Responding to climate change through joint partnership

Insights from the Okavango Delta of Botswana

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Abstract

Purpose – Climate change continues to pose a serious challenge to mankind. Given their socio-economic and vulnerable situations, resource-poor farmers will be hard hit and likely to be the most affected group in Africa – a continent that will bear the full brunt of inclement weather conditions. The purpose of this paper is to address the questions of how local farmers read and predict the weather, and how best they can collaborate with weather scientists in adapting to climate change and variability in the Okavango Delta of Botswana.

Design/methodology/approach – A multi-stage sampling procedure was employed in sampling a total of 592 households heads (both men and women) in eight rural communities in the Okavango Delta, Botswana.

Findings – Analysis indicates that about 80 per cent of the farmers had a good knowledge of weather forecasting. In a knowledge validation workshop organised and implemented in early August 2012, farmers and scientists identified a nine-point agenda and strategies for addressing the challenges posed by climate change to community well-being and agricultural production. Knowledge sharing, installation of community weather stations and local-level capacity building are amongst the strategies identified.

Research limitations/implications – The research is only limited to the Okavango Delta, Botswana.

Originality/value – The paper emanates from original field research. The outcome of the paper provides pertinent information for policy formulation on how best to enhance small farmers' adaptation to climate change.

Keywords Innovation, Sustainable development, Diffusion, Development, Climate change, Development policies

Paper type Research paper

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Introduction

Over the years, resource-poor farmers have continued to face the challenges of climate change and variability in rural communities across the globe. Given their poor socio-economic conditions, Sub-Saharan African countries will bear most of the burden of the changing weather scenarios. Indeed, continental Africa has been tagged as a "vulnerability hot spot" for climate change (Schaeffer *et al.*, 2013). Nonetheless, equipped with local insights in weather forecasting (Ouma, 2009; Onyango, 2009) which gives them the ability to make informed decisions on agricultural practices, small farmers have had to grapple with abrupt weather changes in the past decade. From epistemological and contextual perspectives, indigenous or local knowledge distinguishes the knowledge developed by any given community from international knowledge systems or scientific knowledge (Warren, 1991; Kolawole, 2001; Ifejika Speranza *et al.*, 2010). Community people and farmers thus have an array of internally developed knowledge systems for addressing diverse issues relating to their well-being (Warren, 1991; Rajasekaran *et al.*, 1991) and "regardless of the degree to which they have embraced modernity, [they] continue to prefer concrete knowledge, which belongs to them in time and space" (Kolawole, 2001). More often than not, community people do this to achieve their local-level development objectives, including natural resource management, sustainable agricultural production and climate change adaptation. The theoretical framework of this paper finds relevance in the usage preference theory of indigenous knowledge (Kolawole, 2012), which highlights the reasons why rural community people continue to prefer and perpetuate their knowledge in the midst of burgeoning modernisation and modernity. Finding ways to achieve integrative weather forecasting knowledge is the thrust of a stakeholders' workshop organised for local farmers, weather scientists, community people and other interest groups in August 2012 with a view to devising the best approach to combat climate change and variability in the Okavango Delta of Botswana.

The paper therefore addresses the questions of how local farmers read and predict the weather, and how best they can collaborate with weather scientists in adapting to climate change and variability in the delta.

Methodology

Study area

The Okavango Delta is a globally renowned Ramsar site. It is characterised by permanent watercourses, seasonal floodplains and islands and a range of wildlife and vegetation species. The Okavango River in Ngamiland District is part of a larger northern drainage system that includes the Chobe and Linyati river basins. The Okavango Delta system thus provides perennial water sources that support riparian and non-riparian livelihood activities (see Figure 1). The district is divided into two administrative entities, namely, Ngami and Okavango sub-districts.

The provisional population figure of Ngamiland District (both east and west) in the 2011 population census result is 137,593 people with an annual growth rate of 1.9 per cent (CSO, 2011). The district is characterised by a multi-ethnic setting with a diversity of cultures and ethnic groups who pursue various livelihoods and use resources differently. Some of the ethnic groups include Batawana, BaYei, Hambukushu, BaSarwa, BaXhereku, BaSubiya and BaKgalagadi. While the majority (75 per cent) of the farming activities in this area rely on rain-fed agricultutre, about 25 per cent of farming activities are based on the use of inaundated flood plains locally known as molapo farming (VanderPost, 2009). This traditional farming system is found in the flood plains

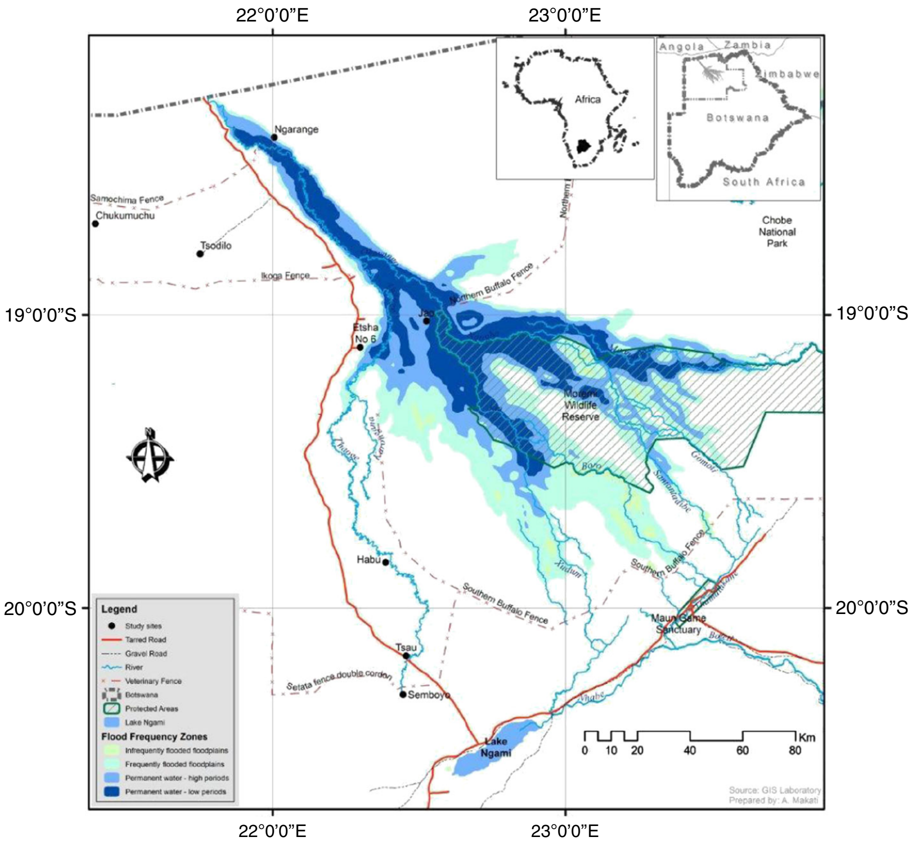

Figure 1.
A map showing the distribution of riparian communities and water channels in the Okavango Delta as well as the communities studied

Source: © Okavango Research Institute, University of Botswana (2011)

and at the western and southeastern fringes of the delta, mainly Gumare/Tubu and in the Shorobe-Matlapaneng/Maun area (see Figure 1).

Measurement of variables

Variables were measured for the purpose of statistical computations. For example, age was measured by the number of years of the farmer. Education level was measured by assigning scores at different levels from "no formal education" (no point assigned); "adult class" (1 point); "primary education" (2 points); "secondary education" (3 points); to "tertiary education" (4 points). Number of years in which a farmer had engaged in farming was assigned a score on that basis. The score assigned to sources of weather information was also based on the number of sources from which the farmer derived his or her weather messages. Knowledge of weather forecasting was based on the average computed for the farmer through a set of eight Likert items/statements rated from 1-5 points (Carifio and Perla, 2007; Glass *et al.*, 1972). A farmer's decision on farming practices was assigned a score based on the use of local knowledge (1 point), western knowledge (1 point) or a combination of both (2 points). The respondent's average score on perceptions on local and scientific knowledge was computed using a set of 11 Likert items/statements rated from 1-5 points (see also Carifio and Perla, 2007; Glass *et al.*, 1972).

Sample size and data collection

Using a multi-stage sampling procedure, a total number of 592 farming households heads were sampled from eight rural communities in the Okavango Delta (see Table I). A fair representation of the population was ensured by sampling three communities from the distal area (Semboyo, Habu and Tsau); two from the mid-Delta area (Jao and Etsha 6); and three from the upper panhandle area (Ngarange, Tsodilo and Chukumuchu). The respondents were interviewed using a pre-tested closed and open-ended interview schedule. A key informant approach was used to elicit qualitative data from farmers in our preliminary survey.

Results and discussion

Farmers' demographics

The demographics of farmers ($n = 592$) were analysed to determine their socio-economic and other characteristics in relation to their well-being and survival. Analysis reveals that 36 per cent of the respondents were males and 64 per cent were females indicating that majority of farmers in the area are women. The average age of the respondents were 51.06 years. Nonetheless, a fairly significant proportion of the farmers (24.8 per cent) were older than 65 years. The data indicate that able-bodied youths who are <40 years are probably not actively involved in farming in the area. While 43.8 per cent of them never attended any formal or non-formal education system, only 3.2 per cent had post-secondary education. Some 18.4 per cent obtained Secondary School Certificate while only 5.1 per cent never finished secondary education. Only 5.4 per cent of the farmers attended adult literacy class. Generally, most farmers in the study area did not acquire requisite (formal) education. The average household size is about four persons. The average income in Botswana Pula (BWP)[1] of the farmers is BWP620.02 per month. While 72.8 per cent earned less than BWP500.00 per month, only 0.2 per cent of the farmers earned more than BWP9,000.00 per month. The analysis indicates that farmers in the Okavango Delta are low-income earners.

Sr. no.	Village	Total number of households (HHs)	25-30 per cent of households (HHs)
1.	Semboyo	118	30
2.	Habu	161	40
3.	Tsau	494	124
4.	Etsha 6	821	221
5.	Jao	63	19
6.	Ngarange	332	95
7.	Tsodilo	78	23
8.	Chukumuchu	128	40
	Total	2,195	592

Source: Field survey, 2011-2012; CSO (2011)

Table I. Villages and total number of households sampled for the survey

Farmers' ethno-meteorological knowledge

Farmers were analysed based on their knowledge of ethno-meteorology[2]. Well over 70 per cent of them affirmed that they could predict the abundance or scarcity of rains in a farming year through personal experience. Some 49 per cent of the respondents either agreed or strongly agreed that they could discern whether it is going to rain or not at a particular time through mere smells of the environment. About 82 per cent opined that they could predict the possibility of precipitations by listening to the chirpings of some birds and sounds from certain insects. Also, 61 per cent of the farmers "[…] make necessary decision to overcome any weather problem as required and deemed fit". Most farmers ($\sim$75 per cent) acknowledged that they could predict whether it will rain or not through certain plants. A great majority ($\sim$94 per cent) of the farmers either agreed or strongly agreed that their forefathers from whom they acquired farming experience have had long standing and proven experience of weather forecast from which they have benefitted. About 79 per cent agreed that they could predict the occurence of rains by observing the gathering of clouds in certain directions and 63 per cent of the respondents affirmed that they could predict the abundance or paucity of rains based on the pattern of early rains in a farming year. About 74 per cent of them also agreed and strongly agreed that they were able to discern, through certain symbols/signs, whether there will be excess or scarce rains in a given farming year. Only 29.4 per cent of the farmers either agreed or strongly agreed that they could predict whether it will rain or not by observing star constellations. Whereas approximately 54 per cent of the respondents either agreed or strongly agreed that they were able to predict the extreme of temperatures in a given farming year through personal experience, 60.1 per cent of them either agreed or strongly agreed that they observed the sequence of yearly weather events to determine the climate pattern in a particular farming season.

The analyses suggest that farmers use diverse animate and inanimate objects, and items to predict the weather. Overall, analyses show that local farmers have the ability to forecast weather events in their immediate environment. Key informant interviews conducted in some of the communities provide vivid information on the specifics of how local farmers predict the weather in a given planting season. A few of these are presented in the following sub-sections.

Linking indigenous hydrological knowledge and climate change. Community people in the Okavango Delta mainly rely on the Okavango River for their livelihoods and everyday survival. Climatic and weather changes in the upland plains of Angola, where the Okavango River derives its water flow, affect the volume of water received in any given hydrological cycle. The recent events and fluctuations in weather scenarios have impacted significantly on the livelihood systems of the riparian communities in the delta. Over the years, community people continue to link certain hydrological indicators with the impending weather conditions in any planting season. For instance, a community chief in Ngarange community remarked that:

> […] the cyclical flow of water in the river channels suggests a looming season of rainfall scarcity – it is a bad omen for small farmers. Nonetheless, a year of plentiful rainfall is imminent when the Okavango River flows freely and in a one-directional manner, too. We then know that the year portends good things for agricultural production (Ngarange community headman – Mr Johane Keemetse).

Combined with other natural indicators such as wind flow and speed, cloud cover, lightning intensity, bird and animal movement, star constellation, temperature, flowering plants, etc. farmers make informed decisions based on their observations of the environment in any given season. Adapting to inclement weather conditions suggests a shift in planting calendar and crop types. For example, crops that have long maturity periods are planted during years of abundant rainfall while those with short maturity periods are grown during years of low rainfall. Arguing from a spiritual dimension, the Ngarange community elder, while supporting the viewpoints of another community chief in Etsha 6 settlement, pointed out that certain community elders have the sole responsibility of predicting the rains. They also engage in special prayers for precipitations after reviewing the year in the month of August; and this is done through dances and divinations.

Gender dimension of weather prediction and indigenous hydrological knowledge. As observed earlier, local farmers, particularly the women, have a startling hydrological knowledge as a part of their weather knowledge repository. One of our preliminary surveys in the Panhandle of the Okavango Delta provides a clear example of this. A village elder and leader remarked:

> In Bogakhwe tribe, women are crop gatherers and selectors. They use tubers most of the time. Women are able to determine the amount of atmospheric water (humidity) in relation to soil capillarity vis a vis the size of tubers they harvest in a given period. To them, the weather is dry if the sizes of tubers harvested are small and appear shrunk. Big sizes of tubers, however, suggest a wet year with high atmospheric humidity (Mr Johane Keemetse in Ngarange).

The logic and science of this reasoning is that dry weather conditions results in the extraction of water from all available sources, wherever and whenever possible. Thus, in dry conditions, water is easily extracted from root tubers in the soil, which invariably causes the tubers to shrink, consequently leading to a reduction in tuber sizes.

Farmers' perception about the nature of local and scientific weather knowledge

Analysis was carried out to examine and determine farmers' viewpoints on the nature of both local and western knowledge in weather forecasting and how effective they thought the two bodies of knowledge are in predicting weather conditions. Essentially, while some of the Likert items/statements used as the units of analysis favour both knowledge systems, some from another perspective disfavour the two forms of knowledge. Nonetheless, most of the statements are more sympathetic towards the efficacy of local knowledge. The Likert items, which were rated on a five-point Likert scale of 1-5 were constructed based on literature (Ifejika Speranza *et al.*, 2010; Orlove *et al.*, 2010) and preliminary field observations in farming communities in the study area. The grand average for the farmers was 3.86 with a standard deviation of ± 0.58. The relatively high value obtained by the farmers suggests that they had positive perceptions about their knowledge systems.While about 45 per cent of the population agreed or strongly agreed that scientific weather forecasting is unreliable, about 49 per cent felt otherwise. Nonetheless, our preliminary investigations with some key informants indicate that local people have a strong opinion that their weather knowledge is more reliable than those of the climatologists as they know nothing about weather "science". This claim supports Onyango (2009) and Ouma's (2009) viewpoints on the effectiveness and reliability of local knowledge in weather predictions. While 61.5 per cent of them either agreed or strongly agreed that scientific weather forecasting is complex compared to ethno-meteorology, about 84 per cent of the the farmers agreed that the production of the two forms of knowledge involve the processes of observation, experimentation and validation. About 94 per cent of the population either affirmed that "[…] local knowledge in weather prediction does not need any sophisticated tools or equipment to do the job" as it applies in scientific weather forecasting. Also, 82.4 per cent of the farmers agreed that formal education or training is not needed to acquire skills in local weather forecasting unlike, what obtains in scientific weather prediction. About 90 per cent of them either agreed or strongly agreed that using local knowledge for weather prediction requires little or no financial investments as comapred to scientific weather forecasting. From another perspective, 59.4 per cent of the farmers agreed that the two bodies of knowledge are dissimilar. Also, 56.4 per cent agreed that local approaches to weather prediction is always accurate and as such are the best in making the right decisions in farming activities. Nonetheless, 93.4 per cent of the farmers affirmed that ethno-meteorology is to a large extent spiritual, unlike scientific weather forecasting, which is purely secular in nature.

Pearson product moment correlation reveals that age ($r = 0.209$; $p \leqslant 0.05$), education level ($r = -0.109$; $p \leqslant 0.10$), number of years engaged in farming ($r = 0.105$; $p \leqslant 0.05$), sources of weather information ($r = 0.177$; $p \leqslant 0.05$), knowledge of weather forecasting ($r = 0.392$; $p \leqslant 0.05$) and farmer's decision on farming practices ($r = -0.464$; $p \leqslant 0.05$) had significant correlation with the respondents' perception about the nature of both local and scientific weather information (Kolawole *et al.*, 2012).

Nonetheless, our preliminary investigations suggest that farmers desired to find a suitable platform where they could work with agro-climatologists/weather scientists with a view to effectively adapting to climate change and variability.

How farmers produce weather knowledge

Farmers were analysed on the basis of how they produced local weather knowledge. About 61 per cent of the respondents claimed that they engaged in context-specific observations and local experimentation to produce weather knowledge, and also relied on many years of experience with their immediate environment to generate weather knowledge. Whereas about 13 per cent of them claimed that they relied solely on local procedure in weather forecasting, 7.4 per cent were of the opinion that they care less about the existence of scientific weather information/knowledge. This is possibly because the majority of the farmers do not have access to scientific weather information. One key informant in Etsha 13 community lamented that they had not interacted with the Department of Meteorological Service (DMS) officials or even heard any information from them except when an individual accidentally came into contact with them through the radio or television. Possibly due to their lack of access to regular information from the DMS, most farmers constantly interact with the natural phenomena around them to generate weather knowledge.

Strategies for addressing the challenges posed by climate change to community well-being and agricultural production

A knowledge validation workshop, which comprised farmer groups and representatives, community chiefs and elders, scientists and officials from the DMS and other stakeholders, was held in August 2012. The main objectives of the workshop were to validate the results and analyses of the social survey earlier conducted in selected communities in the Okavango Delta; and create a forum for all stakeholders to debate the issues on climate change and variability. Among others, nine pertinent issues identified as needing urgent attention are outlined:

(1) developing and strengthening of local capacity to empower communities to use weather instruments;

(2) creating platforms for bringing together all stakeholders in weather and climate issues, including the involvement of local communities;
(3) introducing and incorporating ethno-meteorology contents into the school syllabus/curriculum;
(4) expanding the scope of Meteorological Services across all districts;
(5) conducting more participatory research on indigenous weather forecasting;
(6) setting up committees dealing with weather-related matters comprising scientists, local communities' representations and other stakeholders, locally, regionally and nationally;
(7) training local community members in scientific weather forecast-related issues;
(8) establishing community-based weather stations, which are locally manned but externally supervised; and
(9) communicating effectively: dedicating important aspects of indigenous knowledge on weather-related matters in the national radio and television.

The nine-point strategies are condensed into eight major sub-sections.

Local capacity development

Local community empowerment and capacity development are not mutually exclusive. Participants therefore were of the opinion that there was a need to identify and train particular individuals within the local community who have the inclination and capacity to understand the basics of weather reading procedures, and who are able to use simple instruments of weather forecasting in guiding community actions and decisions. Participants believed that this could enhance community learning and action in climate change adaptation. This, however, cannot be fully realised without a close and regular supervision of weather scientists and officials of the DMS who are particularly dedicated for the purpose.

Stakeholders' platforms

Transforming exchanges occur where people are rightly engaged in meaningful discussions during which ideas are exchanged between people pursuing a common goal. Participants suggested that scheduled meetings and workshop sessions are the right forums through which local farmers and artisans, scientists, agricultural extension workers and other stakeholders could exchange useful ideas on climate change and variability. Doing so will enable stakeholders to identify commonalities of both western and local knowledge in weather forecasting. It will also enable them identify challenges associated with weather prediction and the dissemination of information, and also enable stakeholders to determine the right approach to surmount those challenges.

Incorporation of ethno-meteorological studies in the school curriculum

One major strategy for entrenching and recognising the usefulness of local knowledge infrastructures is by mainstreaming them in the school curriculum of colleges and universities (Kolawole, 2005). Community members who participated in the climate change research workshop suggested that there was a need to teach ethno-meteorology as an important component of climate change subjects in schools at all levels. Apart from recognising the knowledge of community people, these infrastructures are in that manner perpetuated and by so doing enhance sustainable development.

Expansion of DMS services scope
The effectiveness of any information is partly a function of the channel through which it is conveyed and how the message is related to the end-users (see Berlo, 1960; Lee, 1993). Farmers and other community people therefore suggested that the DMS needs to ensure the expansion of the scope of its activities across Botswana.

Participatory research on ethno-meteorology
In addition to the current research initiative, which brought stakeholders together to debate climate change issues, participants at the workshop agreed that there was a need to conduct more community-oriented and dedicated research on issues in local weather forecasting. This stems from the understanding that there are diverse ethnic groups and sub-cultures in the Okavango Delta and Botswana in general; addressing the specifics of the knowledge of these ethnic groups in a more detailed manner will go a long way in enhancing people's better understanding and appreciation of ethno-meteorology in Botswana's rural communities. The involvement of local community people in the research process will also enhance the credibility and usefulness of community knowledge systems at the national level.

Climate change committees
Effective co-ordination of development activities are better enhanced through the formation of committees at various levels of government – local, regional and national. Coordinating weather-related issues and information can prove to be an uphill task where stakeholders are not properly organised and informed about adaptation strategies and measures for alleviating the problems arising from abrupt weather changes. The participants, therefore, suggested that there was a need for committee formations, which comprise scientists, local communities' representatives and other stakeholders at all levels where pertinent climate change and variability issues and information are promptly debated and coordinated.

Establishment of community-based weather stations
This is closely linked to community empowerment and capacity development. Thus establishing weather stations in designated local communities associated with indigenous weather reading and predictions will serve as a laboratory for participants to practically share ideas and viewpoints about the prevailing climatic conditions. Not only will this help in fostering effective interaction between scientists and local community people, it will also enhance local capacity development and weaken the apprehension existing between local people and scientists in relation to development issues in general.

Effective communication
This also has a direct bearing on the expansion of the scope of activities of the DMS. The channels through which information is communicated could make or mar the effectiveness of the message meant for the end-users (Berlo, 1960; Lee, 1993). Participants at the workshop therefore opined that government would need to ensure that dedicated programmes on ethno-meteorology are scheduled and broadcast on a regular basis in order to create a better awareness and entrench local people's knowledge in weather forecasting.

Conclusion
The paper presented an analysis of the perceptions of farmers on the nature of local and scientific weather knowledge as they affect farming decisions in an era of

changing climatic conditions. The farmers studied are predominantly women. Although the average age of those engaged in farming in the population was about 51 years, a significant percentage of the population was older than 65 years. The results suggest that people under 40 years are not actively engaged in farming activities. This has a serious implication for agricultural development policies. Generally, local farmers relied on many years of experience with their immediate environment to generate weather knowledge. About 90 per cent of them were of the opinion that the production of local knowledge in weather forecasting needed no capital investment; neither did it need any sophisticated equipment. In addition, the majority (57.2 per cent) of the farmers felt that scientific weather forecasting should complement the local approach in weather reading and prediction.

Age, education level, number of years engaged in farming, sources of weather information, knowledge of weather prediction and a farmer's decision on farming practices had significant correlation with his or her perception about the nature of both local and scientific weather information. Acknowledging that these factors are crucial for policies and decision making in weather information dissemination, there is a need to address issues on community capacity development, effective weather message communication, creation of suitable platforms of engagement for both local farmers and weather scientists, and mainstreaming of local knowledge (including ethno-meteorology) in national and educational policy issues.

Notes

1. US$1 exchanges for about BWP8.9 at the time of writing this paper.
2. Ethno-meteorology is used interchangeably with indigenous or local weather forecasting knowledge in this paper.

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