondeng [7], the utilisation of water hyacinth is the most suitable way of controlling it. Therefore, in their study of riparian communities in Dunga and

Kichinjio of Kisumu Central Sub County, Kenya, 65% of the respondents reported that green manure made from water hyacinth was highly used especially for gardening and tree planting, contrary to what was reported in this study. This disparity may be largely because those in Kenya had advanced knowledge about the uses of water hyacinth compared to those in this study.

5.3. Respondents' Knowledge About Products from Water Hyacinth

Results of this study indicate that some respondents were knowledgeable about some products that could be made from water hyacinth. A summary of the products outlined by respondents has been presented in Figure 5.

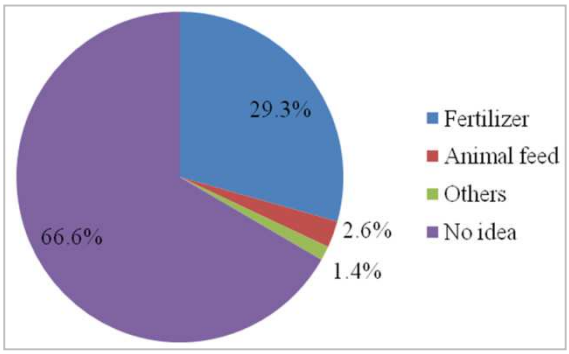

Figure 5. Products from water hyacinth.

Figure 5 indicates that 29.3% of respondents knew the water hyacinth could be used to make fertilizer. The high rating of fertilizer on the list of products outlined by respondents was due to the training programme rolled out by the Agric Department of the Jomoro District Assembly. The percentage was also higher than that of respondents who had actually used the water hyacinth to make fertilizer (Table 2), suggesting that there were respondents who were not part of those trained under the project but were aware of the programme. Other products of water hyacinth identified were biofuel and herbal medicine. Studies had shown that numerous products such as biogas, charcoal briquette, animal feed, artefacts and fertilizers [33, 2, 7] could be made from water hyacinth. Faton et al., [34], found that local authorities perceived water hyacinth as a potential feed for pigs and its stem, an excellent material for making ornamental objects. In addition, the use of water hyacinth to make furniture was reported by fishermen and fish traders in the Lake Naivasha Basin of Kenya [6]. However, a significant majority of respondents in this study could not identify any use for the water hyacinth.

5.4. Potential Economic Opportunities Associated with Water Hyacinth

Since 41 (13.4%) respondents had put the water hyacinth to various uses (Table 2), they were knowledgeable about the economic opportunities associated with the weeds. The opportunities from their perspective have been presented in Figure 6.

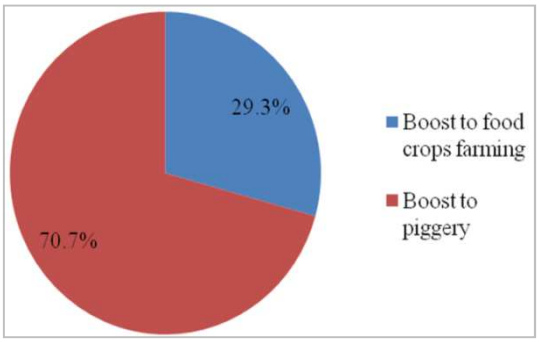

Figure 6. Potential economic opportunities associated with the use of water hyacinth.

Figure 6 shows that 29.3% of the 41 respondents reported water hyacinth invasion could boost agriculture if a fertilizer production factory is established in the district to utilise the weeds. According to them, the use of water hyacinth to make fertilizer will boost food crops farming in the district. In addition, employment avenues will be created as workers would be engaged to work in the fertilizer factory while others remove the weeds from the infested water bodies. This will reduce the extent of the problems created by water hyacinth invasion, in addition to reducing the problem of unemployment in the district. This was reported by Waithaka [6].

5.5. Reasons for Small Scale Utilisation of Water Hyacinth in the Jomoro District

Several reasons accounted for the small scale utilisation of water hyacinth in the study area. Table 3 depicts the reasons provided by respondents.

Table 3. Reasons for small scale utilisation of water hyacinth.

Reasons	Jaway Wharf	Takinta Wharf	Asukro	Adusuazo	Ellenda Wharf	Total
Lack of knowledge on its usefulness	126 (41.3%)	8 (2.6%)	16 (5.2%)	120 (39.3%)	10 (3.2%)	280 (91.8%)
Lack of technology	7 (2.3%)	-	-	10 (3.2%)	-	17 (5.6%)
Lack of funds	5 (1.6%)	-	-	-	-	5 (1.6%)
Difficulty associated with its utilisation	2 (0.7%)	-	-	1 (0.3%)	-	3 (1.0%)
Total	140 (45.9%)	8 (2.6%)	16 (5.2%)	131 (42.9%)	10 (3.2%)	305 (100%)

Table 3 shows that 91.8% reported the lack of knowledge on the usefulness of water hyacinth was the reason why it was not largely utilised in their communities. This was reported in all the study communities. At Asukro, Takinta Wharf and Ellenda Wharf, this reason was reported by all the respondents. Another reason for the low utilisation of water hyacinth in the study communities was due to the lack of required technology to utilise the weeds. According to 1.6% respondents, the lack of funds to invest in the water hyacinth business was an obstacle to its large scale utilisation. Since some of the respondents who had used the water hyacinth to make fertilizer came from Jaway Wharf, it could be induced from the table that the lack of funding was a reason why the fertilizer project could not be sustained. This was because respondents who reported on this challenge came from Jaway Wharf. Regarding the difficulty associated with the use of water hyacinth, it was revealed that it took about a month to produce the fertilizer from it. The following comments illustrate the reasons for the failure of the fertilizer project:

"People from the Agric Department of the Assembly taught us how to use the water hyacinth to make fertilizer. We formed as association and even contributed some amount of money to assist in the project. However, when the assembly did not continue with the provision of the needed inputs, we withdrew our money from the bank and shared it, and the project came to a halt" (A 40-year old boat operator at Jaway Wharf; August, 2016)

"The Agric officers did not continue to supply the seeds to help us continue with the project. Inputs were not supplied and so the programme failed" (A 35-year old boat operator at Jaway Wharf; August, 2016).

6. Conclusion and Recommendation

This study has contributed to knowledge by assessing the utility of water hyacinth in the Jomoro District. The study indicate that a significant majority of the respondents had not put the water hyacinth to any use. This was despite the wide report in the literature about the range of products that could be made from it. However, among the few respondents who had used the water hyacinth, some had utilised it to make fertilizer and animal feed while others had used it to provide shade in their fish traps. Meanwhile, only respondents who had used the water hyacinth to make fertilizer had been formally trained by the District Agriculture officers in that process. The authors found that the main reason for the small scale utilization of water hyacinth in the study area was lack of knowledge on its usefulness. Meanwhile, the few respondents who were a000ware of its usefulness, especially in the making of fertilizer, were of the view that investing in the water hyacinth business in the district would boost agriculture and create employment.

The study therefore recommends that through a planned programme and coordinated efforts by the Jomoro District Assembly and traditional rulers in partnership with other agencies, the fertilizer production programme should be revived so that the weeds could be turned into resource. This will help boost food crops farming and create employment among both farmers and people who will be engaged in the fertilizer production work.

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Declaration of Interest

All the authors do not have any possible conflicts of interest.

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