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Reconstruction of agricultural calendar lessons from Western Kenya: crops, cultural events, astronomy and recurrent climate events

Maria Onyango

The Nganyi Community of Western Kenya is custodians of climatic indigenous knowledge (IK) on which their agricultural calendar has relied for close to 500 years. Reconstructing their agricultural calendar heavily depends on narratives. Constructivists argue that reality is socially-constructed and dynamically interpreted. Reconstruction of agricultural calendar requires analytical review of constructs of the calendar. Meteorological department archives digital data banks of climatic variability, but IK is critical and unique in reconstruction of pre-colonial agricultural calendar. Meteorological archival data and IK narratives come in handy. Discussions here-in refer to findings from participatory climate resilience projects conducted through multidisciplinary and multi-sectoral engagement of modern and traditional scientists for supporting documented social learning for climate change adaptation. Nganyi are Bantus whose genealogy is claimed to root from Sudan/Egypt/Congo; linked to Banyoro. In Kenya they are part of Banyore sub-clan of Luyia. They crossed to Kenya in search of arable land through Uganda settled on hilly grounds of Lake Kavirondo (Lake Victoria). Early settlements and food patterns are associated with hunting, gathering and limited agriculture supported on crude tools, indigenous plants with edible leaves, roots and fruits. They demonstrated IK application in managing agricultural calendar sustainably. Because the Nganyi share ecological zone with Luo, they also share how they have evolved their agriculture through application of IK. Like all communities in the world, they are prone to negative global climatic impacts of climate change on agricultural calendar, and require adaptation to diversified agriculture for building resilience. Transdisciplinary empirical cases of pilot projects from Kenya, Zimbabwe and Tanzania validated IK's role in tracking information through relating agricultural practices on agro-ecological zones. The conclusion is that IK and oral literature are plausible and critical sources of information for reconstructing pre-colonial agriculture and understanding of relationships of tribes and their settlements in contemporary times. Further research should integrate IK with modern meteorology for sustainable agriculture.

1. Introduction

The Nganyi community of western Kenya are renowned for their rare skill, ability and power to make and predict rain. This ability is grounded on a number of biological, social and astronomical indicators. Given that the Nganyi approach of rainfall prediction combines the metaphysical and scientific paradigms, the results of their work complement and sometimes baffle the rapidly improving meteorological science of rainfall prediction. An attempt to explain and understand the origins and practice of rainfall prediction presents one with an opportunity to delve into the complexity and even mystery of this long-held tradition. Discussing the nature of rain prediction knowledge and its association with

environmental resources helps shed some more light on the phenomenon: the community indigenous skills to predict rainfall with reasonable accuracy. For example, the droughts and famines that have ravaged the area in the past were predicted correctly. Some of these events have shaped and reinforced the community's beliefs and rituals that are performed in predicting rainfall. The community has developed and accumulated skill and knowledge that help them to scan the environment for relevant indicators of rainfall. Outsiders have sometimes misinterpreted these skills as myth, but a closer look at the practice reveals that the Nganyi IK on rainfall prediction is neither myth nor witchcraft; rather, it is a corpus of ideas that need to be carefully studied, understood and protected as a valuable resource.

1.1 Origins of the Nganyi community

There are contradicting stories about the Banyore to which Nganyi community belongs ancestry. One version claims that they originated from Egypt or the Sudan and travelled to Uganda where they settled in Bunyali. From there they entered Kenya through Samia to Ebusabakhwa (Sakwa Bondo) currently within Siaya County, where they stayed until wrangles with the locals pushed them to the direction of current Seme. From Seme, they were pushed further to drier hilly area currently known as Ebusiekwe. The other version claims that they came from Congo and lived in Uganda Bunyoro before entering Kenya from the Elgon border and arrived at their present resident through Kima. They then walked and came to Ebuhandu in Bunyore and settled there; they gradually spread out to Ebusiekwe currently their settlement. After their arrival here in Bunyore, some of the Abanyole people emigrated to Tiriki: the Ababayi, the Abang'ali, the Abamutsa, and the Abalukhoba clansmen. Others went to Kano, Gem, and Seme. Those who went to Kano (Sagam) did so only recently. One group of the Abamuli clan went to Kadimo but another section (Umuri) is in Gem. Other Abanyole people are in Kisumu Location. However, some of these people left Bunyore only recently.

The Nganyi are part of the larger Banyore clan and the sub-clan of Abasiekwe. Early kingdoms classify them among the stateless societies alongside Basayo, Nilotic population of Kalenjins, Nandi, Masai and Luo. The closeness of their association and connection with Uganda is traceable in the similarity of language dialects along the borders of Kenya and Uganda. As observed by Christopher Ehret (1985), despite their proximity to the lacustrine Bantus of northeastern Victoria, the societies located to the east of Victoria were different from the lacustrine societies, as evidenced by their culture and interactions. The close cultural semblance with the Nilotics could have been adopted through affective socialization since they lived in adjacent proximity with the Nilotic populations of Luo and Kalenjins. Later trade and religious linkages helped in bonding which resulted into intermarriages and associated dynamics.

Map 1.1 shows in broken lines the possible roots the Abanyole used to cross into Kenya. Observations are made that their settlement patterns were quite akin to those of the Banyoro people in Uganda. Broken lines indicate generic directions of their movements before the Nganyi group of the Banyore settled in Ebusiekwe, which is hilly and endowed with flora and fauna that was conducive to their observatories of IK.

Map 1. Original movement of Abanyole from Uganda
Source: Ottichilo (2016).

1.2 Nganyi community and nexus of Wanga Kingdom

When the Bantus crossed to Kenya from Uganda, they organized themselves in lineage of clans and different Luyia dialects they spoke. The first semblance of a kingdom in Kenya was known as “Wanga.” It appeared to rule over all the Luyia in Kenya in the north-east of Victoria. It is believed that this kingdom had its origins from Bahima group who originated from west of Uganda. The kingdom of “Wanga” would have taken its name from the first monarch of that dynasty, who was called Wanga (Ogot 1985). The kingdom of “Wanga” developed strong exchange relations with the Nandi and the Luo; it is no wonder that in their rainfall predictions and agricultural calender, the Luo and the Nganyi Abaluyia have long history of sharing. This probably provides vague explanations why the monarchic

system of government is so much generalized and without historical expansion in the western region of Lake Victoria.

It is worth noting that Uganda and Kenya were British colonies. The British appointed most of the rulers (kings) who ruled the kingdoms on behalf of the British masters. The British appointed Navongo Mumia to rule over a kingdom, which extended from Jinja in Uganda to Naivasha in Kenya¹. The ancestors of the Banyore people later migrated northwards the fertile land in Lela (*Esinganyinya*, as they called it in Luyia). From Lela the Banyore settled at *Wekhomo*, which was elevated higher than the surrounding areas. To settle in this higher ground they had to fight the Kalenjins who initially settled where Banyore people to which Nganyi community have currently settled. The Banyore referred to the Kalenjin as “*Abarua*” whom they fought with and chased out of hilly areas around Lake Victoria. This was a name of Nyanza that later became an administrative locality referred to as Nyanza Province adopted from it.

According to Ottichilo (2016), the Bantus including the Banyore were made to escape from Uganda where they had settled when they left Congo because of occasional outbreaks of plagues, search for land and war threats in Uganda by eighteenth century. He places their arrival time to about 500 years ago. The Banyore liked setting in higher ground for the purpose of using smoke as a symbol of warning the foes like “*Abarua*” or passing tribal messages with smoke. He further explained that Banyore people were descendants of Muhimba who had two sons. Muhimba was his second son who became the father of Anyole. Anyole was killed in war, leaving behind a pregnant wife who gave birth to a son who was then named Anyole II. Nganyi community descended from Anyole II in Abasiekwe clan.

1.3 Current settlement of Nganyi community

The main group of Nganyi have settled in Esibila, Emuhaya District, which was originally part of Vihiga District, and now Vihiga County. It borders with Butere, Siaya and Kisumu. Emuhaya was divided into two administrative divisions, Emuhaya and Luanda divisions. The Nganyi live mainly in Luanda division. The terrain is characterized by undulating hills and rocky sections (hence the major township and a division, *Luanda* or *Eluanda*, aptly named after the term “rock”). Limitation on land has resulted in a sustained overuse of the available pieces, leading to the depletion of essential soil ingredients that are necessary for positive crop output. As a result of being greatly constrained by land sizes, peasant farming is the most actively pursued mode of agriculture. Maize is the staple crop and hence dominantly cultivated. Other food crops produced, most of which are of indigenous regime, include cassava, sweet potatoes, arrow roots, beans, groundnuts, millet, sorghum, and a variety of traditional vegetables. In a nutshell, there is a broad spectrum of food crop regime, although seriously hampered by spatial challenges. Cash crops are also produced, albeit to a small extent.

1.4 The order of practice of Nganyi community rainfall prediction

The research team learned that the larger Nganyi community had three distinct sub-clans, namely: Ebusiekwe Esibira, Esitsimi Eluchiewo and Ebusiekwe Esibembe. All the three sub-clans have the knowledge and skills to predict rainfall. Moreover, each sub-clan has its own shrines where the prediction process takes place. It is important to emphasize here

1. It is said that Navongo Mumia was Nganyi's first cousin, which positioned the Nganyi family tree in direct lineage with Mumia's chieftainship.

Map 2. Location of Nganyi community (project site) within western Kenya

that the branching of the flow of the skills and knowledge prediction in the larger clan began around Ngaa's son, Etemesi and his brother, Nganyi. This accounts for the various major sub-clans and shrines that are used in the process of rainfall prediction. Among the many minor shrines are Manga, Asikoye, Otenyo, Esilaba, Okwemba, Ingukhu, and Amunga shrines (mixing clans and clans).

Although narratives confirmed that the Nganyi rainfall prediction knowledge and skills originated through a woman, the larger clan is highly patriarchal and disregarded women who were not blessed with children. The same applied to daughters, who could not be bequeathed the skills and knowledge. From the research findings three versions emerge to describe the origin of the Nganyi rain prediction powers. This presents a dichotomous prose, because some narratives actually confirmed some daughters from the community took with them the art of rain-making to marital homes. This accounts for people who live in Ahero in Kisumu County and parts of Yimbo in Siaya County who also call themselves rain-makers. The variations in narratives occurred in the information obtained from different clan groups and clan elders.

Rain prediction presupposes mutual understanding and response to the environment in which and through which social life exists. The family and marriage are some of the institutions through which Nganyi social life has existed. On the other hand, Nganyi clan leadership as an institution has supplied the controlling factors which hold the community social life, including rain making. Thus, both social and political activities at the clan level have made it possible for effective exploitation of the environment for rain prediction.

1.5 Nganyi Indigenous Knowledge and forecast development

Indigenous knowledge constitutes a knowledge system that encompasses ideas, skills and attitudes distinct in a particular community. Further, IK is about originality, autonomy and localization. IK should bring improvement in physical and social conditions with durable gains in people's abilities to control and sustain their conditions. It ought to be seen as a process by which people and associational life become more self-aware, more critically conscious, more capable of challenging socially restricting paradigms, and bringing to birth new consciousness, creativity and responsibility to themselves. The task of facilitating community development has always required conscious engagement with IK.

Indigenous knowledge scientists observe flora, fauna, winds and stars for their prediction process. The IK predictions follow strictly observed sequential stages of definite processes by Nganyi predictors who have been culturally mentored into the art. Normally, the process starts in the morning when rain experts go to the secluded Nganyi sacred shrines for consultations and consensus. It is only the few elderly experts and perhaps the initiated young inheritors of this IK that are allowed entry into the bushes and forests. After gaining entry, the experts sit under traditional trees and begin praying by invoking their ancestral rain makers facing Bunyore, Malondole and Esibila hills. It is believed that the ancestors listen to the invocations from their spirits' resting places up in the three hills. Those who pray are expected to be "clean" before approaching the ancestors. It is because of this belief that only young girls of pre-puberty stage and older women who are beyond their menopause are allowed to get close or into the shrines. However, older women who no longer experience their menses have free access to the shrines. The elders contend that spirits do not like blood and thus sexually active women are forbidden.

Rain prediction among the Nganyi community members takes two major forms. First, traditional experts, mostly elderly men, observe natural phenomena and the environment. Atmospheric conditions are the most relied upon indicators. The timing, intensity and duration of cold temperatures in the months of February and March herald abundant rainfall for the March to May season. The observed behaviour of the other indicators is also used to describe the other characteristics of the coming season.

A second form of rainfall prediction is done through cultural and spiritual practices that include divination, visions and/or dreams by select respected elders. Whereas many of the larger Nganyi community members interviewed believed that the elders performed sacrifices to mediate between the living and the ancestral and earth spirits that inhabit fetish sites, the IK forecasters interviewed denied such activities. However, it was generally admitted that traditional rain experts might receive communication from ancestors or deities through dreams or visions.

After invoking prayers, the elders place three traditional cooking stones under a specific tree. Upon these stones is placed a pot full of water which contains various indigenous herbs that are pounded to make a strong concoction. It was also learnt that in the past an animal sacrifice, either a chicken or sheep/goat, would be offered to the ancestors.

Special reeds are used by one expert to blow into the concoction in the pot, while at the same time, the other elders offer chants in praise of the ancestors. While this takes place, a number of keen observations are made to confirm that their prayers have been heard and answered. They include close monitoring of the water in the pot and changes that take place in the bubbles that result from the blowing of the water. It is believed that the elders have the ability to read and interpret colour changes as indicating the kind of rain to expect. The three colours, black, white and red, are associated with abnormal, normal and destructive rains respectively. Abnormal rains may be either too much or too little. Normal rains are those that fall within the expected ranges and are the right amounts for a good harvest. On the other hand, abnormal rains are characterised by such phenomena as storms, hail, lightning and thunder. These are believed to be invoked rains and are mostly violent downpours (*imbumbuyeka*) accompanied by heavy wind, sharp thunder, and lightning that cause damage to crops, houses and animals. Having read the signs, elders consult each other and come up with one common position that will be communicated to the community and any other person that may be interested in the information. Among other things, the elders forecast the onset of the season and, on the basis of this knowledge, they advise the community on when to start preparing their lands in readiness for plating. Depending on what is observed, the elders may also advise on what crops to plant.

1.6 Wider perception of Nganyi community rainfall prediction and demystification

Indigenous rainfall forecasting, especially from the Nganyi community, has been shrouded in mystery. Modern-day climate scientists often dismissed the forecasts as works of witchcraft, which have no place in science. The project therefore undertook to demystify the Nganyi IK forecasting and to find out if there is any scientific basis for their products. The project engaged the services of two consultants, botanist and zoologist, to relate the IK climate weather indicators and modern-day science. The IK forecasters observe the behaviour of plants, animals and stars and derive their forecasts from these. The consultants were involved in data collection, both indigenous and modern-day science information about the indicator plants and animals, and desk reviews. Part of the demystification was also involved interpretation of the IK indicators by the meteorologists to connect them with the meteorological processes that they use for monitoring and prediction. It also involved discussions during the integrated forecast workshops, and many other forums. Attempts were made to use the knowledge gained from various processes in the demystification of the IK indicators.

The Nganyi community rainfall prediction has close following with cultural practices and patriarchal leadership. The basic landholding unit of the Nganyi community is the extended family. This family essentially comprises the grandparents, the married sons and their families, and the unmarried children. Traditionally, extended family members built their homes on the same piece of property, but each elementary family cultivated its own field. Each of these elementary families constituted a consumption unit in its own right, and in this regard, it is defined as a household. Rights over land ownership were established either by inheriting a piece of the grandfather's land, being apportioned a piece by one's father, or by cultivating a piece of virgin land. In addition to these plots owned by individual families, there used to be some sections that were under the control of the clan head. A part of this land served as a communal grazing ground for all members of the clan. Another part was traditionally held in reserve and in times of need could be

allocated by the head to individual clansmen whose property this land became after they had first cultivated.

The traditional tenure system of the Nganyi community like all Abanyole favours male children who would, ultimately, receive an equal or nearly equal share of the family land and cattle. If a man died before his sons inherited his property, one of his brothers acted as a trustee until the sons came of age. If a man had no direct descendants, his brothers or their sons inherited his property. From a traditional perspective, the social and *de jure* relationship between a *Munyole* (a person of Anyole descent) husband and his wife, just like in other Abaluyia sub-tribes, was ill-balanced. Traditional customs and conventions were defined to prejudice against the wife's status: "... she has no ownership status whatsoever ... she has no right of ownership to any object she handles...she has no right to dispose of any of these objects unless she acts upon her husband's (Wagner 1938: 13–14)." This prejudice was extended even into cultural inheritance like rain-making in Nganyi, which is supposed to have originated from a woman but only males are initiated into the art. Ottichilo (2016) recounts how rain-making was both source of fame and curse to Nganyi in 1919 when there was extended drought and the colonials arrested Etemesi and Nganyi and took them to Kisumu to make rain during an extended drought for which people blamed the two rain-makers. They made rain there against their culture for he had established his official rain-making altar/shrine in Lela. It is believed that while the two rainmakers were under the custody of the whitemen, they were killed because they were becoming very famous.

2. Place of Nganyi community IK in restructuring of agricultural calendar

World meteorological services efficiently provide weather and climatic information by dividing the year into 4 quarterly calendars and issuing quarterly forecast to facilitate planning contemporary agricultural calendars used in different agro-ecological zones. Global climate outlook centralizes on rainfall pattern predictions for guiding what crops can grow where and when. The challenge to reconstruct agricultural calendar for pre-colonial phase is made complex due to the diversity of rainfall prediction approaches that were employed by the different communities and their interpretations for agricultural calendars. Since the conventional year has limited days which are universal, recurrent climate events and scenarios can be predicted and translated into agricultural calendars relevant to communities who share ecological zones. Crop calendar provides information on planting, sowing and harvesting periods of locally adapted crops in specific agro-ecological zones. Agro-ecological data provides combinations of soil, landform and climatic characteristics. It also provides information on the sowing rate of seeds and planting material and the main agricultural practices.

Crop calendar is closely linked to rainfall patterns whereby the rainfall patterns control growth of crops depending on its distribution and intensity. Equipment and technology for collecting modern climate data came during colonial era, which implies that there is data vacuum during pre-colonial agricultural calendar. This does not imply that no agricultural activities take place; what it means is that there has been no documentation of how communities planned and implemented their agricultural calendars. The discussion herein demonstrates that while reconstruction of agricultural from pre-colonial time to the current is challenging, it is possible to integrate different sources of agricultural data overtime observed by local communities and climate scientists' observation and recording to mainstream successive agricultural activities. The assumption is that a

year has 364/365 days and that agricultural calendars recur in chronological ordering of spontaneous livelihood activities that are supported within each numerical calendar year.

3. General Objective

Explore possible pathways for reconstruction of agricultural calendar from pre-colonial Kenya to current time among Western Kenya communities.

3.1 Specific Objectives

1. Identify the dynamics of movement and settlement of the Luo of Siaya County and Banyore Luyia from Vihiga County, western Kenya.
2. Establish the basis of symbiotic association these two communities developed from pre-colonial days.
3. Determine the agricultural calendars these communities used.
4. Draw lessons from past studies for purpose of laying pathways of reconstruction of agricultural calendar from current to pre-colonial era.

4. Scope

The discussion of this paper is limited to western Kenya Banyore Community of Abasiyekwe and the Luo of Siaya County; the genesis of their shared agricultural calendars based on indigenous predictions to guide their transformation from gathering, fishing to organized agricultural calendars based on scientific data.

5. Methodology

The information used in the paper was collected from reviewing relevant documents and articles on resilience to climate and climate adaptation using modern and traditional approaches. The study used interactive methods to explore the nature of the pre-colonial Banyore and Siaya communities focusing on the Luo of Siaya and Abasiyekwe community of Banyore Emuhaya and the methods they used to plan their agricultural calendars. Understanding of IK was based on archival research stored in Kisumu Museum and local IK practitioners. Oral interviews facilitated an in-depth investigation, which consisted of an integrated analysis of existing literature and lessons learned from contemporary agricultural calendars documented through global climate outlook fora.

6. Findings

6.1 Review findings

Reviewed information states that in the past fifty years, demand for food, fuel, timber, fibre and fresh water has increased in East Africa (Swallow *et al.* 2009). In the same period, the population in Kenya has grown rapidly, by 2.7% a year (Regeringskansliet 2010; *The World Factbook* 2010). About 45% of the total area in Kenya is agricultural land and 8% is arable land (Kenya Agriculture Stats 2010). This makes agriculture the main occupation, and the agricultural sector contributes about 21% to Gross Domestic Product (*The World Factbook* 2010). According to *Kenya Vision 2030* (2007), there are more than five million smallholders engaged in different types of agricultural activities in the country. Despite the central role that agriculture plays in the Kenyan economy, the sector continues to face four major challenges that have to do with productivity, land use, markets and value addition.

Agricultural reconstruction and development are seen as key factors for economic recovery in many developing countries. Unfortunately, recent interventions in the

agricultural sector have been of only limited effectiveness, notably in Sub-Saharan Africa (Ward, Kapuya & Saruchera 2012). Agricultural calendars therefore are at the heart of the economy of the Kenyan nation. The vast expanse of Kenya relies on rain-fed agricultural production. This places rainfall patterns in Kenya at the centre of agricultural calendar reconstruction. According to Constructivists school of thought, reality is socially-constructed and there is a possibility of having multiple realities of the same situation depending on the perspective of the focus. Life systems provide lenses through which patterns can be viewed and interpreted differently by different actors in a system. This provides a platform for different scientific teams and systems to act separately or consultatively to interpret phenomena that universally affects them. Agricultural calendar debate affects livelihood and food security as well as economic development.

Reconstruction of agricultural calendar calls for a process of putting together pieces of information which are otherwise disjointed. It is a drive to create meaningful interpretation of themes, patterns and knowledge in the process of integrated social learning that uses participatory approaches for value co-creation and co-consumption. Local communities through accumulated IK have gained from generation to generation, known patterns of weather; how and when local natural disasters occurred; how to plan to cope with their impacts on the natural environment, livelihoods, and lives. According to Onyango, Liwenga & Mugabe (2013), Ouma, Laban & Onyango (2013), many African communities have developed techniques and strategies for forecasting rainfall patterns that provide key information for planning agricultural calendars.

Contemporary agricultural calendars have high level of accuracy because of the level of technological applications used in predicting climate forces trends. Prior to scientific calendar, agricultural calendars were constructed using cultural events of local communities; natural disasters, recurrent changes on flora and fauna of localized areas and the associated impacts on food production systems. While modern sciences have sophisticated equipment and technologies for collecting and collating climatic data, it would be false to suggest that pre-colonial Africa and specifically Kenya was void of climate change data against which the local communities based their agricultural calendars.

Both pre-colonial and current agricultural calendars give agro-ecological information. An understanding of agricultural calendars among the Luo of Siaya and Luyia of Emuhaya, western Kenya, is deeply embedded in applications of indigenous knowledge custody and applications. Indigenous agro-ecological knowledge and practices are inseparable from agro-biodiversity and hence critical in agricultural strategies relevant to household food security and nutrition over time. They represent the connecting axis between rural people and ecosystems and are important to providing local food security whilst offering opportunities for maintaining sustainable agro-ecological systems. Indigenous agro-ecological knowledge and practices deserve adequate recognition, support and enhancement to strengthen the agricultural systems of small-scale farmers. Through cross-cultural exchange and co-operation, they can better improve and adapt to the evolving needs of farmers.

Reconstruction of agricultural calendar brings to mind agro-ecological zones which support specified food crops, variation of planting and harvesting dates in different regions/ecological belts. Ecological zones are key demarcations for structuring and reconstructing information. They are defined in terms of climate, landform and soils and describe specific range of potentials and constraints for agricultural production. In traditional societies the

calendar starts off with sowing/planting periods harvesting time culminated with fixed cultural activities. Planting dates for each crop may vary among farmers within same region and also may differ from year to year depending on prevailing climatic presentations; hence the sowing/planting is presented as a period of time. Rainfall onset demarcates planting seasons. Maturity period of crops are also important for reconstruction of agricultural calendars because many cultural activities including marriages and circumcisions are conducted during harvests when food is plenty. Harvesting period is also given a time span from earliest to the latest date; disease calendar, recurrence and prevalence. This paper shares lessons drawn from Nganyi community in western Kenya who, for over 100 years, have been involved in providing local weather advisories based on their local and Indigenous Knowledge to provide local climate knowledge, in partnership with the local communities such as the Luo from Siaya County. For the Nganyi community, the narratives observe that when they initially arrived in Kenya, they were more of gatherers and hunters. They started farming during the Iron Age when Blacksmiths among them started melting and shaping hoes for cultivation

A calendar year has 364/365 days within which recurrent events like agricultural practices can be fitted. Contextualization of agricultural events and activities by people whose livelihood activities are affected by these calendars is a rich source of relevant data for reconstruction. It is a well documented fact that many African communities used to run successful agricultural calendars prior to modern climate prediction forecasts upon which current agricultural calendars are based. They used indigenous knowledge (IK) as a critical knowledge base for planning agricultural calendars and survival tool for adapting to extreme climate events and other natural hazards. While IK may be defined as an ancient knowledge, its acceptability is closer to local users. It is communal, holistic and spiritual knowledge that encompasses every aspect of human existence in an agro-ecological zone.

6.2 Essentials for reconstruction of agricultural calendars

Reconstruction of agricultural calendars depend on the quality and accuracy of climatic data collection. Climate problem and climate change are critical in the reconstruction of agricultural calendars. The Earth's climate is changing, and the scientific consensus is not only that human activities have contributed to it significantly, but that the change is far more rapid and dangerous than thought earlier (IPCC 2007). On the other hand, successful solution to the climate problem which directly affect agricultural calendars will have to come from within the development process; it will need to begin, rather than end, with developing countries, and be based on a deep understanding of how development occurs, this is the reason Nganyi community and Luo from Siaya are focused on as local cases that have shared agro-ecological zone for well over a hundred years.

In UNEP (2008) it was observed that context-specific approach to understanding agricultural calendars is the way to formulating context relevant mitigation and adaptation options to facilitate reconstructing agricultural calendars. Weather regimes, droughts and floods affect sustainable agriculture. Diversification and flexibility are necessary to improve adaptive capacity and eventually to increase the capability to engage in mitigation efforts. The main failing of the climate discussions is that they have not viewed climate as a development problem that is key to formulation of agricultural calendars (Stern 2006).

6.2.1 Monitoring of weather elements and forecast development

*“Weather forecasting is the application of science and technology to predict the state of the atmosphere for a given location”*² This has been attempted informally through IK for millennia, and formally by using modern climate science since the nineteenth century. The forecasts “are made by collecting quantitative data about the current state of the atmosphere and using scientific understanding of atmospheric processes to project how the atmosphere will evolve.”³ This is true for both the IK and modern climate forecasting.

6.2.2 Modern climate science forecast development

The modern climate science rainfall forecasts are based on data collected through monitoring of weather elements. The monitoring of weather elements is done at observation stations within which instruments are installed. Each country has a network of meteorological stations dedicated to capturing data on the weather elements within their area. However, weather systems are global in nature and usually systems prevailing over a country can, in the long run, affect another country far removed from it. It is therefore necessary to share data among countries for accurate forecasts. This sharing of data and information is normally done within the framework of World Meteorological Organization (WMO), a United Nations Organization mandated with coordination of global meteorological matters.

The data from the observation stations are used in three main ways, including mapping of past climate events, understating the rainfall process, and forecasting for future weather conditions. The mapping of the past events reveals areas that are prone to droughts and floods and identifies when and how frequently the events occurred in the past. This is useful in defining the vulnerability of different areas to floods and droughts. Analysis of the data can give information as to why the weather events occur. This helps in defining the precursors to these weather events that can provide signals of an impending event in the future. For example, El Niño and La Nina events normally herald floods and droughts in many parts of Kenya, respectively. Finally, the data is also used in forecasting the future weather through three main ways, statistical, dynamical and a combination of statistical and dynamical modelling. Statistical models relate the precursors of rain to the actual rainfall, while dynamical approach models the physics of the atmosphere and hence capturing the rainfall development. The combination of the two approaches uses both methods and produces a better product.

6.3 Meteorological Indicators

The Nganyi IK forecasters use IK indicators derived from meteorological phenomena which are further derived from the characteristics and patterns of dew, local temperature, lightning, rainbow, pre-season rainfall characteristics; movements of wind, clouds, dust storms, movement of lake, among others. The IK practitioners say that these indicators give a reasonably high degree of reliability. It is interesting to note that observing atmospheric phenomena is one of the factors considered by modern meteorological services in developing statistically based weather forecasts (Cahir 2001).

Examples of the meteorologically derived indicators used by IK forecasters include among others:

- Direction and speed of wind around the surrounding mountains and from the

2. “Weather forecasting.” Wikipedia: https://en.wikipedia.org/wiki/Weather_forecasting

3. *Ibid.*

neighbouring Lake Victoria. The meteorologists confirmed that local lake breeze and dominance large scale westerly winds favour convergence over the local high ground and occurrences of afternoon rains. The appearance of whirlwinds (*esitula*) or strong winds (*imbutsa*) signifies pending drought. Winds blowing predominantly from north to south indicate a pending dry spell, while the opposite indicates a wet spell. The wind observations were mainly done on Bunyore, Malondele and Esibila hills. These hills had a lot of vegetation and trees, the swaying of which was also used in gauging the wind strength. However, with the deforestation and destruction of most trees in these hills, it has become hard now to assess how this indicator continue to be used by the IK forecasters.

- Observations of soot (*omuyala*) or behaviour of smoke from burning grass (*amasinde*) are used by the IK forecasters in foretelling the kind of rain season expected. The soot is scattered in the air and their direction of smoke movement and rate of scattering used to determine wind direction and speed.
- Movement and clustering of clouds and their speed and direction around the surrounding mountains.
- Building up of dew (*elime*) before the onset of the rains. The meteorologists agree that this is representative of the usual increasing build-ups of humidity before the onset of the rainfall seasons.
- Unseasonal weather occurrences preceding the onset rainfall season.
- The temperatures are monitored through water kept in storage pots. The research observed that the Nganyi elders still have a pot in one of the shrines. Observations of pre season lightning spikes within the sky. Meteorologists do agree that these are representatives of cloud to cloud lightning processes that can only occur due to the building up of atmospheric moisture and clouds.

6.4 IK climate Variability Indicators and Modern Climatic observation Techniques

The pilot study ran (2008-2010) with community-based pre-season planning and seasonal evaluation forums held every six months. Before the beginning of each rainfall season (March to May and September to December), the two systems develop their forecasts in parallel and are merged through a consensus meeting between the modern-day climate scientists from the Kenya Meteorological Society (KMS) on one hand and the Nganyi Indigenous Knowledge (IK) forecasters on the other through the facilitation of experts from a local university. The pilot study observed that even though there was diversity within the consensus climate outlook information developed by KMS, these outlooks were not readily acceptable to the local community. However, the use of the climate early warning information increased substantially when local climate information and the community risk management knowledge were included in the final community climate risk management.

This case study however showed that local and indigenous knowledge of a community can be used to improve a climate early warning system for enhanced resilience to local disasters and climate change adaptation by increasing the uptake of its recommendations at a local level through greater community engagement in generating the forecasts. The seasonal forecasts from the modern-day climate science were noted to be relatively more accurate but the unavailability of local data at community level often makes them unusable by vulnerable subsistence farmers. The study also demonstrated that community-based biological and non-biological indicators are bound to be affected by

Figure 1. The comparative IK and modern science of observatories for climate variability for agricultural calendars

the changing climate. The results from the pilot study have led to the construction of a modern Community Resource Centre by the Kenya Meteorological Department to sustain the initiatives of the pilot project. The Community Centre is now equipped with modern meteorological observation systems and a local FM radio information exchange systemizing the RANET technology. The local community youth have also been trained not only to run meteorological observation systems and the FM radio station at Esibila (Vihiga County), but also in basic disaster management and climate change adaptation for the sustainability of this unique pilot community project. The case study showed how local/indigenous knowledge of a community can be used to improve community-based climate monitoring services and early warning in support of local disaster risk reduction and climate change adaptation and viable planning of agricultural calendars. This pilot study generated output for both application to policy and practice. It should be noted that this all inclusive community forum includes local level administrators, sector specific experts from ministries of agriculture, water, environment, social services and health among others, and all are involved in the development of the local mitigation strategies

6.2 Agriculture in Pre and Post Colonial Kenya

Colonialism in Kenya lasted roughly 68 years—from the end of the nineteenth century to 1963, when Kenya got her independence from British Government. In western Kenya, the dominating tribes were Luo and Luyia and as Ochieng' (1979) explains, the Luyia Bantus were already settled in Lakeside Yimbo and Samia which are currently occupied by the Luo of Siaya. In western part of Kenya the early farming was closely an adaptation from

indigenous plants which naturally grew and yielded edible leaves, roots and fruits. The communities were more of gatherers than farmers. The range of different crops for human and animal use was relatively poor but it was almost the source of food and medicine for people at that time. The hunting and gathering system of appropriation of subsistence from nature is, according to Sherrif (1985: 4, cited by Omvoyo 2000), “*universal and was practised as late as the nineteenth century in Kenya.*” Under this system little energy and time was invested in the production of food. The Luo and the Abasiakwe Luyia supplemented their cultivation by fishing, hunting and gathering, women gathered assorted number of wild fruits and vegetables.

Cultivated agriculture in the target agro-ecological zone was divided into a binary calendar year of dry season and wet season. The two most important crops that were first grown among the Luo of Siaya were *mtama* (sorghum) and cassava. These formed the main staples, with *mtama* the more important. *Mtama* was mixed with dried cassava and grounded to make *ugali*. Pumpkins, vegetables, maize, sweet potatoes together with *wimbi* and sorghum were all grown through an elaborate system of mixed cropping or multiple cropping.

Bimodal rainfall experienced in this zone supported two harvesting seasons. The general rainfall pattern still exists and the agro-ecological zone receives long rains in March-April, and a short rainy season, September-November. Sorghum and finger millet are grown during the long rainy season. The changed land use and agricultural practices of land ownership have the pre-colonial agricultural calendars that were flexible, social and communal. During the pre-colonial Kenya, land was abundant and communally controlled. This provided adjacent communities opportunities to socialize and co-create values for livelihoods. Folke (2004) observed that conflicts over land were seldom and there were no economic incentives to give people property rights to land. The larger land space was used for pasture as there were extremely limited farming activities. The abundance of land meant that the farmers could use extensive agricultural methods.

Post-colonial Kenya witnesses rain-fed agricultural livelihoods in Siaya and Abasiakwe Luyia at subsistence rain-fed agriculture. Extreme weather events such as floods and droughts negatively impact on agricultural production. Kenya Meteorological Department (2010) concluded that climate change trends will increase the severity and frequency of extreme weather events which will increase the burden on existing vulnerable and poor communities. On the other hand, climate has spatial characteristics and is highly variable, and thus requires site specific data, such as rainfall amounts and distribution, rain days and temperature, for proper understanding of its influence. Further, climate interacts with socio-economic factors to influence livelihoods.

The Siaya Luo and Abasiakwe have always lived in same agro-ecological zone and have great similarity in their agricultural calendar. The Wanga group of Luyia whose genesis is traceable as the upper link of Abasiakwe of Emuhaya and the Luo of Siaya have lived next to each since time of exodus from Nile and exhibit strong relationships. The bond between them is so strong with the Wanga clan among Luyia to the extent that the Luo of Siaya to call them *Jokawango*, a terminology which implies “Clansman.” The two community groups have enjoyed symbiotic alignment since pre-colonial Kenya in terms of reinforcing agricultural practices. Luo people were initially nomadic pastoral in culture. Current Sudan from where the Luo originated was called Egypt in the biblical time. For many local communities in Africa, indigenous knowledge has been used for survival,

including forecasting of local hazards by local communities for many generations. The knowledge is passed orally from one generation to another. The community-based forecasts are founded on local indicators derived from behaviour of animals, plants, atmospheric conditions, astronomic features, among others (Ouma *et al.* 2013). Modern day climate prediction tools are based on computer models relying on data and indices derived from measurements of climate parameters to quantify the conditions of the atmosphere, land, water and ecosystems, collected. These data are shared by National Meteorological Services under the coordination of the World Meteorological Organization. Despite the availability of various types of climate information, local communities are still significantly vulnerable to climate related hazards because land use changed remarkably during the era of industrialization.

The Nganyi community case study proved that agricultural production based on cumulative IK prediction systems is comparable to scientific production. Since rainfall patterns form the cradle of agriculture, the work Nganyi community initiated with modern scientists to produce integrated forecasts through a pilot projects produced narratives which trace agro-ecological zones and agricultural calendars to be inseparable. It showed that local and indigenous knowledge of a community can be used to improve a climate early warning system for enhanced resilience to local disasters and climate change adaptation by increasing the uptake of its recommendations at a local level through greater community engagement in generating the forecasts. The seasonal forecasts from the modern-day climate science were noted to be relatively more accurate but the unavailability of local data at community level often make them unusable by vulnerable subsistence farmers.

FAO provides the current agricultural calendar as a tool that provides timely information on planting, sowing and harvesting periods of locally adapted crops in specific agro-ecological zones in Africa. Agro-ecological data provides combinations of soil, land form and climatic characteristics. It also provides information on the sowing rates of seed and planting material and the main agricultural practices. It provides agricultural calendars in terms of ecological factors which affect growth and maturity of crops. Crop calendar is closely linked to rainfall patterns whereby the rainfall patterns control growth of crops depending on the on its distribution and intensity.

Reconstruction of agricultural calendar from current to the pre-colonial era seem challenging because of the fragmented manner in which knowledge is created and consumed between modern scientists and traditional/indigenous scientists. Modern climate forecasts' data are readily available, however African traditional communities still rely on indigenous agricultural planning based indigenous climate change predictions. While both bodies of are scientific and verifiable, in their own rights; there remains a credibility gap for building synergies which both local scientist and modern scientific communities could gain from.

6.3 Indicators of onset of rainfall or drought

The local communities traced the initial known flood to 1929 and it was called *Muhanjo*. The other flooding events came in 1942, 1952 respectively but their impacts were slight and people did not have to seek rescue services because communities were friendlier with one another and people living on raised grounds willingly offered temporary shelter to relatives whose homes were submerged. These floods affected only the Nzoia River and its tributaries, i.e. when Nzoia and Yala Rivers swelled. The community worked together to control flooding from these rivers and their tributaries by heaping soil along the banks of

the tributaries and then planted crops to reinforce the embankments. Flooding affecting the lake occurred after 1961 and the community had no control over flooding that came from the lake. Major flood periods are roughly recognized as March-June and August. In 1942, the area experienced the worst floods (*Marwamba* floods); it was named after the traditional rainmaker called Marwamba, who was responsible for causing the floods; the floods were accidental because *Marwamba* was a rain maker and had been asked to invoke rain after harvest to bring fish to be eaten with the millet and maize; he brought more rains than expected causing the flooding.

6.4 Other local sources of agricultural observatories used by Abasiekwe Luyia and Luo from Siaya

6.4.1 Climatic calendar

Rainfall prediction was done by the Abasiekwe from Nganyi community. The elders used *omuyala* (shoot) or a *masinde*, lighted it and watched the direction of the smoke when it meets the clouds—the interaction with the clouds will show the direction of the rainfall or in-coming drought which the elders would interpret and share with the wider community. Because there were intermarriages between the Luo and Abasikwe, this prediction message would be shared between the communities and used to plan agricultural activities. The blowing of the west lies will indicate the weather condition—dry or wet. For Bunyore, the winds will blow from north to south to indicate dry spell and vice versa—wet period.

When wet spell was predicted, land preparation would start across the two communities in preparation for the planting season. For March-July cereals were planted intercropped with beans, cowpeas, and green grams. The maize planted for long rains was long maturing while yellow quick maturing yellow species. Bunyore Hill, Malondele Hills and Esibila Hill had vegetation and trees that attracted rainfall easily and with the destruction, it has become hard to predict/forecast. Special trees and vegetations are important in forecasting and this included the following trees: plant observatories included Omurembe, Omukhuyu, Isila, Omufutu, Oluseno, Omukabakala, Omuchilisia, Olusolia and Olubinu are known to be highly hygroscopic and respond to raised ground water level which denotes impending onset of wet season.

a) *Stars*. Movement of stars from the east to the west and *vice versa*. The stars take 14 days to change direction and it will use a different position to return to the east. *Yugni Mamon* (Female constellation) was rarely seen but when seen it indicated. *Yugni Machwo* (Male constellation) marked the end of rainy season and was associated with extreme coldness that destroyed crops. The observation is done at midnight. After making observations, Nganyi elders will start to prepare land and this will sound warning to the surrounding Siaya Luo communities to do likewise. Malondele Hills was very strategic for the Nganyi community because everyday the elders will stand at different positions watching towards Lake Victoria and this assisted in forecasting the prediction.

b) *Morning observation of dew*. Formation of dew indicated that rainfall was about to start. Lightning was used also as an indicator of impending rainfall season. Water storage pot's coldness indicated that onset of rainfall was about to start. It must be noted that Nganyi elders still have a pot on Agutu Hills in Seme, which they use to monitor weather in areas around and within the vast Luoland.

c) *Insects as predictors*. *Ong'inong'ino* (black ants), *Lango/Nyasewe* (green and yellow-striped Grasshopper) associated with drought and attached cassava leaves. Since they were precursors to poor harvest, the two communities collected them and preserved them

as protein source during drought. *Thomorno* (safari ants), sensitive to ground water, were interpreted as precursors to wet season; *onyoso* (a species of wasp family) and *kungu* (armyworms) predicted bumper harvest. Butterflies used to hatch from these trees to signify the onset of rainfall or dry spell.

d) *Birds*. *Aluru'* (brown quails) associated with onset of harvest and considered a delicacy by both Luo of Siaya and Abasiakwe. *Magungu'* (white quails) were seen just before the onset of long rains and their appearance marked the beginning of ground preparation in readiness for planting. *Opija* (swallow) nested low when less rain was expected, while *osogo'* and *mire* (weaverbird species) fledged just before harvest.

6.5 Major famines and agricultural adaptation history of famine in Bunyore

Narrative from Abasiakwe explained that famine calendars were associated with extreme drought and they contributed to nomenclature of peer groups in the community. All the children born during a certain famine would be given the name of that famine.

1.	<i>Esileeta Bakhaye</i>	1884
2.	<i>Olwendende</i>	1888
3.	<i>Ongong'a</i>	1902
4.	<i>Opande</i>	1907
5.	<i>Keya</i>	1916
6.	<i>Nyangweso</i>	1932–33
7.	<i>Esikombe</i>	1942–1943
8.	<i>Mau Mau</i>	1953, 1965–1974
9.	<i>Omukorokoro</i>	1980
10.	<i>Saba L'lala</i>	1997

6.6 Famines, Causes and Interventions

i) *Nyangweso, 1932–33*. *Tsisiche* (armyworms) struck and destroyed all vegetation and these were very distinct armyworms. When the Nganyi community suffered food shortage during the *nyangeso*, they got food from their Luo neighbours from Nyanza (Siaya Luo). During the famine periods, they also got food supplements from potatoes and potato vines, which had been introduced into the area by the early white men.

ii) *Esikombe, 1942–43*. This famine was experienced by both Luo and the Nganyi community who were in the same ecological area and as a matter of fact, it was wide spread in the western part of the lake region and was caused by hailstones which destroyed all crops. The mitigation out of this came in the form of food relief, which was given/sold out in a cup (*esikombe*). The ratio depended on the amount of money one could afford.

iii) *Mau Mau, 1953*. When it came to 1953, there was prolonged drought which affected planting. Less rainfall led to weaker crops, causing poor harvest and this was coupled by the onset of Mau Mau War in Kenya. This was concurrent with the armyworms (*tsisiche*) which attacked the crop and wiped it all out plunging the entire western Kenya into hunger devastation. Survival was through hunger crops that included sweet potatoes, arrow roots and cassava. Later in 1965, yellow maize (*kipindi*) was imported into the country from USA as a relief when the trend of low food productivity of grain affected most of Kenya.

iv) *Crops and fruits calendars*. When the Luyia arrived from Uganda, they survived through gathering and hunting. Narratives from the locals were in agreement that original crops that were farmed in western Kenya where Nganyi community lived were mainly millet and sorghum, which was used for making *obusuma* (Luyia) or *kuon* (Luo), known all over Kenya as *ugali*. Most crops widely grown currently in the area are said to have been brought in and introduced by white men to mitigate against famine. These include maize (*lituma*) from India when the Coolies came with it as their staple when the railway was built.

- Vine—sweet potatoes—came in 1931–32 after armyworms struck and cleared all vegetation.
- Elephants waste around this region brought bananas, pumpkins.
- Cassava has its own origin on the coast (Mukhongo). It had two types: one with bitter taste and edible one; the bitter one was used to make *ugali*.
- Fruits like guavas, pawpaw, oranges, were being grown in the 1930s.

7. Conclusion

From the discussion, it came out clearly that the Abasiekwe were widespread because of the role(s) as peacemakers. Wherever there was conflict among their neighbours, the Abasiekwe acted as mediators and this earned that a good image with surrounding communities. Because of their role in the vastly Wanga Kingdom and their relationship (kingship), they called in the kings soldiers to protect them. The Abasiekwe also encouraged intermarriage with their neighbours to foster peace.

- The Abasiekwe had links with Wanga, who in turn had relationship with Buganda Kingdom, which traces its origin from Ethiopia (Ethiopia had relationship with Israel).
- Women were used as ambassadors for peace among the Abasiekwe and especially their daughters married outside the community. Other women married in the clan from neighbours were also used to keep peace and as a means of communication between the Abasiekwe and the rest of the world.

Climate change will directly impact on these indicators, which could lead to inaccuracies in the future IK predictions. Additionally, with modernization of societies through education, a number of people are turning to modern science forecasts. Even the Nganyi community traditional experts have not escaped that influence. However, both prediction methods are geared towards providing early warning information on rainfall. The difference comes from methodological approach, packaging and meaning ascribed to each kind of knowledge. The localised nature of Nganyi IK makes it more culture-specific, and more responsive than modern science forecasts, which capture large scale weather features but are not specific to local areas. It is important to harmonize both systems and make full use of their strengths for a better early warning system. This can be done by acknowledging and appreciating the importance and complementarities of either system.

From the research findings three versions emerge to describe the origin of the Nganyi rain prediction powers.

It was noted that there were cases where some variations occurred in the information obtained from the groups of clan elders. Some attempts were made to derive some consensus through some of the forums that were held with the community. The research team believes that some of these could still be decoded through further interactions with the community who are still not willing to release some of their IK knowledge.

Reconstructing agricultural calendar calls for approaches that demystify IK and develop sustainable framework for integrating IK and western climate risk management science based on cumulative data of climate variability and its effect on crops' production. Further challenges in reconstruction of the agricultural calendar comes in the spartial distribution of scientific data collecting equipment across the country. In as much as the accuracy of scientific early warning systems developed by Kenya meteorological services which has greatly improved accuracy of early warning, many local communities still take the scientific predictions for granted. The following areas are likely hurdles.

Challenges

Scientific predictions are released in complicated language that end users were unable to decode and apply to increase their resilience.

- Technical terms used by meteorologists in their predictions are believed to reduce the potential value the farmers would obtain from scientific early warning systems.
- There is assumptions that developing early warning systems in conjunction with local predictors would provide end-users with localized predictions that reach the users in local languages and recommend livelihood activities' changes that are more familiar and therefore more sustainable in enhancing agricultural production and environmental conservation.
- The community trust on the partners whom they believed would rob them of their livelihood as the Nganyi's were known for the art of rainmaking.

Existing opportunities

- Baseline survey documenting how communities have maintained agriculturay calendar is the starting point.
- Establishment of operational framework for social learning and trading scientific knowledge, data collection modalities and improved packaging and communication of modern science/IK integrated seasonal climate forecasts.

The Nganyi community is widely renowned for the rain-making skills among the entire Banyore community. The collective memory of the art of rain-making is preserved within the shrines, which are distributed across the eleven sub-clans of the Abasiekwe community.

It is observed that current population increase in the area is exerting pressure on the shrines. This is manifested by agricultural encroachment into shrine areas and cutting of trees to meet the increased energy demands. It is therefore imperative on the Abasiekwe community to undertake environmental conservation measures to preserve the shrines and other observatories in the community. Despite the dangers faced, the Nganyi community has proven resilient in recognising the importance of IK in helping restore their environment. Efforts are being made to preserve culture as a strong basis for maintaining a balanced ecosystem and the sustainable use of natural resources.

Generally, IK is increasingly becoming attractive to international community. This is particularly so considering its recognized role in maintaining cultural diversity as a tool for empowerment towards achieving sustainable development. Consequently, there is currently increased policy research, legislative frameworks, and documentation to preserve the IK knowledge.

Some attempts were made to derive some consensus through some of the forums that were held with the community. The research team believes that some of these could still

be decoded through further interactions with the community who are still not willing to release some of their IK knowledge.

Factor/issues	Modern-day Science	Indigenous Knowledge
How approached (Brascoupé & Mann 2001)	Compartmental	Holistic
How communicated (Brascoupé & Mann 2001)	Written	Oral
How taught (Brascoupé & Mann 2001)	Lectures, theories	Attachment of selected few youth to under study elders
How explained (Brascoupé & Mann 2001)	Theory, “value free”	Spiritual, social values
Data/information collection methods	Observatories including space-based technologies and computer models simulations	Indicators from shrines, institutional memory of elders
Skill assessment	Basic statistical tools	Results based on impacts on the community systems
Knowledge sharing	Free sharing of data and basic knowledge with UN/WMO proving baseline standards and guidelines	Knowledge restricted to few IK experts and only final early warning products are shared
Preservation/storage of information and documents	Journals, books, computer files, etc.	Oral memories by the elders and environment resources stored in the shrines
Experts	Well-educated researchers	Most of the IK experts have no formal education
Local area representation of forecasts	Often represents very large area due to poor observational network at most local levels	Data from the shrines provide area specific data and information that has many advantages
Patent of knowledge	System are available for patenting new climate science innovations and discoveries	No system available in Kenya in 2012 for patenting IK

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