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## EXPLORING THE LINK BETWEEN FISHER FOLKS' EXPERIENTIAL KNOWLEDGE AND CLIMATE VARIABILITY IN AN URBAN COASTAL COMMUNITY IN ACCRA

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### ABSTRACT

*The article looked at the possibility of integrating indigenous knowledge and scientific knowledge in fisheries management under the scenario of climate change and variability in an urban coastal community in Ghana. The objective was to explore fisher folk's perception of temperature and rainfall variability impact on fish catch. Focus group discussions were used for data collection in Ga-Mashie. The results show that the fisher folks, through their experiential knowledge were able to tell that fish from marine artisanal fishing sources was getting depleted and this could be attributed to rising temperatures, rainfall variability and anthropogenic activities. However, information on the use of chemicals in fishing and the use of unprescribed fishing nets may have been acquired from public education. The paper calls for a greater collaboration between the local community, the scientific community and policy makers to develop sustainable adaptation and mitigation strategies that will be beneficial to the community.*

**Keywords:** climate variability, indigenous knowledge, scientific knowledge, fish, anthropogenic, fisher folks, Accra

### INTRODUCTION

Globally, the reality of climate change and its adverse impact on fish, fisheries, and fisheries-based economies around the globe as well as broader components of marine ecosystems is evident (Cahill *et al.*, 2012; Hollowed *et al.*, 2013). According to Badjeck *et al.* (2010), climate change may impact fisheries through multiple ways including changes in water temperature, precipitation and oceanographic changes, rainfall, acidification and others. Degradation of traditional fishing ground through rising sea level in the coastal communities in developing countries and Small Island Developing States has more direct impact on coastal communities and populations which depend on marine resources for sustenance. Currently, fish represents about 16% of all animal protein intake, and this is likely to increase (World Bank, 2013). According to FAO (2014), fifty million people could be at risk by 2080 because of climate change and increasing coastal population densities. Employment within the fisheries sector is likely to change profoundly, especially for small-scale fishers who fish for the local market or for subsistence. Allison *et al.* (2009) have suggested that in the absence of enhanced capacity to cope with and adapt to the impacts of climate change, the disruption of fisheries by climate change is likely to affect large

numbers of poor people, and reduce the options for future economic growth in countries with fisheries as an important source of food, employment and export revenue.

Although research derived from empirical scientific studies has provided large-scale responses to climate change and fish stock reduction through aquaculture and other adaptation strategies, it has been argued that it has limitations and cannot always provide an accurate diagnosis or solution. Thus, the top-down application of scientific knowledge rarely integrates different components of any problem, rather focusing on single issues, which can lead to bias and prevent appreciation of the multi-faceted nature of the problem (Reed *et al.*, 2007). As a result, local fishing communities who are affected by the adverse impact of climate change on their livelihood have rarely participated in these scientific assessments. Experiential or traditional knowledge are therefore rarely considered in academic, policy and public discourses (Salick and Byg, 2007).

Studies on experiential knowledge and climate change have been few and far in between (Nygren, 1999; **ACIA** 2005; Oxfam America, 2007; IUCN, 2008; UNESCO, 2009; Ford, 2012; Lefale, 2009; Green and Raygorodetsk, 2009; Green *et al.*, 2010; Codjoe *et al.*, 2014). Studies have focused on how to include experiential knowledge into scientific assessments of changes in weather and climate (Lefale, 2009, Alexander *et al.*, 2011; Ford, 2012). Codjoe *et al.* (2014) note that such studies have mainly concentrated on rural farming communities (Nyong *et al* 2007; Somorin 2010; Kalanda-Joshua *et al.* 2011; FAO 2014; Schneider *et al* 2007) to the detriment of urban areas and some of its occupational characteristics such as fishing. In addition, these studies have concentrated on experiential knowledge rather than combining it with scientific knowledge. This article sought to discover fisher folks' perception of climate variations and its impact on fish catch in Ga Mashie, an urban coastal community in Accra. Under this aim, the specific objectives are;

To discover the experiences of fisher folks pertaining to increasing or decreasing volumes of fish catch. To explore fisher folks' perception of the impact of rainfall and temperature on fishing activities. To explore other factors that fisher folks attribute to fish reduction. This is because the attitudes and lives of the people are framed in their cultural practices and cannot be detached from one another. These cultural practices will influence the way they construct their lives, their beliefs and their approach to nature. Again, the exploration of indigenous knowledge of urban communities is able to complement scientific data that is needed to build a deeper understanding of climate change impacts, adaptation, and vulnerability at the local scale (Codjoe *et al.*, 2014).

## **EXPERIENTIAL AND SCIENTIFIC KNOWLEDGE**

Experiential knowledge, sometimes referred to as indigenous or traditional knowledge, is knowledge accumulated through many generations of close interactions between people and the natural world (Epstein, 1994; Storkerson, 2009). According to Gadgil *et al.* (1993:151), such "diachronic" observations can be of great value and complement the "synchronic" observations on which west-

ern science is based. Through trial and error women and men gain experiential knowledge in what they do within a particular geographic area. Experiential knowledge can be described as expert knowledge in terms of the depth of observation, organisation, representation and interpretation of information (Fazey *et al.*, 2006). Scientific or expert-based knowledge, on the other hand, is defined as the use of empirical observations to conduct research and devise solutions through the advice and input of researchers (McBride and Burgman, 2012).

The use of experiential knowledge in ecology, crop pest management, soil and water management, and biodiversity resources is well documented (Gadgil *et al.*, 1993; Steiner, 1998; Robertson and McGee, 2003; Nederlof and Odonkor, 2006; Boateng, 2006). It has also been used extensively in fisheries management by exploring fishermen knowledge in fishing resources and fishing behaviour (Silvano and Valbo-Jørgensen, 2008; Aswani and Laurer, 2006). This was achieved through community participatory approaches. However, Ngulube (2002) observed that collection, accessibility, storage and preservation of experiential knowledge can be challenging. Hence, we cannot solely depend on experiential knowledge to develop strategic management plans. We need to recognize its limits in order to conceptualise it appropriately (Briggs, 2005). Gaillard and Mercer (2012) propose a more integrative process consisting of local and scientific knowledge since due to increased connectivity and globalization of the world some local knowledge may no longer be viable, while some could exacerbate vulnerability. Hence, experiential knowledge should be hybridized with scientific information to provide a cost effective way of making more confident predictions, build resilience for adaptive capacity and produce useful policy for more effective and sustainable resource management (Folke *et al.*, 2003; Raymond *et al.*, 2010).

In Ghana, marine fisheries management is addressed either scientifically through empirical evidence or socio-economically through indigenous knowledge systems. However, the activities of the artisanal fishing in Ghana have depended heavily on local experiential knowledge. Although one party advocates for a scientific approach to fisheries management in the context of climate change and rising sea surface temperatures (Akpalu and Codjoe, 2013; Nunoo and Aseidu, 2013), others advocate for active involvement of fishers as an essential element in responsible fisheries management in order to protect livelihoods and ensure that management measures gain acceptance among the fishers (Lenselink, 2002). Recent studies in the urban coastal communities suggest that fishers have used certain physical signs to determine fish catch and to manage and adapt to the vagaries of the changing climate (Codjoe *et al.*, 2014).

### **THE COASTAL COMMUNITY - ACCRA**

The coastal community of Ghana stretches over a distance of 565km from the west to the east and bordered on the south by the Gulf of Guinea. Fishing is conducted in four regions namely, Western, Central, Greater Accra and Volta Regions. Artisanal fishing is one of the fishing practices in Ghana which contributes to about 30% of the traditional sector landing (Mensah and Antwi, 2002). The fish-

eries sector contributes about 5 per cent of the national Gross Domestic Product (GDP) whilst 60 per cent of Ghana's population depends on fish for its protein requirement. In the last ten years, Ghana's peak catch of fish has dwindled from 120,000 metric tonnes to 30,000 tonnes. The national statistics indicate that the small pelagic fishery (for sardinellas, anchovies and mackerels), the most critical for food security, has experienced the largest decline. Various reasons, including unsustainable fishing practices, overfishing and lack of good governance have been attributed for the decline (GNA, 2013; Atta-Mills *et al.*, 2004).

Accra is the political and economic capital of Ghana located in the southern part of the country. It holds the seat of government headquarters of various ministries and the judiciary. The specific communities chosen for this study are James Town and Ussher Town (Figure 1) within the administrative Accra Metropolitan Area (AMA). Ussher Town was formerly known as the Dutch Town during the colonial days. James Town is the first destination for the colonial British when they relocated the capital city from Cape Coast to Accra in 1877. Since then, James Town and Ussher Town have rapidly urbanized to become a dense mixture of commercial and residential activities. They are both coastal fishing communities in the Greater Accra Region of Ghana. Presently the combined population of James Town and Ussher Town is about 125,000. The main livelihood of the people is artisanal fishing and fishing related activities. The fishing industry employs about 16,000 people. Men are involved in the actual fishing activity while women are responsible for preservation, marketing and trading. Accra lies within the Coastal Savannah agro-ecological climate zone. The coastal belt is usually warm and comparatively dry. The coastal community experiences high level precipitation due to an increase in sea surface temperatures. The mean annual temperature in the coastal area is about 27.7°C rising from about 27.00C in 1960 giving an indication of rising temperatures in the coastal zone. The rainfall pattern is bimodal with the major season in April to July peaking in June and the minor season in September to November peaking in October. The mean annual rainfall in the dry coastal belt is between 740mm and 890mm (Owusu and Waylen, 2009).

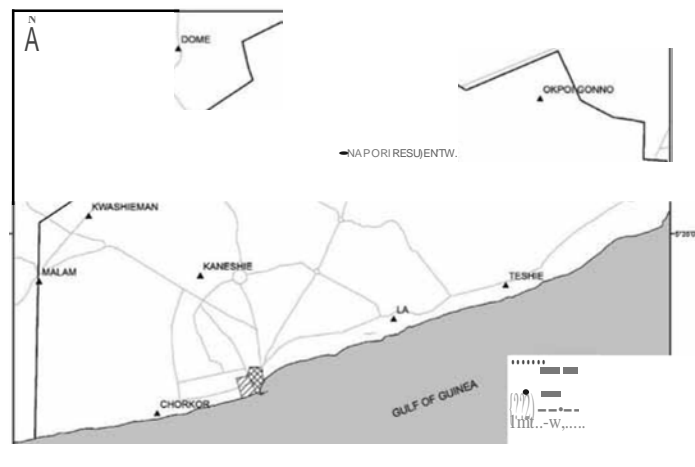


Figure 1: The map of James Town and Ussher Town

## METHODOLOGY

This research is part of a larger research conducted by the Regional Institute for Population Studies from 2011 to 2014 under the IDRC – AARC initiative. The project had two main research components, namely, climate impacts on health and climate impact on food security (fish). In the main research, three main approaches were used to collect data. These are: (i) community focus group discussions, (ii) individual interviews and (iii) household interviews. However, this aspect of the research examines the role of indigenous knowledge in fisheries management under changing climate using focus group discussions. Participants for the focus group discussions were selected from the individual and household survey respondents, youth groups, fishmongers association, fishermen association, traders, teachers, unit committees, assemblyman and head of households/families. It was also ensured that the discussants were a spread over all the 16 enumeration areas within the Ussher Town locality. The enumeration areas were based on the Ghana Statistical Service 2010 population and housing census. A participatory research approach involving interviews, focus group discussions and informal discussions were used in data collection. According to Cornwall and Jewkes (1995), participatory research is a research strategy that emphasizes greater participation and is motivated by pragmatism and concerns for equity. Participatory research focuses on 'knowledge for action' (Cornwall and Jewkes, 1995).

Two focus group discussions (FGD) were held with the community members and the fisherfolk on 13<sup>th</sup> August 2013. August is usually the main fishing month in the community. The first focus group consists of adult males, adult females and the youth from Ussher Town while the second focus group is composed of fisher folks from both James Town and Ussher Town. The first FGD was held at Ga Mashie Development Agency (GAMADA) conference room, a non-governmental organisation in the community. There were 25 participants in all. The second FGD was held under a shed located next to the office of the fishermen association on the Ussher Town beach. In all there were 7 females and 10 males. The males were predominantly fishermen while the females were predominantly fishmongers and spouses of the fishermen. Each session lasted for about one hour and the discussions centred on impacts of climate change on artisanal fishing activity of the people.

The questions sought to ascertain perceptions of climate variations and impact on fish catch. Questions asked include, 1) fisher folks experiences of increasing or decreasing volumes of fish catch, 2) the impact of rainfall and temperature on their fishing activities and 3) other issues militating against fish catch that are outside the changes and variability in climate. The predominant language of communication was Ga (the local dialect of the Ga community) with occasional explanations in Twi (the local dialect of the Akan) and English. The responses from the interviews were coded and categorized into thematic areas relating to fish catch, impact of temperature and rainfall on their fishing activities and practices perceived to militate against fish catch. Rainfall, temperature and fish

data were analysed to find the correlation between change in fish catch and climate variability. The analysed data from the responses is then compared with the analysed data from the rainfall, temperature and quantity of fish catch. Similarities and differences were drawn between fish catch historic data from FAO spanning from 2002 to 2012 and observations made by the fisher folks. The FAO data was modelled using the FishStat software (FAO, 2012). Again, similarities and differences were drawn between fisher folks' climatic experiences and 2002 to 2011 rainfall and temperature analysed data from the Ghana Meteorological Services Department. The rainfall and temperature data were plotted using Microsoft excel to establish the trend over ten years. The results from the comparisons were interpreted.

## RESULTS

### **Fisher folks experiences of increasing or decreasing volumes of fish catch**

The fisher folks had observed that fish catch in the last five years had dwindled because the men did not land enough fish compared to previous years. The women also mentioned that they did not have enough fish to smoke during the 'bumper' fishing season. According to the women, in past years they had enough fresh fish to sell and to smoke. They had enough smoked fish to store and sell them during the lean season. Thus the women explained that they now have to go to Terna to buy frozen fish to smoke and sell. According to the fisher folks, bumper season is usually between August and December. They are able to tell whether they will experience a bumper harvest if the season precedes with a bumper harvest of herrings and salmon. However, observations made in recent times show that the volume of pelagic fish catch has decreased considerably.

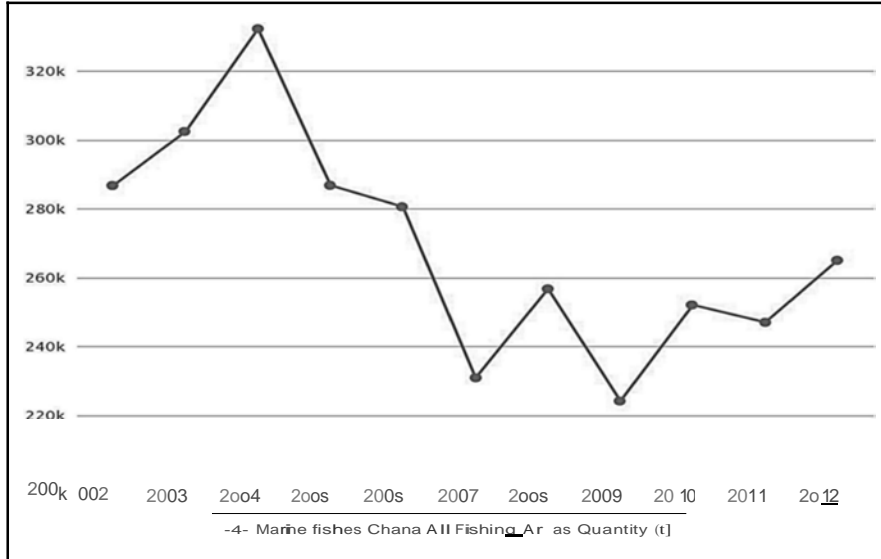
A participant commented that:

"We do not have enough fish to catch when we go to sea and this has been happening for the past five years".

Another commented that:

"For some years now, the herrings (*ma1J*) and salmon (*Sama1J*) that we have been catching in August is decreasing and this is really affecting our income". (*Sama1J* is also used to describe mackerel.)

The marine fish catch data from FAO indicates that fish catch in Ghana has been decreasing over the past ten years. In 2004, marine fish catch in Ghana was a little over 330,000 tonnes. In 2009, this decreased to 225,000 tonnes. This was the least fish caught over the last ten years. After 2009, fish catch has gradually been increasing but not as high as recorded between 2002 and 2006. In 2012, about 265,000 tonnes of fish were caught from the sea. The decrease in fish catch between 2006 and 2009 may be attributed to poaching by foreign vessels that may have depleted fish stocks in Ghana's 200 mile Exclusive Economic Zone (Antwi-Asare and Abbey, 2011). Although this is reasonably high, it cannot be compared to the years up to 2006. The results confirm the observations of the fishermen that fish catch has been dwindling.



**Figure 2: Marine Fish catch in Ghana 2002 –2012 (tonnes).**  
 Source: FAQ (2012)

**THE IMPACT OF RAINFALL AND TEMPERATURE ON FISHING ACTIVITIES**

From the discussions, the fisher folks suggested that increased rainfall intensity in August is affecting their fishing activities. August is generally known to be one of the dry months in the coastal belt of Ghana. While the women claimed that the increased rains impeded fish smoking and drying activities, the men were also of the opinion that the heavy rains resulted in flooding the lagoon within the community and this pushes the fish further into the deep sea.

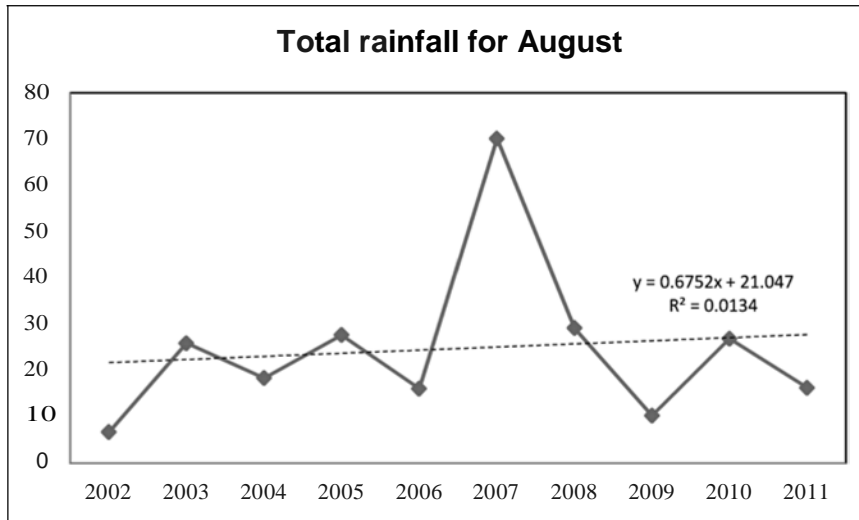
A respondent explaining the rainfall pattern in August claimed that:

"The heavy rains we are experiencing these days in the month of August are really affecting us. When it rains heavily, the place gets flooded and the flood water pushes the fish away from the shores further into the deep sea".

Another respondent reiterated that:

"Fish catch is often good when there is less rainfall but increased rainfall and flooding in the hinterlands floods the lagoons pushing the fishes into the deep sea and it takes the fishes a long while to swim back into our waters".

The recorded rainfall for August 2002 to August 2011 indicates that rainfall intensity is generally increasing and becoming variable (Figure 3). The daily rainfall for the month of August was summed up to represent the total rainfall for the month. It was calculated for each year (2002 – 2011). Between these years, the highest recorded total rainfall for August was about 70mm (2007) and the lowest recorded total rainfall was 6.7mm (2002). From the trend analysis it shows that rainfall intensity in August is increasing confirming the perception of the fisher folks.



**Figure 3: Total rainfall for August (2002 -2011)**  
**Source: Ghana Meteorological Agency**

Again, the fisher folks complained of increasing temperatures during the month of August. According to them, they have noticed that it gets warmer in the night now than in previous years. A respondent commented that:

"Although we live by the sea, it really gets warm in our rooms at night and so we come out and sleep outside".

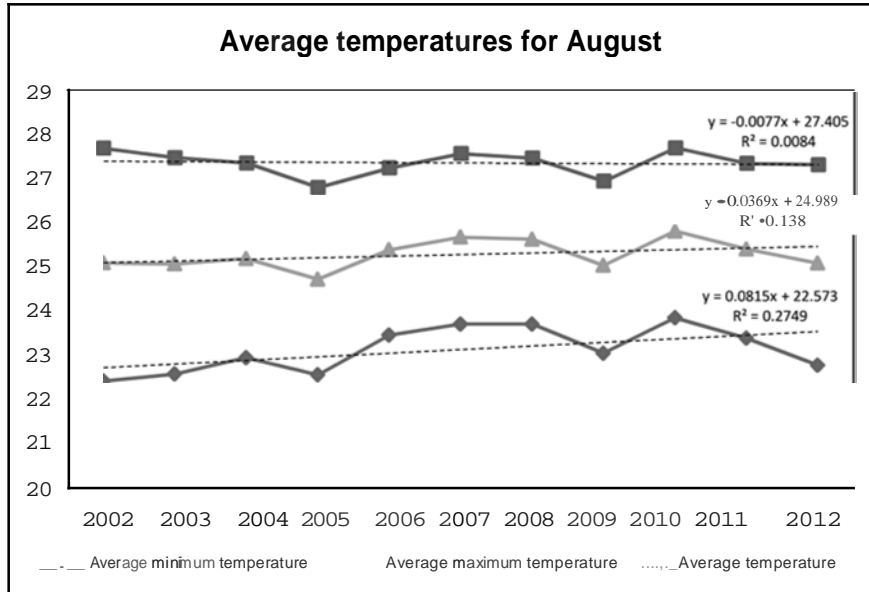
Others mentioned that cold weather was conducive for bumper fish harvest, claiming that temperature increases associated with climate change tend to reduce fish catch

One person explained,

"When the temperature is cold, our fish catch increases. So with this warm temperature our fish catch is reducing".

Fisher folks explained that fish catch is usually good in August when the weather is cold but unfortunately August is becoming warm. Temperature increases are measured by how warm or cold they felt during night time. The average minimum and maximum temperatures trend for the month of August shows that minimum temperatures for August is increasing while maximum temperatures are slightly reducing. In 2002, the minimum temperature was 22.5° Celsius and the maximum temperature was 27.4° Celsius.

In 2010, maximum and minimum temperatures increased considerably to 27.7° Celsius and 23.8° Celsius respectively. However, the maximum and minimum temperatures in 2012 reduced slightly to 27.3 degrees and 22.7 degrees respectively. The trend shows that the average temperature for August is increasing, thus supporting the observations made by the fisher folks claiming that temperatures are increasing.



**Figure 4: Temperature changes for August (2002 -2012)**  
**Source: Ghana Meteorological service**

**OTHER FACTORS**

The community members in a focus group discussion claimed that they do not believe it is only the changes in temperature and the heavy rainfall that affected their fish catch. They assigned other reasons to the reduced fish catch. Some of the reasons are non-adherence of traditional practices and beliefs and unsustainable fishing practices. It was suggested that ending the strict cultural practices of the ancestors is having serious implications on fish catch. The queen mother of the fish mongers association explained;

"Our elders are not respecting our cultural beliefs and practices. They ignore them and we are now suffering. They are supposed to bury a whole cow in the sea to pacify the gods but now they slaughter the cow, eat the good part and just dump the intestines into the sea. This is not enough for our gods so that is why our fishermen are not catching enough fish when they go to sea".

Unsustainable fishing practices, including the use of light in fishing, the use of unapproved fishing nets and the use of chemicals like carbide are affecting fish catch. Light fishing and small mesh size nets used by some fishermen trap the fingerlings resulting in fish scarcity during the bumper season. One respondent explained;

"The light used by the big fishing trawlers is now affecting us".

The general consensus was that big trawlers using light for fishing is leading to over fishing and reduction in fish stock. Again, the fish are not left to mature

because other fishermen use small holed nets to fish. One respondent commented that:

"These days, the fishermen use small-holed fishing nets and they even catch the fingerlings".

They also attributed the decreased fish catch to the use of chemicals in fishing.

## DISCUSSION

Fish catch had continuously reduced over the past ten years. The observation could be attributed to variable rainfall, rising temperatures and harmful fishing practices. Rising temperatures and rainfall variability may affect production, distribution and population dynamics of small pelagic species (FAO, 2014; Attrill and Power, 2002; Meynecke, *et al.*, 2006). The increase in water temperature has implications on the feeding rates and metabolism of fish and fish diversity (Portner *et al.*, 2001), while increased rainfall have translated into higher catch (Meynecke, *et al.*, 2006). The analysis pertaining to the relationship between fish catch and high temperatures and increased rainfall does not necessarily support indigenous knowledge. An inverse relationship is rather established. This means that the observed fish reduction may be attributed to other factors such as flooding and pollution as claimed by the fisher folks.

Harmful fishing practices such as over-harvesting and bottom trawling are degrading fish habitats thereby threatening the entire productivity of ocean biodiversity hotspots, making them more vulnerable to climate change (Nellemann *et al.*, 2008). Over-fishing through the use of small mesh fishing nets reduces the age, size, and geographic diversity of populations and the biodiversity of marine ecosystems, making them more sensitive to additional stresses such as climate change (Brander, 2007). Although chemical use in fishing may not necessarily reduce fish catch, it may result in post-harvest losses and compromise on the quality of fish catch (FAO, 2014). Light fishing is another unsustainable fishing practice operated by some foreign vessels in Ghana. In 2014, a news report captured fishermen complaining about the impact of light fishing on artisanal fishing activities (Opoku Gakpo, 2014). Although it is banned, it is done illegally. The identification of unsustainable fishing practice may not necessarily be an indigenous knowledge but may have been acquired through disseminated information from the television, radio, newspapers, research forums and consultative meetings.

The coastal peoples of southern Ghana regard the sea as a deity and a sacred space where rituals and sacrifices were made to ensure that fishing seasons were successful (Akyeampong, 2007). Similar research conducted in the community identified sixteen indigenous systems used to monitor or forecast local weather and climatic conditions including fauna, atmospheric and celestial elements and sea conditions (Codjoe *et al.*, 2014). Research has shown that some social taboos and religious beliefs have been intertwined with ecological factors and may contribute to conservation and local resource management (Colding and Folke, 2001; Sarto-Mensah and Oduro, 2007). In Ghana, Sarto-Mensah and

Oduro (2007) observed that these religious cultural beliefs and superstitions are enforced by prohibitions. However, the observance of such taboos has declined with widespread adoption of Christianity, modernization and increasing heterogeneity of the communities (Codjoe *et al.*, 2014). The lack of adherence to these traditional management practices has eroded the benefit of ensuring fish maturity, fish breeding and regulating fish harvest (Entsua-Mensah, 2002). Although it could not be ascertained the correlation between burying a whole cow and increased fish catch, the belief of the people must be respected. However, there is the need to observe, organise, represent and interpret the local knowledge.

## CONCLUSION

This article has demonstrated the relationship between experiential knowledge and scientific evidence. Although the local fisher folks used experiential knowledge to explain their observations regarding the relationship between cultural practices climate variability, and harmful fishing practices and the reduction of fish catch, some of their explanations were substantiated with empirical scientific evidence. According to Campbell and Salagrama (2001), formal science operates within a knowledge system and it is at the interface between the indigenous knowledge systems of fishers and that of formal science that the problems of transferability, valuation and quality arise. Akyeampong, (2007) mentions that the local knowledge of fisher folks in James Town and Ussher Town have evolved over several hundreds of years even before the arrival of the Europeans in Ghana and this indigenous knowledge cannot just be ignored. Agrawal (1995) advises that the theoretical and epistemological frameworks underlying western scientific and indigenous knowledge systems have fundamental differences and the strengths of each knowledge system should be specifically developed and evaluated within the context of the study.

It is also not enough to draw ecological management plans based only on experiential knowledge. This is because projected climate changes will exceed any previously experienced changes and traditional coping mechanisms may therefore, not be sufficient to deal with impacts of climate change (AGRA, 2014; Kalanda-Joshua *et al.*, 2011; Salick and Byg, 2007; Boko, *et al.*, 2007). Salick and Byg, (2007) advocate that to capitalize on, develop, expand and mainstream experiential knowledge into global adaptation strategies, traditional knowledge should be further studied, supported and integrated into scientific research. One relevant conclusion of a study in Malawi was that increased rainfall variability in recent years associated with climate change had reduced farmers' confidence in indigenous knowledge, hence reducing their adaptive capacity and increasing their vulnerability to climate change (Kalanda-Joshua *et al.*, 2011).

This calls for greater collaboration between the local community and the scientific community. By working with the indigenous people as traditional caretakers of marginal and fragile ecosystems, policy makers and the scientific community will be able to develop sustainable adaptation and mitigation strategies beneficial to the community. This brings several aspects of local strategies that are extremely

important for climate change adaptation and locally relevant adaptation strategies. One of the overriding views of many development partners is that local communities are almost entirely antagonistic and ignorant of conservation issues (Harcourt *et al.*, 1986). Although many have acknowledged the difficulties in assessing knowledge, attitudes and values of communities towards a resource, the local community in this study area seem to have reasonable knowledge about local resources and climate variability. The bottom-up approach to fisheries management through capacity development may empower local communities to better adapt and adopt sustainable fishing practices. To achieve sustainable fisheries management, fisheries resources will need to be co-managed by the fisher folks, the community and the local and national authorities (Trimble and Berkes, 2013).

There is the need to establish, strengthen fisher folks cooperatives and to push for greater cooperation as they bring on board their experiential knowledge in fisheries management in Ghana. According to FAQ (2014), the drivers and motivations for establishing fishers and fish workers organizations include the need for empowerment as a means of engaging with and challenging government authorities on fisheries management issues (FAO, 2014). It is also to enable stakeholders participate and have a voice in social, economic and political processes and to share the responsibility of promoting and practicing sustainable fisheries.

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**REFERENCES**

- Agrawal, A. (1995). *Dismantling the Divide Between Indigenous and Scientific Knowledge. Development and Change*, 26(3), 413-439.
- Akyeampong, E., (2007). *Indigenous Knowledge and Maritime Fishing in West Africa: The Case of Ghana* (Eds) Emmanuel Boon and Luc Hens, Indigenous Knowledge Systems and Sustainable Development: Relevance for Africa, pp173-182. Delhi:Kamla-Raj Enterprises.
- Akpalu, W., & Codjoe, S. N. A. (2013). *Economic Analysis of Climate Variability Impact on Malaria Prevalence: The Case of Ghana. Sustainability*, 5(10), 4362-4378.
- Allison, E. H., Perry, A. L., Badjeck, Marie-C., Adger, N. W., Brown, K., Conway, D., Halls, A. S., Pilling, G. M., Reynolds, J. D., Andrew N. L., & Dulvy, N. K., (2009). *Vulnerability of National Economies to the Impacts of Climate Change on Fisheries, Fish and Fisheries*, 10, 173-196.
- Arctic Climate Impact Assessment (ACIA) (2005), *Arctic Climate Impact Assessment*. Cambridge: Cambridge University Press.
- Aswani, S., & Lauer, M. (2006). *Incorporating Fishermen's Local Knowledge and Behavior into Geographical Information Systems (GIS) For Designing Marine Protected Areas in Oceania. Human Organization*, 65(1), 81-102.
- Atta-Mills, J., Alder, J., & Sumaila, U. R., (2004). *The Decline of a Regional Fishing Nation: The Case of Ghana and West Africa. Natural Resources Forum*, 28(1), 13-21.
- Attrill, M.J., & Power, M. (2002). *Climatic Influence on a Marine Fish Assemblage. Nature*, 417(6886), 275-278.
- Boateng, W. (2006). *Knowledge Management Working Tool for Agricultural Extension Practice: The Case of Ghana. Knowledge Management for Development Journal*, 2(3), 19-29.
- Badjeck, M. C., Allison, E. H., Halls, A. S., & Dulvy, N. K. (2010). *Impacts of Climate Variability and Change on Fishery-Based Livelihoods. Marine Policy*, 34(3), 375-383.
- Baka, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman Elasha, R. Tabo & P. Yanda, (2007). Africa. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Eds)., *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 433-467. Cambridge: Cambridge University Press.
- Brander, K. M. (2007). *Global Fish Production and Climate Change. Proceedings of the National Academy Of Sciences*, 104(50), 19709-19714.
- Briggs, J. (2005). *The Use of Indigenous Knowledge in Development: Problems and Challenges Progress, Development Studies*. 5(2), 99-114.

- Cahill, A. E., Aiello-Lammens M. E., Fisher-Reid, M. C., Hua, X., Karanewsky, C. J., Ryu, H. Y., Sbeglia, G. C., Spagnolo, F., Waldron, J. B., Warsi, O., & Wiens, J. J., (2012). *How Does Climate Change Cause Extinction? Proceedings of The Royal Society B: Biological Sciences.*
- Campbell, J. and Salagrama, V., (2001 ). *New Approaches to Participation in Fisheries Research.* FAQ Fisheries Circular No. 965.
- Codjoe, S. N. A., Owusu, G., & Burkett, V. (2014). *Perception, Experience, and Indigenous Knowledge of Climate Change and Variability: The Case of Accra, A Sub-Saharan African City. Regional Environmental Change, 14(1), 369-383.*
- Colding, J., & Folke, C. (2001). *Social Taboos: "Invisible" Systems of Local Resource Management and Biological Conservation. Ecological Applications, 11(2), 584-600.*
- Cornwall, A., & Jewkes, R. (1995). *What Is Participatory Research? Social Science & Medicine, 41 (12):1667-1676.*
- Entsua-Mensah, M. (2002). *Traditional Management of Water Resources in West Africa.* In S. Castelein and A. Otte (Eds.). *Conflict And Cooperation Related To International Water Resources: Historical Perspectives.* Selected Papers on The International Water History Association's Conference on the Role of Water in History and Development, Bergen, Norway, 10-12 August, 2001. IHP-VI
- Technical Documents in Hydrology (TOH). No. 62. UNESCO, Paris, pp 49-57.
- Epstein, S. (1994). *Integration of the Cognitive and The Psychodynamical Unconscious. American Psychologist, 49(8), 709.*
- Fazey, I. O. A. N., Fazey, J. A., Salisbury, J. G., Lindenmayer, D. B., & Dovers, S. (2006). *The Nature and Role of Experiential Knowledge for Environmental Conservation. Environmental Conservation, 33(01), 1-10.*
- Folke, C., Colding, J., & Berkes, F. (2003). *Synthesis: building resilience and adaptive capacity in social-ecological systems* (Chapter 14). In: Fikret Berkes, Johan Colding, Carl Folke (Eds.) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change, 352-387:* New York: Cambridge University Press.
- Food and Agriculture Organization (FAQ) of the United Nations (2012). *FISHSTAT.* Rome, Italy: **FAQ.**
- Food and Agriculture Organization of the United Nations- FAQ (2014). *The State of the World Fisheries and Aquaculture.* Fisheries and Aquaculture Department.
- Ford J. D (2012) *Indigenous health and climate change. American Journal Public Health 102,(7):1260-1266.*
- Gadgil, M., Berkes, F., and Folke, C., (1993). *Indigenous Knowledge for Biodiversity Conservation. Ambio, 22 (2/3), 151-156.*
- GNA (Ghana News Agency), (2013). *Unsustainable fishing practices dwindles Ghana's fish catch - USAID Business & Finance, 27 February 2013.*

Available at <http://www.ghananewsagency.org/economics/unsustainable-fishing-practices-dwindles-ghana-s-fish-catch-usa-id-56888>,  
Accessed: on 14 May 2016.

- Hollowed, A. B., Baranga, M., Beamish, R. J., Brander, K., Cochrane, K., Drinkwater, K., et al., (2013). *Projected Impacts of Climate Change on Marine Fish and Fisheries*. *ICES Journal Of Marine Science* 70(5), 1023-1037.
- Gaillard, J.C. & Mercer, J., (2012). *From Knowledge to Action: Bridging Gaps in Disaster Risk Reduction*. *Progress in Human Geography* 37(1):93-114.
- Green, D., & Raygorodetsky G. (2009) *Indigenous Knowledge of a Changing Climate*. *Climatic Change*, 100(2), 239-242.
- Green D, Billy J, Tapim A (2010). *Indigenous Australians' Knowledge of Weather and Climate*. *Climatic Change*, 100(2), 337-354.
- International Union for Conservation of Nature (IUCN) (2008). *Indigenous and Traditional Peoples and Climate Change*. *IUCN Issues Paper*, Gland, Switzerland. Available on [https://cmsdata.iucn.org/downloads/indigenous\\_peoples\\_climate\\_change.pdf](https://cmsdata.iucn.org/downloads/indigenous_peoples_climate_change.pdf). Accessed: on 14 February 2016.
- Kalanda-Joshua M, Ngongondo C, Chipeta L, Mpembeka F (2011). *Integrating Indigenous Knowledge With Conventional Science: Enhancing Localised Climate and Weather Forecasts in Nessa, Mu/anje, Malawi*. *Physics Chemistry of the Earth, Parts A/BIG* 36(14-15), 996-1003.
- Lefale PF (2009) *Ua 'Afa Le Aso Stormy Weather Today: Traditional Ecological Knowledge of Weather and Climate. The Samoa Experience*. *Climatic Change*, 100(2), 317-335.
- Lenselink, N. M. (2002). *Participation in Artisanal Fisheries Management for Improving Livelihoods in West Africa: A Synthesis of Interviews and Cases From Mauritania, Senegal, Guinea and Ghana*. FAO Fisheries Technical Paper No. 432, Rome: FAO.
- Mahama, A. S., Acheampong, A. T., Peprah, O. B., & Bofo, Y. A., (2011). *Preliminary Report for Ga Mashie Urban Design Lab*. The Millenium Cities Initiative. The Earth Institute at Columbia University/ University Of Ghana.
- McBride, M. F., and M. A. Burgman. (2012). *What is Expert Knowledge, How Is Such Knowledge Gathered, and How Do We Use it to Address Questions In Landscape Ecology*. Eds: A. H. Perera, C. A. Drew, and C. J. Johnson, *Expert Knowledge And Its Application In Landscape Ecology*, 11-38, New York: Springer ..
- Mensah, J. V. & Antwi, B. K. (2002), *Problems of Artisanal Marine Fishermen in Ghana: The Way Ahead*. *Singapore Journal of Tropical Geography*, 23(2), 217-235.
- Meynecke, J. O., Lee, S. Y., Duke, N. C., & Warnken, J. (2006). *Effect of Rainfall as a Component of Climate Change on Estuarine Fish Production in Queensland, Australia*. *Estuarine, Coastal and Shelf Science*, 69(3), 491-504.
- Nederlof, S. E., & Odonkor, E. N. (2006). *Lessons From an Experiential Learning Process: The Case Of Cowpea Farmer Field Schools in Ghana*. *Journal of Agricultural Education and Extension*, 12(4), 249-271.

- Nellemann, C., Hain, S. G., & Alder, J. (Eds.). (2008). *In Dead Water: Merging Of Climate Change With Pollution, Over-Harvest, And Infestations in The World's Fishing Grounds: Rapid Response Assessment*. UNEP/Earth Print.
- Ngulube, P. (2002). *Managing and Preserving Indigenous Knowledge in The Knowledge Management Era: Challenges And Opportunities For Information Professionals*. *Information Development*, 18(2), 95-102.
- Nunoo, F. K., & Asiedu, B. (2013). *An Investigation of Fish Catch Data and Its Implications for Management of Small-scale Fisheries of Ghana*. *International Journal of Fisheries and Aquatic Science* 2(3), 46-57.
- Nygren, A. (1999). *Local Knowledge in The Environment-Development Discourse From Dichotomies to Situated Knowledges*. *Critique of Anthropology*, 19(3), 267-288.
- Nyong A, Adesina EF, Elasha O (2007). *The Value of Indigenous Knowledge in Climate Change Mitigation and Adaptation Strategies in The African Sahel*. *Mitigation Adaptation Strategy Global Change* 12, 787-797.
- Opoku Gakpo J., (2014). *Fishermen Struggling to Make a Living As Light Fishing Activities Destroy Business Joy FM News, Ghana*, Available on <http://www.myjoyonline.com/news/2014/august-21-st/fishermen-struggling-to-make-a-living-as-light-fishing-activities-destroy-business.php#sthash.Vrdld7uh.dpuf> Accessed: on 16 March 2015.
- Owusu, K., & Waylen, P. (2009). *Trends in Spatio-Temporal Variability in Annual Rainfall In Ghana (1951-2000)*. *Weather*, 64(5), 115-120.
- Oxfam America (2007). *Papua New Guinea: the islands are shrinking*. Available on [www.oxfamamerica.org/articles/papua-new-guinea-the-islands-are-shrinking](http://www.oxfamamerica.org/articles/papua-new-guinea-the-islands-are-shrinking). Accessed: on 22 March 2015.
- Portner, H. O., Berdal, B., Blust, R., Brix, O., Colosimo, A., De Wachter, B., & Zakhartsev, M. (2001). *Climate Induced Temperature Effects on Growth Performance, Fecundity and Recruitment in Marine Fish: Developing a Hypothesis for Cause And Effect Relationships in Atlantic Cod Continental Shelf Research*, 21(18), 1975-1997.
- Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., & Evely, A. C. (2010). *Integrating Local and Scientific Knowledge for Environmental Management*. *Journal of Environmental Management*, 91(8), 1766-1777.
- Reed, M. S., Dougill, A. J., & Taylor, M. J. (2007). *Integrating Local and Scientific Knowledge for Adaptation to Land Degradation: Kalahari Rangeland Management Options*. *Land Degradation & Development*, 18(3), 249-268.
- Robertson, H. A., & McGee, T. K. (2003). *Applying Local Knowledge: The Contribution of Oral History to Wetland Rehabilitation at Kanyapella Basin, Australia*. *Journal of Environmental Management*, 69(3), 275-287.
- Salick, J., & Byg, A. (2007). *Indigenous Peoples and Climate Change*. Tyndall Center for Climate Change Research, Oxford.

- Sarto-Mensah, P., & Oduro, W. (2007). *Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review Of Local Concepts And Issues On Change And Sustainability*. Available at <http://www.feem.it/userfiles/attach/Publication/NDL2007/NDL2007-090.pdf>. Accessed: on 15 March 2016.
- Schneider, S.H., Semenov, S., Patwardhan, A., Burton, I., Magadza, C.H.D., Oppenheimer, M., Pittock, A.B., Rahman, A., Smith, J.B., Suarez A. and Yamin, F., (2007). Assessing key vulnerabilities and the risk from climate change. In: In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Eds). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II To The Fourth Assessment Report Of The Intergovernmental Panel on Climate Change*, 779-810. Cambridge: Cambridge University Press.
- Silvano, R. A., & Valbo-Jørgensen, J. (2008). *Beyond Fishermen's Tales: Contributions of Fishers' Local Ecological Knowledge to Fish Ecology and Fisheries Management*. *Environment, Development and Sustainability*, 10(5), 657-675.
- Somorin AO (2010) *Climate Impacts, Forest-Dependent Rural Livelihoods and Adaptation Strategies in Africa: A Review*. *African Journal Environ Science Technology* 4(13):903-912.
- Steiner, K. G. (1998). *Using Farmers' Knowledge of Soils in Making Research Results More Relevant to Field Practice: Experiences From Rwanda*. *Agriculture, Ecosystems & Environment*, 69(3), 191-200.
- Storkerson, P. (2009). *Experiential Knowledge, Knowing and Thinking*. Paper Presented At *EKSIG International Experiential Knowledge Conference*, London Metropolitan University, London, UK.
- Sullivan, S. (2000). *Getting the Science Right, Or Introducing Science In The First Place? Local 'Facts', Global Discourse-'Desertification' In North-West Namibia*. P. Stott, S. Sullivan (Eds.), *Political Ecology: Science, Myth and Power*, London: Arnold.
- Trimble, M., & Berkes, F. (2013). *Participatory Research Towards Co-Management: Lessons From Artisanal Fisheries In Coastal Uruguay*. *Journal of Environmental Management*, 128, 768-778.
- United Nations Educational, Science and Cultural Organization (UNESCO) (2009) *Climate Change and Arctic Sustainable Development: Scientific, Social, Cultural And Educational Challenges*. UNESCO.
- Warren D.M. (1992). *Indigenous Knowledge, Biodiversity Conservation and Development*. Keynote Address at International Conference on Conservation of Biodiversity in Africa: Local Initiatives and Institutional Roles. Nairobi, Kenya, 30 August-3 September.
- World Bank (2013). *FISH TO 2030: Prospects for fisheries and aquaculture*. Agriculture and Environmental services discussion paper 03. World Bank report number 83177-GLB. Available at <http://www.fao.org/docrep/019/i3640e/i3640e.pdf>. Accessed: on 12 March 2016.