Adaptive Responses of Small-Scale Fisheries to the Vulnerabilities Resulting from Crude Oil Extraction in Western Ghana

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Offshore crude oil exploration activities affect marine-based occupations, including fishing. These activities lead to the loss of biodiversity, natural resources, and income. In many areas, fishing entrepreneurs/ professionals along the fish value chain have raised concerns ranging from declining fish catch to loss of properties and restricted access to fishing grounds. These issues require attention to promote resilience and support a transition of small-scale fisheries from vulnerability to viability. Previous research has focused on vulnerabilities fishers face as a result of crude oil extraction. However, limited knowledge exists on the adaptive responses used by small-scale fisheries (SSF) in response to vulnerabilities of crude oil extraction.

Hence, in this research, the study aimed to 1) explore the extent of oil and gas activities in the Western Region of Ghana and the nature of Akwidaa SSF's in the Western region of Ghana. Specific attention is on the impact of oil and gas activities on fisher livelihoods; 2) investigate the vulnerabilities SSF face due to crude oil production in Ghana; 3) provide an in-depth understanding of the adaptive responses available to SSF transitioning from vulnerability to viability.

The study employed a Description and responses and Appraisal for Typology (IADAp-T) approach to extensively review and assess existing literature on vulnerabilities affecting SSF, their institutions, and various adaptation strategies that have been devised in the past in the face of growing oil and gas activities.

The results from the assessment of past studies revealed that SSF is impacted by conflicts, low fish catch and increased social vices. Other impacts include environmental pollution and increased cost of accommodation and living expenses. These impacts have caused loss of

income and the inability of SSF to provide for their families. In addition, the decreasing standard of living has led to a loss of livelihood resilience, declining well-being, and lack of capital.

In response to these vulnerabilities, fishing groups resort to short- and long-term coping strategies. Livelihood intensification and diversification to enhance fishing efforts have been used in the past by fishers. Other adaptive responses include increased access to capital (social, natural, physical, financial, and cultural). Sustainable fisheries policy and participation, community mobilization, migration and education have proven successful in responding to stressors and enhancing the resilience of small-scale fisheries. The study recommends an improved avenue for representation of SSF in policymaking and development, enhanced access to capitals, capacity building and training and strict environmental regulations to improve well-being and resilience. Further studies on these strategies can strengthen communities and provide possible pathways for transitioning to viability.

Keywords: Oil and gas activities, small-scale fisheries, vulnerabilities, adaptive responses, Ghana, Akwidaa, crude oil extraction, livelihoods capitals

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Chapter 1
Introduction

1.1 Background

Fisheries worldwide play a pivotal role in human nutrition, healthcare, job provision, and development, especially in marine-based communities across the globe (Allison & Ellis, 2001). For this reason, enhancing the total well-being and development of small-scale fisheries (SSF) is vital, given its massive contribution to human development. In many developing countries, SSFs support about 90% of people engaged in fish capture (World Bank, 2012). Despite these contributions to human development and survival, SSFs are vulnerable to many obstacles deterring their efficiency and success. Factors like harbor developments, expansions along coastlines, climate change, and several adverse economic policies are some of the contributing factors causing changes and disturbances on the livelihoods of SSFs (Kolding et al., 2014; Perry et al., 2011). Crude oil extraction and production in many areas across the globe have caused the emergence of negative consequences in the lives of fisherfolk and groups who heavily rely on fishing for sustenance (Bozigar, Gray & Bilsborrow, 2016).

The activities of offshore oil and gas companies, which occupy fishing space for SSF, are perhaps responsible for the greatest impact on SSFs. While supporting foreign reserves, taxes, and the infrastructural base of some host countries, oil and gas activities harm local ecosystems and the livelihoods of those who depend on the health of these areas (Ngene et al., 2016; Rouse et al., 2018). For instance, studies have revealed increasing vulnerabilities and reduced incomes among women due to crude oil extraction in those areas (Adusah-Karikari, 2015; Boohene & Peprah, 2011; Ordinioha & Brisibe, 2013). Oil and gas activities have

contributed to issues of vulnerabilities by way of pollution of natural resources by larger vessels and unfavorable trading policies (Rouse et al., 2018). The ultimate effect of these root issues is marginalization and vulnerability of SSF's. In view of the large benefits to be drawn by an efficient system of SSF, studies examining adaptive strategies to cope with the current obstacles imposed by oil and gas activities become pivotal.

'Artisanal,' 'subsistence,' and 'traditional' fishing are different synonyms used to describe small-scale fisheries. They are usually heterogenous, they target multiple fish species, and they all use standard fishing and processing techniques (Smith & Basurto, 2019). Berkes (2001) views SSFs as those characterized by customary fishing practices, traps, and other manually operated tools. Belhabib, Sumaila and Daly (2015) expand this definition with a study based in West Africa, expanding it to include fishing for household consumption and foreign markets requiring a lot of labor and less capital and funds.

The fishery sector makes remarkable impacts on many groups around the world. In Africa, it supports a significant part of the continent and serves as a source of food, eco-tourism and medicine (Atta-Mills, Alder & Sumaila, 2004). SSFs provide livelihood support to about 6.7 million people in West Africa (Belhabib, Sumaila & Pauly, 2015). However, these SSFs struggle with issues of overfishing, climate disasters, economic stressors, and environmental change that requires attention. Records on Africa's fisheries have shown a decline in fishing activities since the 1960s (Atta-Mills, Alder & Sumaila, 2004). This decline in fishing has been attributed to illegal fishing activities, climate change, and waste from manufacturing companies and other infrastructural developments (Golden et al., 2016).

In Ghana, millions of people rely on small-scale fisheries for sustenance. Fishing activities in Ghana are characterized by inland and marine fisheries, of which the marine fisheries sector contributes 85% of the overall national catch (Nunoo & Asiedu, 2013). Recording an average total production of 400,000 metric tons per year (Food and Agricultural Organization, 2021), the fishery value chain in Ghana employs many people in the coastal areas.

Fishing in Ghana is an essential aspect of the economy and lifestyle, especially amongst rural folks. However, past studies in the country reveal a decline in fishing activities and a dwindling fish catch which can be attributed to the emergence of crude oil activities and poor governance (Atta-Mills, Alder & Sumaila, 2004). Ghana's fish production recorded a decline from 420,000 tonnes to 202,000 tonnes from 1999 to 2014 (FAO, 2021). In recent times, crude oil exploration and production activities in Ghana have been identified as one of the contributing factors to declining fish. Existing studies have revealed loss of income, decreased fish catch and increased environmental pollution as impacts of oil and gas activities (Amoasah, 2010; Egyir, 2012). These impacts need to be addressed to improve Ghana's SSF's well-being and resilience, while supporting their transition to economic viability and sustainability.

1.2 Problem Statement and Rationale

SSF contribute significantly to the world's fish catch. They form 90% of fisheries' workers and offer half of the Earth's total fish catch (Béné, 2006). Despite these tremendous contributions, SSF remain marginalized in national policies (Béné, 2006). More specifically, they are exposed to climate change, migration, global trade, and unfavorable policies that have

left them vulnerable to the impacts of oil and gas activities (Kolding et al., 2014). Globally, SSFs suffer from uncertainties, shocks, and pressures, which may either occur from a local or an external source (Kittinger et al., 2013). Consequently, SSFs in Ghana have reported declining fish catch and loss of livelihoods since the start of crude oil activities in the country (Amoasah, 2010; Bybee & Johannes, 2014; Peprah, 201).

Ghana's western region houses a significant portion of the country's coastline and offers several landing sites to communities within and outside the region (Nunoo & Asiedu, 2013). In addition to farming, people in the region engage in fishing as a significant source of livelihood. It is mainly practiced along the coast and offers different livelihood support to the rural folks and groups in the region (Nunoo & Asiedu, 2013). When crude oil exploration commenced in Ghana, many expected a boost in business and economic development as well as an improvement in the population’s well-being. Contrary to these expectations, research has revealed opposing outcomes such as a falling standard of living, the spread of seaweed, increased crime rates and high production cost, especially among fishers and host communities (Amoasah, 2010; Baidoo, 2013).

With the spread of oil and gas activities, fishers in the region and other surrounding areas have identified issues of dwindling fish catch, and high living costs (Ackah-Baidoo, 2013; Adusah -karikari,2015; Boohene & Peprah, 2011). Districts within the region with higher impacts include Agona East, Dixcove, Shama, Ahanta West, and Jomoro (Bybee & Johannes, 2014). Problems such as high cost of production, reduced fish catch and competition for space have presented a negative effect on fishers in these districts (Bybee & Johannes,

2014). These impacts affect the overall socio-economic activity of fishing groups. Furthermore, strict safety zone policies, the presence of lights on rigs, and vessels' movement on the sea have contributed to this decline (Adusah-karikari, 2015; Bybee &Johannes,2014). Other studies have also recorded an increasing spread of seaweed owed to Ghana's crude oil production (Ackah-Baidoo, 2013).

Despite numerous studies on vulnerabilities and the perceived impact of oil activities on host communities and their livelihoods, limited research has been undertaken on how affected areas cope and respond to the impacts posed by these companies' operations, particularly in countries found in the global south. This study, therefore, aims to identify various adaptation strategies of Akwidaa small-scale fishers to the livelihood vulnerabilities resulting from oil and gas activities and prospects of achieving viability.

1.3 Study Objectives and Research Questions

The goal of the study is to identify various adaptive responses of small-scale fishers to the vulnerabilities resulting from oil and gas activities. Specifically, the study aims:

(a) To understand the extent of oil and gas activities in the Western Region of Ghana and the nature of small-scale fishery in Akwidaa; to find answers on the extent of oil and gas activities in the Western Region of Ghana and nature of small-scale fishery in Akwidaa the following research questions were asked:

   i. What is the extent of oil and gas activities in the Western Region of Ghana?

   ii. What is the nature of small-scale fishery in Akwidaa?

Investigating the size, intensity, and overall outlook of oil and gas activities in the area will facilitate the researcher's goal to visualize their impact on Western Ghanaian fishers, which will then support the researcher's formulation of possible adaptive responses.

(b) To examine the influence of oil and gas activities on incomes and capital of small-scale fishers in Akwidaa. Specifically, this will be investigated through additional research questions that will help to assess how fishers have been affected by oil and gas activities:

i. What are the key livelihoods, Income, and social capital characteristics of Akwidaa small-scale fishers?
ii. What are the key impacts of oil and gas activities on small-scale fishers in Akwidaa?
iii. What are the major vulnerabilities resulting from the impacts of oil and gas activities?

(c) To map adaptive responses of small-scale fishers in Akwidaa to reduce the vulnerability emanating from oil and gas operations and enhance their viability. The following research questions guide the mapping of adaptive responses:

i. What are the responses of Akwidaa SSF to the identified vulnerabilities?
ii. Are the identified responses helping them adapt to the identified changes?
iii. Are these adaptive responses able to promote viability?

These questions help to assess the strategies that have been used in response to the specific vulnerabilities that have been identified and lends to an examination of the effectiveness of impacted fishers in moving from vulnerability to viability.

1.4 Literature Review

SSF contribution to nutrition and employment, especially in developing countries, cannot be under-emphasized. Despite their contribution to society, SSF are left out in policy planning and often marginalized (Béné, 2006). The lack of support from stakeholders in the fisheries industry and several environmental challenges threaten fishers' livelihoods and challenge food security and the viability of coastal communities resulting in a loss of identity (Weeratunge et al., 2013). Supporting SSF and helping them move from the vulnerabilities they face to viability is thus necessary to ensure their sustainability. According to Nayak and Berkes (2018), reducing vulnerabilities in fishing communities is one route by which viability can be achieved. Improving access to capital, increasing well-being, and building resilience can help reduce vulnerabilities of fishing communities and help in promoting their survival.

Vulnerability in this sense is explained as a loss of resilience, lack of any form of capital and decreased well-being (Nayak &Berkes, 2018). Resilience is described as a system's capacity to "absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks" (Walker et al., 2004. p.5). The term 'Resilience' in my study describes the ability of SSFs to respond and reduce stressors on their social-ecological system. Building resilience helps overcome uncertainties whilst supporting learning and adaptation (Folke et al., 2010).

Improving access to all forms of capital enhances the cultural, financial, social and human resource and development communities (Nayak & Berkes, 2018). McGregor (2008) defines well-being as "a state of being with other, which arises where human needs are met, where one can act meaningfully to pursue one's goals, and where one can enjoy a satisfactory quality of life" (p.1). Well-being can be conceptualized as material well-being, relational well-being, and subjective well-being (Sen, 1999). Poor or declining well-being among fishing communities leads to issues of vulnerabilities (Nayak & Berkes, 2018), and so well-being needs to be increased to promote sustainability.

The challenges fishers face call for the innovative application of political, social, and ecological theories and approaches to deal with human evolution complexities in environmental systems. These can be defined as the adaptive response of the system. Crawford and Davies (1994) explain adaptive response as the ability of a system to withstand the impacts of stressors and uncertainties (Crawford & Davies, 1994). Vulnerability issues can be addressed by developing short to long-term strategies aimed at responding to uncertainties.

1.5 Significance of Study

Since SSF contribute significantly to human livelihoods and support nutrition, understanding their adaptation strategies to the threats they face is vital. The research findings will offer information on how fishing communities respond to changes and pressures affecting them and what factors contribute to their resilience.

Mainly, this study's outcome will inform fishing communities and other community members on decisions regarding livelihood that will enable them to improve their adaptive

capacities. Additionally, this study will be of interest to the government and oil and gas companies like Tullow Oil, Exxon Mobile, and Aker Energy on directing them to execute their corporate social responsibility strategies.

Finally, this study will contribute to the academic literature on the nexus between crude oil extraction and livelihoods of fishing communities, specifically enhancing studies seeking to develop the viability of fishing communities negatively affected by oil and gas extraction.

1.6 Thesis Organization

This study provides an understanding of the adaptive responses of small-scale fishers to the vulnerabilities resulting from crude oil extraction. Chapter one (1) starts with a theoretical background of SSF and the types of uncertainties they face; it describes the research objectives and significance of the study. Chapter two (2) reviews the literature and the theoretical underpinnings underlying This study. Chapter three (3) illustrates the methods and tools used in finding answers to the research problem. Chapters four (4) and five (5) present results and findings from this study on the extent of small-scale fishery in Akwidaa, nature of oil and gas activities in Ghana, the types of vulnerabilities affecting fisheries and their adaptive responses. Chapter five (5) gives a conclusion of this study and highlights the key insights and areas for further studies

Chapter 2

Moving from Vulnerability to Viability in the Context of SSF: A Conceptual Understanding

2.1 Introduction

There is no doubt about the millions of lives that global fisheries support, many of whom are exposed to multiple environmental stressors and shocks that threaten their existence and subsistence. However, researchers' debates vary on the presumed impact of vulnerabilities on such communities from socio-ecological challenges and climate perspectives. Indeed, these vulnerabilities have caused concerns that require analysis and "understanding the governance of complex social-ecological systems" to comprehend how to improve livelihoods and transfer them to viabilities (Sowman and Wynberg, 2014 p.i). As Sowman and Wynberg (2014) state, "environmental challenges, conflicts over dwindling natural resources, stark disparities between rich and poor and the crises of sustainability" are among the challenges experienced by fishers in the third world and developing nations (p. i). Indeed, understanding the governance structures that influence environmental sustainability and social justice in the use of natural resources can be a turning point to influencing change and moving fishers from the point of vulnerability to viability.

Challenges affecting small-scale fishers include issues such as environmental risk, financial uncertainty, and resource fluctuation. These issues dominate much of the literature on the problems and challenges faced by fishers globally. Saldana et al. (2017) are among the scholars who highlight these issues and the plight faced by anglers. They cite the oceans' poor health as a cause of increased hardships for fishers operating at a microscopic scale and those

in subsistence fishing, most of whom cannot cope with the sea's changes. Such fishers' inability to diversify their income generation methods or move from the area affected by the changes further complicates agencies' and other stakeholders' ability to improve their situations. Crude oil extraction is one of the major causes of fishers' vulnerability in many areas. Undoubtedly, other variables also compound these issues considering the diversity of the communities.

Crude oil is one of the most valuable resources on the planet. As such, it is explored in numerous locations around the world. Research has shown that crude oil activities have harmed the fisheries industry. For example, oil exploration in the Niger Delta has resulted in massive oil spills that have damaged the local ecosystems. Nigeria stands as Africa's largest oil producer, and this precious resource is the foundation of its economy. Oil spills could cause air, land, and water pollution, oil waste dumping, underground oil pipe leaks, and gas flaring, among others (Elum et al., 2016). These activities affect the livelihood of farmers and fishers within the local communities. Consequently, the pollution of traditional fishing areas can result in hunger and increased poverty. Due to the chemical composition of the oil, spills can take prolonged periods to clean up, thereby destroying the ecosystem. These spills and other forms of environmental pollution affect the lives of fishing communities where they occur. However, literature on fishers' vulnerabilities resulting from crude oil in many oil-producing locations remains insufficient.

Study shows that fishing provides a livelihood for 80% of the coastal villages in Western Ghana. However, after oil exploration began in the country, there has been a dramatic fall in fish volume. As a result, local fishermen moved to catch small and younger fishes,

thereby depleting the future fish reserves (Bybee & Johannes, 2014). Additional research shows that offshore oil and gas exploration accidents have a significant impact on the fisheries industry. For example, an exclusionary zone is created when an accident occurs and a ban on fishing within the area. People's perception of fish from an area with an oil spill is mainly negative, and as a result, they are not willing to buy the products resulting in a market adjustment.

Other effects of crude oil activities include deaths of schools of fish, a disruption of the fish's behavioral and reproductive capacity (Gomez, 2013). This affects local environments and the local social and economic wellbeing. Further research is needed to analyze the vulnerabilities affecting these fishers and respond to these changes in the social-ecological system. Examining these vulnerabilities and their corresponding adaptive strategies would help provide the needed support to improve incomes, build resilience and support their transition into viability.

2.2 Understanding Fishers' Vulnerability

Small-scale fishing communities and their environment represent a social-ecological system where interaction occurs between systems at all levels and scales (Béné et al., 2009; Mahon et al., 2008; Nayak, 2014; Ommer et al., 2011). Globally, small-scale fisher groups have distinctive cultures, organizations, and modes of operation and work in different geographic settings (Cheunpagdee and Jentoft, 2015). In most developed countries, despite these distinctions, existing studies focusing on the nature of SSF shown revealed their high dependence on the natural environment, which has led to their vulnerability causing these

fishers to be more susceptible to environmental shocks and unfavorable government policies (Allison and Ellis, 2001).

In addition, poor fisheries governance in these countries has equally contributed to environmental changes in small-scale fishing groups. The absence of proper management strategies and over-reliance on the environment presents a complex fold of vulnerabilities. The problem of inefficient fisheries governance, coupled with other environmental and socio-economic stressors has resulted in declining incomes (Nunoo and Asiedu, 2013). Further, the issue of declining fish catch has led to increased vulnerability among the female population and a loss of livelihood (Owusu & Andriesse, 2020).

The different sources of vulnerabilities from local and national levels makes it even harder to respond to these issues. These vulnerabilities are hence multidimensional, complex, and highly dynamic arising from an interplay of social, economic, and institutional arrangements (Berkes & Nayak, 2018).

The complex nature of most socio-economic systems requires a transdisciplinary approach in moving from its vulnerable state to a viable one (Berkes and Nayak, 2018). The vulnerability of a system is explained by Adger (2006) as the susceptibility to harm from exposure to stressors associated with social and environmental change and the lack of ability to adapt to these changes. Nayak and Berkes (2018) gives a different perspective of vulnerability as the inability to access any form of capital, declining resilience, and well-being of a system. This definition focuses on the abundance of capital, improved well-being, and

enhanced resilience as a contributing factor to viable communities. Measuring the ~~vulnerability~~ susceptibility of a given system to disturbances gives room for adaptation strategies.

The literature on vulnerabilities experienced by fishers has two aspects: sensitivity exposure and adaptive capacity. To meet the challenges in assessing, analyzing, and accurately describing the vulnerabilities to specific regions, there is a need to accurately combine indicators of adaptive capacity, sensitivity, and exposure (McCarthy et al., 2001; Luers et al., 2003). In this view, Senapati, and Gupta (2017), citing Multi-Criteria Analyses (MCA) and the Sustainable Livelihoods Approach (SLA), define the indicators as social, environmental, technical, economic, and financial variables – which also qualify as quantitative variables following their ranking scoring and weighting.

However, as Islam et al. (2014) contend, "exposure, sensitivity, and adaptive capacity are highly context-dependent," meaning, "numerous factors affecting fishers livelihoods underpin on a combination of physical, natural and financial capital issues and are influenced by the diversity of livelihood strategies" (p.292). In this view, the literature on the fishery industry's vulnerabilities requires focusing on improving the characterization of the vulnerabilities and how to identify the best means to adapt to the environmental challenges. Nonetheless, scholars generally accepted that fishers should tackle vulnerabilities by addressing adaptive capacity, exposure, and sensitivity issues.

Other scholars classify vulnerabilities into two categories: contextual exposure and outcome vulnerability. Among these scholars are Khattabi and Jobbins (2011), who argue that contextual vulnerability represents the process and multidimensional perspectives from climate change and its associated impact within society. Khattabi and Jobbins (2011) further

state that outcome vulnerability occurs when adaptation measures can offset any impact from climate change on a community. These causes are part of a more extensive combination of natural and technological influences beyond human control for most fishers. Nonetheless, the above arguments are not conclusive as vulnerabilities extend beyond the two categories and are a factor of multiple stimuli. As a counterargument and an addition to the above claims, it is essential to evaluate society's role, geography, and poverty in creating or exacerbating the vulnerabilities. In this context, Cutter et al. (2013) contend that a long history of fishing practices and culture influences fishers to exploit resources in a particular geography, thus adding to the cycle that entrenches the cause of their problems.

Similarly, Bene (2009) found poverty to be a notable contributor to fisheries challenges. Indeed, numerous literature links poverty to exposure to vulnerability, health complications, economic shocks, and stress (McCulloch and Calandrino, 2003; Salas et al., 2011). As previously highlighted, the high dependence on natural resources around coastal regions is the primary cause of the vulnerabilities experienced by many of the fishers in these areas. Vulnerability studies and assessments provide a guide on the complex issues affecting socio-economic systems in many locations. It promotes visibility to communities and illuminates' ways through which their vulnerabilities can be measured to assist.

2.3 Moving from Vulnerability to Viability

In many communities, fishers are considered nearly irrelevant and largely ignored by the society and governing entities, yet it is in the greater interest to manage coastal resources alongside the anglers. Citing Svein Jentoft's arguments, Berkes and Nayak (2018) state that the fishers and the entire fishing industry supply chain require empowering for it to be

sustainable. The authors contend that communities that were previously dependent on fishing have vanished following the lack of investment and regulation of the industry, along with ecological problems that are not limited to "resource degradation" (p. 241). The lack of support by stakeholders in the fisheries industry and several environmental challenges threaten fishers' livelihoods and challenge food security and the viability of coastal communities resulting in a loss of identity. Although many organizations are likely to adapt to these emerging challenges, many impacted communities will bear the crisis. Nonetheless, scholars agree that many of these communities can respond to their environments and adjust.

Extensive research on fisher vulnerabilities has emerged in the wake of increasing evidence on environmental change, increasing society's complexities and interactions within the natural system (Young, 2010). Scholars such as Ommer et al. (2011) contend that these interactions have, in turn, raised concern over the ability of these communities to comply with demands for environmental management as required by local and international regulators. These interactions also highlight the need for extensive analysis on the fishery social-ecological systems that scholars such as Scheffran et al. (2012) refer to as the complex adaptive systems. To understand these systems, scholars use terms such as drivers, stresses, vulnerability, adaptive capacity, and resilience to refer to the implications for the social-ecological systems experienced by fishers (Bavinck et al., 2018). Adger (2006) contends that vulnerability and resilience theories intersect to find what constitutes a stressor, coping mechanisms, and adaptive capacity. This study builds on the vulnerability to viability concept, calling for an improvement in fishers' resilience and well-being as a means to achieving viability in their livelihoods.

The notion of moving from vulnerability to viability describes a mode of transition where impacted groups can build their resilience, capitals, and well-being to be able to deal with future changes sustainably. This idea of achieving viability corresponds with the idea of reducing vulnerability, as explained by Nayak and Berkes (2018). This is different from treating 'vulnerability' and 'viability' separately. Rather a multi-dimensional means where people can build their resilience, enhance access to capital and improve their well-being to achieve viability as a process. Consequently, SSF can achieve viability by building their capital base, improving their total well-being and resilience. This description of vulnerability also stresses the need to reducing existing vulnerabilities of communities to achieve viability (Nayak &Berkes, 2018).

2.3.1 Resilience

The actions of humans in socio-ecological systems tend to harm the environment, leading to increased vulnerabilities and a fall in resilience (Folke et al., 2002). Improving resilience, therefore, reduces the impacts of human activities and external stressors on the system and while also reducing their vulnerability **(**Ommer et al., 2011). Folke et al. (2010) interpret resilience as "the capacity of a system to absorb disturbance and reorganize while changing to retain essentially still the same function, structure, feedbacks and the capacity to change to maintain the same identity." Folke et al., (2002. p 65) stipulate that social-ecological systems' resilience deals with: (i) "the number of stressors it can take while remaining in its original state"; (ii) "the capacity to re-structure and re-organize"; and (iii) "the extent to which training, and learning can take place".

Improving the resilience of SSF enhances their ability to respond to diverse forms of stress and shocks occurring at various scales and levels (Maclean et al., 2014). Aggregated efforts and social networks aimed at reducing vulnerability promote sustained resilience (Newman & Dale, 2005). Community resilience interconnects with the resource base, assets, and skills present in their social-ecological system. As Kais and Islam (2016) note, access and availability intersect with vulnerability and resilience.

2.3.2 Capital

Capital as defined by Gutierrez-Montes, Emery and Fernandez-Baca (2009) as the properties individuals own and have access to. This includes the social, physical, natural, financial and human capital available for enhancing or obtaining g livelihoods. These capitals are further explained below;

i. Social Capital

Prior studies highlight the importance of social networks in supporting the adaptive capacities of communities (Bruque et al., 2008; New & Dale, 2005). Different studies highlight trust, norms, and social structure as relevant components of a society that fosters collective action and cooperation (Gibson,2001; Chow&Chan,2008). The social capital of communities can be measured by assessing social groups, religious bodies, corporations, networks, and organizations in influencing policies.

ii. Physical Capital

Infrastructural buildings, amenities, and critical developmental projects present in communities impact their ability to deal with shocks. A well-developed infrastructural base

protects against disasters such as flooding. For example, communities with quality healthcare systems can deal with pandemics and disease outbreaks (Mayunga, 2007).

iii. ***Natural Capital***

The natural assets of a community consist of air, water, and all living things, which support human survival. Many communities' natural capitals support adaptation efforts by offering disaster mitigation resources, to the extent that communities with abundant and well-protected natural resources can better cope with natural disaster (Lemos et al., 2007) These resources are often used in disaster preparedness and planning to reduce future stressors on systems. Low access to capital reduces resilience and increases vulnerability (Sarker, Wu, Alam, & Shouse, 2020).

As many scholars have established, the most vulnerable fishers are the small communities along coastal regions that rely on marine resources for sustainability. Most of the prior research suggests that the resources available to communities contribute to their economic, social and cultural well-being, particularly regarding their income, food security, and employment (The et al., 2011; Belhabib et al., 2015). Unfortunately, many coastal communities do not conserve their environment, although it is their source of livelihood.

iv. ***Financial Capital***

According to other scholars, vulnerabilities should also be considered from a financial capital perspective and focus on the fishers' ability to make a living. Schuhbauer and Sumaila (2016) are among scholars with this school of thought. The arguments, in this case, lie in the ability to include social-economic influences and economic models in the analysis of the challenges facing fishers. To other scholars such as Gustavson (2002), such studies should also

include cost-benefit analysis for its ability to assess the economic viability of fishing and assess the temporal aspects that influence the trade based on its net benefits. Access to monetary resources like savings and credit facilities enhances the ability of communities to cope with disasters.

v. ***Human Capital***

The skills and training of a population in a community make up its human capital (Smith et al., 2002). It also entails the knowledge and experiences that individuals and groups have acquired through learning, which is crucial to community adaptation. Communities with sufficient and healthy human capital are less vulnerable and have higher adaptive capacities than those with lower levels of human capital (Mayunga, 2007). Despite the benefit each capital type brings, a combination of all five is necessary for planning adaptation measures; however, accurately measuring the available capital of communities is problematic given its complexity.

vi. Importance of Capital in moving from vulnerability

Transitioning from vulnerability to viability entails coping with future stressors, and this cannot be fully achieved without access to human, natural, social, financial, and natural resources. Access to loans and credit facilities in times of disasters helps impacted groups provide for their needs (Freduah et al., 2018). Well-developed networks and institutions increase people's participation in social movements and collective action (Ruiu, Seddaiu, and Roggero, 2017). Access to good healthcare, education, and shelter promotes human development and supports their well-being. Knowledge and skills are sometimes required in dealing with specific stressors, which makes the availability of a skilled workforce necessary

to support adaptation strategies. In essence, all forms of capital are essential and must interrelate in building resilience and achieving viability.

2.3.3 Well-being

Well-being in SSF is another means by which vulnerabilities can be reduced to transition to viability. McGregor, Camfield &Woodcock (2009) describe well-being in a "comprehensive and hybrid sense to denote a holistic conception of living well, combining notions of objective and subjective well-being". Well-being can also be socially explained as "a state of being with others, resulting from a satisfaction of human needs, where a person can attain his goals and enjoy a satisfactory quality of life" (McGregor, 2008, p.2). Well-being can be conceptualized from three dimensions; material, relational, and subjective (Sen, 1999). Armitage et al. (2012) highlight the interplay of well-being and resilience from a social-ecological perspective by examining their interaction. Linking well-being to resilience allows for a better appreciation of complex systems where individuals interact and act as agents of change in social-ecological systems (Armitage et al., 2012). Reducing vulnerability requires increasing the relational, material, and subjective well-being of a system (Nayak& Berkes, 2018).

i. *Material Well-being:*

The income, wealth, properties, and resources obtained in the ecological component of a system contribute to material well-being (Armitage et al., 2012). An abundance of natural and physical resources, a safe working environment, and capital affords and supports resiliency and promotes an improved standard of living.

ii. *Relational Well-being:*

Relational well-being is based on the interactions with groups, institutions, family. Networking, group initiatives aimed at supporting and building resilience is relevant in promoting viability.

iii. Subjective Well-being:

Subjective well-being depicts one's notion of self and aspirations (Russel, 2008). An individual with higher self-worth can contribute towards nation-building and support collective action (Bond &Lun,2014). Additionally, Russel (2008) highlights the importance of subjective well-being in building positive work habits.

2.3.4 Importance of Well-being, Capitals and Resilience in Moving from Vulnerability to Viability

Enhancing the well-being of SSF promotes their resilience and reduces their vulnerability. The opportunity to attain higher education and contribute to policies that affect fishing livelihoods is necessary for transitioning from vulnerability to viability. SSF's subjective, relational, and material well-being are important elements for dealing with uncertainties that may occur in their social-ecological system.

In a similar way, viability cannot be fully achieved without access to human, natural, social, financial, and natural resources. Access to loans and credit facilities in times of disasters helps impacted groups provide for their needs (Freduah et al., 2018). Well-developed networks and institutions increase people's participation in social movements and collective action

(Ruiu, Seddaiu, and Roggero, 2017). Access to good healthcare, education, and shelter promotes human development and supports their well-being. Knowledge and skills are sometimes required in dealing with specific stressors, and so the presence of a skilled workforce supports adaptation strategies. In short, all forms of capital are essential and must interrelate in building resilience and achieving viability.

As mentioned earlier in this chapter, SSF can achieve viability by having access to capital, well-being, and increased resilience. Recognizing and enhancing these important components of viability is important in reducing vulnerability. Focusing on just one of these requirements may not produce the intended effects: an interplay of all these factors is thus necessary. Lastly, building resilience includes developing adaptation strategies aimed at reducing existing vulnerabilities and preventing future stressors.

2.4 Adaptation: Building Resilience to Achieve Viability

The challenges fishers face call for the innovative application of political, social, and ecological theories to build a pathway to viability. Adaptive strategies occur in response to changing socio-economic conditions, to variable weather and environmental conditions, or a combination of both (Hovelsrud, Dannevig, West and Amundsen, 2010). Notably, fishers lack the capacity and resources to prevent or stop the effects of environmental change on oceans and the coastal environment. However, including strategies that create resilience and social well-being could empower fishers and other stakeholders to build their resilience and reduce vulnerabilities.

Developing strategies to respond to stress or changes can be described as adaptation (Nelson, Adger, and Brown,2007). Traditionally, adaptation in resilience studies considers the ability of a system to maintain its function and bounce back after disturbance (Nelson, Adger & Brown, 2007). However, Armitage et al. (2012) contend that "synthesis of resilience, vulnerability, and political ecology emphasizes on the social dimensions of resilience can help in part to redress this imbalance." In other words, human agency, as agreed upon by numerous authors, plays a critical role in transforming vulnerabilities and how stakeholders develop frameworks and strategies to improve and sustain ecosystems to meet livelihood needs. The adaptive capacity of a system is determined by available resources and assets utilized in finding solutions to stressors (Adger and Vincent 2004). Similarly, Brooks et al. (2004) contend that a system's adaptive capacity is its ability to make its coping properties increase in dealing with shocks. Adaptation is pursued at different levels as an individual and in groups or at an institutional level (Adger & Vincent,2005).

The measures coastal communities take to adapt to ecological challenges vary based on society and recommendations on adapting to the changes. Savo et al. (2017) note that the adaptability of coastal communities "depends on the multitude of social and ecological factors including cultural norms, local environmental conditions, worldview, societal values, lifestyle, age, gender, social-economic status and processes of marginalization and inequality" (p. 882). The subsistence level does not demand developing or implementing strategies to cope with environmental changes for many communities. However, many organizations require to implement conservancy measures; among these, we find strategies that include "planting mangroves, building sea walls to counter erosion, and planting trees to act as windbreakers"

(Savo et al., 2017 p.882). Nonetheless, given that most fishers are subsistence-oriented, the chosen method to promote them to viability and protect them from extreme weather events requires finding solutions to pollution, overfishing, and the deterioration of coastal habitats. It is thus crucial to integrate adaptation studies into decision-making processes. In this view, Shaffril, Samah, and D'Silva (2017) suggest that identified adaptation strategies can be a basis for policymakers, managers, and local leaders to produce adaptation strategies that align with the community's needs, abilities, and abilities interests.

Investigating previous adaptation studies provides valuable examples of what SSF undertake as adaptive responses to changes. It provides a theoretical framework for assessing the adaptive capacities of various case studies and their progress in achieving viability.

2.5 Conclusion: *Relevance of the Notion of Vulnerability to Viability*

SSF around the world provide diverse support to livelihood and nutrition despite being politically undermined. Assessing SSF and the nature of their social-ecological system is relevant in analyzing the causes of their vulnerabilities. This study understands the importance of examining the drivers of vulnerabilities, as well as their impacts and possible responses. Under the conception of moving from vulnerability to viability as presented above, capitals and well-being are fundamental for a successful transition. The ability to satisfy these two requirements results in a resilient community that can respond to future changes efficiently. SSF with abundant social, natural, financial, cultural, and human capitals can mobilize and employ them in their response to uncertainties. Similarly, a resilient community able to deal with shocks has a higher standard of relational, material, and subjective well-being.

The relationship between these two critical aspects of 'vulnerability to viability' is represented in figure 2.1. a. Access to all capitals supports well-being and vice versa. The notion of vulnerability to viability stresses that well-being and capitals interact to build resilience, ensuring that movement from vulnerability to viability is achieved.

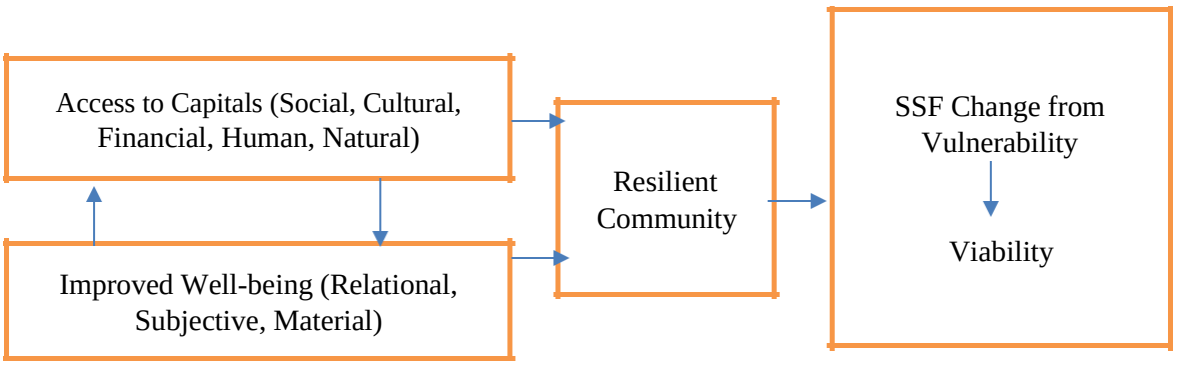


Figure 1 Strategies for ensuring a change from vulnerability to viability in Small-scale fisheries

Fisheries are a vital aspect of most economies, so much that they must be used sustainably and must be protected from potential risk factors. While this section has presented a process of vulnerability to viability as part of a multi-dimensional approach that can support fisheries sustainably, further studies are required to analyze additional solutions.

Chapter 3

Methodology: A Review of Research Methods and Data Analysis

3.0 Introduction

This chapter explains the methodology and approach used in selecting literature to answer the research questions. It specifically discusses the research approach, methods, and analysis used in This study and why they were chosen. This chapter also provides background information on This study area, describing the social-ecological system of the location. The remaining sections discuss the key insights, justifications, and limitations of the data collection and analysis stage.

3.1Research Methodology and Approach

Research methodologies are described as how researchers seek solutions to the identified problem of study and the strategies to be employed in the process of seeking a solution (Goddard & Melville, 2001). These strategies for finding solutions to an identified research problem are usually determined by the nature of the research problem to be investigated (Morgan & Smircich,1980). A research methodology is also described as the approach, and Grover (2015., p. 1) describes a research approach as the “plans and procedures for a research that encompass the steps from broad assumptions to detailed data collection methods, analysis and interpretation.” Understanding which research approach to employ in a study is usually determined by the nature of the worldview the researcher agrees with. Creswell and Creswell (2018) described the research worldview as the “philosophical orientation about the world and the nature of research the researcher brings to the study. While various forms of

worldviews exist, the four types of world views which form the basis for most research are: constructivism, post-positivism, transformative, and pragmatism. Table 3.1 below highlights these philosophical world views and their underlying assumptions.

Table 0.1 This table describes the various worldviews and their key assumptions

Worldview	**Key Assumptions**
Post-positivism	Determination, realist, objective
Constructivism	Subjective, Theory-based
Pragmatism	Problem-centered, Real-world practice
Transformative	Governmental, Change focused

Source: Creswell & Creswell, (2018).

The constructivist worldview relies on people's perceptions and knowledge developed through their interaction with real-world issues (Grover, 2015). Post-positivism uses a cause-and-effect relationship to find answers to research questions. It tries to identify the reasons by which a phenomenon occurred (Creswell and Creswell, 2018). Research studies involving a post-positivist approach see theories, scientific observation, and measurement as essential elements in arriving at solutions (Creswell &Creswell,2018). The pragmatic worldview relies on all methods available to solve a research problem without adhering to any philosophical viewpoint. Pragmatism depends on what is readily available and valuable at the time of the study (Petersen & Gencel, 2013). Finally, the transformative worldview deals with underrepresented and marginalized groups in society. It performs inquiry by combining politics and governance issues to support marginalized groups (Creswell & Creswell, 2018).

This study uses a transformative research method. Transformative worldview tackles inequality, poverty, and under-represented groups in society (Creswell& Creswell, 2018). Stetsenko (2019) examined the importance of transformative worldview in finding solutions to social and economic problems to achieve overall transformation. SSF are marginalized by oil and gas activities conducted by large oil companies backed by the government. This marginalization creates the inequalities and livelihood constraints that a transformative worldview aims to tackle in its inquiries. Applying the transformative worldview allows the researcher to understand real-world issues and draws ideas from various viewpoints and approaches to solve an underlying problem (Creswell &Creswell, 2004). This worldview usually deals with societal issues and links inequalities to the result of socio-economic and institutional constraints. The transformative worldview also agrees with the use of mixed methods of study in that it gives room for the use of different research instruments. The researcher believes that problems arising from a global change affecting small groups such as SSF should be analyzed critically to help inform policies, hence choosing this worldview.

For this study, the researcher employed qualitative research methods in the form of a systematic literature review to investigate the vulnerabilities affecting SSF and ways they respond to such vulnerabilities. Qualitative research methods are defined as those methods which enable a better understanding of real-world situations and provide insights on views, beliefs, and experiences through interaction with participants (Creswell & Creswell, 2003; Pathak et al., 2013). The different disciplines of studies used qualitative research methods like observation, document analysis, and participation to complement quantitative research and

provide an alternative means of obtaining data that cannot be evaluated with figures (Ohman, 2005; Pathak et al., 2013).

I collected data by employing a systematic literature review using different scholarly search engines and a combination of different keywords. Document analysis provides access to a wide range of information and gives the researcher a lot of flexibility in choosing data that is relevant for the study (Bowen, 2009). The researcher used the I-ADApT methodology in selecting and discussing the governing, natural, and social systems of identified literature and case study.

3.2 I-ADApT

The I-ADApT (Assessment based on Description and responses and Appraisal for a Typology) is a data collection tool developed by the Human Dimension Working Group (HDWG) of the Integrated Marine Biosphere Research aimed at understanding the changes marine and fisher group systems face. It also aids in showcasing how they respond to these changes developing long-lasting interjurisdictional solutions. Prior studies using the I-ADApT have been undertaken in Japan, South Africa, and India. The I-ADApT tool was designed by examining various case studies on how global changes have affected the social, natural, and governing systems of marine systems and how these case studies have responded to the identified changes.

Specifically, I-ADApT consists of three linked sub-categories. First, the description category, which looks at changes affecting various systems of a case study. The description

category explored the forms of a vulnerability affecting the system. Second is the appraisal category, which explores the strengths and weaknesses of identified coping responses to such vulnerabilities or changes. Third, typology, where the findings of its two previous categories are synthesized and applied in decision making and policies.

For this study, the I-ADApT system helped select literature that corresponded to the three categories of the socio-economic system. Focusing on the descriptive category under I-ADApT, the study investigated the natural component. Here, the data was selected according to the physiological characteristics to ensure that they were similar to the area of study, Akwidaa. Features such as the location of the study site for the document, its hydrological features, and the entire environmental makeup of the place provided a good starting point for selecting data.

Secondly, the governing system of the selected data's study area was also investigated. The I-ADApt tool aided in selecting case studies based on their governing systems, institutions, and interactions between these systems. The study focuses on SSF, which are characterized by governing institutions and systems in which these fisheries operate. This means that selecting case studies with similar institutions and networks will provide meaningful examples for the study. Lastly, the social component of the selected case studies was taken into consideration in the data selection process to choose areas with similarities in terms of occupation, level of development, dynamics, and interactions. Thus, these three components: governing systems, natural systems, and social systems, form the basis for the description category.

The second category of the I-ADApt tool, appraisal, helped measure how responses to changes in selected study areas successfully dealt with the changes. Existing documents were analyzed to see the success of their adaptive responses to livelihood impacts caused by environmental changes. One significant finding was that most of these adaptive responses in various small-scale fishing case studies were aimed at impacts of climate change.

Lastly, based on the finding and results from the selection procedure, which considered the various aspects of the I-ADApt tool, the typology, which is the final aspect, is developed. The typology provides a guideline for understanding the types of vulnerabilities affecting fishers

3.3 Data Selection Process: Literature Review

A systematic literature review is a critical review and analysis of an existing study on a subject matter or a research question (Skills for learning, 2018). Several researchers use this method to investigate existing theories and to examine the grey areas in specific theoretical underpinnings (Okoli and Schabram, 2010). A well-conducted literature review is analytical, comprehensive, and well organized (Ridley, 2013). This literature review investigated existing studies and documents on small-scale fisher's vulnerabilities and adaptation strategies.

To start with this review, the researcher started with a total of 8 keywords obtained from the research topic and objective after critical analysis. Keywords such as Oil and gas activities, SSF, vulnerabilities, adaptive responses, Ghana, Akwidaa, Crude oil extraction,

livelihoods capitals were selected. Table 3.2 Highlight the keywords and the various search engines used in the literature review.

Table 0.2 Search terms and the search engines used in the data selection stage

Keywords	**Search Engines**
Oil and gas activities/crude oil extraction	Jstor
SSF	
Vulnerabilities	Scopus
Adaptive Responses	Google Scholar
Ghana	
Capitals/Livelihood Capitals	
Akwidaa	

These keywords were selected from the study topic, "the adaptive responses of SSF in Akwidaa to oil and gas extraction."

The study objectives are:

a. To investigate the extent of oil and gas activities and the nature of small-scale fishery in Ghana.

b. To understand the vulnerabilities of SSF due to oil and gas extraction.

c. To examine adaptive responses to such vulnerabilities.

The keyword "SSF" was generated from the title based on the subject matter. The focus of the study is specifically on SSF, which will help narrow down existing case studies on SSF.

i. ''Oil and gas activities" was also used as a search term because the study aims to understand the impact oil and gas activities have had on these fishers.

ii. "Vulnerabilities" was chosen because the study objective is to understand the types of vulnerabilities small-scale fishers face.

iii. "Adaptive responses" is another keyword selected based on the study objective that aims to understand the adaptive responses small-scale fishers use in response to identified vulnerabilities.

iv. Finally, "Akwidaa" and "Ghana" are used as search terms because the study area for this research is Akwidaa, located in Ghana.

v. Key terms like "crude oil activities were used interchangeably with "oil and gas activities" to ensure different data types were captured.

vi. "Livelihood capitals" was selected from the second objective, which aims to investigate the vulnerabilities affecting the capitals of the fishers.

Some word combinations produced vast results and needed to be narrowed to get results related to the research themes. This allowed saving time while also giving the researcher a sense of direction amid extensive search results. Attention was paid to the time and year the research data was produced and the social and ecological setting of the case study areas. These criteria also supported the selection of data that related to the themes and subject matter. The researcher handpicked a few of the data based on the researcher's experience and past experiences. The researcher performed the search based on similar case studies in different regions, country-specific case studies, similar topics, and years.

A search of "vulnerabilities of oil and gas on fishers" produced 22,100 results on Scopus. The search entry "SSF" on Scopus produced 4,562 results. As interesting as it produced many new documents, the researcher needed to further narrow down the search. Including the keyword "vulnerabilities" proved efficient as it produced 192 results. Google scholar produced 705,00 results for a search "SSF". Then the search was then narrowed by

adding “vulnerabilities”, which resulted in 30,400 results. These searches were performed on Jstor, google scholar, and Scopus as well.

The researcher further narrowed down the search by introducing a third keyword: “adaptive responses”, which provided 22,200 results. However, a lot of the articles from this 22,200 were focused on climate change vulnerabilities on fishers; so, the keyword “oil and gas activities " was added to the initial search terms in google scholar. In summary, the key terms “SSF”, “vulnerabilities”, “adaptive responses”, “oil and gas activities” were searched on google scholar and produced 17,400 results. The keywords (“SSF”, “vulnerabilities”, “adaptive responses”, “crude oil extraction” also produced 17,400 search results. The researcher observed that the search terms with crude oil activities and oil and gas activities produced similar search results. Most of the publications were current for both searches. In cases where results of a combination did not answer a particular search engine, a different search engine was used.

The data retrieved from these three search engines were saved on Zotero file manager with tags and then assigned to their respective tags. Documents relating to oil and gas operations were grouped into one category; those relating to SSF were combined in another category. These categories help in quickly choosing the subject matter and their corresponding document for analysis.

Table 3.3 below illustrates the keyword combinations and their respective results obtained in google scholar, Jstor, and Scopus. Table 3.4 provides a summary of all the search results from Google Scholar,JSTOR and Scopus. A pictorial image of the Zotero application, highlighting the final selection is described in Figure 1.

Table 0.3 Specific search terms used and their results from each search engine.

Search Engine	Search terms	Results
Jstor	SSF (SSF)	58,981
	SSF+ Vulnerabilities	40
	SSF+ Vulnerabilities+ Adaptive responses	36
	SSF + Vulnerabilities+ Adaptive Responses +oil and gas activities	16
	SSF+ Vulnerabilities+ Adaptive Responses+ crude oil extraction	4
	SSF+ oil and gas activities +livelihoods capital	1563
Google Scholar		
	SSF (SSF)	818,000
	SSF+ Vulnerabilities	30,400
	SSF+ Vulnerabilities +Adaptive responses	22,200
	SSF+ Vulnerabilities+ Adaptive Responses +oil and gas activities	17,400
	SSF+ Vulnerabilities +Adaptive responses +crude oil extraction	17,400
	SSF+ oil and gas activities+ livelihoods capital	23,200
Scopus		
	SSF (SSF)	32889
	SSF+ Vulnerabilities	4918
	SSF+ Vulnerabilities +Adaptive responses	1,337
	SSF +Vulnerabilities+ Adaptive responses +oil and gas activities	112
	SSF+ Vulnerabilities +Adaptive responses +crude oil extraction	12
	Vulnerabilities +oil and gas activities	4,922
	Crude oil exploration +Ghana	443
	Crude oil exploration +Akwidaa	0
	SSF+ oil and gas activities+ livelihoods capitals	82

Table 0.4 Overall summary of search results obtained using Google scholar, JSTOR and Scopus

(Scopus +Google Scholar +JSTOR)	Search Terms	Total Results
	SSF (SSF)	909,870
	SSF +Vulnerabilities	35,358
	SSF +Vulnerabilities+ Adaptive responses	23,573
	SSF+ Vulnerabilities+ Adaptive Responses+ oil and gas activities	17,528
	SSF+ Vulnerabilities+ Adaptive responses+ crude oil extraction	17,416
	SSF+ oil and gas activities+ livelihoods capital	24,845
Scopus	Crude oil exploration+ Akwidaa	0
Scopus	Crude oil exploration +Ghana	443
Scopus	Vulnerabilities +oil and gas activities	4922

Data Analysis: Final Selection and Analysis in Zotero

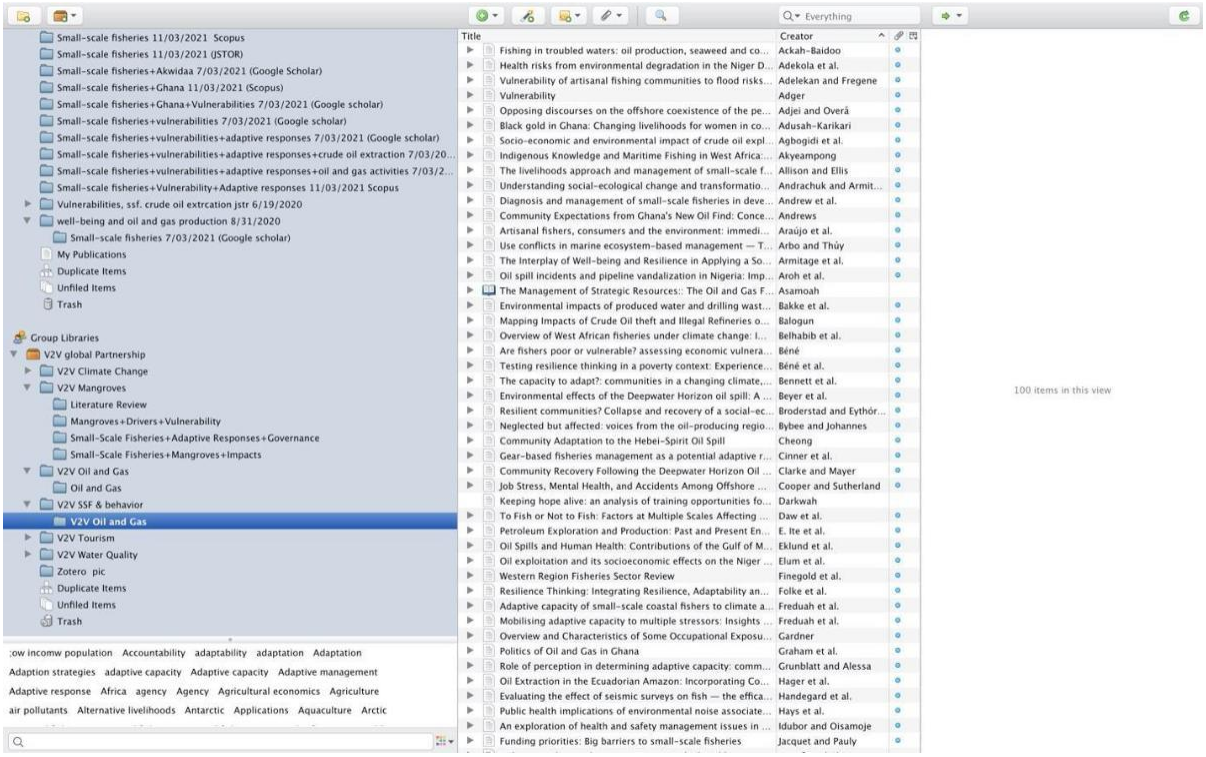


Figure 2 An image from the Zotero showing the final 100 selected documents

A final selection was made to identify 100 articles that were relevant to the study. This final selection was made using name tags derived from the keywords and research objectives. These name tags were created in Zotero to help categorize data selected through the various search engines. The same keywords used in the process of keyword selection were used: “SSF”, “vulnerability”, “adaptation”, “resilience”, “Ghana”, “oil and gas”, “Akwidaa”, and “capitals”. These tags were used in grouping data findings from the literature review to enhance analysis. The abstract of these journal and research papers obtained during the search stage was analyzed to help group them under the name tags.

An annotated bibliography was conducted on the final selected 100 documents to understand the topic, research methods used, and their limitations. An annotated bibliography describes and gathers helpful information on a selected data source (Zaccarian & Teel, 2011). In addition, the annotated bibliography helped in planning the sequence and flow of the results chapter.

The analysis process described above was conducted in Zotero. The researchers' ability to utilize the Zotero manager was made possible through a capacity-building workshop organized in Summer 2020 by Professor Prateep Nayak. This workshop enlightened and aided me through the data collection to the analysis stage by supporting me through the organization of data for later analysis. Table 3.5 provides a detail of the articles selected and used for this study.

Table 0.5 Final 100 selection made, and the search engine used for the selection.

Source	**Word Combination**	**No.**
Google Scholar	Small-scale fishers+ Vulnerabilities	15
Scopus	"Crude oil exploration" +Ghana	6
Scopus	SSF+ Vulnerabilities +Adaptive responses	11
Google Scholar	Small-scale fisheries	10
Scopus	Crude oil exploration +Ghana	13
Scopus	SSF +Vulnerabilities+ Adaptive responses+ oil and gas activities	18
JSTOR	SSF+ oil and gas activities +livelihoods capitals	15
Scopus	Vulnerabilities +oil and gas activities	12
	Total Selected Documents	100

In view of the goal of this study, the researcher scanned through the abstract of the documents to check if it could support this study's aim. This research focused on SSF, oil and gas activities, as well as their vulnerabilities. Publications that mentioned these keywords, including other search terms like "capitals", "resilience", "Akwidaa" and "Ghana" were selected. Next, publications that mentioned these keywords were analyzed to extract the relevant documents. After a careful analysis using the criteria mentioned earlier, a total of 100 documents was selected.

3.4 Study location: Akwidaa

This study focused on Akwidaa, a town found at 4°45′0N and 2°1′0W of the Ahanta West District, which is a part of the Western Region of Ghana. It is an hour and a half drive from the oil rig offshore Takoradi. Historically, the name "Akwidaa" can be traced to the Dutch colonial days, known as the "Fort Dorothea." The name "Akwidaa" has a connotation of an old man who transported people across the water to other towns (Briggs, 2014). The people of Akwidaa speak "Ahanta," a language common in most parts of the coastal areas of the Western Region. It is noteworthy that there are two parts of Akwidaa, i.e., the "Old Akwidaa" and the "New Akwidaa," which are separated by the Ezile river. However, the people from both parts of the town all do celebrate an ordinary weeklong festival in September with drumming, dancing, and pouring libation called the "Kundum Festival," where different foods are prepared in various homes to foster reconciliation and to announce the bumper harvest (Ghana West Coast, 2010). Figure 3.1 illustrates the map of Western Region Ghana and Akwidaa

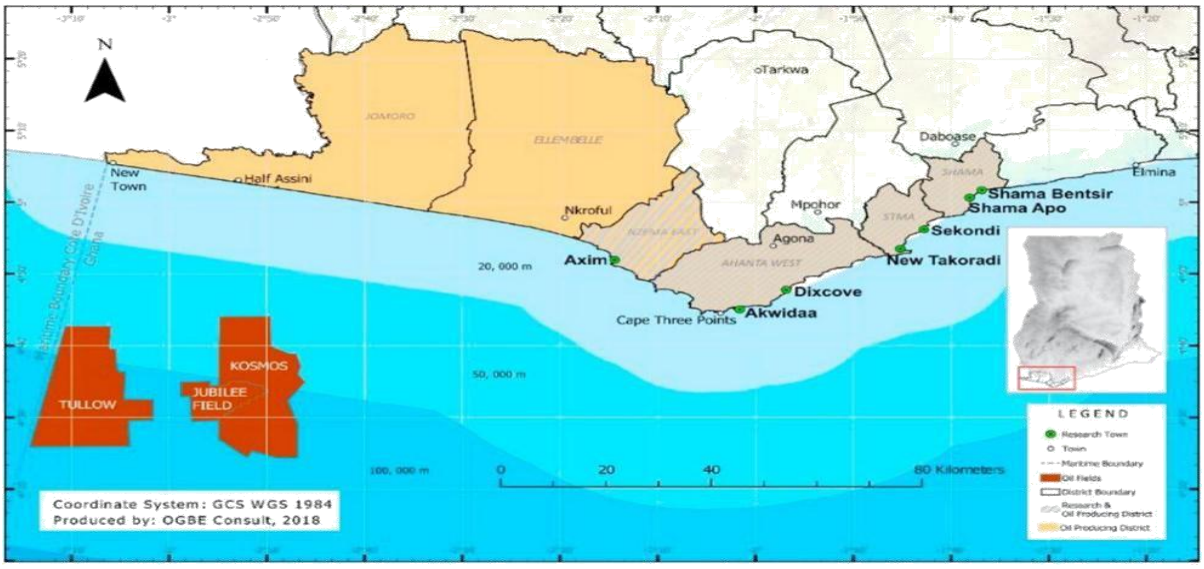


Figure 1. Map showing the study areas in Western Region of Ghana.

Figure 3 Map of Western Region of Ghana, indicating Akwidaa

Source: Owusu&Andriesse (2020).

On a broader scale, the Ahanta West District has a population of over 141,344 residents, which has 73,959 females and 67,385 males (Ghana Statistical Service, 2020). Pertinent to Akwidaa, its residents are approximately 8,355 (GetaMap, n.d.). Within this population, the primary occupation among the indigenous is agriculture. Specifically, due to the water bodies available, the predominant occupation among the indigenes is fishing. A study by Owusu & Andriesse (2020) revealed that more than half of the total men and women in Akwidaa are involved in fishing. In total, these fish farmers have approximately 250 canoes (180 motorized and 70 using paddles). In addition, 30% of men and 30% of women living in Akwidaa are involved in farming. Farming activities in this community are typical as a result of the lean season in fishing. Here, some of these farmers do farm for subsistence reasons while others

farm for commercial reasons. These farmers concentrate on maize, cassava, palm nuts, and tomatoes (Owusu & Andriesse, 2020).

As a community, the people of Akwidaa are governed by both traditional leaders and a Unit Committee within the Ahanta West District 3.1 (Cripps et al.,2013). (Cripps et al., 2013). However, the fishing activities in Akwidaa are regulated by the Ministry of Fisheries and Aquaculture Development (MoFAD). This regulation is based on the Fisheries Act 2002 (ACT 625) and the Fisheries Management Plan (2014–2019), which was set up to ensure that fishing is done appropriately and in a manner that enhances the livelihood of fish farmers in the country. Yet, the Ghana Statistical Service (2018) statistics reveal that fish farmers in Akwidaa are not living in the best conditions. The report showed that the average income of fish farmers in the village is between 0- ¢800 (Ghana Cedis). Assessing this, the report revealed that fish farmers earning between the bracket of 0–¢199 were 0.0%, ¢200–¢399 (32%), ¢400– ¢599 (28%), ¢600- ¢799 (36%), above ¢800 (4%).

Moreover, the discovery of oil in Ghana has made Akwidaa a new place for investment due to its oil reserves (Block) near Cape Three Point. In addition, Akwidaa has increasingly attracted attention for its beautiful scenery and many touristic sites. Over the years, both local and international tourists have visited the area to enjoy the beach, canoe rides, and to view endangered sea turtles. Tourists also hike near the Ezile bay, engage in hook fishing, view monkeys, crabs, mudfishes, and crocodiles (Ghana West Coast, 2010). Akwidaa is one of the most exciting towns in the Western Region due to the diversity it presents.

3.5 Covid-19's Impacts on this Study and the Researcher

The ongoing Coronavirus pandemic has had a severe toll on many people worldwide, and the researcher had a fair share of that. This research at the initial planning stage aimed to use primary data such as interviews and surveys to provide future studies with insights on firsthand experiences. However, with the University of Waterloo's travel restrictions, the researcher had to change plans on how to obtain data for the study. The next option was using secondary data such a peer-reviewed journals, newspapers, and other publications. Primary data is firsthand data originally collected from study participants for a specific research problem (Hox & Boeije,2005). On the other hand, secondary data describes existing and formerly collected information that has been reused in other studies (Hox & Boeije,2005).

This secondary data source included documents from journals, books, newspapers, and online publications.

This was a new experience, and hence with the help of other researchers from the "Vulnerability to Viability" group and a research supervisor, the researcher navigated around the Zotero applications manager for the study. The Zotero applications provided a means for storing and analyzing documents gathered during the data selection process

3.6 Change from Primary Data to Secondary Data and its Implications on the Study

The switch to secondary data affected the study because it could not afford the researcher the chance to obtain data directly from participants. Obtaining information originally from participants helps in social research because first-hand experiences give better

insights into social research. Secondly, the quality of data may be compromised if the secondary data was not collected properly in its original study; hence critical assessment must be made to select secondary data. This also stresses the need to use peer-reviewed articles and journals for reviews. However, resorting to secondary data was relatively inexpensive and afforded the researcher knowledge of what earlier studies have discussed and analyzed. This assessment included their challenges and experiences in dealing with similar research topics. This was a great learning opportunity that served as a guide in my research.

3.7 Experiences, Challenges, and Learning Opportunities

The period of collecting data was very challenging, with a lot of ups and downs. This stems from the fact that the use of secondary data was very new to the researcher. Therefore, accurately searching and synthesizing high-quality data that will meet the requirements of the study was difficult.

Another issue that posed a problem was describing and writing in the study area (Akwidaa), an area about which there is little research. With insufficient literature and few peer-reviewed documents, the researcher faced many challenges. In addition, the researcher was faced with lots of results focusing on climate effects on fishing and few on the effects of oil and gas activities had to gauge between studies the vulnerabilities of fishers owing to climate change with vulnerabilities of small-scale fishers

By selecting and analyzing obtained data, I learned how to search for valuable, high-quality data and concludes based on the findings. This has been a great learning stage in my academic life and has given me considerable exposure to the world of secondary data.

Chapter 4

The Vulnerabilities of SSF as a Result of Crude Oil Extraction

4.1 Introduction

i. Overview

Small-scale fisheries are an integral part of many economies. They support activities of coastal communities but are also affected by many vulnerabilities. To respond to these vulnerabilities affecting SSF, creating these vulnerabilities and how they affect SSF must be studied to help find solutions. This chapter hence examines the nature of SSF and the extent of crude oil production activities in Ghana. The purpose of this chapter is to provide an understanding of the size, statistics, and total outlook of fisheries and crude oil activities for a better analysis of the relationship between them and SSF. This answers the first objective of understanding the nature of SSF in Akwidaa and oil and gas activities in Ghana. Finally, the chapter will draw on existing studies on vulnerabilities affecting small-scale fishers in different areas worldwide and analyze how oil and gas activities affect fishers. This responds to the second objective of this study which aims to understand the types of vulnerabilities affecting SSF as a result of oil and gas activities.

ii. The State of the Oil Industry

Oil production has had a dwindling growth for years due to oil price changes, trade policies, and global economic factors. Fluctuating oil prices impacts economic activities directly and indirectly in many countries (Mory,1993). When prices of oil increase, it affects

the overall production cost of affects profit margin. In recent times, oil production has seen changes resulting from a global oil price change, and in 2018, the global supply of oil stood at 98.1 million barrels daily (IEA, 2020).

In Africa, crude oil production has experienced a tremendous change despite the drop in oil prices. In the past nine years, multinational oil companies have engaged in large-scale drilling activities of about 41.5 Bboe in Africa (GEoExpro, 2020). In 2019, the continent's oil supply declined to 9% of the world's oil output (GEoExpro, 2020). In addition, the discovery of new oilfields has taken place in Ghana, Namibia, Sierra Leone, and Uganda. These new developments are attributed to an interplay of improved geological knowledge, higher economic returns on investments, abundant oil reserves, and the availability of sophisticated technology (Iledare and Pulsipher, 1999).

Fig.4.1 illustrates where in Africa oil exploration and production are taking. As shown, both activities are widespread throughout the continent. However, given the benefits of SSF on both the local economy and fishers' livelihood and drawbacks of extensive oil exploration and production, concerns for the health of host countries' economies have been raised. The studies reported below will show some of the many problems caused by a higher focus in oil production on host countries, spanning from an increased number of local conflicts to worsened livelihoods to general environmental degradation. Infamous for this type of repercussions is Nigeria, where the oil economy has resulted in increased agitation amongst the youth, pollution, and high levels of corruption (Agbogidi et al., 2005; Egede & Egede, 2016).

Similarly, past studies in Ghana discuss the loss of livelihoods and increased vulnerability of small-scale fishers since oil production (Amoasah, 2010; Ackah- Baidoo, 2013; Darkwah, 2013). A study conducted by Egyir (2012) in the Western Region of Ghana highlighted declining fish catch by fishers due to the presence of lights on the oil-producing vessels.

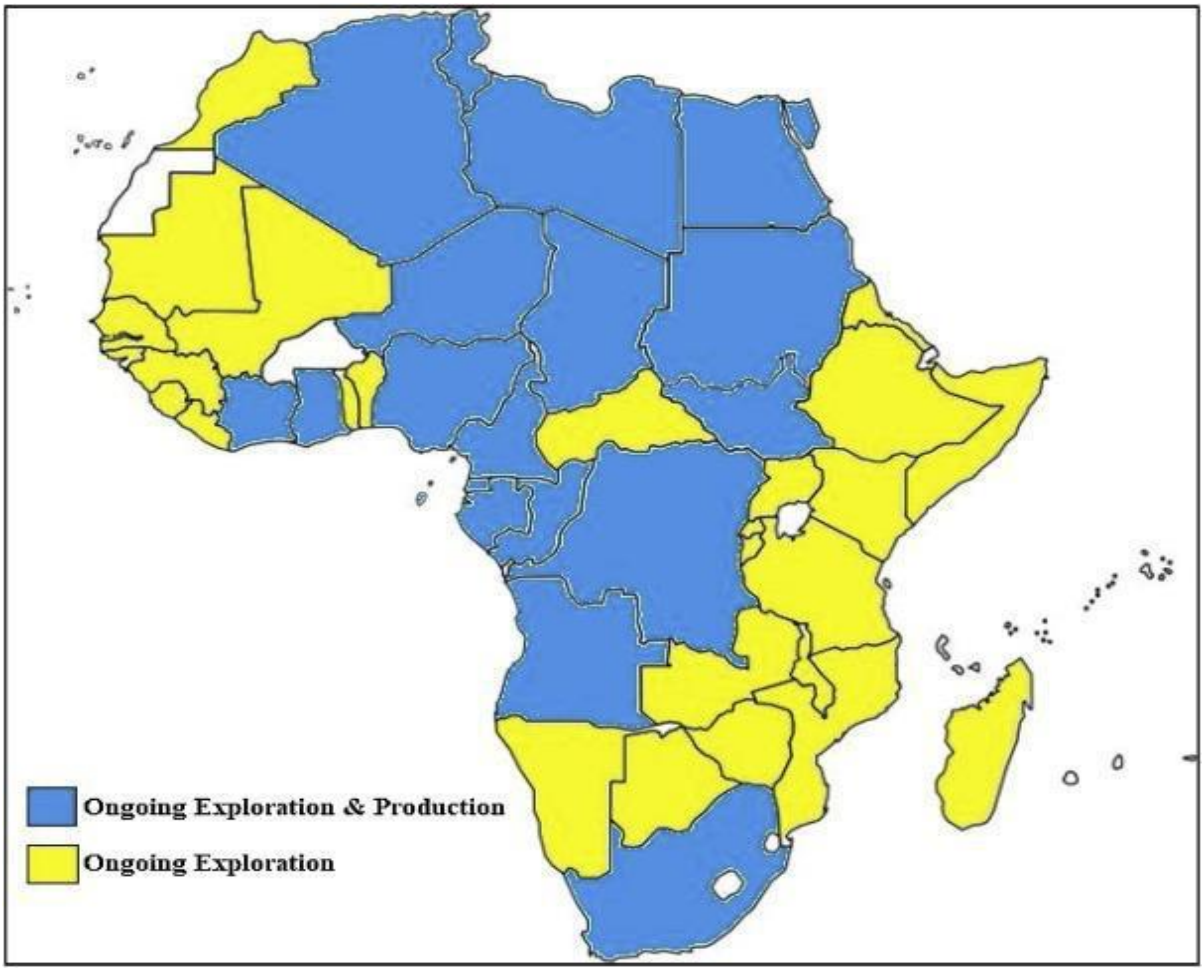


Figure 4 This image above shows Oil and gas exploration and production activities in Africa

Source: (Graham & Ovadia, 2019)

iii. Importance of SSF and how the Oil Industry Harms S.S.F.

Small-scale fishers constitute 90% of the planet's fisheries, yielding half of the world's total yearly fish catch. (World Bank, 2012). Many of the world's total SSF are in developing countries, whose livelihood heavily depends on this economic activity (Allison and Ellis, 2001). SSF contributes more than half of the total fish catch in developing countries, with about 95% consumed locally (World bank, 2012). While providing livelihood support for many, these fishers target different and use different forms of equipment (Kittinger et al., 2013).

Despite their significance to both the local and international economy, SSF faces many obstacles, spanning from overfishing, climatic uncertainties, and poor fisheries management policies (Pinkerton & Davis, 2015; Béné & Neiland,2004). These stressors, which are usually unplanned, harm the small-scale fishery economy. At the heart of these obstacles is offshore crude oil production and exploration, which has significantly impacted the success of small-scale fishers in many locations (Philips, Hailwood & Brooks, 2016; Bozigar, Gray & Bilsborrow, 2016). In its harming of SSF, the impacts of crude oil economy have extended to the livelihoods, well-being, and overall socio-economic system of the SSF stakeholders (Quist & Nygren, 2015).

4.2 Ghana's Fisheries

Ghana's economy has long been heavily characterized by its fishing activities. The 1960s saw an upsurge of fish catch from 105,100 tons to 230,100 in 1971 (FAO, 2016). The industry was characterized by a production rate of 234,100, with 199,100 tons coming from a marine source and 35,00 tons from freshwater production. However, in 1990 fish catch decreased from 319,000 tons to 289,675 tons in 1991 (Nunoo and Nunoo, 2013). This decline is s attributed to several factors, such as poaching from international trawlers, overfishing, and poor fisheries governance structure (Nunoo and Nunoo, 2013). The decline in fish production continued with total production reducing from 420,000 tonnes in 1999 to 202,000 tonnes in 2014(FAO, 2016). To curb this decline, the Ghanaian government invested in aquaculture production to supplement fish availability (FAO, 2016). Fig. 6 Illustrates Ghana's fish production in Metric Tonnes from 2010-2017, whereas marine and inland capture began to decline; aquaculture was then intensified to support fish supply in the country.

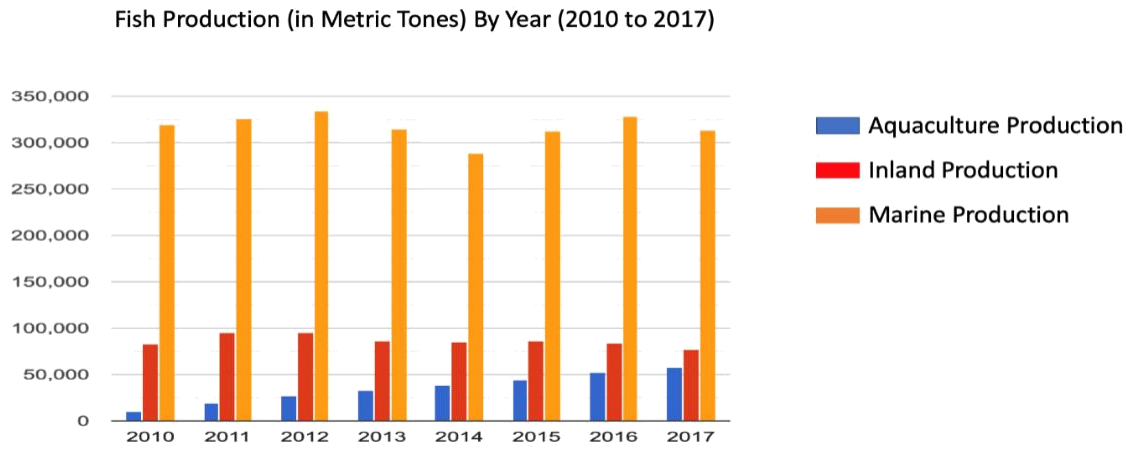


Figure 5 Fish Production (in Metric Tons from 2010-2017)

Source: Ministry of Food and Agriculture, Ghana, 2020

Fishing is a vital economic activity in many coastal countries, and Ghana is no different. The nation's continental shelf supporting the fishing sector covers about 24,300 square kilometres, with a coastline measuring about 550 kilometres (Gyesi, 2012). Ghana's small-scale fishery sector covers 304 landing sites in 189 fishing communities (Finegold et al., 2020). Marine species range from small pelagic such as mackerel, horse mackerel, and sardines to larger ones such as whales and dolphins (Waerebeek, Ofori-Danson, and Debrah, 2009). The nation's fishing sector is dominated by marine artisanal fisheries providing over 85% of annual catch, while aquaculture and inland lagoon support the remaining 15% (Nunoo and Nunoo, 2013). The marine sector is divided into four categories based on fishing operations' scale and location: SSF, semi-industrial, industrial, and tuna zones (Nunoo & Nunoo, 2013).

As estimated in 2010, the marine sector provides food and other nutritional benefits to more than half of the country's population with a hit catch of 305,000 metric tonnes (Nunoo & Nunoo, 2013).

Commonly used fishing equipment include purse seines, beach seines drift gill nets, surface nets, dugout canoes, and semi-mechanized canoes (Doyi, 1984). In most cases, fishers using drift gill nets or hook and line operate 50-meter depth water zone and employ Global Positioning System software (GPS) to enable them to navigate deep waters (Doyi, 1984). Ghana's fishing sector provides jobs to 135,000 marine fishers, with 92% (124,000) being small-scale fishers (Ghana Fisheries and Aquaculture Development Plan, 2011). In addition, a total of 12,000 marine small-scale fishing canoes operates along Ghana's shores, 234 semi-industrial and industrial trawlers. Men dominate harvesting across Ghana's fish production chain, while women represent most post-harvest activities onshore (Nunoo & Nunoo, 2013).

Fishing activities have supported the nations' economy for a long time, serving as food, income, and security sources to about 10% of Ghana's population (Nunoo & Nunoo, 2013). However, despite contributing about 4.5% to Ghana's annual Gross Domestic Product (Dogbevi, 2015), the sector has not prioritized policy planning (Nunoo & Nunoo, 2013). Like other SSF across the world, Ghanaian SSF faces climatic issues, unfavourable trade policies, and offshore industrial activities (Pinkerton & Davis, 2015; Béné & Neiland, 2004; Béné, 2009).

4.3 Ghana's oil and gas industry

i. The extent of oil activities

Crude oil prospecting in Ghana goes as far back as 1896 when the nation discovered quantities of crude oil in the Saltpond and onshore Tano basins (Asafu-Adjaye, 2012). In 2007, commercial quantities of crude oil were discovered along the country's western coast (Adjei and Overå, 2019), bringing hope to its citizen for promising economic prospects (Owusu, 2019). Reports indicate that Ghana's petroleum sector contributed USD 3993.7 million to the economy from 2011 to 2017 (Ackah et al., 2020). Furthermore, Ghana's daily oil production was projected to increase from 196,089 barrels in 2019 to 420,020 barrels in 2023 (Ministry of Finance, 2023). The crude oil sector in Ghana is now dominated by multinational companies such as Kosmos Oil, Tullow Oil, Anadarko, Petro SA, Baker Hughes, Hess, and Schlumberger. In recent times, the leading players at the initial start of Production were Tullow Oil, Kosmos Oil, and the Government of Ghana. These leading players have entitlements in two oil fields: The Jubilee and TEN fields and work together to develop the fields. Table 4. 1. And 4.2 highlights the various companies and their share in the Jubilee and TEN field. Fig 6 Gives a pictorial description of Ghana's Jubilee and TEN oilfields.

Table 0.1The Jubilee Partners and the entitlement in percentage (%)

Jubilee Partners	Entitlement (%)
Ghana National Petroleum Corporation	17.96
Tullow Ghana Limited	33.71%

Kosmos Energy Ghana HC-	22.58%
Anadarko WCTP Company-	22.58%
Petro SA	2.59%

Source : Kosmos Energy https://www.kosmosenergy.com/ghana/

Table 0.2 The TEN Partners and the entitlement in percentage (%)

TEN Partners	Entitlement (%)
Ghana National Petroleum Corporation	15%
Tullow Ghana Limited	47.185%
Kosmos Energy Ghana -	17%
Anadarko Petroleum Company-	17%
Petro SA	3.815%

Source: Kosmos Energy 2015 https://www.kosmosenergy.com/ghana

Figure 6 Ghana's Jubilee and TEN Field

Source: Tullow Oil Ghana, 2020.

The first commercial oil was lifted from Ghana's Jubilee field, positioned 60 km southwest away from Ghana's communities along the Western Region coast, directly between the Deepwater Tano and West Cape Three Points block. The field covers an area of 110 km² (Tullow oil, 2020). In 2011, the Jubilee field had an annual production rate of 995,259 barrels of crude oil from the field and was expected to accrue an estimated US$ 110 million for Ghana (Gnpc, 2019). In 2008 the International Monetary Fund (IMF) estimated that in the ten years to come, revenue from the field would reach as high as US$ 20 billion (IMF, 2008). The second field is the Tweneboa, Enyera, and Ntomme (TEN), which came into the entire operation in August 2016, increasing offshore activities and attracting many multinational oil companies. Other oil companies operating in Ghana's oil field include Angio Company, Aker Energy,

Bayfield oil services, Savfuel Petroleum, and Ghana Oil Company, to mention a few. While some of these were locally set up, most of them are multinational.

The Sankofa-Gye Nyame Field is the third-largest oilfield owned by the Ghana National Petroleum Company and the Offshore Cape Three Point Companies. In 2019 this field averaged a daily production of 44,297 barrels (MoF, 2019 Annual Report). Essential stakeholders in Ghana's oil and gas sector include the Ministry of Energy (Ghana), Ministry of Finance (Ghana), Ghana Parliament, Ghana Gas, Extractive Industries Transparency Initiatives, the Auditor General, Energy Commission, and the Environmental Protection Agency. These institutions work collaboratively to ensure efficient use and accountability of oil resources (GNPC, 2019).

Ever since oil and gas activities began, the Ghanaian government implemented several regulations in the form of laws and Acts to promote accountability and ensure citizens benefits from the oil gains. As a result, infrastructures such as schools, hospitals, and roads have received considerable improvements since the activities started (Arthur and Amo-Fosu, 2020). Despite this, the livelihoods of fishing groups in these areas have been destroyed. For instance, unemployment rates in the affected areas have not experienced a change despite building new oil sites in many communities (Boohene&Peprah,2011). Moreover, oil exploration has also resulted in low fish catch and reduced living standards (Adjei & Overå, 2019.)

4.4 Drivers of SSF vulnerabilities

Conducting crude oil production offshore alongside fishing likely results in a struggle for space and other resources (Quist and Nygren, 2015). In turn, if left unmanaged or poorly

regulated, this struggle will harm multiple users and stakeholders (Arbo and Thuy, 2016). Crude oil production has several stages: beginning with exploration, it develops into on-site drilling and extractions, culminating with the transportation of the final product. Substantial volumes are produced in each stage, heavily impacting the local environments and habitats (Achaw and Danso- Boateng, 2013). For example, fish and other aquatic species located in areas where spatial surveys are conducted experience changes in their habitat due to drilling and movement of oil rigs (Bakke et al., 2013).

In addition, as explained in further detail below, the pollution coming from each stage of oil production harms local communities and the environment (Achaw and Danso- Boateng, 2013) in different manners.

i. ***Seismic Surveys:***

Seismic surveys are preliminary tests conducted to determine the presence and quantity of crude oil at a location (Gausland, 2000). They usually form part of the initial stages of oil exploration, and production requires software to scan the location (Kloff and Wicks,2004). During this stage, fishers are informed to stay away from the survey areas, resulting in several missed workdays and a significant loss of income (Quist and Nygren, 2015). In addition, seismic surveys produce varied sound waves that affect fish movement. Fish communicate via sounds waves and interact with other sea creatures via sound frequencies. As seismic surveys produce a disruption of these frequencies with noise pollution, and since communication among sea creatures' travels via sound waves, this stage of the survey results in the fish becoming disoriented (Hawkins, Pembroke, and Popper, 2014). Additionally, high sound

waves produced by the seismic planes could cause permanent hearing loss and distort the behavioural pattern of many sea species (Gausland,2000).

ii. Drilling activities:

Drilling affects fishing seasons, routes, and fishing modes, disturbing total fish catch obtained by fishers operating in the area (Glazier et al., 2006). In addition, drill cutting made in the ocean affects fishes and sea creatures through waste and noise pollution. Therefore, drilling also affects the availability of fish and the income of fishers (Bakke et al., 2013). Moreover, drill muds created in cutting drills contain waste substances such as oil and water, harming the environment. Finally, polymers and other chemicals compounds are used in the drilling process to enable its function ha. Therefore, drilling muds produced using other complex chemicals and polymers could harm the environment when released into the surrounding areas (Dashtian et al., 2009).

iii. *Gas Flaring, Venting*

During production times, excess gas produced is burned out in a process called flaring. Gas flaring releases excess gases and gaseous waste from oil wells, rigs, and engines during production into the atmosphere (Ngene, 2016). These gases (in the form of methane, benzene, and carbon dioxide) are discharged through combustion and contribute to greenhouse gases (Ngene,2016). The release of these toxic gases negatively impacts air quality, which will later harm crop life and vegetation, and rain, as is the case of Nigeria, flares 17.3 billion m 3 of gas annually (Anosike, 2010).

iv. Unfavourable government policies:

Oil and gas activities support national revenue and foreign exchange generation. Thus, the taxes, royalties, and rent obtained from the crude oil sector provide significant economic benefits, which indeed sways government decisions in their favour while sidelining fishers (Sovacool,2010). This menace is evident, especially in developing countries where government structure is sometimes unstable and inefficient in allocating resources (Sovacool, 2010). For example, in Ghana, the government and the oil companies implemented an exclusive zone policy, restricting fishers from accessing certain parts of the marine space (Bybee and Johannes, 2014). Restricting access to previous fishing grounds has resulted in conflicts between the Ghana Navy and fishers who disobey the law (Bybee & Johannes, 2014). Following these conflicts, fishers are given penalties in the form of fines or may even get their fishing gear confiscated, further harming their livelihoods (Bybee & Johannes, 2014).

v. Struggle for Space:

Several stakeholder groups along Ghana's western coast obtained their income and made a livelihood off the sea until oil and gas activities pervaded the area and slowed down those economic activities in a struggle for space (Bybee & Johannes, 2014). As introduced before, oil and gas activities have created a fight for space between local fishers and oil companies. Seismic surveys, drilling, vessel movement, and implementation of restricted zones by oil companies have limited fishing space and operation times. The implementation of restriction areas such as exclusion zones and advisory zones of 500m and 1000m, respectively, around oil rigs prevent fishers from fishing within that space. These restrictions are made to

prevent a collision with incoming vessels (Adjei & Overå, 2019). In Mexico, oil and gas activities in the Tabasco waters offshore deprived fishers of the opportunity to catch trophy size fishes and other important fish species, as exclusive zones were implemented around the rigs for safety (Quist & Nygren, 2015). Struggle for space has led to collisions and conflicts among sea users (Adjei & Overå, 2019). Fishers' have been blamed for being irresponsible and non-compliant by government officials (Arbo &Thuy, 2016; Adjei & Overå, 2019).

4.5 Impacts from drivers resulting in SSF Vulnerabilities

In the previous section, 4.4, the specific drivers and activities of crude oil production that resulted in SSF vulnerabilities were discussed. These drivers discussed; seismic surveys, drilling activities, gas flaring, unfavourable policies, and struggle for space impact SSF. When these drivers interact with SSF activities, the resulting impacts include increased cost of accommodation, increased crime, environmental pollution, and resource conflicts. These impacts are further discussed below:

i. ***Environmental Pollution:***

a.*Noise Pollution from Seismic Operations*

Oil and gas exploration and production cannot be successful without assessing the available quantity of crude oil present in the earth and its location. This critical step can be executed through a seismic survey, making use of sophisticated technology. Studies in the past by several researchers have demonstrated the different impact forms of seismic surveys have on marine organisms (Engas & Lokkeborg, 2012; Popper et al., 2005; Stone &Tasker, 2006). Seismic surveys conducted during oil and gas activities generate higher pitch sound levels that travel within the ocean and surrounding areas and damage hearing while changing oceanic

species' behaviours (Bröker, 2019). Guns and submarine blasts were employed in capturing data on the distribution and proved to be detrimental to the heath of fishes (Engås et al., 1993). Evidence has shown a significant reduction in total fish catch after high pitch sound has been introduced to an existing fish habitat ((Skalski et al., 1992; Engås et al., 1993). The rate at which fish is captured is also minimized after air gun is blasted during the seismic survey (Løkkeborg& Soldal, 1993), affecting fishers' overall livelihoods in the long run.

b. *The Harmful Outcome of Oil Spills*

Oil spills resulting from accidents during crude oil production and transportation offshore enters the marine environment and even spreads to farther areas within the ocean (Chang et al., 2014). Therefore, depending on the area's proximity where the spill occurred to coastal communities, its attendant impacts could be high or low.

The dense nature of crude oil makes it travel beneath the sea surface where fishes, sea turtles, and other zooplanktons reside, thereby affecting the habitat and movement (Beyer et al., 2016). Again, oil spills result in economic vulnerabilities when fishing-related activities and other forms of tourism that thrive on aquatic resources are halted to clean the affected areas, resulting in the loss of livelihoods among people who depend on the sea to survive (Soares et al., 2020).

Additionally, the occurrence of oil spills in a marine ecosystem may affect the environment's food web. The oil droplets consumed by organisms accumulate and undergo fragmentation, making it easier to transfer from one organism to another at a different trophic

level, potentially causing harm in the long run to other organisms and consumers such as humans (Beyer et al., 2016). In Brazil, an offshore oil spill that occurred about 700km away from the coastline stretched as far as 3000km from the source, polluting the country's critical protected areas such as the coral reefs and destroying marine resources (Soares et al., 2020). Ongoing research on the variations of oil spills' impacts on different aquatic mammals reveals an even more harmful effect of droplets of oil created by chemical dispersants on aquatic life than crude oil alone (Buskey et al., 2016). In coastal mangrove areas, the incidence of oil spills inhibits ecosystem services such as fisheries protection and maintenance, carbon sequestration, storm protection, and many other benefits obtained from mangroves (Ronnback et al., 2007). The inability of the ecosystem to function correctly impacts human life (Onyena & Sam, 2020).

c. *Waste Discharge*

Crude oil production comes with the discharge of waste substances and particles such as 'production water and drilling waste.'

Studies reveal that the accumulation of large organic materials, acids, and other wastewater compounds is primarily made of injection water and condensation water. This form of wastewater consists of injection and condensation water and other hazardous chemicals released into the ocean, which could have harmful long-term impacts on the marine ecosystem (Bakke et al., 2013). Other harmful chemicals released into the environment during oil production are drilling fluids and cuttings, which pollute the environment and endangers the ecosystem.

ii. Resource Conflicts

The coexistence of crude oil activities and fishing offshore has its attendant problems. Fishing for food and income has been practiced across different geographic locations for many years until crude oil exploration began. Despite this, governments in most countries where crude oil exploration takes place accord higher importance to the crude oil sector, ignoring fisheries' benefits (Johnson and Welch, 2009; Nayak et al., 2014; Nayak & Berkes, 2014). When oil and gas activities commence in a country, the people and state officials expect a positive outcome in the country's economy (Smith, 2015). The government's interest in these financial benefits from crude oil translates into the way the government makes policies to protect these oil companies' operations and activities even at the detriment of other users, especially in the case of offshore oil exploration. Safety zone restrictions are examples of measures taken by the government. These restrictions ensure that fishers and other users of n the sea space are prevented from operating at a particular location close to where oil activities are taking place. IFor example, inGhana, the state government enacted a 500 nautical mile exclusive zone around the oil rig to prevent accidents, collisions and protect all users from possible damage. However, laws are made to punish offenders seen around or within these restricted areas, and in the case of most fishers, fishing equipment is confiscated (Adjei and Overa, 2019).

iii. Low Fish Catch and Accidents

Accidents and other risk hazards such as canoe capsizing occur when fishers enter these dangerous zones, usually having installations located within the ocean (Akakpo et al., 2018).

Restriction of fishing grounds reduces the space available for fishers, reducing the incomes generated from fishing (Boohene & Peprah, 2011). Fishers have also reported declining fish stocks due to various lighting systems on these drilling vessels and platforms, attracting many fishes (Bybee&Johannes,2014. In addition, the movement of vessels offshore poses navigation risks for fishers who do not have access to proper navigation instruments like GPS, which, in some cases, brings about the collision, which sometimes results in loss of lives and properties (Bybee&Johannes,2014). These accidents also mean affected fishers must lose operation hours to recover from these accidents and repair damaged or destroyed fishing equipment. In cases like these, fishers who are the primary breadwinners in the family cannot feed themselves. Their family and other people who work on these canoes must find other jobs or available income elsewhere. Table 4.3 discusses the drivers, impacts, and the resulting vulnerabilities of oil and gas activities on SSF.

iv. ***The increased cost of accommodation and living expenses:***

Several studies discuss how communities located near oil-producing fields report a spike in the cost of rent (Graham & Ovadia, 2019). Communities in oil-producing areas are usually concentrated due to the migration of new people. Relocation of people to oil-producing communities increases the demand for accommodation and other essential goods, creating scarcity and increasing cost (Akakpo et al., 2018). In the Jomoro District of Western Ghana, fishers have reported increases in the cost of food and the inability to access basic needs due to oil activities in the region (Akakpo et al., 2018). Yalley and Darko (2012) revealed that in Ghana, the emergence of oil activities in the Sekondi Takoradi Metropolis of the Western

region increased the cost of land and accommodation when compared with the Kumasi Metropolis within the Ashanti Region.

v. Increased Crime

As rents increase and the search for jobs increase, people are forced to engage in illegal and criminal activities to obtain income (Elum et al., 2016). Poor fish catch and loss of fishing equipment because of oil exploration activities could also lead to an inability for people to meet their basic needs (Akapko et al., 2018). High levels of conflict and civil unrest among youth in oil-producing areas is rampant in West African countries such as Nigeria (Ukiwo, 2011).

Table 0.3 The Drivers, impacts of crude oil activities, and the resulting vulnerabilities

Drivers	Impacts	Vulnerabilities
Oil and Gas exploration and production activities: (Glazier et al., 2006; Egyir, 2012); i. Seismic surveys (Gausland,2000; Kloff &Wicks,2004) ii. Drilling Activities (Dashtian et al., 2009; Bakke et al., 2013). iii. Gas Flaring, Venting (Anosike, 2010; Ngene, 2016).	1. Resource Conflicts- Struggle between fishers and oil rigs, struggle between fishers and navy officials (Arbo & Thuy, 2016, Adjei & Overå, 2019; Quist & Nygren, 2015). 2. Low fish catch (Skalski et al., 1992; Engås et al., 1993) 3. Increased crime (Elum et al., 2016) 4. Environmental pollution (Sakyi et al., 2012 ; Chang et al., 2014).	1. Loss of livelihood Resilience – Low fish catch leads to loss of income and the inability of fishers to provide for themselves (Pegg & Zabbey,2013; Haller et al., 2007). 2. Poor/decline in well-being- Decline in incomes impacts access to basic needs and decreases the standard of living. (Boohene & Peprah, 2011). Adusah-Kariksari, 2015; Peprah, 2015) 3. Loss of capital - - Pollution, the struggle for incomes, poor access to health care, conflicts affect the overall availability of capital. This then leads to vulnerability in the absence of resources needed for basic survival (Freduah et al.,2018).

iv. Unfavourable government policies (Sovacool,2010; Bybee &Johannes,2014) v. Struggle for space (Quist & Nygren, 2015; Arbo &Thuy, 2016)	5. The increased cost of accommodation and living expenses ((Akakpo et al., 2018; Graham & Ovadia, 2019)	

Source: Adapted from Obeng- Odoom, 2014

4.6 Resulting Vulnerabilities of Crude Oil Activities on Fisheries

SSF is exposed to various vulnerabilities, resulting from the discussed impacts in the previous sections resulting from impacts of oil and gas activities. These vulnerabilities include loss of livelihood resilience, loss of capital, and reduction in well-being. This section discusses how livelihood resilience, capital, and well-being of SSF are made vulnerable. Understanding the nature of identified vulnerabilities will help in devising strategies to promote the sustainability of SSF.

i. *Loss of livelihoods Resilience*:

The Western Region of Ghana houses many small-scale fishing communities whose cultures are deeply rooted in fishing. Fishing provides various income generation activities and employs about 80% of the region's workforce, including women (Finegold et al., 2010). One canoe owner can employ as many as 12 people as crew members to work on the canoe. A reduction in fish catch leads to lower incomes and an increase in unemployment (c). Families whose lives depend on revenue from fish production could be exposed to incidences of poverty which decreases their resilience and makes them vulnerable to future economic stressors. Crude oil activities in Ghana have caused an increase in women's vulnerabilities due to loss of

livelihood (Adusah-Karikari, 2015). Gas flaring, water pollution, and oil spills every day in Nigeria's Niger Delta due to crude oil activities have affected fishing and farming occupations activities in the area (Elum et al., 2016).

ii. Loss of Capitals (Human, Social, Cultural, Financial, Natural): a. Natural Capitals:

Destruction of fishing habitats and marine- species results is one consequence of crude oil activities (Beyer et al., 2016).

The availability of capital in communities plays a pivotal role in their resilience and response to changes. The decline in fish, contamination of water bodies by oil spills, and air pollution impact the quality of natural resources (Pegg &Zabbey). Natural capitals such as favourable weather conditions for work, abundant fishes in certain areas, and the location of communities with regards to fishing sites enhance their livelihoods opportunities; their absence, therefore, increases community vulnerabilities (Freduah et al., 2018).

b. Financial Capital:

Income from savings and other sources of financial capital fishers obtain are possessed by fishers impacted as fish catch (Ackah-Baidoo, 2013). Sea space restrictions leave fishers with insufficient fishing space, which translates to lower fish catch and high production costs (Elum et al., 2016). In cases where fishers enter these restricted zones offshores, their fishing nets are confiscated by the navy and other government personnel who send these nets away

and make the retrieval process cumbersome for culprits (Adjei & Overå, 2019). As a result, fishers waste time and resources repairing destroyed equipment or retrieving confiscated nets and canoes. Another paramount concern of fishers in the western region has been the spread of seaweed along the region's coast, affecting fish catch and overall income (Ackah-Baidoo, 2013).) Financial capital is also impacted in the events of oil spills when production time is wasted in cleaning affected areas, which is costly (Balogun, 2015).

c. Human Capital:

The collision between small-scale fishers and oil vessels could also lead to losing lives and properties (Adjei & Overå, 2019). Affected persons may have to take some time off to get treatment and recover from any injuries, and this requires money that would otherwise have been used for food and upkeep channelled to support access to healthcare (Akakpo et al., 2018). In addition, health and quality of life can be affected when humans encounter toxic waste and gases through oil and gas operations (Pegg & Zabbey,2013; Eklund et al., 2019). In some areas, fishers lose their crewmen to other vocations because of declining income levels (Boohene & Peprah, 2011). In Nigeria, studies have shown that oil spills that occur in the Niger Delta contaminating the environment could lead to severe and long-term medical conditions in humans (Ordinioha & Brisibe, 2013).

d. Cultural Capital:

The loss of fishery livelihoods can result in high crimes and prostitution. These crimes resulting from lack of local employment and low incomes can contribute to the loss of cultural

capital. Migration of impacted fishing groups into other communities impacts existing community institutions and practices (Freduah et al.,2018).

e. Social Capital:

Social groups among fishing communities, family ties, and robust networks are impacted. When people migrate to other locations for additional incomes and alternative livelihoods, families are impacted. Networks and social groups used to influence decision-making are impacted and made less effective (Freduah et al.,2018).

iii. *Reduction in Well-being*

a. **Material Well-being of Fishers**

Oil spills, toxic waste in the form of gases, and liquid waste lead to the destruction of marine ecosystems and, most importantly, fish (Buskey, White, and Esbaugh, 2016; Dave & Ghaly, 2011). The movement of fishes away from noisy environments and the death of some due to oil spill causes several strains on the financial assets and capitals of fishers who operate in affected areas. For example, in Brazil, the occurrence of an oil spill in the Pernambuco area caused a significant reduction in the total revenue obtained from the sale of certain essential fish species such as mackerel, salmon, and goldfish (Araujo, Ramalho, and Melo, 2020). The declining fish catch again meant that revenue needed to provide essential food items like rice and coffee was insufficient, and fishers' levels of debts increased (Araujo et al., 2020).

Oil and gas activities, which lead to the release of toxic gases into the atmosphere, could have serious health consequences (Ronnback et al., 2007; Chang et al., 2014; Adekola et al., 2017). When oil spills occur and contaminate fishes and other forms of edibles in the ocean, consuming the contaminated food could lead to food poisoning or even loss of lives in some instances. Fishers and consumers who get affected will have to seek medical care with their already lower income, reducing the money available for food and other needs (Nurul Islam et al., 2014).

Activities of oil companies that result in noise pollution could also have an impact on well-being. Working on oil rigs and platforms offshore have its attendant consequences, just like other workplaces have its attendant issues on workers' health and well-being (Runyan et al., 2007). For example, factors such as stress and the increasing probability of getting affected by accidents could result in higher anxiety levels, resulting in decreased workers' mental well-being (Cooper & Sutherland, 1987).

Impacts of noise pollution, leading to a total fish catch reduction, can also translate into lower incomes for fishers. Poor fish catch means that available income must be used to ensure family members' welfare, primarily when the whole family depends on one breadwinner. Decreased incomes of fishers may result in their inability to obtain quality healthcare and access to quality education. Fishers who use their income obtained from fishing to access vital assets are impacted when their incomes reduce because it affects the accumulation of other social, political, and capital assets such as land (Nurul Islam et al., 2014). As the population size of oil communities increases, it exerts much pressure on the environment and available

resources. The pollution and pressure mounted on the environment affect the ecosystem services and impact access to the ecosystem's essential services.

Safety zone restrictions offshore limit the operation area available to the fishers (Adjei & Overå, 2019). Some fishers lose their entitlements when the government and other multinational corporations take over previous fishing grounds owned by fishing groups. Livelihoods of fishers are affected; hence, access to essential capitals like land and fish is reduced or removed. The collision of fishers with oil and gas companies' vessels could lead to accidents, destroying fishing gears, canoe, or seizure (Doworkpor, 2015).

An essential aspect of SSF is the nature of labour employed in operation. Most SSF worldwide use manual labour in their daily activities (Allison & Ellis, 2001). When restrictions are imposed on fishing areas, some cannot get enough fish catch (Adjei & Overa, 2019), revenues decrease, and resorting to other jobs becomes an option. Loss of livelihoods may affect the total human capital available in the area as people shift jobs or move to other locations, searching for better working opportunities. Canoe owners would have to struggle to find crew members and would also have to increase their wages to keep them.

The destruction or seizure of fishing materials during accidents brings about loss of income and even lives in cases where accidents are fatal, affecting the total capital accumulated and overall wealth of impacted community members. Their well-being is ultimately affected as they have to use their savings or borrow money to repair damaged items or purchase new ones, increasing the incidence of poverty within these communities.

b. **Crude Oil Extraction and its Result on the Subjective Well-being of Fishers**

Declining fish catch may also lead to loss of employment opportunities and cause livelihood vulnerabilities in coastal areas where offshore oil and gas is taking place. These resulting vulnerabilities are usually interlinked and interconnected; hence, the declining fish catch will affect the total income of affected groups and again reduce seafood availability, vital for human nutrition. A decline in fish catch again brings about lower employment opportunities in fishery-related jobs and results in insufficient incomes and lower living standards (Haller et al., 2007). In addition, decreasing revenues resulting from oil and gas activities mean fishers may be affected by their inability to provide adequately for themselves and their loved ones (Boohene & Peprah, 2011).

Reduction in household revenue tends to affect the existing relationship and trust between parents and their children. (Mcloyd, 1989). A father's inability to provide for his family's basic needs and other dependents may result in stress and trauma among all parties (Mcloyd, 1989). It can render children unhappy and dissatisfied with their parents or caretakers. Loss of trust among fishing groups and relocating fishers and other groups from oil and gas activities to other fishing grounds could also destroy family ties and unity (Gunasekara, Grant, and Rajendran).

Further, loss of some cultural traits among migrants is possible as they move from their original areas of residence to new locations (Curran and Saguy, 2001). Migrants take up foreign cultures as they enter new territories and lose their cultural identity and consciousness in the long run (Gunasekara, Grant, and Rajendran, 2019). When parents move from where

they originally reside and leave behind offspring in the care of other relatives, the children sometimes pick up harmful lifestyles hence impacting their well-being (Zhao et al., 2016).

c. Relational Well-being

The migration of people to other areas searching for jobs and better fishing grounds impacts skilled workers in the resident community and destroys existing social ties present in fishing communities (Owusu, 2019). Studies based on the vulnerability of Ghanaian women also show that women in oil-producing communities suffer the loss of incomes and are made susceptible to poverty, inequality and can lose their power to influence decision-making in their communities (Adusah-Karikari, 2015). Fishing groups and other strong institutions that managed and regulated fishing actives are destroyed and made less effective when there is a loss of trust and unity (Haller and Merten,2008). Mobilization of efforts towards achieving goals like influencing unfavourable policies may be unsuccessful if there is mistrust, dissatisfaction, or permanent migration. Weak institutions affect the well-being of community members because their concerns may not be met or resolved (White, 2017).

4.7 Conclusions

Based on the data gathered, obtained study results explain the adverse conditions that result in fishers' livelihoods and well-being due to crude oil extraction in many parts of the world. The coexistence of oil and gas companies with fishers offshore results in vulnerabilities that primarily affect fishers. Fishing communities where oil and gas activities occur face livelihood challenges and health concerns, amongst others. With these identified

vulnerabilities occurring at different scales and levels within fishing groups and locations, coping strategies to long-term adaptation measures are developed. These strategies devised by SSF in response to identified livelihood vulnerabilities need to be investigated and reviewed to enhance the sustainability of SSFF and support the transition from vulnerability to viability.

Chapter 5

Adaptive Responses of SSF to Crude Oil Vulnerabilities

5.1 Background

SSF experience loss of livelihoods caused by environmental, political, and institutional stressors, making them vulnerable and reducing their well-being (Allison and Ellis, 2001). These vulnerabilities affect the development of fisheries and make them unable to provide for themselves and their family (Adger, 2006). Small-scale fishery communities are typically affected by climate change, harsh trade policies, poor fisheries management, and other disasters causing them to lose their income, capital, and cultural identity (Allison & Ellis, 2001). Several studies have documented many stressors affecting the ecological and social unit of most coastal communities. Global uncertainties affect both the ecological and the social components of these communities and make them challenging to resolve due to their associated complexity. However, due to the complexity of such socio-economic stressors, the livelihoods and well-being of impacted groups are affected. These complex vulnerabilities require mechanisms that will build the resilience of impacted groups and help them cope with disasters and unplanned events.

This chapter aims at investigating the adaptive responses used in reducing the vulnerabilities identified in Chapter 4. The chapter starts by highlighting some few vulnerabilities mentioned in Chapter 4 and how it affects fishers. Next, it explains the concept of adaptation and how adaptive capacity influences adaptation. Lastly, this chapter will describe the adaptive strategies used in response to identified vulnerabilities. Analyzing the strategies of

different communities impacted by similar vulnerabilities provide examples and lessons for further research and sound policy formulation in other areas. Additionally, studying the adaptive responses of fishers is essential, especially in the context of Ghana, because a lot of studies focus primarily on vulnerabilities with limited knowledge on adaptation. The concluding part of the chapter provides a direction on moving from vulnerability to viability.

5.2 Adaptation as a Means to Achieving Viability

In Chapter 4, the researcher discussed in detail the types of vulnerabilities affecting fishers. These vulnerabilities were assessed based on the effect it brings on the fishers and the overall well-being of social-ecological systems. Issues of vulnerabilities like loss of livelihood resilience and declining capitals bring consequences such as death, illness, loss of marine species, and destruction of family ties due to migration. There have been studies in the past detailing strategies coastal communities use in response to environmental uncertainties (Hovelsrud et al., 2010; Pinsky& Mantua, 2014). Adaptation studies focusing on SSF is essential, especially in developing countries like Ghana, because many studies focus primarily on vulnerabilities with limited knowledge on adaptation.

Adaptation studies have focused on pathways through which social-ecological systems affected by changes have achieved resilience (Folke et al., 2010). For example, in climate-related studies, communities and fishing groups' adaptation strategies are analyzed to understand how to deal with the impacts of abrupt weather changes such as droughts, flooding, and cyclones (Freduah et al., 2006; Perry et al. 2011; Bennett et al., 2014). Adaptation, as described by Smit and Wandel (2006), as a "process, action or outcome in a system (household,

community, group, sector, region, country) for the system to better cope with, manage or adjust to some changing conditions, stress, hazard, risk or several opportunities" (p. 284-2006). The coping adaptation and transformation strategies of vulnerable groups are part of a range of measures taken by coastal communities in reducing the impact of changes in their socio-ecological system. Adaptive responses are also explained as methods used in reducing the impact of a vulnerability on a system (Belhabib, Lam, and Cheung, 2016).

The ability to respond successfully to vulnerabilities reflects the adaptive capacity of a group or community. A community's ability to adapt to changes reflects its adaptive capacity (Cinner et al., 2015). The adaptive capacity of communities is context-specific depending on the interplay of location and available capitals (Freduah et al., 2018). Also, the ability of a community to adapt reflects their adaptive capacity to deal with stressors sustainably, which could vary with time in response to a change in the community's socio-economic status (Smit and Wandel., 2006). In this study, short-term coping responses and long-term adaptive measures have not been strictly differentiated. However, these adaptive responses reflect a continuum where both strategies of coping and adaptive responses are used separately or combined to respond to identified vulnerabilities

5.3 Adaptive Response to Livelihood Resilience

5.3.1 Livelihood Diversification and Intensification

One of the widely researched means of adapting to livelihood vulnerabilities is by increasing fishing efforts and diversification. Loss of incomes and declining fish catch can be

reduced by increasing fishing hours and using improved fishing tools. (Perry et al., 2011; Belhabib et al., 2018) In addition, finding new business ventures that require less capital and skills can supplement fish income and improve the resilience of small-scale fishers (Fredual et al., 2018). Lowe et al. (2019) report that fishers who engage in two or more forms of livelihoods respond quickly to changes in any one livelihood, hence providing a means of surviving.

In the past, fishing communities in Mozambique have resorted to non-fishing jobs such as bicycle repairing, poultry farming, and the sale of wood products as a means of supplementing declining fish income (Blythe, Murray and Flaherty 2014). Likewise, in Nigeria, farming households impacted by oil spills engaged in non-farm income activities to support their household incomes (Apata, Akinlua, and Igbalajobi,2010).

In a similar instance, rural communities in Ghana's Western region have ventured into tourism, gold mining, and unskilled jobs outside fishing to reduce livelihood vulnerabilities (Owusu,2019). In addition, rural Laos communities take on roles in crop cultivation, vehicle operating, professional jobs such as teaching and general labor jobs as alternative livelihoods to support incomes generated from fishing (Martin, Lorenzen, and Bunnefeld, 2013). Finally, Trung Thanh, Tschakert, and Hipsey (2021) note that SSF in Vietnam resort to aquaculture farming as a significant response to the livelihood difficulties resulting from multiple stressors.

5.3.2 Policy Formulation and Restructuring

Formulation and implementation of favorable fisheries policies can aid and improve the structure of fisheries governance (Freduah et al., 2018). Marine-social and ecological systems in the Central region of Ghana, North West, and North-East Atlantic employ long-term strategies like influencing favorable government policies to promote better working conditions for fishers (Siakwah, 2018). Enhanced interaction between fishing groups and decision-making bodies can help increase local involvement in decision-making. These fishers also undertake restructuring in government and local institutions involved in the fishing industry (Perry et al.,2011). Siakwah 2018 recommends improved government regulations to resolve grievances and promote communication between the government, oil companies, and fishers in Ghana.

5.4 Addressing Poor/Declining Well-Being:

5.4.1 Improving Access to Capitals

Fishers can provide for their family, obtain, or improve fishing gear to enhance fishing through loans and credit facilities (Emdad Haque et al., 2015). Improving the well-being of impacted fishing groups can be made possible through government loans, grants, and compensations. Family and friends of impacted fishers can support them through cash gifts to help them access basic needs and resources (Broderstad and Eythórsson, 2019). Supporting the capital base of fishing households improves family relationships as needs are met, and improved living standards are achieved (Coulthard & Britton, 2015). Females involved in micro-business in the fishery sector in Sao Tome and Principe have improved their social status

through financial management programs and saving strategies (Allison and Horemans,2006). Access to food, quality healthcare, and a safe environment promote good health conditions (Freduah et al., 2018). Fishers affected by environmental pollution can access better healthcare when there are financial capital and physical structures such as hospitals. Ghanaian artisanal fishers who faced short-term economic vulnerabilities relied on support from family and friends due to the absence of government support (Lenselink,2002).

5.4.2 Community Mobilization

The well-being of fishing groups could be improved through mobilization, innovation, and participation (Freduah et al., 2018). In addition, strengthened community institutions and belief systems can help reduce the incidence of social vices and promote the well-being of community members. A safe community devoid of high crime incidence can attract back family members who moved out to other areas for reasons related to personal safety (Freduah et al., 2018).

5.5 Addressing loss of Capitals

5.5.1 Education (Training and capacity-building)

Access to information on fishing activities, improved fishing methods, preservation, and marketing can increase the incomes of impacted fishers and support their resource base (Sowman,2020). Sowman (2020) stresses the use of information and sensitization as a response to environmental pollution. Through public awareness, communities and government institutions undertake sensitization programs on the harmful effects of spills and reduce their

impacts on human life and the ecosystem (Sowman,2020). Education on environmental health protects the natural capital (Perry et al., 2011). Additionally, training fishing groups on preparing loan documents enhance their access to financial capital (Perry et al., 2011). Upgrading the fishing skills of impacted fishers can help them obtain other occupational skills such as soap making, piggery farming, and vegetable cultivation to supplement household needs (Belhabib et al., 2016). Shaffril, Samah, and D'Silva (2017) note that fishers undertake education by improving weather-related disasters in response to climate change. Likewise, in Ghana, farmers troubled with climate change issues have been supported by deploying agricultural extension workers who provide knowledge and technical support to impacted
farmers (Gyimah et al., 2020). Building this capacity enhances the quality of human capital (Perry et al.,2011).

Regulatory bodies and environmental agencies must additionally sensitize fishing groups on the impacts of illegal fishing and maintain strict supervision over activities of oil companies in the management of waste (Achaw and Danso-Boateng, 2013). Education and training afford fishermen management skills to protect and repair fishing equipment to prolong their lifespan (Perry et al.,2011).

5.5.2 Migration

Moving from old fishing communities to other areas searching for new fishing grounds and market opportunities, supports the capital base of fishers (Perry et al., 2011). West African fishing groups in Ghana, Benin, and Nigeria have, in the past, migrated to countries like Congo and Gabon to obtain cheaper pre-mix fuel, sell in better market conditions, and be able to save

money (Njock and Westlund,2010). Ghanaian migrant fishers during the overthrow of Dr. Kwame Nkrumah in 1966 migrated to Cameroon and Guinea for safety and in search of better work conditions (Njock &Westund,2010). Table 5.1 gives a brief description of the identified vulnerabilities and their adaptive responses:

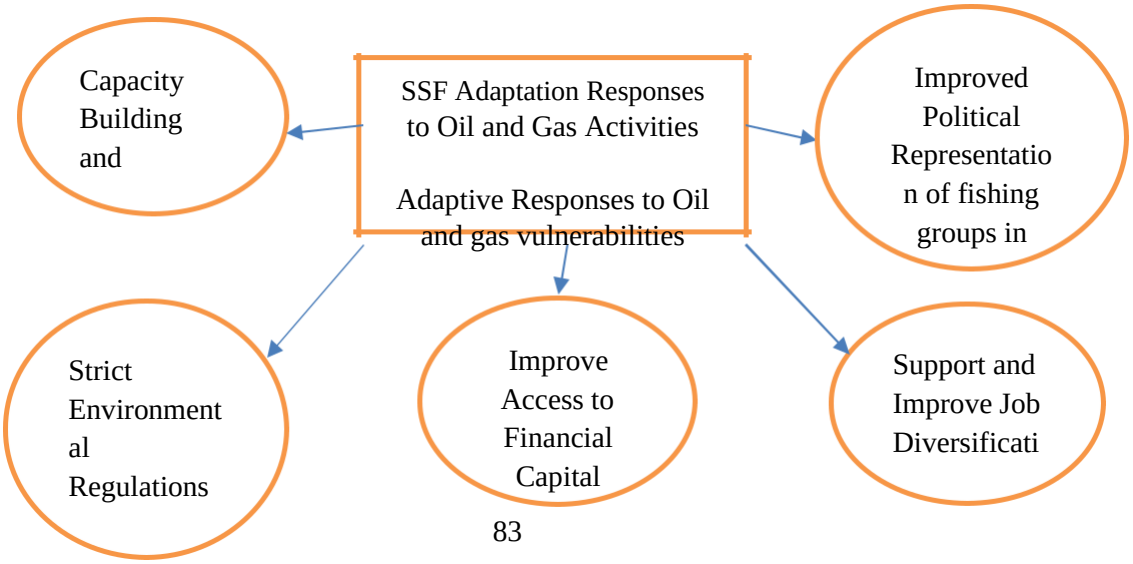
Table 0.1: Adaptive responses Developed in Response to Identified Vulnerabilities

Vulnerabilities	Adaptive responses
1. Loss of livelihood Resilience – Low fish catch leads to loss of income and the inability of fishers to provide for themselves (Pegg & Zabbey,2013; Haller et al., 2007).	Livelihood intensification and diversification - Increasing fishing efforts or finding non-fishing jobs like vegetable farming. (Blythe et al., 2014; Freduah et al., 2018). Policy formulation and restructuring- Formulation and implementation of favorable fisheries policies can aid and improve fisheries governance. (Perry et al., 2011; Siakwah, 2018)
2. Poor/ decline in well-being- Decline in incomes impacts access to basic needs and results in decreased living standards. (Boohene & Peprah, 2011).	Access to capitals - Fishers can be able to provide for their family, obtain or improve fishing gears to enhance fishing through loans and credit facilities (Allison&Horemans,2006; Coulthard & Britton, 2015) Community mobilization and participation (Freduah et al., 2018)-Social groups and local networks in communities can collaborate to pursue effective adaptation strategies
3. Loss of capitals - Pollution, the struggle for incomes, poor access to health care, conflicts affect the overall availability of capitals. Lack of access leads to vulnerability in the absence of resources needed for basic survival (Freduah et al.,2018).	Education (Training and capacity-building)– Access to education and knowledge on fishing activities, improved fishing methods, preservation, and marketing can enhance the incomes of impacted fishers and promote their resource base (Perry et al.,2011; Sowman,2020)

	Migration- Moving from old fishing communities to other areas in search of new fishing grounds and new jobs (Njock &Westlund,2010; Perry et al., 2011)

5.6 Application of Adaptive Strategies in the Case of Ghana

Studies around the world on adaptation provide valuable examples for further studies, especially among developing countries. For example, coastal communities impacted by offshore oil and gas exploration can learn from communities that have been exposed to similar vulnerabilities in the past. Figure 5.1 explains the factors that can promote the adaptive capacities of SSF. From the analyses of adaptive responses pursued by communities in different locations, these recommendations can contribute to efficient adaptive capacities and strengthen coastal communities. In addition, the presence of strict environmental policies, adequate capitals, political participation, capacity building, and improved sources of alternative livelihoods can enhance well-being and resilience. These contributing factors are explained further below:



5.6.1 Improve Access to Capital

Access to financial support, foreign aid, and the presence of social groups contribute to the adaptive capacity of communities (Freduah et al., 2018). The ability to obtain loans, credit, and support increases the resilience of fishing communities when confronted with disasters and uncertainties. Fishing communities can set up cooperatives to provide financial support and guidance to members in times of disasters. Government must provide adequate compensations and tax relief services for impacted communities, as was in the case of the Korean Hebei Spirit oil spill (Cheong, 2012), for example. If funds are made available and easy to obtain, impacted groups will meet their basic needs and provide for their family to enhance their well-being. Promoting educational initiatives aimed at preventing pollution improves the natural resource base and reduces poverty. Improving communities' skills through training increases the quality of available human capital and provides an opportunity to venture into other businesses in times of crisis (Smit &Wandel,2006). Adaptive capacity is efficient in the presence of capital, including social, financial, cultural, human, and natural capital (Smit & Wandel,2006). Improving accessibility to all types enhances a groups resilience and ability to deal with uncertainties (Freduah et al., 20018) Capitals

5.6.2 Support and improve livelihood diversification

The results from this chapter (5) have shown that one necessary means by which fishers respond to livelihood vulnerabilities is by finding other job opportunities. The presence of other jobs and entrepreneurial opportunities reduces the burden of insufficient incomes on impacted fishers. Cassava plantations, greenhouses, and aquaculture, piggery farming have

been introduced into communities by oil companies such as Tullow Oil Ghana Limited to help complement fish catch and support the needs of fishing communities. The government and various Non-governmental Organizations such as the Western Regional Coastal Foundation should support these projects in the communities to promote their sustainability even after oil companies have exited these communities.

5.6.3 Strict Environmental Regulations to Check Oil and Gas Operations

Together with relevant stakeholders, government institutions must join forces in ensuring that oil companies adhere to strict environmental guidelines. Again, environmental protection can be achieved by monitoring and evaluating waste management plans. In Ghana, the Environmental Protection Agency and Ghana National Petroleum Company, and other regulatory bodies have the mandate to supervise waste disposal and release toxic gases into the environment. However, Achaw and Danso-Boateng's (2013) studies on the ways oil companies in Ghana dispose of waste revealed shortfalls attributed to corruption. They recommended strict policies and sanctions to ensure oil companies efficiently dispose of their waste

5.6.4 Capacity Building and Retraining

Perry et al. (2011) stresses the need to build potentials and enhance the skills of impacted communities exposed to vulnerabilities. In addition, retraining ensures that fishers are abreast with new technologies and software to help them increase fish catch and enhance revenue (Cochrane et al., 2010).

Another means of increasing fish catch is by navigating to deeper waters and new locations with the help of GPS and outboard motors (Belhabib et al., 2016). Education on the

use of new technology is therefore crucial. Fishers should be trained on improved means of preserving food to prevent food waste and scarcity. Ghanaian fishers have practiced methods such as smoking and drying to preserve fish in the past. These methods are less capital intensive and can be complemented by other marketing skills to increase revenue generation.

5.6.5 Improved Political Representation of Fishing Groups in Policymaking

Decisions making processes must involve all stakeholders to ensure the formulation and implementation of sound policies (Andrew et al., 2007). Social groups and community leaders should be involved in the decision-making process. Participation ensures that concerns of vulnerable groups are included and considered in law-making and governance policies regarding marine resources (Andrew et al., 2007).

5.7 Key Insights

It is worth noting that the given recommendations must work together to ensure efficiency in achieving a resilient community. These recommendations are essential conditions for achieving resilient communities. The capacity of fishing groups needs to be enhanced, capitals for improving their well-being must be accessible and environmental policies must be enforced to protect the environment and promote well-being. Additionally, fishers must have fair representation in government decision-making bodies to influence decisions that protect fishing livelihoods.

However, it must be stressed that to achieve a resilient community, these given recommendations must be pursued closely together for sustainability. Political representation of fishing communities will work better with sufficient income, well-informed fishing groups,

and a local working institution. Similarly, the improved political representation of essential stakeholders and fishers in decision-making will provide an avenue for pursuing decisions to support the fishing group through financial assistance from the government. Environmental regulations that monitor the activities of oil companies will help reduce health complications and protect human capital, which is vital for political participation. Strict environmental monitoring promotes good health, meaning that a healthy individual can actively participate in policymaking and community demonstrations. Finally, since resilience building requires a multi-dimensional approach, one strategy may not be efficient in reducing vulnerabilities

5.8 Conclusions

5.8.1 Moving from Vulnerability to Viability; the Way Forward

Small-scale fishing communities continue to support nutrition while serving as a means of livelihood to many rural communities. With many studies focusing on the adaptive capacities and responses to environmental change and stressors, enhancing their resilience to reduce vulnerability will position them towards viability. In many communities, adaptive responses are usually not used in isolation but combined with different strategies for significant results. For example, Mabe and Asase (2020) discuss the combination of diverse, sustainable adaptation strategies as a sure response to a loss of income and falling fish catch. This enhances the resilience of fishing groups, especially if one strategy fails or becomes less effective.

Enhancing group adaptive capacity also means that people must be sensitized. For example, Cinner et al. (2015) show the different response rates among community members. In most instances, vulnerable family members are less responsive to changes, which can affect total resilience. Similarly, studies in other rural areas of Thailand show the communities' low

adaptive capacity to environmental pollution and unequal response by different members to identified stressors; achieving viability requires mobilizing, and educating vulnerable groups is vital.

Small-scale fishing communities reflect a complicated relationship between human-nature interaction, bound to face challenges and uncertainties. Adaptation strategies meant to reduce or mitigate impacts on such certainties require learning and unlearning through time. Continuous learning will enable impacted members to determine what works best for them in future events.

Oil and gas exploration and production activities undeniably bring economic benefits to many countries. However, their activities tend to affect fishing communities located close to areas where oil companies operate. To ensure safe operations, environmental institutions and regulatory bodies must work together closely to ensure that the oil production activities are conducted safely to protect the environment. Despite the enactment of the 1984 Petroleum Exploration and Production laws made by the Ghana government regarding the oil sector, many concerns have been raised regarding issues of accountability and efficiency; the past has had issues managing its natural resources; hence revenue from oil should be adequately managed to avoid issues of mismanagement and corruption.

Stakeholder engagement plans and development activities should be geared towards developing fishing communities and reducing the impacts of oil activities. SSF should be involved in decision-making and implementation. In addition, access to financial support and socio-economic resources should be enhanced to improve their well-being.

Further research should be conducted to understand how oil and gas vulnerabilities in coastal communities can be reduced or prevented. The findings from these studies will provide relevant information for social performance planning and corporate responsibility projects in these communities.

Chapter 6

Summary, Limitations, and Recommendations

6.1 Introduction

Small-scale fishing communities are significant contributors to national development across many jurisdictions. Despite supporting incomes and livelihoods, they face many forms of vulnerabilities. This study sought to investigate one of these vulnerabilities, oil and gas activities, its effects on fisheries, and the adaptive responses of these fishers.

The following sections summarize the chapters and critical insights. It then concludes with highlights of the study's limitations and recommendations.

6.2 Problem Analysis

Chapter one (1) explained the nature of SSF, their contribution to livelihoods, and their overall importance to rural households and discussed SSF in the Western Region of Ghana and the vulnerabilities they face due to crude oil extraction in the area. It was followed by the problem statement and research questions, and objectives. SSF, despite being undermined in national policies, support nutrition, incomes, and healthcare. In Ghana, oil and gas activities have increased livelihood vulnerabilities among fishing communities close to crude oil operation sites. Prior studies have reported low fish catch, declining incomes, loss of livelihoods, environmental pollution, and high rent costs. With many studies focusing on such vulnerabilities, there was a scholarly gap concerning SSF strategies to overcome such issues. This study aimed to analyze these vulnerabilities and investigate the adaptive strategies that have been used in responding to such vulnerabilities. Specifically, the study aimed to;

understand the extent of oil and gas activities and nature of SSF in the Western Region of Ghana; examine the influence of oil and gas activities on incomes and capital of small-scale fishers in Akwidaa, and map adaptive responses of small-scale fishers in Akwidaa to reduce the vulnerability emanating from oil and gas operations and enhance their viability.

6.3 Conceptual and Methodological aspects

Chapter two (2) discussed the literature section of the study. The primary literature in the study focused on SSF, the notion of vulnerability to viability, and adaptation.

I. SSF and issues of vulnerabilities: As mentioned earlier, fisheries contribute immensely to rural livelihoods. However, they face vulnerabilities arising from an interplay of social and ecological factors. These vulnerabilities occur from local and international sources. Therefore, the vulnerabilities affecting fishing communities require a multi-dimensional approach reducing them and enabling fishing groups to build their resilience and move from vulnerability to viability.

II. Vulnerability to Viability: The notion of vulnerability to viability describes a transition from a low resilient poor state to one that can deal with stress and future uncertainties. Moving from vulnerability to viability requires improving access to capital, well-being, and improving livelihood resilience. Resilience building is a requirement in achieving viability because a resilient state can respond to stressors sustainably. Access to social, natural, physical, cultural, and financial capital improves the livelihoods of fishing communities. Additionally, enhancing the relational, material, and subjective well-being ensures that people are better

positioned to respond to stressors adequately. Fishing communities through community innovations, technology, and institutions can support resiliency building. Access to loans and compensations in times of disasters enables impacted groups to afford their basic needs.

III. Adaptation: The challenges fishers face call for the innovative application of political, social, and ecological theories and approaches to deal with human evolution complexities in environmental systems. SSF employ short-term coping responses to long-term adaptation plans to help deal with stressors. The adaptive capacity of a system is influenced by factors such as the resource base, location, and nature of the community. Adaptive capacity determines the ability of a social-ecological system to respond to stressors.

Chapter 3 details the study methodology and approach used in obtaining data for the research. The study employs a transformative worldview in understanding the vulnerabilities affecting SSF. It conducted an extensive literature review of existing studies on fisheries vulnerabilities to find out what has been studied in other locations. With the help of the Zotero storage manager, selected articles from Jstor, Google Scholar, and Scopus search were gathered and analyzed to help find answers to research objectives. Using the I-Adapt framework developed by the Integrated Marine Biosphere Research working group, the selected data's natural, governing, and social systems were analyzed to understand the nature of vulnerabilities affecting them.

6.4 Objectives

6.4.1 Objective 1 Extent of Oil and Gas and Small-Scale Fishery

This objective aimed to understand the nature of oil activities and the extent of fishing in Akwidaa, Ghana. Chapter 4 of this study found that small-scale fishing activities are a critical contributor to Ghana's fishery industry. It provides about 85% of the country's annual marine fish catch. Also, intensive crude oil activities in the country commenced in 2007 and are dominated by international companies like Tullow Oil, Kosmos Energy, and Petro S.A. The study analysis indicated that fishers had reported severe livelihood consequences since oil activities started in the area.

6.4.2 Objective 2. Resulting vulnerabilities of SSF

SSF in the area are affected by a myriad of problems due to the location of crude oil activities near them. From the aerial surveys, drilling, production, and transportation stages, problems of declining fish catch, environmental pollution, increased social vices, and increased cost of living have been reported by host communities. The results of such impacts have caused a decline in livelihood resilience, capitals, and well-being of impacted fishing groups.

6.4.3 Objective 3. Adaptive Responses of SSF:

i. Key insights from objectives 1 and 2: SSF in Ghana is an important contributor to rural livelihoods. Oil and gas activities have resulted in increased cost of accommodation , pollution, declining fish catch and social vices. These impacts cause loss of livelihood resilience, capitals and decreased well-being. These vulnerabilities need to be addressed to promote SSF viability.

Chapter 5 describes the adaptive responses used by communities to cope with declining livelihood resilience, low capitals, and poor well-being. Fishing groups impacted by activities of oil companies respond through livelihood diversification and intensification, community mobilization, education and training, migration, policy formulation, and restructuring, as well as increasing access to capital.

6.5 Limitations

This research experienced a few limitations that affected the type of data used. Due to the Covid-19 travel restrictions, the study had to use secondary data, which could affect the credibility of the information provided. Again, the travel restrictions prevented the study from gaining first-hand information and insights from impacted fishing groups in Akwidaa.

Finding information pertaining to Akwidaa and fisheries activities in Ghana was difficult because of limited studies in the area. This resulted in the use of other case studies in Africa and other continents.

6.6 Recommendations

The study recommends that building resilient communities require capacity-building to improve human capital's quality and skill base. Strict environmental regulations should be put in place to check the activities of oil companies and ensure proper monitoring is conducted to preserve the environment. Access to all forms of capital and other livelihoods outside fishing should be increased to help communities provide their basic needs and respond to uncertainties successfully. Finally, representation of fishing groups in law-making is necessary to ensure favorable policies.

Further research should be conducted using primary data in specific areas to assess the level of vulnerability and the adaptive capacity of host communities. By ensuring these factors work together sustainably, movement from vulnerability to viability can be achieved

6.7 Conclusion

Oil and gas activities support GDP growth and international trade of host countries; however, its consequences on fisheries cannot be overlooked. These two economic activities; fishing and oil and gas production activities need to be well managed and regulated to ensure a peaceful co-existence and their sustainability. Attention should be paid to the drilling and production activities of oil companies to prevent pollution and protect the disasters. SSF are vital components of the economies of many developing countries and should be prioritized in national development planning to enhance their viability.

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