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Indigenous methods of rainfall prediction among farmers and fisher-folks in Ethiope east local government area of delta state, Nigeria

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Abstract
Methodical documentation and consequent incorporation of Indigenous knowledge in seasonal rainfall forecasting is one of the promising ingenuities that need to be explored. Historically and to date, local communities in different parts of the world have continued to rely on Indigenous Knowledge (IK) to conserve the environment and deal with natural disasters. Despite these, indigenous method of weather and climate prediction is under threat of disappearance due to lack of coordinated research to investigate the accuracy and reliability of Indigenous Knowledge forecasting. This study therefore investigated the indigenous methods of rainfall prediction among farmers and fisher-folks in Ethiope East Local Government Area of Delta State, Nigeria. Specifically, the study aimed at identifying the indigenous bio-indicators used for rainfall prediction and the perception of farmers and fisher-folks on the level of reliability of indigenous knowledge compared to the conventional weather forecasting methods in the study area. Through a multi-stage sampling, 220 questionnaires were administered to farmers and fisher-folks randomly selected from 4 settlements with concentrated farming and fishing activities in Ethiope LGA. The study reveals that the farmers relied heavily on experiences obtained from the combinations of plant phonology, animals and insects' behaviors in predicting changing weather and Climate pattern in addition to using their knowledge of meteorological and astronomical indicators, as the farmers adjudged the method as very reliable with high degree of accuracy compared to the conventional weather forecasting method. The study thus conclude that IKS can provide significant value and boosts in the improvements of forecasting accuracy and reliability if analytically integrated in conventional forecasting system as the documentation of IKS will be a good resource for the establishment of effective adaptation strategies to lessen the impacts of climate change.

Keywords: indigenous methods, rainfall prediction, bio-indicators, Ethiope

Introduction

Studies on the use of Indigenous knowledge in the understanding and prediction of weather pattern by local communities have been brought into limelight in recent time. This is due to the burgeoning literatures (Robinson and Wallington, 2012; Chan, Yanda, and Ngana, 2010; Mutasa, 2011) [26, 7, 20] on the possible impact that indigenous knowledge could have in the understanding of weather pattern and its prediction which aids decision making, in relation to farmers' preparedness for changing weather phenomenon and, the planning of farming operations in an agrarian community. Prior to the introduction of conventional weather and climate forecasting, our forebear mostly in the rural communities, have essentially depended on homegrown knowledge to predict weather through the observation and monitoring the behavior of animals, birds, plants and insects. This is as a result of the predominantly agrarian nature of the rural communities whose fortune and all-round development largely depends on the sustainability of agricultural growth that is basically dependent on favourable weather and climate system.

Because agricultural activities are mainly weather and climate sensitive, productivity of crops largely rely on the apt and effective decision on what, when and where to plant, which in turn depend on the accuracy and reliability of seasonal rainfall forecasting. Notwithstanding the slight improvement in forecasting accuracy, evidence abound that the present-day forecasting accuracy from weather forecast, which is 75%, is very inadequate and the challenges are still numerous due to the strong spatial and temporal variability nature of rainfall (Ogallo, 1989; Nyenzi *et al*., 1999; Zorita and Tilya, 2002) [24, 22, 29]. Latest climate change forecast indicates increased climate variability in the context of climate change over most part of the world (IPCC, 2007) [14]. Resulting from the apparent weakness associated with the dissemination and inaccessibility of information generated from the convectional weather forecast to most of the rural people, the rural communities thus rely heavily on weather forecasting indicators derived from their environment to advantageously make decisions regarding their farming operations. A Study by Ajibade and Shokemi, (2003) in Nigeria reveals that farmers are able to use knowledge of weather systems such as rainfall, sunshine, thunderstorm, windstorm, and harmarttan (a dry dusty wind that

blows along the north-west coast of Africa), for the planning of farming operations and preparing for imminent changes in weather and climate.

Aside this, rural farmers in Nigeria widely relied upon indicators such as timing, intensity and duration of low temperature and wind characteristics, timing of fruiting by certain local trees, water levels in streams and ponds, insects and nesting behavior of small squall like birds in the environment etc. otherwise known as Indigenous Knowledge in the schedule of their farming activities. Indigenous knowledge (IK) thus refers to a systematic body of knowledge gained by people who settled in a specific location through accumulation of experience, information, experiment and intimate understanding of the environment (Robinson and Wallington, 2012) [26]. It reflects how people living in an area understand their environments and how they use that knowledge to enhance their lives (Islam and Banda, 2011) and socio-economic wellbeing. It is the accumulated knowledge, skills and technology of the local people gained from the direct contact with the environment (Tabuti and Van Damme, 2016).

The dissemination of conventional climate information in Nigeria is vested on the Nigerian Meteorological Agency who is charged with the responsibility of collating, collecting, processing, and disseminating all meteorological data and information to aid good policy in decision making. The agency is also charged with the responsibility of updating the common Nigerians on weather forecasts and predictions which is very helpful in the field of agriculture in the quest for the attainment of food sufficiency. The herald of the Nigerian Meteorological Agency (NIMET) has always been that farmers should listen to daily, weekly, and monthly forecast and consult appropriate and relevant authorities as part of their planning efforts. This of course is the ideal situation, however not all farmers, especially those in remote areas have access to the mode of climate information dissemination by NIMET such as radio, television and other means of communication through which they can be abreast or informed of the day to day conventional weather reports that is made available by this agency. Even if these peasant rural farmers have access to this information, interpreting and understanding those reports is not easy as it requires specialized skills. Faced with the above unfortunate situations, the use of indigenous methods of rainfall prediction which they (the farmers) are acquitted to remains the only way out for these farmers.

In spite of the overwhelming importance of Homegrown Knowledge in weather and climate prediction, field experience has shown that Homegrown Knowledge is under threat of extinction due to inadequate methodical documentation of the knowledge; lack of coordinated research to investigate the accuracy and reliability of Indigenous Knowledge forecasting and the dearth of the knowledge accumulated for several years due to the passing away of the custodian of such body of knowledge. The documentation of Indigenous Knowledge will be a good resource for the establishment of Indigenous Knowledge forecasting database aside being an important resource in the establishment of effective adaptation strategies that are cost effective, participatory and sustainable which could lessen the impacts of climate change by the peasants' farmers and fisher-folks.

Against the background that Indigenous Knowledge provides significant value and boosts in the improvement of forecasting accuracy and reliability, this study was therefore designed to identify, analyze and document local indicators used in Indigenous Knowledge forecasting in Ethiope LGA of Delta state, Nigeria and to assess the perceptions of the farmers and fisher-folks on the application and reliability of both Indigenous Knowledge and conventional forecasting in their agricultural and fishing activities in order to identify the needs for improvement.

1. Conceptual Clarification

According to Rajaskeran (1993), IKS are the systematic body of knowledge acquired by local people through the accumulation of experience, informal experimentations and intimate understanding of the environment in a cultural lens. Unfortunately, these local adaptation strategies have not been properly documented. Although the adaptive capacities of the local people in developing countries are low, it is a fact that such capacities have sustained the people over the years in their respective territories.

According to Mapara's (2009) [16] Indigenous Knowledge are bodies of knowledge of indigenous people of particular geographical areas that have survived on for a very long time. Those bodies are developed through process of acculturation and through kinship relationship that societal groups form, and are handed down to posterity, rites and oral traditions. Indigenous Knowledge is the glue that binds societies as they constitute communicative processes through which knowledge is transmitted, preserved, and acquired by humans in society. It is the basis for local-level decision making in many rural communities and in many countries.

Indigenous knowledge is a broad term that consists of the actual knowledge, skills and practices or method of doing things based on local materials developed through various types of experimentation and practical experience overtime by the people of the place adapted to the local situation. The term is used to describe the knowledge systems developed by a community as opposed to scientific knowledge (Ajibade and Shokemi, 2009) [3], which are linked to the communities that produce them, (Hammersith, 2007); those natural communities are characterized by complex kinship systems of relationships among people, animals, the earth, the cosmos etc. from which the knowledge emanates.

Indigenous Knowledge have been variously described as indigenous ways of knowing (Nyota and Mapara, 2008), traditional knowledge, indigenous technical knowledge, rural knowledge as well as ethno-science (people's science) (Altieri 1995). Indigenous knowledge system manifest themselves through different dimensions, amongst these are agriculture, medicine, security, botany, zoology craft skills and linguistics. In

Africa, indigenous knowledge system (IKS) was used to administer peace, harmony and order amongst people and their physical environment (Mawere, 2010) [17]. Though the importance of indigenous knowledge in agricultural sustainability has been brought into limelight, it is, however, only applied sparingly (Mutasa, 2011) [20]. This informed the basis for Muchena and Williams (1991) [18] proposition that there was a need for identifying, collecting, developing and incorporating indigenous knowledge into weather and climate forecasting. Thus, indigenous knowledge, experiences, culture and other social factors are reflected in the understanding and interpretation of information received from the surrounding environment and transforming it into physiological awareness. In this sense, the individual is a part of the system being perceived, and certainly moves within it, rather than being a passive outsider (Adeyanju and Esin, 2015) [1]. Traditional knowledge is built around how the local people sense, mentally process, and act on the patterns they perceive in space and time. Given that modern method of weather and climate forecasting could be expensive and time consuming for rural people, their local knowledge should be considered while predicting changing weather and climate pattern in order to avert imminent catastrophes and to respond to climate change.

The significance of integrating local peoples' knowledge into climate change policies is that the palliative methods adopted to respond to climate change impacts depend on how climate change is perceived by the indigenous people. Aside these, the response of indigenous people to measures aimed at reducing climate change impact depend on how they understand and relate these measures to their own context (Adeyanju and Esin, 2015) [1]. However, care should be taken in combining local and indigenous knowledge into climate change as IKS should not take the place of modern scientific knowledge but should rather complement each other.

Significance of Indigenous Knowledge in Climate Change

The growing awareness of the profundity and extensiveness of knowledge that exist in many indigenous societies and its potential value in addressing issues of contemporary significance has been identified by Goduka (2001). Miller (2005) underscored the concept of "ancestor-centrism" in indigenous knowledge which he noted as a binding force that recognizes the place of the ancestors in many unseen forces and actions that control elements of the universe resulting in new sets of relationships, which point to the essential balance and diversity that help the people to cope and adapt in their environment.

Chukwu & Chukwu (2002) [8] refer to the technical aspects of IK as folk science, and a combination of folk science and cosmovision as traditional wisdom. According to Haverkort (1999) peoples' cosmovisions give rise to several rituals in which the elders, the priests, soothsayers and spiritual leaders play a prominent role. Emeagwali (2003) opined that the African way of knowing seemed to be less transferable than conventional science, given its holistic, socio-cultural and even spiritual dimensions. Nagebu (2010), in his study of local knowledge in climate change assessment in the Kano region of Nigeria, found that the most significant information gathering exercise for local knowledge is oral traditions, namely the collective testimonies and recollections of the past in various forms of verbal testimonies. He advised that caution should be taken to analyze and differentiate between orally transmitted information that is myth, legend or of identified or unidentified origin. Traditional wisdom as an intellectual resource is therefore prone to erosion because of globalization/modernization trends and changes in religious beliefs. As the society changes, the younger generations tend to forget the technical and belief systems that enabled our forefathers cope with the vagaries of weather.

A commonly held view among Africans is that events such as agriculture can be influenced by the practice of seasonal rituals. Rituals are activities by which people urge the spiritual world to allow events to take place in the natural world (COMPASS, 1997). These rituals solicit the blessings of nature, ancestor spirits and the creator (God) in farming and farming-related activities such as preparation for planting, harvesting, transhumance practice and hunting. Elders and traditional leaders play significant roles in decision-making on agriculture and natural resources management. It is widely held that old age and closeness to the world of ancestors is associated with wisdom.

Reijintjes *et al*., (1994) bemoaned that the emphasis on Indigenous Knowledge is centered mostly on the technical aspects such as traditional intercropping, agro-forestry, and ethno-veterinary medicine. Less attention is paid to the worldviews and belief systems ("cosmovisions") that form the basis of these traditional practices. Cosmovision is defined as IK embedded in the spirituality and cosmology of the people. It includes the assumed relationships between the physical, spiritual, natural and human worlds (CECIK, 1996; Haverkort *et al*., 1999). Any disequilibrium in this relationship will spell doom for the human race. This concept is akin to eco-theology (Ituma, 2010) which is a theological standpoint that the earth is God's sacred design and should be protected, cared for and managed in an orderly and most circumspect manner that depicts the fear of God. Secondly, it is necessary so that human actions do not create imbalance in God's design. Thirdly, a deviance from protecting God's design may result in a chaotic and disastrous existence of human life. When people disregard eco-theology or cosmovision in any environmental setting in the quest for food and money, they work against themselves, not against God.

The Concept of Rainfall in Indigenous Knowledge System

Amid the elements of climate, rainfall receives the greatest attention in indigenous knowledge systems in Africa. This is so because many indigenous Africans link rainfall with spirituality and agriculture, which are the main factors that influence their socio-economic wellbeing and survival. Rain is regarded as one of the greatest

blessings of God, who is often regarded as the giver of rain. Many societies make sacrifices, offerings and prayers to God in connection with rain (Tabuti, 2005) [27] and rain makers abound in several communities in Africa. Their duties are to solicit for the creator's help in providing rain, or in halting it if too much rain falls. Similarly, wetlands are perceived as expressions of spiritual beings in Zimbabwe (Gonese, 1999) [12]. Gonese (1999) [12] asserted further that, spirit mediums make decisions about the use of wetlands and many taboos exist about felling trees, and use of water. In Ghana, Tengan (1991) [28] reported that among the Sisala of northern Ghana, the sky is closely associated with personified rain. According to them, rain as lightening is the source of 'hot death', rain as water brings coolness and fertility. The rainwater, though associated with the sky, is believed to come from the horizon, the meeting of sky and earth. Among the Burunge of Tanzania, Oestberg (1995) [23], reported that the people believe that rain brings soil. New soil is continuously being added to the land surface by wind-transported material, by rain containing soil particles and by decaying organic material, rising up from below. Mukamuri (1995) [19] reported that Shona people in Zimbabwe perceived rainfall as a component of soil fertility and rain making ceremonies are central in the cosmovision of Shona people. That belief is that ancestral spirits deal with rain and other climatic influences.

2. Indigenous Techniques of Weather and Climate Forecast Practices

Weather forecast is a significant cultural segment for farmers. Rural farmers' and fisher-folks depend on observation and the interpretation of specific phenomena, such as trees, behavior of birds, animals, sky and mountains etcetera which may be found in their surrounding environment. Observations of environmental indicators in weather and climate forecast by the rural people are based on their experiences which are largely leant from the elders, and their daily interaction on the street, at the market and with the family members which greatly influence their ability to observe and interpret these signs. The indicators which farmers rely on in the study area are the temperature during the dry season, the fruits production of some trees, the intensity and direction of the wind and the behavior of certain birds and insect throughout the year. These indicators are broadly classified into bio indicators and non-bio-indicators. Bio-indicators are those living beings/biotic agents which change their behavior with slight changes in environmental factors in their surrounding environment. Non bio-indicators are those non-living phenomena/materials that change in response to the change in the surrounding environment.

Materials and Methods

1. The study area

Ethiope east is one of the Seventeen (17) Local Government Areas in Delta State. The local government is located between longitudes $5^{o}00$ and 6^{0} 45' East and Latitude 5^{o} 00 and 6^{o} 30^{1} North. Isiokolo is the headquarters of Ethiope East Local Government Area which is one of the oil producing areas of the state. It was created out of the defunct Ethiope LGA and occupies a land area of about 380 square kilometres, with a population of 200,792 (NPC. 2006 Census), with over ninety per cent of the people being Urhobos. It is made up of two clans; Agbon and Abraka each headed by a traditional ruler. The main towns are Isiokolo, Kokori Inland, Orhoakpo, Okpara Inland, Ovu Inland, Okpara Waterside, Eku and Abraka. The people are mainly into subsistence farming, fishing and animal husbandry. The area has a tropical wet and dry climate, with a lengthy wet season and relatively constant temperatures throughout the year. The wet season runs from March through October, though August sees somewhat of a lull in precipitation. This lull nearly divides the wet season into two different wet seasons. The remaining months forms the city's dry season. Like a good portion of West Africa, the area experiences the harmattan between the month of November and February. The location of the study was in Kokori, Eku, Ovu and Okpara Inland.

2. Methods of Data Collection

Data for the study was collected through interview guided by the use of unstructured questionnaire. This was complemented by data obtained through focus group discussions, in-depth interviews and direct observation. Focus group discussions (FGDs) were employed to bring together all the farming households in the selected communities. Each focus group consisted of 5 farming and fishing heads' of households. Effort was made to ensure that the focus group discussions were as representative as possible, with specific attention paid to gender representation and age differential. The study population covers all the farming and fishing household heads in the study area. A population sample of 220 respondents was drawn from four (Kokori, Eku, Ovu and Okpara Inland) farming communities in the LGA. Multi-stage sampling technique was employed in selecting the representative respondents. The first stage was the selection of four (4) farming communities noted for large scale farming and fishing, while the second stage involves the random selection of 55 farming/fishing head of households in each of the selected communities for interview proportionally to their population thereby bringing the total number of sampled respondents to 220.

The selection of study villages was based on the accessibility to the respective villages and availability of extension officers. The study interviewed only heads of households, but where relevant information could not be provided by the head of households (assumed to be the decision-maker), their spouse or other household members were asked to provide such information. Respondents who had lived in the village for the past 15 years and preferably older than 30 years were mainly targeted. Interviews of the selected respondents were conducted in their homes using open- ended questionnaires; this gave them the opportunity to describe significant features

of their local weather forecast systems while detailing features that are more germane to them. Data on demographic characteristics and indigenous knowledge of forecasting the onset of the rain and dry seasons was collected. Since the data were mainly qualitative, descriptive statistical technique was employed in analyzing the data generated for the study.

Results and Discussions

Table 1: Demographic Data of the Sampled Respondent

Gender	No of Respondent	Percentage
Male	121	60.5
Female	79	39.5
Total	200	100
Age distribution		
15-21	1	0.5
22-35	10	5
36-60	77	38.5
61 and above	112	56
Total	200	100
	Duration of stay	
1-20 years	9	4.5
21-40 years	139	69.5
41-60 years	45	22.5
60 years and above	7	3.5
Total	200	100
Duration of farming		
1-20 years	26	13
21-40 years	139	69.5
41-60 years	35	17.5
60 years and above	----	-----
Total	200	100
Educational qualification		
Formal education	19	9.5
Primary school completed	24	12
Primary school incomplete	56	28
Secondary school completed	45	22.5
Secondary school incomplete	11	5.5
Tertiary school completed	40	20
Tertiary school incomplete	4	2
Total	200	100

Source: field work (2020)

The demographic and social economic characteristics of the respondents such as occupation, duration of stay in the village, duration of farming, and educational qualifications, all play a significant role in determining the understanding of home-grown knowledge relevant to weather and climate change prediction. Table 1 show that in all the four villages sampled, majority (60.5%) of the respondents are males while 39.5% are female. The preponderance of males in the farming villages is because the culture of the Orhobos arrogates farming responsibility solely to males. Virtually 94% of the respondents were aged 35 years above (Table 1) which constitute the focal target group for the study. This is so because farming/fishing in the Orhobos culture are exclusively carried out by the elderly. Literacy and schooling are important indicators of the quality of life as well as being key determinants of rural households' ability to better comprehend their culture and other social factors as reflected in their understanding and interpretation of information received from the surrounding environment and transforming it into physiological awareness. It is revealed in Table 1 reveals further that majority (62%) of the respondents had formal education which is very important in the understanding of their indigenous knowledge with respect to changing weather patterns and the indigenous methods employed in climate forecasting.

Figure 1 shows that majority (90%) of the respondents agreed to be aware of climate change (rainfall variation) while only (10%) claims not to be aware. A number of questions concerning climate change were asked using the Indigenous Knowledge of climate change (IKCC) questionnaire complemented by issues raised during the focus group discussions in order to explicate the rural farmers' understanding of climate change concept. Majority of the participants in the focus group discussions and respondents' in the 'IKCC' questionnaires consistently agreed that though they had never heard of climate change, they were however, aware of changes in climate variables and pattern. According to farmers' of Orhoakpo, the present weather condition is tough and has resulted to sickness, erosion of farm lands and intense flooding which threatens livelihood activities and the welfare of the people. The people claimed they are aware of climate change which, according to them, is indicated by poor harvests, long dry spells, excessive heat, change in rainfall pattern and shorter periods of

harmattan. The rural farmers' claimed that their farmlands and forests resources are degraded; and streams, where available, were significantly reduced in size, in addition to reduced fallow periods and diminished productivity of soils. Awareness of climate change (rainfall variability) will enable farmers to prepare themselves to adapt to the status quo by evolving numerous strategies to cope with the attendant adverse impacts of climate variation within their locality.

On the level of awareness of climate change by the farmers' and fisher folks', both participants in the focus group discussion completely demonstrated a high level of climate change awareness as they all agreed that widespread climate and environmental changes had occurred over the period that they have lived in the locality. It should, however, be noted that the artisanal fish farmers demonstrated extensive knowledge of the meteorological drivers of changing weather patterns than the farmers'. Majority of the rural farmers' based their knowledge of climate drivers on bio-indicators. The farmers' averred that the present weather conditions are bad as indicated by hot sun, unstable rainfall, lack of harmattan season, etc. According to them, compared to 30 years ago, there is an increase in amount of rain, rainfall intensity, rain fall frequency, sunshine intensity; wind speed and decrease in harmattan period; August break, rainy season and dry season periods are no longer definable. They lamented that their forests, land and soils are degraded; fallow periods have shortened from about four years to about two years and in some cases fallows have been completely eliminated. The commonly held belief among the participants in the focus group discussion is that the rainfall amount has increased significantly, which has impacted negatively on their socio-economic wellbeing as several expanse of their farmlands are made vulnerable to flooding with attendant decrease in crop yield.

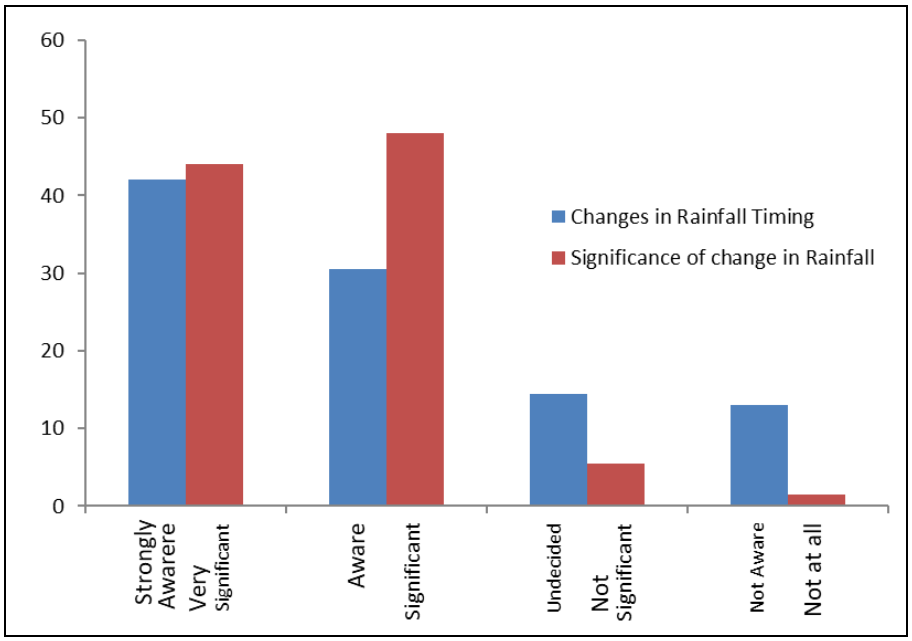

Fig 1: Farmers' Knowledge of Rainfall Variation in Ethiope LGA

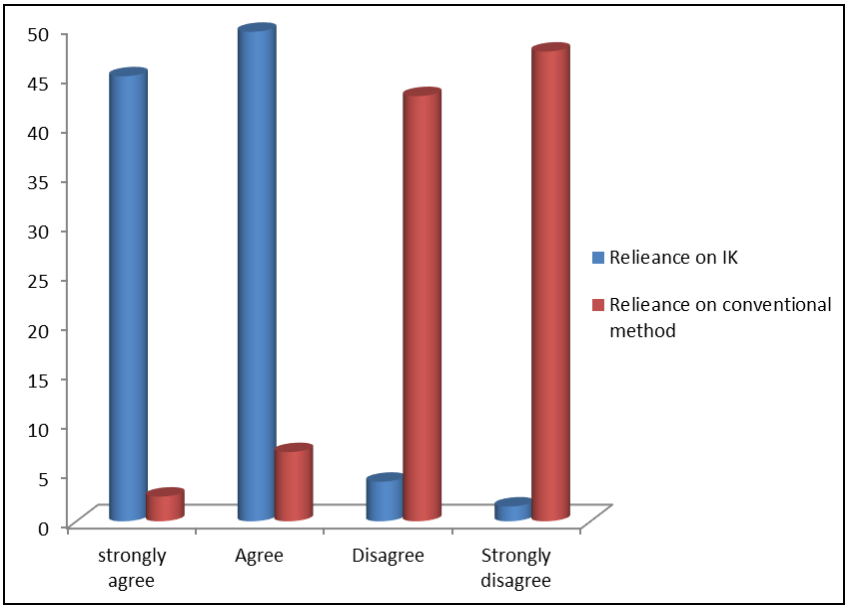

Fig 2: Methods of Weather/Climate Change Knowledge and Forecasting

The sources of information on climate change for both farmers' and artisanal fish farmers' are presented in Fig.2. It is clear in fig.2 that both farmers' and fisher folks' relied extensively on Indigenous Knowledge in accessing climate change information. This is expected to be so as it was observed during the field survey that climate information from the conventional source is not readily available to both the farmers' and fisher folks to enable them get the right kind of services to increase their adaptive capacity. Even where available, the rural farmers' and fisher folks find it difficult to understand the format in which the climate information from the conventional weather stations are presented to the ruralites, hence their over reliance on indigenous knowledge. The common response of both participants in the focus group discussion is that they do not have an information source supplying them with climate data. Although considerable number of the farmers' claimed to have radio and television set, they were however, of the opinion that they relied heavily on climate information obtained through Indigenous methods. Discussants in the FGD as well as key informants recounted that in the absence of climate information institutions and irregularity of the 'news' on weather from radio stations, they relied more on their peers for climate information. Within the artisanal fishing communities, the artisanal fisher folks and divers, they claimed, were their major sources of climate information. Asides these sources of information, the farmers' claimed that they were also able to discern current changes in weather pattern in their community and compare same with the past from their personal experiences which enabled them make judgment on how the prevailing climate situation is.

It was observed that climate institutions such as weather stations and meteorological stations did not appear on the mention of sources of climate information of the rural farmers', indicating that the institutions do not make information available to the farmers'. Further observation shows that extension agents do not act as climate information sources to the farmers' and artisanal fisher folks. **T**his validates the position of Aklilu (2007) that information about climate change in Africa is still confined within the academia and research institutes and as a result many local farmers though aware of it, lack sufficient knowledge about it.

Table 2: Bio Indicators of Rainfall Prediction

S/n	Local Indicator/Behavior	Local Names	Rain Type	Explanation
1	Return of migratory birds	*Eferefe*	Short	The migration of these birds from N-S is a sign of approaching raining raining season while from S-N marks the end of the rainy season.
2	Singing of certain types of birds	*Okareko*	Short	Sign of imminent rain
3	Movement of termites in row	*Imophopho*	Short	If both atmospheric and soil surface humidity are high, termites move in large numbers in rows since rain is expected when humidity is more. These termites are believed to indicate rain in a few hours.
4	Dogs barking continuously	*Erako*	Short	Due to the release of heat from water vapor into the atmosphere, cloud formation takes place resulting in restlessness among dogs indicating imminent rain.
5	Chirping of birds	*oka*	Short	When these birds move at height above 0-5kms, they sense the upper air wind and chips. Usually, rain bearing clouds occur at heights between 0.5-2.5km because of the sensitivity response of these birds to the winds, farmers employ it to predict rain.
6	Frogs croaking underneath stones and leaping of small frogs	*Ogoro*	Short	Frogs under stones become restless because of deficient oxygen and come out from the hole for want of air, hence they croak indicating impending rainfall.
7	Movement of black ants in row	*esakpa*	Short	Increase in humidity triggers the process of carrying their eggs by the black ants to a safer place. This process is observed by thousands of ants moving in a stream thereby indicating looming rain.
8	Squeaking of owls	*ahe*	Short	Owls are blind to light but sensitive to humid conditions. The fear of increasing humidity and heat released by clouds instigates restlessness among owls. The peculiar squeaking sound of owls has been attributed to be an indicator of rain.
9	Positioning of nest by weaver birds	*Orioka*	Long	When the nest of these birds hang high on trees, it indicates that the raining season will

				be heavy, and when the nest hangs low, it indicates a low or short raining season.
10	Movement of dragon flies	*rha*	Short	When humidity reaches saturation, a couple of hours before, dragon flies move in swarms signifying rain.
11	Flapping of ears by goats	*evwe*	Short	Increasing moisture causes uneasiness and sweating to goats leading to the flapping of ears by the goats indicating imminent rain.
12	Flocking of sheep and goats	*Oghewekoko*	Short	When low clouds are formed, enough energy is released from water vapor resulting in the formation of excess heat which cannot be tolerated by sheep and goats; hence they form flocks indicating impending rain.
13	Fishes jumping into air frequently	*Pho uwo*	Short	This signifies the onset of rainfall.

Source: Fieldwork (2021)

It is evident that local weather and climate is assessed and predicted by rural people through locally observed variables and experiences using combinations of plants, animals, insects, and meteorological and astronomical indicators. The different weather and seasonal climate indicators used to predict rainfall in the Ethiope LGA are sampled and summarized in Tables 2 to 3.

Table 1 show that animals' behavior and the appearance and movement of birds and insects are often employed by elders in the study area to predict changing weather and climate patterns in their communities. For instance, it is widely believed that the migratory tendency of the white and black stock is associated with the oncoming dry season. Recent scholars have reported that many animals' species undergo movement of varying distance depending on the prevailing rainfall pattern. An example of birds whose presence is rain associated in the study area is the weaver bird. The chirping, singing, positioning of nests and the returning of these birds and others depicts imminent rain. This corroborates the assertion that the presence of some birds such as the woodland kingfisher of West Africa, the swallow and the white and black stock are rain associated (Wikipedia, 2006). The local type of kingfisher is associated with heavy falls within days of its appearance, as the understanding is that the nature of the sound that it produces resembles clattering of rainfall drops which is a characteristic of a heavy downpour. Land preparations and precautionary measures are adopted as a safeguard from impending storms that could be linked to the expected rains. Over, the emergence of ants from their holes in large numbers to collect food from homes and vend is known to be associated with an impending long wet spell in the study area. The ants disappear less than twenty- four hours before the storm. Ants' behavior triggers farmers to collect firewood to dry places in preparation for a long wet spell. Ant behavior has long since been regarded as a portent indicator of rain to come (Australian Broadcasting Corporation, 2006). If ants seem hyperactive or if they build high walls around the entrances to nests then it will rain and seeing them in strange places like ceiling or ice chest was another sign of rain (Australian Broadcasting, Corporation, 2007). Similarly, the sight and sound of a lot of croaking frogs is indicative of an imminent wet spell. It was also revealed during interactive session with a cross section of the farmers' that, intense thirst and a high frequency of drinking water by human beings is a sign that rain will fall. However, the period superseding this behavior and the coming of rains was not detailed.

The flapping of ears by domestic animals such as goats and the flocking by sheep and goats among others is also used in seasonal forecast and disaster prevention in Ethiope LGA. Increasing moisture causes uneasiness and sweating to goats leading to the flapping of ears by the goats indicating imminent rain. It was further revealed by the farmers' at interactive session that when game animals give birth in large numbers, it signified a normal to above normal season and the reverse is true. This is in line with the observation by Mount (1979) that most tropical animals become fertile when day length is short so that they pastorate in summer when food is abundant. Again, it is evidenced in Table 1 that the nesting of some birds such as the weaver birds indicates imminent rain. This is also established in some parts of Nigeria. For example, in northern Nigeria, Fulani herders during the pasture of their animals watch the nesting of a quela-like bird called gado in Hausa. When its nest hangs high on trees, the rainy season will be heavy and when its nest hangs low, the rainfall will not be much. The jumping and running of cattle during pasture indicate possibility of rainfall. Many Fulani herdsmen believed that cattle anticipate rainfall a few hours early by sensing a cool breeze developing few hours before rainfall starts. The movement of ants/termites in the study area is said to indicate looming rain. Study has shown that similar bio-indicator is also employed in predicting imminent rain in northern Nigeria. The movement of black ant (*Tururuwa*) in a row is a sign of rain because increase humidity triggers the ants to carry their eggs to a safer place. Once this change of behavior is observed among the ants, rain may likely fall in short period. Other Fulani herders believed that the biting nature of flies is a sign of imminent rain; they observed that flies become active whenever atmospheric humidity reaches saturation. The flapping of the ear by goats is a sign that rain may fall because increasing humidity causes uneasiness and sweating of goats; hence trigger flapping their ears. The movement of dragon flies is also used as an indicator of imminent rainfall, because when humidity reaches saturation for a couple of hours, dragon flies move in swarms indicates imminent rainfall. The people of Ethiope also used the arrival of migratory birds (*Eferefe*) from the north to the south as indicator of approaching raining season and its movement from south to north as a sign of end of rainfall. Literature search has revealed that the

Hausas also use the arrival of migratory birds (*Cilkowa*) from the north to the south as indicator of approaching raining season, and its movement from south to north is a sign of end of rainfall season. Furthermore, the movement of "*Shamuwa*" a long neck bird from east to west is also a sign of approaching raining season.
The singing of the bird (*Okareko*) and the squeaking of owl (*ahe*) are also useful bio-indicator of rainfall prediction which is believed is indicators of imminent rainfall. The Ethiope farmers' believed that even though the owl is blind but it is sensitive to humid conditions. The fear and feeling of increase humidity and heat released by clouds instigate restlessness among owls. Hence, their squeaking sound which many farmers believed to be an indication of an imminent rainfall. The singing of the bird, (*Mutaru Mukwana)* is also employed by the Hausa and Fulanis is a sign of forecasting imminent rainfall. The Hausa and Fulani also observe the squeaking of owl (*muyiya*) to forecast rainfall. Also the jumping of fishes into the air frequently (*pho uwo*) indicates the onset of rainfall while the flocking of sheep and goats (*oghewekoko*) are indicative of impending rainfall (Table 2).

Table 3: Non-Bio Indicators of Rainfall Prediction in Ethiope LGA

S/n	Local Indicator/Behavior	Local Names	Rain Type	Explanation
1	Counting of months after harvest	*Okiorho*	Short	Farmers' usually counts 5-6months after harvest before the first rain.
2	Wind blowing from the East	*Odju*	Short	Wind blowing from the east towards the south is a sign that rain is approaching.
3	Formation of hallow around the moon	*Emeravwe*	Short	Hallow around the moon is formed due to high moisture content in the atmosphere. Hallow is effectively seen as night progresses.
4	Less thunder sequence	*Agbrara*	Short	High clouds traveling at a faraway distance become nimbostratus clouds giving rain.
5	Roaring sea	*Ozighi urhie*	Short	Salts released due to the interaction of sea surface with atmosphere act as condensation nuclei resulting in rain.
6	Rainbow in a sunny weather	*Ovworo*	Long	Due to high relative humidity, water vapor becomes saturated due to copious amount of water entering the area resulting in rain. When rain occurs, rainbow also appears because within its vicinity clouds are absent indicating possibility of no further rain.
7	Dark rowling clouds	*Roro ogidibo*	Short	Stratocumulus clouds (dark cloud) form into stratus and nimbostratus in East direction in a short span of time resulting in rain.
8	Dull/dark cloud sky	*Ubiebi ikoro*	Short	Increase in moisture and formation of low cloud results in a moderate drizzle to heavy rain depending on the wind speed.
9	Low cloud	*Kperi ikoro*	Short	Stratocumulus, stratus, and nimbostratus are rain bearing low clouds anyone or all of these three types of clouds give rain.
10	Dull appearance of cloud	*obiebi ikoro*	Short	High relative humidity in the atmosphere is a sign of rain.

Source: Fieldwork (2021)

Changes in weather elements such as clouds, formation of hallow, wind intensity and direction, thunder sequence, rainbow and counting of months were cited as good indicators to determine future weather patterns in Ethiope LGA (Table 3). The Ethiope people believed that the prevalence of whirl wind is associated with hot weather conditions and gusty winds. Haze indicates hot and dry conditions which usually takes place in November-January when people start to prepare land for the dry season. Haze indicates that during the day temperatures would be very high. When there is a prolonged cold season crippling into months of November to January a drier season is expected. On the contrary a warmer season is expected to yield high rainfall during the raining season. Dark rowling feathery clouds (Roro Ogidibo) indicate the coming of rain while the appearances of dull dark cloudy sky (ubiebi ikoro) indicate a moderate drizzle to heavy rain depending on the wind speed. Similarly, the formation of hallow (emeravwe) in the sky is considered as a good indicator of coming rains within two weeks. Generally, respondents were of the view that cold temperature produces less rainfall. The

presence of mist and dew in the morning was a signal for fine weather conditions during the day. The appearance of rainbow (ovworo) when it has been raining indicates that the rains have come to an end (Table 3).

Other atmospheric weather forecasting indicators employed in the study area are observation of changes in wind direction. Some farmers observe changes in the wind direction from easterlies (*odju*), while others look for shifts from southerlies to northerlies to determine the changes of the season. Many farmers indicate that the ocean was the origin of rain; they suggested that during the dry season, the wind blows westerly towards the ocean to pick up water and return blowing eastward. Most of the Ethiope farmers' believed that delay in rainfall and drought may likely occur if the normal weather pattern changes. Some farmers have argued that even if after the first rainfall and the wind has not changed direction, sowing will not take place because it is assume to be a false rain.

The farmers in Ethiope always observe the sky to know the type of cloud, the direction and speed at which the cloud is moving in order to determine whether the cloud will bring rain or not or will move to drop rain. When different clouds such as cumulus stratus (*kperi ikoro*) are observed, it is an indication that the clouds are gathering momentum to form rain. In addition, farmers observed the sequence of thunder from the far distance (*egbrara*), many believed that less thunder sequence implied that rain could come in a week or two. While several days of heavy clouds indicate a short interval before the beginning of the rain. The farmer believed that rainbow (*ovworo*) appears due to high relative humidity and some have argued that even if the rainbow is visible there is the tendency for rainfall. Again, the farmers' usually counts 5-6months after harvest (*okiorho*) before the first rain to determine the arrival of imminent rain and otherwise.

Other indicators include animal and plant behavior, as well as wild fruit availability and wind direction prior to the rainy season. Although these indicators can be said to be indigenous, they certainly show some level of dynamism and integration of western science which has also tapped into these and use wind direction to predict rainfall patterns. According to The Food and Agricultural Organization (FAO) (2004), in Zimbabwe, only 3% of farmers use climate information for planning purposes. Some of the reasons given are that the information is not received on time and that farmers do not trust the meteorological information. Although framers listen to weather forecasts from radios, the poor and the marginalized farmers prefer to use their traditional knowledge system as a control. Field observation reveals that farmers and fisher folks in Ethiope LGA rely more on indigenous knowledge and conjecture in weather forecasting. When contemporary climate forecasting deviates from traditional forecasts, the farmers‟ inclination is towards indigenous information for reasons that it has been tried and tested and has been found to meld well with their culture.

The study reveals a striking similarity between indigenous and contemporary weather indicators. Some indicators such as wind direction, clouds, formation of hallow and thunderstorms exude similarity in content and application in both systems. One of the most important animal indicators is the behavior of insects such as birds, termites' dogs, frogs' sheep and goats. Elderly male farmers formulate hypotheses about seasonal rainfall by observing natural phenomena, such as the appearance of certain birds, mating of certain animals and flowering of certain plants, while cultural and ritual specialists draw predictions from divination, visions or dreams. This view point has been highlighted by Roncoli *et al*., (2001). The singing and chirping of birds is said to be a good sign in so far as rainfall is concerned. In particular, if weaver birds are heard singing, it is believed to be a very good sign of an imminent good rainy season. Equally, if a lot of owls squeal and white stork are seen in the locality, they are suggestive of the onset of a favorable rainy season. The study has shown further that farmers are able to use knowledge of weather systems such as rainfall, thunderstorms, windstorms and sunshine to prepare for future weather operations. The most widely relied-upon indicators are the timing, intensity and duration of temperatures during the raining season (March to October).

It was evidently clear from the focus group discussions that majority of the respondents (90%) acknowledged the existence of traditional methods of weather and climate forecasting in their communities while 98% acknowledged using traditional weather and climate forecasts in their agricultural activities. However, most (85%) of the respondents noted that IK is more accurate and reliable than the modern method of climate prediction, which informed their reliance on it.

Conclusions and Recommendations

The study found that traditional methods of weather forecasting can be utilized for the purposes of short term and long term seasonal weather predictions by local communities. It was noted that these methods ranged from biological, atmospheric, relief and astronomical features among which animals and insects behavior are the mostly used indicators in rainfall prediction. The study thus conclude that IKS can provide significant value and boosts in the improvements of forecasting accuracy and reliability if it will be methodically incorporated in conventional forecasting system as the documentation of IKS will be a good resource for the establishment of effective adaptation strategies to lessen the impacts of climate change.

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