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Local Collective Action and Challenges of Seaweed Management in the Western Region of Ghana.

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abstract

This study examined the challenges posed by seaweed invasions in the coastal communities of Ghana. It focused on the general perceptions of seaweed, its effect on fisheries and livelihoods, and the removal mechanisms adopted by affected communities. The paper used a mixed-method approach consisting of a questionnaire survey of 300 fishing-dependent households and 12 interviews with stakeholders. The study revealed a predominantly negative perception of seaweeds among fisherfolk in the studied communities. This perception emanates from the devastating impacts of seaweed invasion on their livelihoods. The accumulation of seaweed offshore disrupts fishing activities, damages fishing nets resulting in decrease catch. This has resulted in significant economic hardships, leaving some fisherfolk unable to sustain their families or continue in the fishing industry. Despite the significant challenges posed by seaweed invasions, the study revealed that seaweed removal mechanisms are primarily informal and driven by the communities. However, these initiatives tend to be unsustainable and insufficient to address the problem on a broader scale. While communities show resilience through informal seaweed removal strategies, these efforts are inadequate in addressing the problem. Increasing awareness about seaweed's economic and ecological benefits and implementing effective management practices could transform seaweed from a threat into an asset. Government agencies, NGOs, Civil societies should prioritize seaweed management by allocating resources for research, supporting mechanical removal, and establishing offshore collection infrastructure. Policies should also promote collaboration between local associations/cooperative, local authorities, national and transnational organizations for sustainable management of marine and coastal environments.

1. Introduction

Small-scale fisheries (SSF) contribute significantly to coastal livelihoods and food security among coastal states in developing countries (FAO, 2022). The SSF in Ghana contributes between 60 to 70 per cent of marine output and accounts for 1.5% of the nation's Gross Domestic Product (GDP) (MOFAD, 2022). The sector provides livelihoods for about 10 per cent of Ghana's population representing 3.2 million people and provides about 60 per cent of animal protein consumed (Townhill et al., 2023; MOFAD, 2022). Despite the contributions of the small-scale fisheries, the sector is confronted with several challenges including competition with industrial trawlers, and offshore petroleum companies over the use of ocean space (Mensah-Bonsu et al., 2025; Owusu et al., 2023; Adjei & Overa, 2019). The sustainability of fisheries is under threat due to factors such as overfishing, habitat degradation, and the impact of climate change on marine ecosystems (Townhill et al., 2023; Belhabib et al., 2016). Since 2011, the coastline of Ghana has witnessed persistent seaweed invasion affecting coastal environments (Atiglo et al., 2024). The challenges of managing the persistent seaweed influx in coastal fishing communities poses a major risk for the livelihoods of fisherfolk which raises a major concern about their ability to respond to such changes in order to secure their livelihoods.

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This study focuses on the recent seaweed invasions in the Western coast of Ghana by interrogating its effects on fishing as well as the various local collective actions mechanism deployed by coastal fishing communities to mitigate these effects. Marine macroalgae, also known as seaweeds, are economically important in most economies of the world where they are found. They are mostly found in rocky shore habitats of coastal intertidal zones (Atiglo et al., 2024). Marine macroalgae are used for a wide variety of economic purposes. They are used for culinary purposes: in the sushi industry eaten raw in salads (López-Contreras et al., 2021). Others also use them to produce shakes and smoothies. Seaweeds are also known for their medicinal, cosmetic, pharmaceutical and industrial value, being used in everything from lipstick to body lotions, animal feed, toothpaste, iced cream and paint (López-Contreras et al., 2021). Seaweed derivatives are also used in the medical field in the form of alginates for use in electrophoresis as part of lab testing among others (Myers, 2015). They are also used for compost, biogas and fertiliser for the agricultural industry (López-Contreras et al., 2021). The cultivation of seaweed is said to have a monetary value of about 6 billion US dollars worldwide (Myers, 2015).

However, floating marine algae such as Sargassum vulgare also exist. The sargassum vulgare is a free-floating marine alga and reproduces vegetatively on the high seas which is different from other seaweeds that reproduce and begin life on the ocean floor (Atiglo et al., 2024). It is believed that, the dense mats of Sargassum seen washed ashore on West African beaches break off from parent aggregations in the gyres of the Caribbean Sea; get trapped in warm-water eddies that break off from the gyre, and are then transported to the West African coastline by currents (Ofori & Rouleau, 2020; Addico &

DeGraft-Johnson, 2016). In Ghana, the presence of Sargassum vulgare is believed to have originated from the Sargasso Sea in the Caribbean (Atiglo et al., 2024). Sargassum vulgare was first detected in Ghana in 2009; however since 2012, there has been an increase in quantity; with greater biomasses found in the coastal waters of the Western Region in Ghana (Segbefia et al., 2018; Atiglo et al., 2024).

The seaweed influx has become a problem for coastal communities that rely on fishing for their main source of livelihood, yet limited empirical studies has been conducted to document the impacts of free-floating marine algae on coastal fishing communities (Ofori & Rouleau, 2020; Atiglo et al., 2024). This study fills this gap by investigating the perception of fisherfolk concerning how the seaweeds affect fisheries. The study also considers local collective action to mitigate seaweed invasion. Local associations and cooperatives can facilitate access to microcredit, mitigating illegal fishing, promoting and safeguarding ecosystem services and improving preparedness towards environmental hazards (Yang et al., 2019; Lashley & Warner, 2015).

The seaweed invasion along the Western coast of Ghana has created new set of challenges for coastal dwellers who are mainly fishers and fishmongers. Using the Sustainable Livelihoods Approach (SLA) and collective action literature, the study argues that seaweed invasion in the Western coast of Ghana has further impoverished coastal fisherfolk who are already struggling to protect their livelihoods. Informal community-driven initiatives to mitigate the impacts of seaweed invasion have proven to be unsustainable and insufficient to address the problem on a broader scale.

The paper contributes to the literature on rural coastal development by investigating the perception and experiences of fisherfolk about seaweed invasion and its ramifications on fisheries livelihoods. It further highlights the role of local community-driven initiatives to mitigate seaweed invasions.

The next section presents the theoretical framework of the study. Section 3 presents the introduction of the study area and research methodology. Section 4 presents and discusses the findings from the study, which is followed by the implications of the study in Section 5. Section 6 concludes the study.

2. Sustainable fisheries livelihoods and local collective action.

The Sustainable Livelihoods Approach (SLA) is an analytical framework that helps to comprehend the livelihood conditions of households or individuals at the micro scale (Owusu & Andriesse, 2022). The SLA pays focuses on the factors that hinder the access to assets and or improve livelihood opportunities with households as its main focus (Allison & Horemans, 2006). It explores how institutions, organizations, policies and processes transform livelihood strategies to determine livelihood outcomes. The SLA includes the vulnerability context, capital assets, PIPs, livelihood strategies, and outcomes (Allison & Ellis, 2001; Allison & Horemans, 2006; Scoones, 2009).

The interaction between the livelihood assets, the vulnerability context and institutions, organizations, policies translate into livelihood strategies which in turn determines livelihood trajectories/outcomes (Allison & Ellis, 2001; Allison & Horemans, 2006). The human capital includes education, skills, knowledge, health, nutrition, ability to work and the capacity to adapt (Serrat, 2008). Natural capital may include water and aquatic resources from which fish is extracted. The natural capital is often impacted by anthropogenic activities such as intensification of fishing and overfishing (Yang et al., 2019). Household's financial resources such as savings, credit, debts, remittances, pensions, insurance and wages comprise financial assets (Owusu & Andriesse, 2020). Productive assets such as canoes, fishing nets, and outboard motors are key physical assets of coastal fisherfolk. Coastal community's social capital includes all social and community networks that support and promote mutual understanding for peaceful co-existence in the community. These livelihood trajectories are expected to serve as a feedback mechanism for developing and making new ideas, changes, and improvements in relation to livelihood assets and transformation structures and process with the aim of reducing vulnerabilities (Serrat, 2008). The SLA has been applied to understand how rural coastal fisherfolk utilized their livelihoods asset portfolio to make their living in the face increasing environmental vulnerabilities and uncertainties (Owusu & Andriesse, 2022).

The vulnerability context in SLA examines the changes in the external environment and how they affect or influence people's livelihoods. The SLA is deployed in this study to examine fisherfolk vulnerabilities in relation to seaweed invasion in the coastal fishing communities of Western Region. The vulnerability includes seasonality, trends and shocks which are often beyond household control (Allison & Horemans, 2006). Trends include decreasing catch rates, increasing prices for fish, and other factors such as increase food prices. Shocks comprise storm damage to coastal infrastructure, toxic algal blooms, and fuel-price hikes that affect the costs of fish production and seafood prices (Allison & Horemans 2006; Owusu, 2025). The massive influx of marine algae bloom (seaweeds) is considered to have caused a major shock and stress on the capital assets of fisherfolk. These vulnerabilities can be understood in terms of the disruption of fishing activities, damages to fishing gears, and loss of income. The understanding of the failures and success of fisherfolk in their attempt to secure their livelihoods in the face of sargassum invasion associated with diseases occurrence, disruption in fisheries work, environmental pollution can facilitate the design of suitable policies and better interventions to assist people to improve their existing coping and adaptation capacity (Allison & Horemans, 2006).

This paper proposes employing a modified SLA based on insights by studies on rural, coastal development and collective action (Figure 1). The study accounts for human agency by introducing collective action. Collective action involves group of people working together to solve environmental resource management challenges (Zenbaba, 2024). The study positioned collective action as a viable livelihood strategy in response to coastal environmental degradation. In order to adapt to environmental vulnerabilities and to act in accordance with complex market demands, collective action is seen as one of the most promising ways forward. Development experts and academics perceive collective action such as working together in associations, cooperatives, informal local community development as well as promoting and safeguarding ecosystem services as an effective and inclusive strategy for rural households (Yang et al., 2019; IFAD, 2016; Mudege et al., 2015). Local communities can be the best positioned stakeholders to solve problems and manage common pool resources (ecosystems) such as fisheries, forests, irrigation systems, and mangrove forests (Ostrom, 2010). Local cooperatives /associations can be formal or informal and are regulated by a set of rules, values and behaviors. They provide avenues for collective actions through representation, participation in decision making and other related matters like persuading local and national authorities for support (Planitz & Kuzu, 2015; Serrat, 2008). However, in the case of rapid environmental changes such as massive seaweed invasion most coastal impoverished communities are not able to provide sufficient emergency support; no matter how well they were prepared and participated in disaster risk reduction schemes (Atiglo e t al., 2024; Ofori & Rouleau, 2020). Rural cooperatives generally perform better with cautious government support compared with those that are imposed by governments or at the behest of NGOs. (Yang et al., 2019). A more successful collective action in addressing coastal environmental degradation will include collaboration and support from higher authority including civil societies, governments and multinational development partners to achieve long term success (Zenbaba, 2024; Yang et al., 2019). Coastal livelihoods are sustainable when fisherfolk can earn more income, improve food security, and reduce vulnerability, resulting in an overall improvement in the standard of living and well-being (Yang et al., 2019; Owusu, 2025).

Figure 1 presents the analytical framework of the study. It examines the vulnerabilities of coastal fishing communities impacted by seaweed invasion and accounted for local agency by introducing collective action as a livelihood strategy.

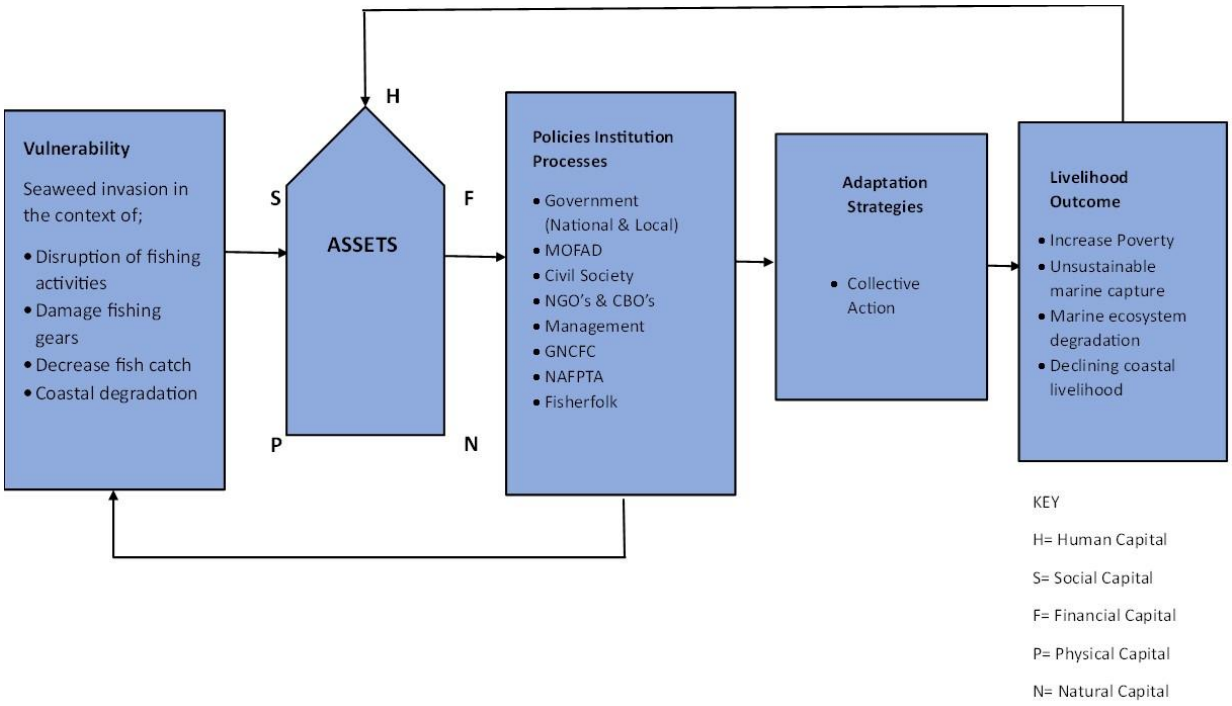


Figure 1. Analytical framework
Source: Adapted from Carney et al., (1999)

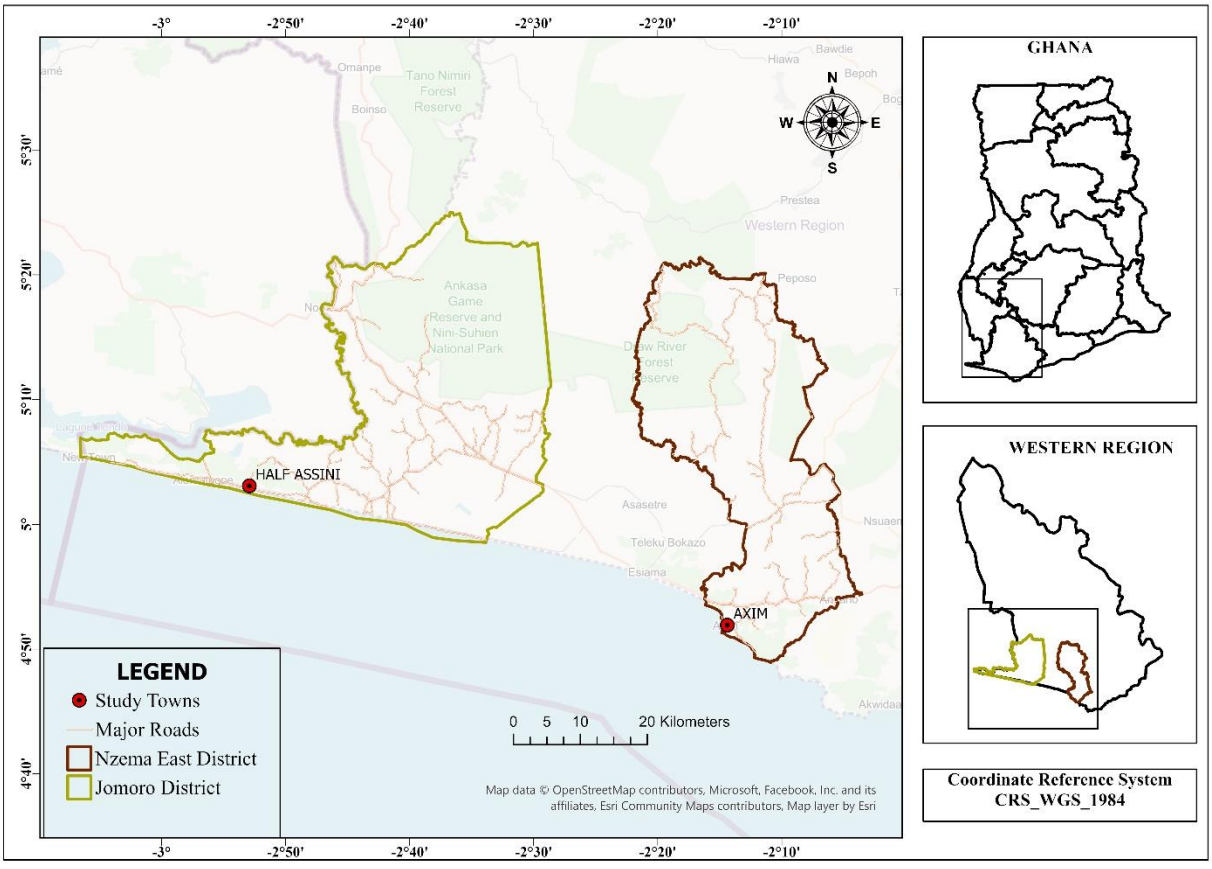


Figure 2. Map of the study areas in Western region of Ghana

3. Study area and methodology

The Western region is located south-western part of Ghana and has six coastal districts. The population of the Western region is 2,060,585 (Ghana Statistical Services, 2021). Two coastal communities namely Half Assini and Axim in the Western region were selected for this study (Figure 2). These coastal communities were selected because the major economic activity along the coast is fishing and its related activities, such as processing and trading (Owusu et al., 2023).

Nzema East Municipal Assembly (NEMA) is one of the existing fourteen MMDAs in the Western Region of Ghana. The municipality is located on the southern end of the region between longitude 2^0 05' and 2^0 35' west and latitudes 4^0 40' and 5^0 20', north with digital address WN- 001-6226. According to the 2021 Population and Housing Census, the population of the municipality is 94,621 and is 24.6% urban and 75.4% rural (Ghana Statistical Service, 2021). The municipality lies between the wet semi-equatorial climate zones of the West African Sub- region. Rainfall is experienced throughout the year with temperatures between 250^0C - 30^0C. The capital of Nzema East Municipality, Axim, records the highest rainfall in the country with the yearly average of about 2000 millimeters of rainfall. Agriculture, including fishing, is the main economic activity in the Municipality in terms of employment and income generation (Coastal Resource Center & Friends of the Nation , 2010). It also constitutes the main source of household income in the municipality. The municipality is a major player as far as marine fishing in the country is concerned. 13 out of the 90 landing beaches in the Western region are located in the municipality (MOFAD, 2022). Marine fishing is seasonal. Axim, has a total of 3,187 fishers and 584 canoes that support the local fishing industry. Annual average fish production in the district over the past five years is 2,106 Mt (MOFAD, 2022). The major fishing season is between July & September with minor season occurring from November to January. The common types of fish landed being sardinella and tunas. There are 992 registered canoes in the municipality.

The Jomoro district is located in the Southwestern part of Ghana with Half Assini as its capital city. It lies between latitude 04°55' – 05°15'N and longitude 02°15' – 02°45W. The Municipality covers an area of 1,344 square kilometers. According to the 2021 Population and Housing Census, the population of the district is 126,576 (Ghana Statistical Services, 2021). The district geography comprises of flat, hilly and undulating landscapes. Coconut trees have planted along the coastline, there variety of mangroves adjacent the lagoons and rivers in the district (Coastal Resource Center & Friends of the Nation , 2010). Agriculture is the main economic activity in the Municipality in terms of employment and income generation, with majority of the people engaging in fishing, farming and agro-processing (Coastal Resource Center & Friends of the Nation2010). The average annual fish production in the district over the past five years is 24, 197mt (MOFAD, 2022). There is a total of 923 fishermen 44 canoes that support the artisanal fisheries sector in Half Assini (MOFAD, 2022).

Research Methodology

Data collection

The paper used a mixed-method approach to examine the effects of seaweed invasion on fisheries livelihoods. The quantitative data collection process preceded the qualitative data collection. Information from the data collected at this stage formed a basis for improving the qualitative interview guide. The empirical data consists of a questionnaire survey of 300 fishing-dependent households and 12 interviews with stakeholders. The household surveys and interviews were conducted between December 2023 and January 2024 in the communities of Axim and Half Assini. In-depth semi-structured interviews were conducted with canoe owners n=(8), leaders of fish processors and traders n= (4), community leaders (2) and government officials n= (1) to gain insights into seaweed occurrence and community management strategies. The interviews covered four broad thematic areas of inquiry including basic socio-economic and demographic information, knowledge of origin and seaweed seasons, perceived effects of seaweeds on livelihood assets of fisherfolk and local management strategies deployed to mitigate these impacts. The household questionnaire covered four broad thematic areas: socioeconomic and demographic information, origins and seaweed seasons, and management mechanism. The questionnaire included closed-ended, open-ended, and multiple-choice questions. The open-ended questions allowed the respondents to freely talk about their experiences and knowledge relevant to the seaweed invasion and local collective actions. The survey lasted between 30 minutes to 50 minutes on the average per person.

Sampling method and sample size

Simple random sampling technique was employed in selecting respondents for the household survey. According to the 2022 national canoe frame survey, there were 3,187 fishermen in Axim and 923 in Half Assini. The number of fishermen in the study communities was similar during the survey. Information on the population of fishermen was sourced from the Chief fishermen to constitute the sample frame. A total of 300 fisherfolk were engaged in the household survey, including 200 randomly selected fishers engaged in small-scale commercial fishing from Axim and 100 from Half Assini. Purposive sampling technique was used to select 12 stakeholders comprising canoe owners, leaders of fish processors and traders, community leaders and a government official. These stakeholders were purposively selected because of their knowledge of fishing and its related activities such as fish processing and trading. Simple random and purposive sampling techniques are efficient data gathering methods used by researchers to interrogate coastal livelihoods and fisheries resources management (Penney et al 2017; Owusu & Adjei, 2021; Adjei & Overa, 2019).

Data analysis

SPSS Version 23.0 and Excel were used to analyze the results from the household surveys. The findings were presented in frequency tables and charts. The qualitative interviews were recorded with the permission of participants and were later transcribed verbatim. The transcribed data was manually coded and organized into relevant themes based on the study objectives and components of the SLA. Selected narratives from the interviews were presented as direct quotations to illustrate key findings.

Secondary data were collected from published and non-published reports, journal articles, online newspaper articles, and internet sources to support the analysis and to situate the study findings in a broader context.

Ethical considerations

There is no known risk associated with the conduct of this study or participating in it.

Informed consent was obtained from all research participants prior to the conduct of surveys and interviews. Thus, various levels of ethical conduct of research, especially, for consent seeking was strictly observed from institutional points of view, as well as community and individual.

4. Findings and discussions

The results from table 1 show that both study communities recorded high household size compared to the national average of 3.6 members (Ghana Statistical Services, 2021). The highest number of fishers with no formal education (74.4%) was recorded at Axim. For household monthly income earned from fisheries, Half Assini recorded the most people (14%) earning more than GHS 800 (USD 73). The lowest monthly income from fisheries work was recorded at Axim in Nzema East with 8% of fisherfolk earning less than GHS 99 (USD 36) per month. The average monthly income earned from fishing was between GHS 599-799 (USD 54-73).

The results displayed in table 2 show that majority of the fisherfolk had a considerably long experience in fishing with 46%% fishing for over 15 years. An overwhelming 87% of fisherfolk indicated that compared to 10 years ago, the quantity of fish catch has reduced resulting in decrease income. Only 3% of participants believe that seaweed appeared on the beaches quite recently that is less than 5 years, 13% believe it appeared within the last 5-10 years, and 83% of participants claim to have observed the presence of seaweed over 10 years ago. 93% of participants believe that, the seaweed invasion affects their livelihood, and 6% believe that the invasion of seaweed has not affected any aspect of their lives, either directly or indirectly (Table 1).

The next section explores the origin and occurrence of seaweeds from the perspectives of fisherfolk.

Table 1. Characteristics of the study sites and persons surveyed

DISTRICTS	NZEMA EAST (Axim)	JOMORO (Half Assini)
Average household size	6.6	6.4
Education level		
No education	74.4%	72 %
Elementary	25%	26 %
Secondary	1%	3 %
Tertiary	-	-
Type of fisher		
Captain	5%	-
Canoe owner	28 %	26 %
Crew member	67%	74 %
Commonly caught fish	sardine, tuna	Tuna, sardine
Common fishing gear	Hook & line, Pursing net, lobster net	Pursing net, Beach seine
Monthly income (fisheries)	0-199 (0.0%) 200-399 (8%) 400-599 (35%) 600-799 (44%) Above 800 (13%)	0-199 (0.0%) 200-399 (11%) 400-599 (42%) 600-799 (33%) Above 800 (14%)
Monthly income (non-fisheries)	0-199 (15%) 200-399 (7%) 400-599 (0.0%)	0-199 (8.0%) 200-399 (4.0%) 400-599 (5.0%)

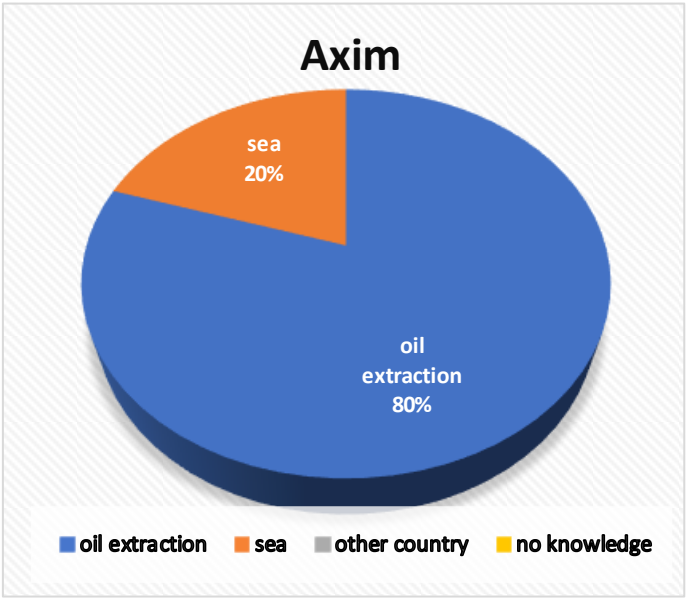
Exchange rate: USD 1 = GHS 11 as of August 2025

Table 2 key survey results

VARIABLE	CATEGORIES	N	%
Duration of fishing			
	Less than 5 years	14	4.6
	5 – 10 years	53	17.6
	11 – 15 years	95	31.7
	Over 15 years	138	46
Purpose of catch			
	Only commercial	280	93
	Both commercial and subsistence	20	17
Catch quantity changes (compared to 10 years ago)			
	Increased	18	6
	Decreased	262	87.3
	No change	20	6.6
Income changes	Higher	10	3.3
	Lower	270	90
(compared to 10 years ago)	No change	20	6.6
Presence of seaweed	Less than 5 years	10	3
	5-10 years	40	13.3
	Over 10 years	250	83.3
Effect of seaweed on fisheries livelihoods			
	Yes	280	93.3
	No	20	6.6
Economic relevance of seaweeds			
	Yes	11	3.7
	No	289	96.3

Fisherfolk perception about origin of seaweed invasions

The findings of this study provide an understanding of how seaweed invasion is perceived in the Western Region of Ghana, especially in the Jomoro and Nzema East districts. The data reveals how fisherfolk view the origins of seaweed, its seasonal patterns, and economic effects. This offers an understanding of local environmental knowledge and its effect on livelihoods. Fisherfolk presented varied opinions about the origins and causes of seaweed invasion. While some believed seaweed invasions were due to natural causes directly from the sea, others perceived the causes to be human induced activities from the offshore oil and gas exploration in Ghana. The results from the two study communities show that fisherfolk have different opinions about the origin of the seaweed invasion (Figure 3).



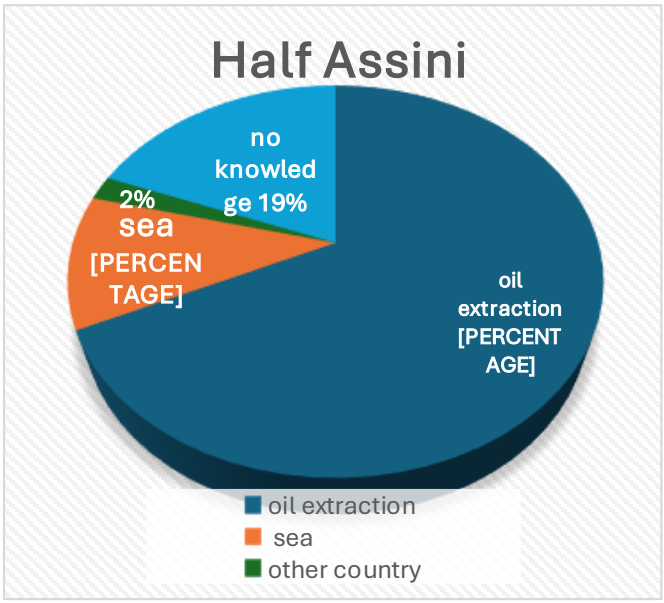


Figure 3. Fisherfolk Perception of Seaweed Origin (% of fishers; n=300

In Axim, 80% of fisherfolk, believed the seaweeds emerge from the oil extraction, 20%, also reported that the seaweeds come from the sea. On the contrary, in Half Assini, 11% of fisherfolk attributed the emergence of the seaweed to the sea. 68% of the participants, believed that seaweeds emanate from the offshore petroleum extraction activities. 19% also said they had no idea about the source of the seaweeds, while 2% of participants, mentioned that the seaweeds come from other countries. Excerpts from interviews with fisherfolk support the findings above:

*"We have been asking our leaders about the source of the seaweed, but for me l strongly believe the seaweeds comes from the oil extraction site. Initially, we were told in a meeting that the seaweeds are coming from Cote D'Ivoire, but l disagree with them (*Canoe owner, Half Assini).
The seaweeds are found under the oil extracting machines, so whenever they are working, the machines deposits seaweed at the beach. If you check properly, it's something that was not there. It was when they started drilling the oil that we also saw it (Canoe owner Axim).

Results from table 1 shows that 50 % and 56% surveyed fisherfolk reported that appearance of seaweeds over the past 10 years. The periods also roughly coincide with start of the offshore oil and gas production in 2010, which has made some of the fisherfolk to believe that petroleum extraction is the cause of the seaweed invasion.
According to the local assemblyman at Half Assini, the community believed the seaweed emanated from the offshore oil and gas production until after several engagements with municipal assembly and other government officials before realizing it was not coming from the oil production site:

When it gets to its time, it comes. It can even spread from here to the beach so if you stand here, you will see it spreading all over. Initially, we even thought it was as a result of the oil drilling but as we investigated with the help of our leaders, we realized it wasn't coming from the oil drilling. But when it comes, we can't do anything about it so we have to wait for it to be dried under the sun after which we will clean and dump them
(Chief fisherman, Half Assini).

The study revealed varied perceptions regarding the origins of the seaweed invasion between the Jomoro and Nzema East districts. This discrepancy highlights the role of contextual influences, such as proximity to industrial operations and local environmental alterations, in shaping community beliefs. These results partially support the claims of the existing literature that emphasize the detrimental effects of oil and gas exploration on coastal ecosystems (Ackah-Baidoo, 2013; Marsh et al., 2021; Adjei & Overa, 2019; Ofori and Rouleau, 2020). However, the variation in response indicates substantial environmental literacy and awareness deficiencies among coastal inhabitants. Majority of the fisherfolk demonstrate a limited grasp of the biological and ecological dynamics that drive seaweed invasions. This observation aligns with the findings from Atiglo et al. (2024), which indicated that communities impacted by such issues frequently misinterpret the causation, lifecycle, and management strategies related to seaweed. Addressing these misconceptions is essential to understand the invasion's dynamics coherently. The findings also show that the local marine ecological knowledge of fisherfolk is not in tandem with rapid global environmental change. Additionally, the divergent perceptions could affect community approaches to seaweed management. Communities attributing the invasion to natural causes might anticipate external or governmental intervention, while those recognizing human influences may be more inclined to pursue localized, community-driven solutions.
The study also probed the periods associated with the appearance of the seaweeds. Regarding the seaweed season, it was revealed that seaweed invasions in both study communities occur in March, April, May, July, August, September, October, and November, but are less abundant in January, June, November, and December. However, they reach their peak in April and August.

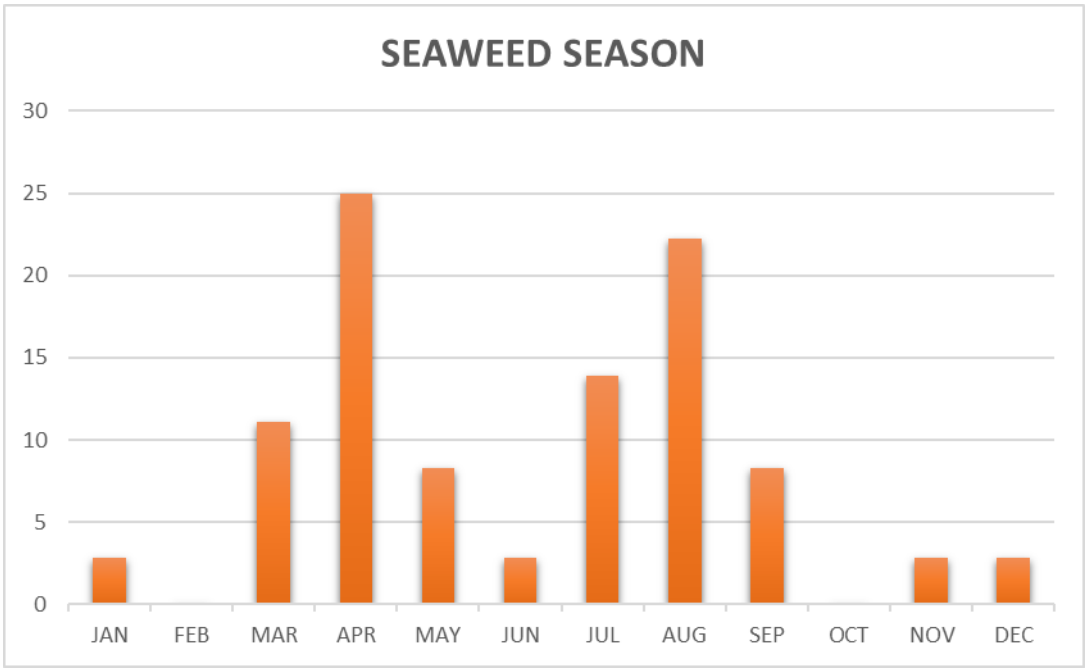


Figure 4. Seaweed occurrence season (% of fishers; n=300)

According to the results, seaweeds do not occur in February and October in both study communities (Figure 4). In an interview with the chief fisherman at Half Assini, he emphasized that the seaweeds mostly arrive in April, July, and August.

The seasonal variability of seaweeds highlighted in this study highlights their ecological complexity. Participants indicated that seaweeds are most abundant in April and August, while they are nearly absent in February and October, with lower levels observed in January, June, November, and December. These findings align with a study conducted by Tano et al. (2015) emphasizing the geographical and seasonal variations in seaweed growth and proliferation. Interviews with fisherfolk provided insights into the practical implications of this seasonality. For example, a chief fisherman from Nzema East remarked that seaweeds predominantly appear in April, July, and August which corresponds with the major harvest season. These periods coincide with the coastal upwelling systems that that bring cool, nutrient rich water to the surface, resulting in high productivity (Finegold et al., 2010). These observations align with previous studies showing that environmental factors such as water temperature, nutrient availability, and ocean currents significantly influence the seasonal patterns of seaweed blooms Hu et al., 2016). The localized knowledge of fisherfolk is an essential complement to scientific data. Their observations regarding peak months and fluctuations in seaweed abundance could effectively guide policymakers and researchers in developing adaptive management strategies that consider these temporal dynamics (Akrong et al., 2021).

The next section presents the perceived impact of seaweeds on fisherfolk livelihoods.

Impact of the seaweed on fisheries and livelihoods.

The majority of fisherfolk view seaweeds as an unprofitable resource. They view the seaweeds as a threat to their fishing activities. Table 1 shows that only 5.5% of participants mentioned that seaweeds have economic benefits, and 94.5% believe it has no economic benefit, as it causes nuisance in their fishing activities. For example, an assemblyman from Jomoro recounted a failed initiative to sell seaweeds to foreign buyers, resulting in wasted efforts;

We went to a meeting and we were told some Chinese wanted to buy them … they didn't come so it became a waste. So, there are no benefits from it to anyone here.

(Assemblyman, Half Assini).

Similarly, fishermen reported that seaweeds have become a burden on them further compounding their economic struggles;

Currently the seaweeds do not provide us with any economic benefits, it has rather become a burden to us because we spent a lot time and resources trying to clean the beach and bury those that are washed ashore (Canoe owner, Axim).

Globally, seaweed is recognized as an essential resource with diverse applications, including food production, biofuel, and cosmetics. Research in low-income countries has demonstrated that seaweed farming can provide a sustainable livelihood, particularly for women and marginalized communities (Msuya, 2006; Valderrama, 2012; Mantri et al., 2017). However, in the studied regions, seaweed is perceived as a threat to livelihoods rather than being an asset. Participants expressed discontent regarding the economic viability of seaweed management. This negative perception contrasts successful case studies from other regions, where investments in seaweed value chains have created job opportunities and alleviated pressure on fishing activities (Sievanen et al., 2005; Msuya et al., 2014). In Jomoro and Nzema East, limited market access, inadequate infrastructure, and insufficient technical knowledge hinder the community's ability to benefit from the potential advantages of seaweed (Atiglo et al., 2024). This observation aligns with Liulea's (2021) findings, which indicate that perceptions of environmental resources differ across various geographical contexts, shaped by socioeconomic factors and ecological dynamics. Additionally, the lack of investment in seaweed farming or processing points to broader issues, underscoring the need for government and private sector involvement to understand the economic potential of this resource.

Table3. Impacts of the seaweed on assets of fishing households

Capital asset	Perceived impact of seaweed
Natural capital	Reduction in offshore fishing space, coastal ecosystem pollution
Human capital	Environmental pollution affects the health and well-being of fisherfolk.
Financial capital	Disruptions in fishing leads to decreased fish catch, low income with repercussions and ripple effects to the local economy.
Physical capital	Damage fishing inputs such as nets affects financial resources of fisherfolk
Social capital	Inadequate external support to remove seaweeds

Results from the qualitative interviews further revealed that disruption of fishing activities, pungent smell, reduced catch, and destruction of fishing net are the main effects of seaweed on the livelihoods of fisherfolk.
Fisherfolk reported that the presence of the seaweed disrupts their fishing operations leading to reduce catch:

When the seaweed appears, you always see them on the surface of the water so whenever we go for fishing, we find it difficult to fish. They are also trap our nets. They make fishing very difficult; it prevents us from casting our nets to the targeted place. At times, we need to spend a lot of time before removing the seaweeds from the fishing nets (Fisher, Half Assini).

The seaweeds hinder the activities of the fishermen. The fishermen reported that the seaweeds obstruct their fishing net whilst casting it into the sea which makes fishing difficult for them. The seaweeds are slowing the fishing activities compared to the previous years. It reduces the quantity of the fish. Sometimes they catch both fish and seaweeds. When that happens, they have to spend several hours to separate the waste from the fish. (Community leader and fisher, Axim).

Excerpts from the above interviews shows declining natural capital of coastal communities from which fisherfolk extract the fish. The presence of seaweeds offshore reduces the space available for fishing activities. Fisherfolk, also noted that seaweed gets stacked in fishing nets, diminishing their effectiveness and requiring more labor. Fisherfolk also complain that when the seaweeds clogged their nets it destroys part of it, thereby making it difficult for them to drag their net from the sea to land. This is problematic considering the fact that the abundant seaweed season (July-August) also corresponds with the major fish harvesting season. The disruption in fishing activities during these periods has negative consequences on the financial capital and wellbeing of fishing –dependent households. These findings conform with observations by Ofori and Rouleau (2020) and Atiglo et al. (2024) who documented similar fishing disruptions caused by invasive seaweed species and dire economic consequences on the livelihoods of affected coastal fishing communities.
Some of the fisherfolk reported finding it very difficult to cater for their children and provide other basic living amenities. Others also reported that if the seaweeds invasion continues unabated, they may be compelled to exit the fisheries and completely relocate to other coastal areas without the seaweed menace;

The quantity of fish caught started declining when this oil drilling started. Now we have also observed that we don't get enough quantity as the previous year since the seaweed invasion started. Because of the machines they use in oil drilling, all the fishes have been attracted to the machines because of the lights and the heat, and the fishermen have also been given a particular distance they are supposed to fish. Due to this, most fisherfolks are planning to relocate to their hometowns because they are running at a loss. (Canoe owner, Axim)

It cost us GHS 3,000 approximately 280 Liters of petrol for a fishing trip. Can you imagine that you go with (280 liters) and catch barely nothing, so it is a major problem facing the fishermen. I am not speaking for Half Assini alone but fishers from Benin to New town as well. Because in the olden days when I was young where there wasn't any oil extraction and seaweed invasion, at this particular time at the seashore, you will find fish in abundance (Fisher, Half Assini).

The livelihood challenges reported by fishers have direct effects on other workers in the fishery. These concerns were articulated by women fisherfolk who engage in the buying and processing of fish;

Things have really changed drastically, the quantity of fish we used to have reduced totally. Some years ago, at just one night at the sea, the fishers catch high quantity of fish. We find it difficult to smoke or preserve the fishes that period because of huge catch but now we don't even get some frequently. Now fishers need to spend three to five days on the sea and would still not get that quantity of fish they used to get. In terms of cost too, some years ago, the highest price per pan was GHS200 but currently the prices have risen rapidly to GHS1800, and even GHS2000 so the work have actually changed and it is very difficult. (Fish processor and trader, Half Assini).

Excerpts from the above interviews suggest that the economic consequences of seaweed invasion are enormous, as many fisherfolks struggle to maintain their livelihoods, facing challenges in meeting basic needs and supporting their families. Some have even considered abandoning fishing altogether. The reduction in fish catch has significantly affected financial capital of fisherfolk. These results reflect broader global concerns about the socio-economic effects of seaweed invasions, as highlighted by Hu and Juan (2014), who noted their impact on fisheries, tourism, and marine infrastructure in various regions. The situation in Ghana is particularly alarming, given that coastal communities heavily rely on fishing as their primary source of income (Owusu & Andriesse 2022; Hasselberg et al., 2020). Participants in both study areas also reported that when the seaweed stays longer on the surface of the sea, it decays releasing a very bad smell, which they believe can affect their health. Some interview extracts suggesting the presented data are:

The seaweed appears green when it's on the surface of the sea but turns to brown when it's washed ashore at the beach. It then begins to release a bad smell so if you get close to it, which l think is not good for our health. People living along the beach usually have cold and catarrh. Also, it also comes along with a skin disease when it's been exposed to heat at the beach without cleaning it. (Fisher, Axim).

This finding is illustrative of the health impact of the seaweed menace in coastal fishing communities. Results from household surveys and interviews revealed some level of anxiety and fear whenever fisherfolk encounter the seaweeds. This fear emanates from the possibility of contracting an unknown disease. Decaying seaweeds releases hydrogen sulphide a pungent gas that causes irritation and skin itching (Quansah, 2026). Besides economic losses from seaweed impacts, fisherfolk are also exposed to other diseases that affect their health and well-being with implications on human capital development in coastal areas.
Seaweed invasions along Ghana's coastlines, particularly in the Jomoro and Nzema East districts, present an interaction of ecological and socio-economic challenges. Seaweed invasions have negatively affected the natural capital of fishing households (Figure 1). Natural capital is often the most impacted as it is directly affected by climate change and other environmental changes such as seaweed influx. The decaying of seaweed biomass underwater affects fish stock which contribute to declining in fish catch affecting the income of fisherfolk. The financial, human and physical capital of fisherfolk have also deteriorated because of massive seaweed invasions at the coastal areas (Table 3). The small-scale fisheries sectors are already facing numerous pressures. Nolan et al. (2022) wrote about how climate change interacts with blue growth (expansion of industrial fishing, port infrastructure expansion and offshore oil and gas extraction) contributing to deteriorating of fisheries and coastal livelihoods.

Collective actions /Management Strategies during Seaweed Invasion
The collection and removal of seaweed is a collective responsibility of all stakeholders within the fishing community. The government, fishers and any fisher's association, as well as non-governmental organizations having interest in fishery. All these stakeholders have a role to play in the management of seaweed invasion in the coastal areas. The massiveness and recurrence nature of the seaweeds requires a concerted effort from all stakeholders to effectively address this challenge.
This section examines the collective action mechanisms local communities implement in response to seaweed invasions and assesses their effectiveness. Table 4 indicates that although many fisherfolks are affiliated with various associations, these organizations broadly fall short in facilitating targeted assistance for managing invasive seaweed. Participants acknowledged some benefits provided by these associations, including material, financial, and social. However, only a few respondents from both study areas reported receiving assistance in addressing seaweed-related challenges. This limited support from associations highlights a broader issue of insufficient institutional capacity and a lack of prioritization of seaweed management within these entities.

Table 4. Fisherfolk association/ cooperatives

STUDY AREAS	HALF-ASSINI	AXIM
Member of association or cooperation		
Yes		
No	67%	43%
	33%	57%
Years of membership		
1-2 years		
2-4 years	15%	16%
>4 years	15%	14%
N/A	35%	0
	35%	70%
Benefits of membership		
Material benefit		
Financial benefit	5%	10%
Social benefits	20%	19%
Political benefits	17%	1%
Information	5%	0
N/A	5%	0
	30%	70%
Associations are aiding in mitigating seaweed issues		
Yes		
No	7%	10%
	93%	90%
Government support in recent years		
Yes		
No	10%	12%
	90%	88%
Nongovernmental organization support in recent years		
Yes		
No	0	0
	100	100

N(300) = number of respondents, key results are in percentages (%)

Without organized governmental or institutional frameworks, fisherfolk in Jomoro and Nzema East have predominantly resorted to informal community-driven initiatives to mitigate the impacts of seaweed invasion. Local governance structures, particularly community leaders and assembly members, have initiated communal labor programs to physically remove seaweed from coastal areas. An interview with a local assemblyman illustrates proactive measures undertaken to tackle this challenge:

I have implemented a weekly schedule every Thursday dedicated to communal labor for removing seaweed. This initiative attracted the attention of the Ghana Maritime Authority, which subsequently provided us with a rake and other tools, enabling us to maintain this effort consistently. However, there weeds are many, so as you clear them, it keeps coming, so it'll be challenging to clear everything. It's always floating on the water.

Another fisher who doubles as a canoe owner as opined;
When the seaweeds become too many at the beach, we organize clean up exercises to remove them. After, collecting them, we deposit them in a dugout hole at the beach (Canoe owner, Axim).

Reponses gathered from the interviewee's points to the fact that most of the associations face financial constraints which affects their operations.

We have associations over here, the leaders sometimes invite us to clean or remove the seaweeds from the beach, but due to financial crisis, these unions are not functioning properly. Sometimes you call for meetings and out of about 60 members, only 20 members will show up because of financial issues. So, it's really difficult for us here, we are suffering honestly, we need help (Chief fish processor and trader, Axim)

This communal approach underscores the resilience and self-sufficiency of the affected populations. Nonetheless, the current practice lacks long-term viability. While it effectively addresses the immediate issue of seaweed accumulation in critical zones, it fails to confront the underlying causes of the invasion. The studied communities are requesting for more support and cooperation from higher levels of authority to assist in the collection of the seaweeds*;*

if the government through the Chinese or the Japanese can bring some machines to help remove those weeds from the water, it would help but removing them manually will be very difficult. Unless maybe when it gets to the beach, the government pay fisherfolk to remove them, either than that, it will be very difficult to take them manually with our limited resources. So, it is required of the government to provide the right solution to help the fishermen (community leader, Half Assini)

Research indicates that organized associations in regions such as the Caribbean and Central America mitigate the impacts of seaweed invasions. Specifically, community-driven frameworks have been established in Belize and Mexico to effectively collect and capitalize on seaweed for commercial use (Chávez-Molina et al., 2023). This model presents a viable opportunity for groups in Ghana to harness similar strategies, optimizing collective resources to transform seaweed into a valuable commodity. A concerning observation from the study is the apparent lack of governmental and NGO support regarding seaweed management in the analyzed regions. Only few surveyed participants reported receiving assistance from government entities, and a mere 5% acknowledged receiving minimal NGO support. The Environmental Protection Agency in Ghana adopted a seaweed cleanup policy after the first wave of Sargassum occurrence in 2011 (Ofori & Rouleau, 2020). The Ghanaian directed municipal and districts authorities in the affected coastal districts were directed to regularly remove seaweeds from the beaches and inshore areas to protect coastal ecosystem and fisheries (Ofori & Rouleau, 2020). Interviewed participants reported that officials from the district assemblies visit the coastal areas when there is seaweed occurrence at the beach. They only support they offer is to advise them to remove seaweeds without any major financial and technical support. Ghana does not have a dedicated funding mechanism to provide financial assistance to implement seaweed removal (Ofori & Rouleau, 2020).
This deficit in institutional support burdens local communities, compounding stress on their already scarce resources (Liranzo-Gómez et al.2021). Countries such as Barbados and Jamaica have experienced benefits from government-led interventions and international collaborations to address seaweed invasions. These countries have implemented mechanical removal techniques and utilized inflatable booms to safeguard essential coastal environments (Liranzo-Gómez et al., 2021; Oxenford et al., 2021). Such strategies underscore the advantageous potential of integrating technological and infrastructural solutions with grassroots efforts to enhance coastal resilience against seaweed invasion.
Globally, strategies for managing seaweed invasions have evolved into proactive and reactive measures. In Central America, offshore collection and disposal have successfully minimized the effects of sargassum blooms on coastal areas (Liranzo-Gómez et al., 2021; Chávez et al., 2021). Similarly, mechanical removal and decomposition techniques have been employed to stabilize coastal dunes while mitigating environmental disruption (Williams & Feagin, 2010). However, Ghana has not yet implemented such practices. The absence of beach management strategies, including mechanical removal and offshore collection, reveals a significant gap in the nation's coastal management framework. Additionally, innovative methods like inflatable booms or repurposing seaweed for commercial applications, which have proven effective in other regions, remain untested in Ghana. These findings highlight the urgent need for a multi-faceted approach to seaweed invasion management in the country. Several strategies may be considered when learning from global practices.

Implications of the study for sustainable seaweed management

The findings from this study highlight the urgent need for a coordinated and multi-stakeholder approach to tackle the challenges posed by seaweed invasions. While communities show resilience through informal seaweed removal strategies, these efforts are inadequate to address the scale of the problem. Increasing awareness about seaweed's economic and ecological benefits and implementing effective management practices could transform seaweed from a threat into an asset. Collaborative efforts involving government agencies, NGOs, and local associations are essential for empowering coastal communities, ensuring sustainable fisheries, and enhancing resilience against ecological disruptions. By integrating global best practices with localized interventions, Ghana can unlock the potential of seaweed as a resource and a means of diversifying livelihoods.

First and foremost, government agencies should prioritise seaweed management by allocating resources for research, mechanical removal, and establishing offshore collection infrastructure. Policies should also promote collaboration between local associations/cooperative, local authorities and national organisations. Enhancing the capacity of fisherfolk associations can empower them to take an active role in seaweed management efforts. Training programs, alongside partnerships with non-governmental organisations (NGOs), could provide these associations with essential technical, financial, and logistical support. While communal labor is commendable, such initiatives should be backed by adequate tools, financial incentives, and technical expertise to improve efficiency and effectiveness (Ofori & Rouleau, 2020).

Moreover, exploring the economic potential of seaweed, such as its uses in agriculture (as fertilizers), aquaculture, and biofuels, could transform it into a resource. Public-private partnerships could be pivotal in developing these value chains. Educating communities about seaweed invasions' ecological and economic aspects can help foster a more proactive and adaptive response. Collaborative initiatives, such as the partnership between the Technical University of Denmark (DTU), the Council for Scientific and Industrial Research (CSIR), and Kwame Nkrumah University of Science and Technology (KNUST) in Ghana, aim to harness seaweed for economic growth (Msuya et al., 2022). These programs could serve as a blueprint for transforming seaweed into a valuable asset in Jomoro and Nzema East. However, without targeted interventions, there is a risk that these communities will continue to view seaweed as a threat rather than an asset. Experiences from East Africa, where seaweed farming has been adeptly integrated into local economies, offer valuable lessons. Msuya (2006) highlighted the impact of seaweed farming on poverty alleviation and women's empowerment in Tanzania, underscoring the critical importance of education, capacity building, and access to markets. The findings highlight a challenge for policymakers and stakeholders in addressing the immediate impacts of seaweed invasions on fisheries while sharing their economic potential to fisherfolk. A multi-pronged approach is necessary to transform seaweed from a perceived nuisance into a valuable resource.

The seaweed removal mechanisms employed by communities in Jomoro and Nzema East highlight the resilience and limitations of local efforts to manage seaweed invasions. While communal labor and association-based support offer immediate relief, these measures are insufficient to address the scale and complexity of the problem. Lessons from global practices indicate an integrated approach combining community efforts, institutional support from higher authorities and innovative technologies is essential for sustainable management of seaweed invasions (Almela et al., 2023). By adopting such strategies, Ghana can mitigate the adverse effects of seaweed invasions, while harnessing its potential as an economic resource.

Conclusion

This study examined the challenges posed by seaweed invasions in coastal communities of Ghana. It focused on the general perceptions of seaweed, its impact on fisheries and livelihoods, and the removal mechanisms adopted by affected communities. The findings offer insights into how coastal populations perceive and respond to this rising ecological issue.

The study revealed a predominantly negative perception of seaweeds among fisherfolk in the Jomoro and Nzema East districts. Despite the global recognition of seaweeds for their economic and ecological benefits, local fisherfolk primarily view them as a nuisance due to their disruptive impact on fishing activities. Only a few participants are aware of the potential economic benefits of seaweeds, such as their applications in various industries. This perception is primarily the result of limited awareness, and the absence of structured programs to leverage seaweed's economic potential. The prevailing sentiment indicates unexploited opportunity to integrate seaweed as a valuable resource into the livelihoods of coastal communities.

Seaweed invasions have had considerable negative impacts on fisheries and the livelihoods of fisherfolk. The accumulation of seaweed damages fishing nets and diminishes fish catches. This has led to significant economic hardships, leaving some fisherfolk unable to sustain their families or continue in the fishing industry. Many in the fishing community attribute the decline in fish stocks to seaweed, suggesting that it disrupts marine habitats and hinders fishing efforts. The belief that decaying seaweed underwater drives fish away and further deepens the link between seaweed invasions and reduced fishery yields. These observations emphasize the connection between the potential benefits of seaweed and the immediate challenges it poses to local livelihoods.

Despite the significant challenges posed by seaweed invasions, the study reveals that removal mechanisms are primarily informal and driven by the communities. In certain areas, such as Jomoro, local authorities have organized collective efforts to remove seaweed at the beach. However, these initiatives tend to be unsustainable and insufficient to address the problem on a broader scale. Associations that could play a crucial role in mitigating the impact of seaweed have proven ineffective, with most participants indicating that their associations offer little no support in managing these invasions. Furthermore, support from government and NGOs is virtually non-existent, forcing communities to rely on their limited resources. Unlike other regions that have implemented innovative strategies such as mechanical removal, offshore collection, and valorizing seaweed, coastal communities in Ghana remain hindered by gaps in resources and knowledge.

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