Incorporating Indigenous Knowledge in the Local Government's Early Warning System: A Case Study from Baringo County, Kenya

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Abstract
There is growing interest in using indigenous knowledge to supplement scientific early warning systems within disaster risk reduction. In October 2016, the government in Baringo County, Kenya incorporated indigenous knowledge in a drought scenario building and response-planning workshop. Specifically, three indigenous forecasters provided weather forecasts using star movements and goat intestines. The aim of this study was to understand how indigenous knowledge was incorporated into the local government's early warning system. Further to this, the following aspects of the case study were investigated: indigenous knowledge characteristics, incorporation process, driving factors, impact to the government and indigenous forecaster interface, and future scenarios. This qualitative study was primarily based on interviews with thirty-five informants including indigenous forecasters, and government, NGO and research representatives. The results revealed a stark contrast between indigenous and scientific knowledge in forecasts, forecasters and recognition. The indigenous forecasters were engaged through a top-down participatory development programme, which combined the indigenous and scientific forecasts into one message for planning and dissemination. While there was strong evidence that the communities' acceptance of the early warnings improved with the consolidated message, it was not clear how much of an impact it had on the government's decision-making processes. While many informants were hopeful of increasing and even mainstreaming indigenous knowledge incorporation, some took a more conservative view that the role of indigenous forecasting might weaken with an increase in scientific forecast accuracy and communities' technical capacity. The study recommends the national and local government to conserve and promote indigenous forecast capacity with long-term community engagement, while addressing issues from incorporation activities.

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List of Acronyms

ASDSP	Agricultural Sector Development Support Programme
BCG	Baringo County Government and County Commissioner's Office
CBON	Community-Based Observation Network
DRR	Disaster Risk Reduction
EW	Early Warning(s)
EWS	Early Warning System
IK	Indigenous Knowledge
IKF	Indigenous Knowledge Forecaster(s)
IPCC	Intergovernmental Panel on Climate Change
ITK	Indigenous Technical Knowledge, used in the same way as IKF in Baringo County
KMD	Kenya Meteorological Department
NDMA	National Drought Management Authority
NGO	Non-Governmental Organization
PSP	Participatory Scenario Planning
SK	Scientific Knowledge
SKF	Scientific Knowledge Forecaster(s)
UNISDR	United Nations Office for Disaster Risk Reduction

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1. Introduction

In 1994 at the first World Conference on disaster and climate risk management, governments and other stakeholders came together and declared early warning systems (EWS) to be a key measure to reduce disaster risks (United Nations, 1994). Almost a decade later, echoing the UN Declaration on the Rights of Indigenous Peoples, the value of indigenous knowledge (IK) was recognized by government officials and stakeholders in the subsequent international disaster risk reduction (DRR) strategies (UNISDR, 2015c; United Nations, 2005, 2008). These frameworks promote people-centered and broad-scope approaches to DRR, where scientific findings are complemented by IK. Over the years, a small, but growing body of scholarly literature has emerged, capturing various IK integration efforts around the world in relations to natural hazards, particularly in Asian and African developing countries (Dube, 2013; Hiwasaki, Luna, Syamsidik, & Shaw, 2014; Mercer, Kelman, Suchet-Pearson, & Lloyd, 2009; Mercer, Kelman, Taranis, & Suchet-Pearson, 2010; Songok, Kipkorir, & Mugalavai, 2011; Syafwina, 2014).

Another decade later, EWS and IK crossed paths in Baringo County, Kenya. Figure 1 photo was taken at a government-led seasonal forecast workshop in October 2016. At the workshop, three indigenous knowledge forecasters (IKFs) performed weather forecasts using stars and goat intestines, while government and other stakeholder participants watched and listened. To the researcher, the image is as fascinating as Leonardo da Vinci's Last Supper painting is to millions of people. Like the painting, the photo captures a dramatic moment of Baringo's EWS meeting IK, with different stakeholders' gestures making visible the significance of incorporating IK in DRR activities.

Figure 1 Photo taken at Baringo County's seasonal forecast workshop in October 2016

The dynamics of the incorporation spiked the researcher's interest to study how IK is incorporated in the local government's EWS to identify future DRR strategies, policies and programmes. A better understanding is needed of the social, political and economic dimensions, and organizational issues involved and affected by such DRR activities. This thesis is a qualitative case study of how IK was incorporated with DRR activities in Baringo County, Kenya. It describes the key stakeholders and their interfaces and interprets the long-term implications of such DRR activities. The research question is: **What are the driving, impacting and future aspects of incorporating indigenous knowledge in the government's early warning system in the case of Baringo County, Kenya?**

To expand on the research question, the following sub-questions were developed:

1. What is the nature and application of IK and scientific knowledge (SK) in the EWS in Baringo County, Kenya?
2. How is IK incorporated in the local government-led early warning activities?
3. What are the driving factors behind the activity including social, political, economic, technical and environmental aspects?
4. How have the EWS activities influenced the interface between the government and the IKFs, and the interface between indigenous and scientific knowledge forecasters?
5. What are the possible future scenarios of IK incorporation?

1.1. Key Term Definitions

The section provides the definition for the key terms in the study to facilitate comprehension and discussion for the research.

Generally, scientific knowledge is testable explanations and predictions about the universe (Heilbron, 2003). Over time, the word "scientific" became increasingly associated with the "scientific method" in studying the natural world, which is defined as "a method or procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses" (Oxford Dictionaries, n.d.). Other names for SK include "modern knowledge", "western knowledge" and "conventional knowledge". A Scientific Knowledge Forecaster (SKF) is a practitioner who provides weather forecast based on meteorology, a branch of SK related to the atmosphere and its phenomena, including weather and climate. Examples of SKFs include meteorologists working for international and national institutions including the Kenya Meteorological Department (KMD).

In comparison, in the simplest terms, IK is a knowledge system developed over time and is used by farmers to make appropriate crop management decisions (Soropa et al., 2015). The

Intergovernmental Panel on Climate Change (IPCC) recognizes IK as "the basis for local-level decision-making in many rural communities" (Boko et al., 2008). Other names for it include "traditional knowledge", "folk knowledge", "local knowledge", "indigenous technical knowledge" and "traditional science" (John Fien, n.d.). An Indigenous Knowledge Forecaster (IKF) is a practitioner who generally provides local-scale weather forecast based on his/her IK and observations of weather and climate forecast indicators. Typical examples of IKFs are elders in rural communities.

Early Warning System (EWS) is a set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss (UNISDR, 2009). An effective EWS has the four separate, but interlinked components: risk knowledge; monitoring and warning service; dissemination and communication; and response capability. Failure in any one element can result in the failure of the entire EWS.

UNSIDR (2009) defines "forecast" as "definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area". The words "forecast" and "prediction" are often used interchangeably both academically and colloquially. IPCC (2014) provides a common definition for a "climate prediction" or "climate forecast" as a most likely description of the actual evolution of the climate in the future.

1.2. Thesis Structure

Following the Introduction chapter, the rest of the thesis is structured along the following chapters:

- *Literature Review* which demonstrates the existing relevant knowledge on the topic,
- *Methodology* which describes the research approach and limitations,
- *Results* which summarizes the categorized data to address the research questions,
- *Discussion* which connects the results to the theories presented in the literature review, and
- *Conclusion*, which provides recommendations to the future, related EWS and DRR programmes.

2. Literature Review

This section summarizes the results of my research process to understand the academic discussions to-date on the topics of IK and EWS. The review results helped develop the research objectives and questions, which are detailed in the Introduction chapter.

2.1. Indigenous Knowledge on Early Warning

Around the world, significant research efforts have been made to identify and document the IK on EW in dealing with various forms of hazards. During a disaster preparedness training project in coastal Bangladesh, an NGO gathered information from the older people of the communities on how local early warning indicators had helped them in past cyclone events (Howell, 2003). Even though the total death toll reached 200,000 people in the 2004 Indian Ocean tsunami, on an island close to the epicentre, there were only 7 victims out of the total population of 78,000, thanks to a traditional story that acted as part of the earthquake EWS (Syafwina, 2014). A study conducted in a small rural village in Pakistan sheds light on the rich IK the locals have developed over generations, including weather predications based on winds and animal behaviours, to deal with a myriad of disasters including droughts (Khetran, Khan, & Chaudhry, 2012). Research in the Makueni district of Kenya shows that agro-pastoralists hold IK on indicators of rainfall variability to monitor and mitigate risks of droughts (Speranza, Kiteme, Ambenje, Wiesmann, & Makali, 2010). Northwest from Makueni, another group of Kenyan researchers in the Lake Victoria basin area gathered a list of frequently used traditional indicators used for rainfall forecasting including trees, migratory birds, winds, clouds and lightening among others (Kipkorir, Mugalavai, & Songok, 2012). Research conducted in six regions of Uganda focused on the IK of seasonal weather forecasting, and identified indicators that are used by the local communities including blowing of winds, and appearance of insects and birds (Okonya & Kroschel, 2013). The research in this subject area has grown exponentially in the past two decades considering there was hardly any literature prior to 2000.

Some researchers have tried to specify the differences between indigenous and scientific forecasts and Table 1 provides a comprehensive summary of their distinctions (Ziervogel, Churi, Houenou, Kisiangani, & Wanda, 2010). However, forecast characteristics aside, the ultimate comparison would be in terms of accuracy and effectiveness. Studies in Zambia, Zimbabwe and Kenya showed a good convergence between IK and SK between the 2008/9 and 2009/10 seasons (Guthiga & Newsham, 2011; Mugabe et al., 2010). Another study in Zimbabwe compares indigenous and scientific weather forecasts for the 2012/2013 season and showed that indigenous forecasts were more accurate at the local scale (Chisadza,

Tumbare, Nyabeze, & Nhapi, 2014). Furthermore, IK does a better job interpreting early warning messages in rural communities as it is part of the local knowledge system (Kamara, 2005; Shifidi, 2014). Despite the differences between the two knowledge systems, the current consensus among researchers is that the two knowledge systems are not mutually exclusive but complement each other (Kniveton et al., 2015; Mugabe et al., 2010; Speranza et al., 2010; Ziervogel et al., 2010).

Table 1 Comparison of indigenous and scientific forecasts (Ziervogel and Opere 2010)

Indigenous	Scientific
Use biophysical indicators of the environment as well as spiritual methods	Use weather and climate models of measurable meteorological data
Forecast methods are seldom documented	Forecast methods are more developed and documented
Up-scaling and down-scaling are usually complex	Up-scaling and down-scaling are relatively simple
Communication is usually oral	Communication is usually written
Explanation is based on spiritual and social values	Explanation is theoretical
Taught by observation and experience	Taught through lectures and readings
Adapted to local conditions and needs	Formulated at a larger scale and often of reduced relevance at local level
Refers to rainfall duration and distribution and it is aligned to crop-weather indicators	Refers to rainfall quantity at a regional level
It is language based and qualitative	It is number-based
It is explicit in its social-context aspect and it is an integral part of communities' culture	Has little social context

Besides having many diverse early warning indicators, the communities also actively utilize the indications as part of their early warning and local knowledge system. The degree of utilization can vary significantly from area to area due to the community's social, economic and political conditions. This ranges from solely or extensively relying on IK in the absence of a scientific forecast (Khetran et al., 2012; Syafwina, 2014), to using indigenous indicators as backup in the case of failure of formal EWS (Luo, Shaw, Lin, & Joerin, 2014). Studies reveal that over 80% of farmers in some parts of Ethiopia, Kenya, Zambia and Zimbabwe relied on IKFs (Luseno, McPeak, Barrett, Little, & Gebru, 2003; Mugabe et al., 2010). IK can also be used as a knowledge base which local people can use to interpret scientific forecasts (Speranza et al., 2010). However, in some cases where the indicators conflict, the farmers resort to using those that they know (Mugabe et al., 2010). In addition to early warning, there are also plenty of value in IK for coping mechanisms, climate change adaptation and sustainable development (Baumwoll, 2008; Warren, 1997; Dekens, 2007; Hansen et al., 2009).

2.2. Driving Factors

Before the process of incorporating IK is discussed, it is essential to understand why it gained a foothold on the development agenda. International development practices provide an essential theoretical framework for various activities funded by international agencies and guide the design and implementation of EWS projects in developing countries. From the literature review, the section describes two predominant practices and other driving factors.

2.2.1 Participatory Approach

A participatory approach of engaging stakeholders provides an important basis for the various EWS development projects that incorporate IK. In general, there is a weak understanding of the human dimension of early warning, i.e. how people and communities interpret and respond to early warning messages (Thomalla & Larsen, 2010). A participatory approach that is inclusive and based on partnership is essential to get the communities' buy-in to such projects. In a case in Washington State, United States, an educational video based on traditional oral story was successfully produced due to the partnerships involved (Becker, Johnston, Lazrus, Crawford, & Nelson, 2008). Furthermore, Mercer (2012) indicates that the participatory approach addresses the crucial needs of more dialogue between stakeholders, which builds trust and more space for further dialogues.

Research scientists who work on bridging IK and SK recognize the importance of an inclusive participatory approach. Over the past few years, a participatory research methodology involving stakeholders from indigenous communities was employed in several case studies including in Kenya, Uganda and Southern Africa (Chisadza et al., 2014; Kipkorir et al., 2012; Okonya & Kroschel, 2013; Speranza et al., 2010). Participatory research can take a number of forms including IKFs and SKFs taking turns to present their knowledge, conducting experiments together, and scientific researchers validating the IK on forecasting (Hayward, Simpson, and Wood 2004). A study by the International Research Institute (2011) identified the interaction and dialogue between climate experts and decision-makers as a key to the successful uptake of forecast information.

2.2.2 Community-Based Observation Network

The Community-Based Observation Network (CBON) aims to achieve overall EWS success through improving community resilience and capacity. In the past, institutions spent substantial resources on developing institutional and individual capacities, e.g. food storage and household evacuation plans, but the level of preparedness within communities received

less attention (Paton & Johnston, 2001). A more holistic resilience model places the community between the institutions and individuals (Leonard et al., 2006). CBONs use a set of human observers, including indigenous observers, connected via a network to provide comprehensive environmental observations to institutions in a bottom-up approach (Alessa et al., 2016). Invariably, by adopting this model, an effective EWS is considered most successful when community resilience is considered and developed (Becker et al., 2008). Similarly, a socio-economic assessment of the consequence of flooding in Northern Namibia recognized the need to incorporate IK and communities in the early warning initiatives for at-risk villages, and encouraged the adaptation of a community-based disaster risk management practice (Shifidi, 2014). Ultimately the community-based approach allows for more risk knowledge at the community level to achieve the goal of benefitting the communities (Luo et al., 2014).

While many in theory support the CBON approach, reality does not reflect that it is a general practice. In the case of a remote village in Pakistan, while the community structure existed in the form of a council of elders, the structure worked in isolation and was not connected to any government institutions (Khetran et al., 2012). For CBON to take root, Alessa (2016) argues that the EWS will need to be owned by the community to capitalize on opportunities, and not the institutions.

2.2.3 Other factors

Previous research has established that providing more accurate and accepted forecasts is an important driving factor for incorporating IK (Howell, 2003; Mercer, Dominey-Howes, Kelman, & Lloyd, 2007). It is thought that the integration can address the early warning communication challenges of at-risk communities often ignoring or not responding to formal forecast messages (Kniveton et al., 2015; Masinde, Bagula, & Muthama, 2013). The 2015 UNSIDR Global Assessment Report on Disaster Risk Reduction (2015b) highlights the gap that while much more disaster risk information is generated today than ever before, it is not necessarily accessible to households.

Another important driving factor is the international DRR frameworks, including Hyogo and particularly Sendai, which promote the value of indigenous DRR knowledge (UNISDR, 2005, 2015c). In addition, many researchers urge bridging the two knowledge systems to get the most out of both worlds (Howell, 2003; Roncoli, Ingram, & Kirshen, 2002) or to develop a new form of knowledge that is a hybrid of both knowledge systems (Mercer et al., 2012; Valdivia et al., 2010).

2.3. Incorporation Process Frameworks

Motivated by the driving factors presented above, different process frameworks have been proposed to achieve the goal of incorporating IK. In one case focusing on DRR for small island developing states, Mercer (2012) advocates a four-step process framework of: community engagement; identification of vulnerability factors; identification of indigenous and scientific strategies; and development of an integrated strategy (Figure 2). It was emphasized that the process needs to be participatory and multi-disciplinary. In another case based on disaster response practices, but more specific to forecasting, Chand (2014) suggests a four-step Participatory Rural Appraisal framework: identify priority communities; develop an infrastructure for collection; recording and monitoring; integrate indigenous and scientific forecasts; and disseminate consensus forecasts. In a third case, Kniveton (2015) proposes two innovative approaches: knowledge timeline, which compares IK and SK weather information; and participatory downscaling, which translates national and regional weather information in ways that local levels can act upon.

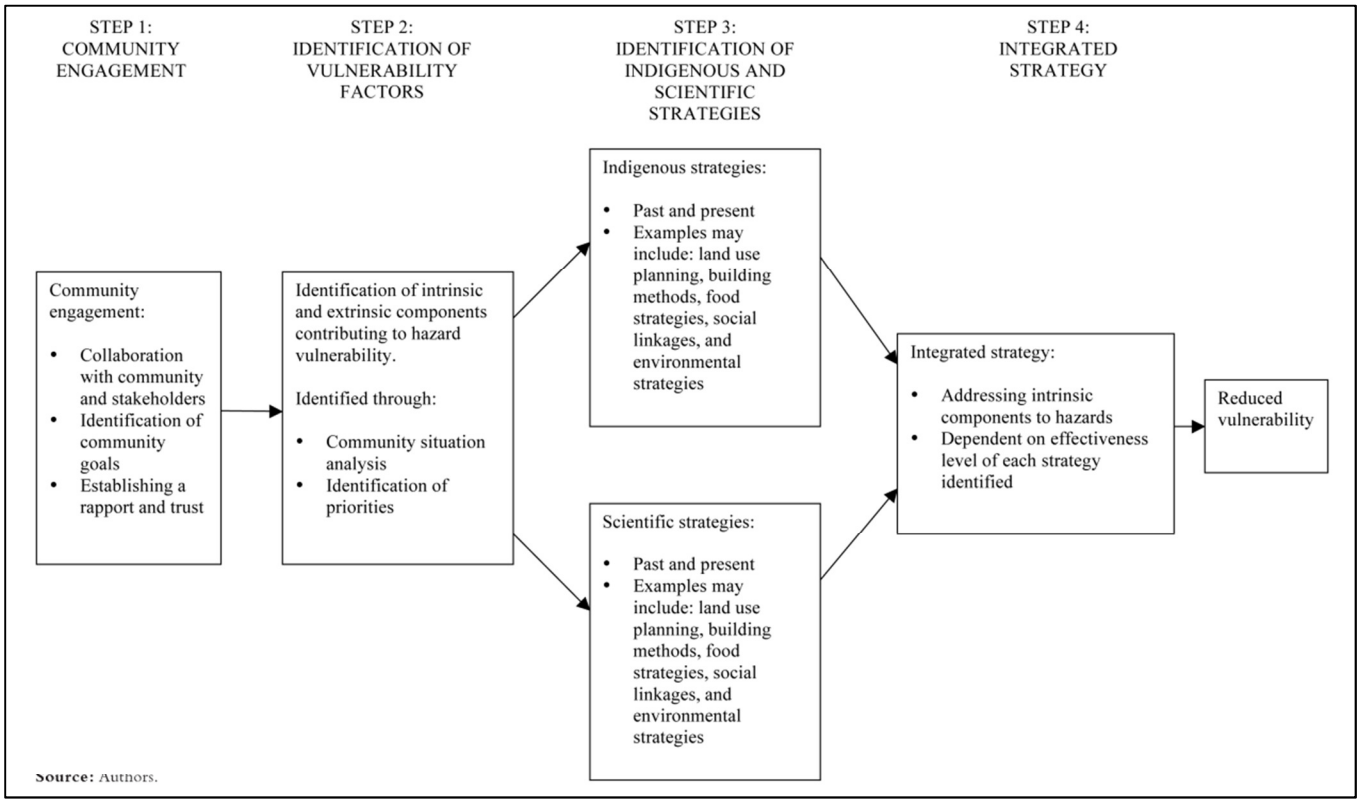

Figure 2 Integration Framework of Indigenous and Scientific Knowledge

The frameworks cater to more theoretical aspects and generally do not address the subtlety of the integration details, which are just as critical. The Sendai Framework indicates that it is important "to ensure the use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge" (UNISDR, 2015a). While the process frameworks provide guidelines at the high level, tangible advice on how to integrate IK "as

appropriate" is missing. As much as IK is proven valuable in some DRR aspects, it may not always have a positive impact in practice. An example from Indonesia concluded that traditional beliefs and broader socio-economic characteristics were intricately intertwined causing evacuation failure (Donovan, 2010). Another challenge in creating such a platform is the diverse needs and priorities using participatory approaches (Thomalla & Larsen, 2010).

2.4. Existing Cases

Despite few platforms being available for incorporating IK (Thomalla & Larsen, 2010), initiatives to do so are growing. Initially most of the effort focused on the technical aspects with researchers documenting the IK and comparing it to SK (Kipkorir et al., 2012; Okonya & Kroschel, 2013; Songok et al., 2011).

In recent years, there has been a shift to a more social development aspect. In 2008, a pilot project in Western Kenya brought national meteorologists and IKFs together to produce a further downscaled consensus forecast (Ziervogel et al., 2010). In 2011, an NGO funded two pilot workshops using the knowledge timeline and participatory downscaling approach: one in Senegal and the other in Kenya, each extending over two rainy seasons (Kniveton et al., 2015). In 2013, a workshop confirmed the usage of indigenous forecasting knowledge with involvement of the Vanuatu national meteorological and the volunteer rainfall observer network (Chand et al., 2014).

One case that stands out is a "purely community-based initiative" spearheaded by a local focus group in the Mbeere district in Kenya (Masinde et al., 2013). The initiative integrated indigenous forecasts with scientific forecasts and made use of mobile and wireless sensor technology to downscale weather/drought forecasts directly to individual farmers. In the pilot cases, an advisory board was set up to provide project direction, and was made up of IKFs, national meteorological representative, and church representatives.

However, in all these cases, the effort was more on the national government and local governments were typically not involved. Thus, it is difficult to identify how the initiatives affected the local governments with the communities. Furthermore, there was very little indication of how indigenous and scientific forecasting information influence the DRR activities at the local government level.

2.5. The Baringo County Context

Baringo is one of 47 counties in Kenya in East Africa. Figure 3 shows that Baringo is situated in the Rift Valley region with the Equator cutting across the county (NDMA, 2016). Baringo County falls in the arid and semi-arid regions of Kenya. However, unlike other arid regions in arid area of Kenya, the county is advantaged due to the varying topography. The rains fall twice annually, the long rains from March to May and the short rains from August to November. However, the rainfall is erratic in many parts of the country.

Figure 3 Baringo county location in Kenya (Source: Wikipedia)

With over half a million people and an annual growth rate of 3.3%, the three main communities in the county are Tugens, Pokots and Ilchamus. Over 90% of the population are pastoralists with subsidy livestock herding, farmers with subsidy food or cash crops, or agro-pastoralists with a mix of both. One leading cause of nearly 60% poverty rate among the Baringo population is that inadequate and unreliable rainfall leads to crop failure and drought (BCG, 2013). Christianity is the most practiced religion in the county.

Baringo is prone to natural and human-made hazards, including drought, floods, forest and bush fires, diseases, landslides and conflict. Among the hazards, drought remains the biggest threat to food security in the region. The introduction of devolution in March 2013 was the most significant change in governance in Kenya since independence. According to the 2010 Constitution of Kenya and the Ending Drought Emergencies programme, DRR is a shared responsibility of the national and county governments. Following this, Baringo County Government (BCG) has developed DRR policies and strategies to protect its population from food security related hazards like drought, floods and landslides, and has set aside resources to finance investments in both risk reduction and disaster response (Baringo County, 2014; BCG, 2013).

In a recent drought preparedness workshop in Baringo County, three IKFs were engaged by the National Drought Management Authority (NDMA) Baringo office to provide early warnings to the BCG and other institutional stakeholders as indicated in the report cover photo. The indigenous forecasts, along with scientific ones from the KMD, provided input for developing drought scenarios and contingency planning.

3. Methodology

This chapter presents the methods employed to obtain the research aim, including interviews and literature review as well as techniques used to counter inherent limitations.

3.1. Theoretical Framework and Design Approach

Based on the above frameworks, a qualitative approach was adopted to explore the research question with inductive logic. A qualitative approach examines the "why" and "how" of decision making, not just "what", "where", "when", or "who". A "bottom-up" inductive approach was employed, which meant that the research began with making observations, detected patterns in the observations, and finally formulated general conclusions. By its very nature, this approach is open-ended and exploratory, and well-suited for case studies with probing research questions such as the ones employed here (Creswell, 2013).

The overall research methodology followed a process through which the research data was identified, collected, interpreted and analyzed (Tobin, 2016).

3.2. Data Sources and Collection

In the study, a range of qualitative data was employed to maximize perspective diversity, including interviews, documents and audio-visual materials. The data was collected in Kenya by the researcher from October to December 2016.

Semi-structured interviews were the main form of data collection. An interview guide (see Appendix A) was developed based on the research question in the previous chapter. The semi-structured interviews were open, allowing new ideas to be brought up during the interview as a result of what the interviewee said, even though the interviewer did not anticipate them. Appendix B shows a list of the thirty-five interview informants consisting of people identified through the government workshop activities, gatekeepers (individuals in an organization that have the power to grant or withhold access to people or information), researcher's own network and referrals by the informants themselves. Figure 4 shows the composition of the informant groups to achieve a balanced input: there were 6 IKFs, 5 SKFs, and 24 people from government, NGO or research institutions. In addition, 25 informants had experienced government-led IK incorporation activities in Baringo, 8 had similar experiences in other counties, and 2 were local IKFs who had only ever practiced in communities and never in government activities.

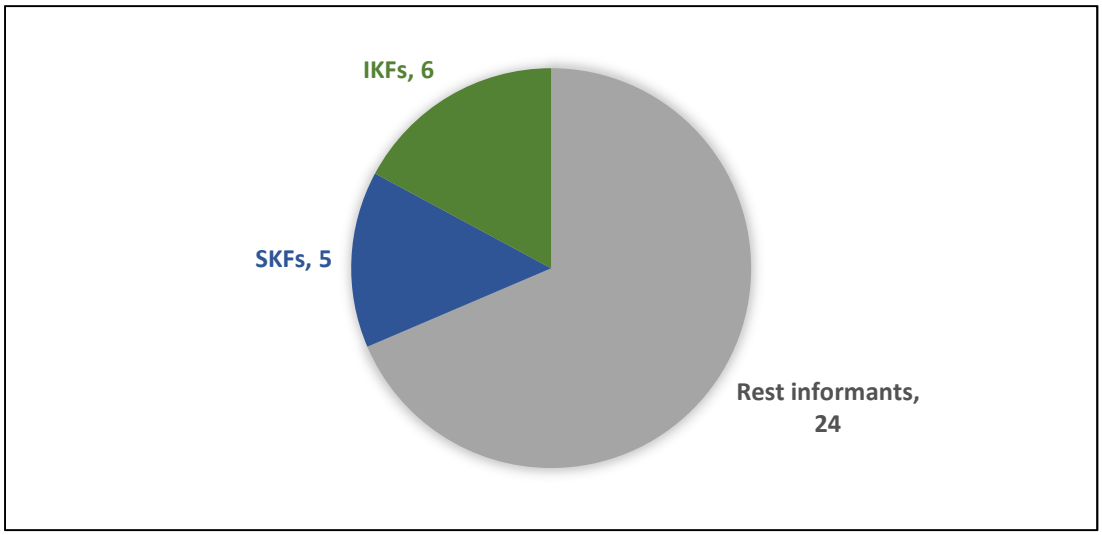

Figure 4 The groups of interviewees and the corresponding number

The interview data represented a wide range of perspectives from different groups including IKFs, SKFs, national and local government officials, NGO, and Kenyan researchers working in relevant fields. Based on the research framework, the researcher deemed it was important to talk to the informants directly and see them behave within their context, so the interviews were conducted one-on-one face-to-face in the field rather than a research facility. Three interviews were conducted by phone calls where physical access was difficult. Five of the six IKFs did not speak English, so the interviews with them were conducted with translators. All interviews were recorded and transcribed for data analysis.

A literature review was carried out to identify documents that provided secondary data to the case study. The review was used for informing the researcher's study on the topic as seen in Chapter 2, and helping structure the interview guide. The selection of literature was performed in two ways: asking key informants for recommendations, and using search engines. With regards to the former, grey literature produced by various institutions were solicited from the informants, as they were not widely distributed, but typically contained data relevant to the case. The Lund University library and Google Scholar were used for the latter whilst searching literature based on the search terms "indigenous knowledge early warning" and "indigenous knowledge forecasting". Snowballing from reference lists in relevant literature identified additional documents. The search results were then narrowed down based on the relevancy to the case study topics. In the end a total of 26 publications were identified as the core documents for analysis.

Audio-visual materials served as the third form of qualitative data used in the study. The researcher took photographs and videos during the Baringo county workshop in October 2016. At other similar Baringo activities, photographs and videos were recorded by interview informants, and shared with the researcher upon request. The audio-visual

materials were an extension to the other forms of data and provided the context for the case study.

3.3. Data Analysis

For both interview transcripts and secondary data, the following iterative and recursive process was followed based on qualitative data analysis and representation strategies (Creswell, 2013):

1. The interview transcripts and secondary data were reviewed to identify a list of codes, i.e. small categories of information, related to the research questions.
2. MindMap software was used to capture the data points from each interview transcript and secondary data relating to the codes.
3. For each code, inducing them from the relevant data points formed general statements.
4. Findings from different groups of informants, e.g. IKF vs. SKF, were contrasted and compared.
5. Finally, the key findings from the interview analysis were connected with previously identified ideas from the literature review.

3.4. Research Limitations

The following is a list of the key research limitations in practical, logistical and methodological terms, and the mitigation measures that the researcher employed where possible:

- Quality of the interviews due to language and culture barrier. There is a wide range of language skills across the informants. It is a challenge to ensure that informants share a common understanding of the interview questions. For this reason, additional time was spent on explaining concepts in different ways to ensure informants understand the questions. However, cultural and language barriers between the researcher and the informants might have given rise to misinterpretation of some of the responses. Hence, the findings and discussion should be approached with some caution.

- Quality of the interviews with the IKFs due to factors including access to informants, remote locations, language barriers, project coordination structure, etc. To mitigate this, the researcher engaged six different IKFs through multiple gatekeepers and

verified the interviews with additional interpreters. While the face-to-face interviews had the advantage of probing and interacting with the interviewees, it had the disadvantage of introducing more of the researcher's bias with body language.

- Difficulty in accessing the informants in governments and NGOs. To mitigate this, the researcher approached the gatekeepers through both formal and informal channels. With the research topic, it is likely that those who accepted the interview requests were more accepting of IK and open to discussing it. Therefore, there may be an inherent bias among the informants to favor the incorporation.

- The current research focused on the case of incorporating IK in Baringo County's EWS because it represents a unique situation, and the findings may lead to practical recommendations for similar cases. However, the focus on the Baringo case may lead to limitations on the findings, as they may not apply to other counties in Kenya. In addition, the researcher conducted this as an "outsider" looking in without the benefits of true internal perspectives. The study recognises that qualitative methods are open to the researcher's and informants' subjectivity and interpretation, which were dealt with by systematic reflection by the researcher.

- The literature review was conducted in English language only. Given the topic of IK, there may be literature in languages other than English.

3.5. Ethics

Efforts were made to meet with informants privately before the interview to make it clear that they were under no obligation to take part and they could choose to be anonymous by informing the researcher. Prior to each interview, the researcher requested the informants' permission to record the interviews and informed them that the recordings would be used for academic purposes only. During data analysis, password protection was used to store sensitive information to protect their identities.

As for cultural sensitivity, appreciation took place within social norms and the constraints of research and personal ethics. The form of appreciation varied from informal feedback and active listening to small monetary remunerations to IKFs. The researcher recognised the research topic is socially and politically sensitive, and endeavoured to conduct the research in an objective manner.

4. Results

This chapter presents the main findings in the five areas: forecast knowledge characteristics; incorporation process; driving factors; interface impact; and future scenarios. The thematic areas emerged from the data analytical process, and are identified as more important based on the frequency of their appearances in the primary data.

4.1. Forecast Knowledge Characteristics

This section examines the indigenous and scientific knowledge characteristics from three angles: forecasts, forecasters and recognition. The summary in Appendix C reveals a stark and complex contrast between the IK and SK from different informants' perspectives.

4.1.1 Forecasts

In the case of Baringo County, the indigenous weather forecasts are generally considered more accurate and reliable than the scientific ones by the informants. Four informants indicated that the indigenous forecasts generally "*come true*". In addition, three of the IKFs expressed absolute confidence in their own forecasting accuracy, *"If we say it is this way, it will be like that."* In addition, nine of the informants using EWS voiced that the scientific forecast was less accurate or reliable: *"it has failed the government many times"*. Several informants speculated on the causes, ranging from the tools KMD uses, to the forecasting models, to the forecasting over a wider area. However, one national government informant commented that the scientific forecast accuracy has improved and is becoming more reliable. Only one of the SKFs claimed that the scientific forecasts performed more accurately than the indigenous ones, although he did not know if anyone had done research to compare the two types of forecasts. None of the other SKFs made any comments on the accuracy and reliability of either indigenous or scientific forecasts.

About half of the informants, including two SKFs, commented that the indigenous forecasts were generally more holistic and covered topics other than weather. The area that drew the most attention was forecasts on security conflicts. Three informants mentioned a government-led seasonal forecast in 2015 where one IKF saw a lot of death of young people while conducting the forecast. A few days later, Garissa University Massacre occurred in a neighbouring county where 147 students were killed in a terrorist attack (BBC News, 2015). Other informants gave examples of indigenous forecasts of armed security distresses in the county including cattle rustling (communities raiding each other's livestock). One SKF theorized that it might be possible for IKFs to predict security stresses during drought

conditions based on area mapping information, e.g. boreholes and dry season grazing locations.

The differences in the type of forecasting instruments lead to different levels of subjectivity and labor intensity. About half of the informants noted differences in forecasting instruments between IK and SK, where IK relies on indicators in the natural surroundings including animal intestines, migratory bird movements, plants and trees, stars, etc., whereas KMD/SKF uses satellite images and other technical devices, etc. There were more concerns with the indigenous instruments. One researcher questioned how sustainable it is to slaughter a goat to obtain weather forecasts. One government informant pointed out that indigenous forecasting required commitment because slaughtering animals and observing stars at night was "*dirty and involving work*". Another government informant pointed out that the indigenous indicators were subject to observation and interpretation by humans, and appeared less objective compared to the scientific instruments with precise readings.

4.1.2 Forecasters

There are many differences between the indigenous and scientific forecasters. One of the most important factors is the physical distance between the forecasters and the users of the EWs. Figure 5 shows that the interviews with five IKFs were carried out in areas for which they provide forecasts, whereas the interviews with four SKFs were conducted in Nairobi. The proximity to the farmers and pastoralists has a direct and significant impact on other characteristics of IKFs and SKFs, particularly their knowledge areas, education, communication and roles in the communities. Several informants credited the accuracy and reliability of indigenous forecasts to the closeness between IKFs and the users of their forecasts. However, this closeness does not always prove to be beneficial for the IKFs, as one of them pointed out there would be more pressure to deliver accurate forecasts, as they did not want to disappoint their communities. The knowledge areas for IKFs and SKFs are distinctively different. Figure 7 shows that the IKFs have more varied and comprehensive knowledge at the local or "horizontal" level, ranging from social, environmental, cultural, security and politics, etc. As one informant pointed out, some of the IKFs were farmers themselves, so the IKFs consumed the forecast information themselves in hope of benefiting their sources of income. The IKFs also have extensive environmental knowledge of their local surroundings as their indicators depend on the natural setting. As another IKF claimed, "*The MET only knows about the clouds, but us, we know when the cattle are moving from one place to another because of droughts.*" In contrast, the SKFs typically have a more "vertical" and homogenous meteorological knowledge based on global, regional, national and local weather forecast information. One NGO informant pointed out that this could be

an issue when SKFs are brought in from other places resulting in disconnect in understanding the local context.

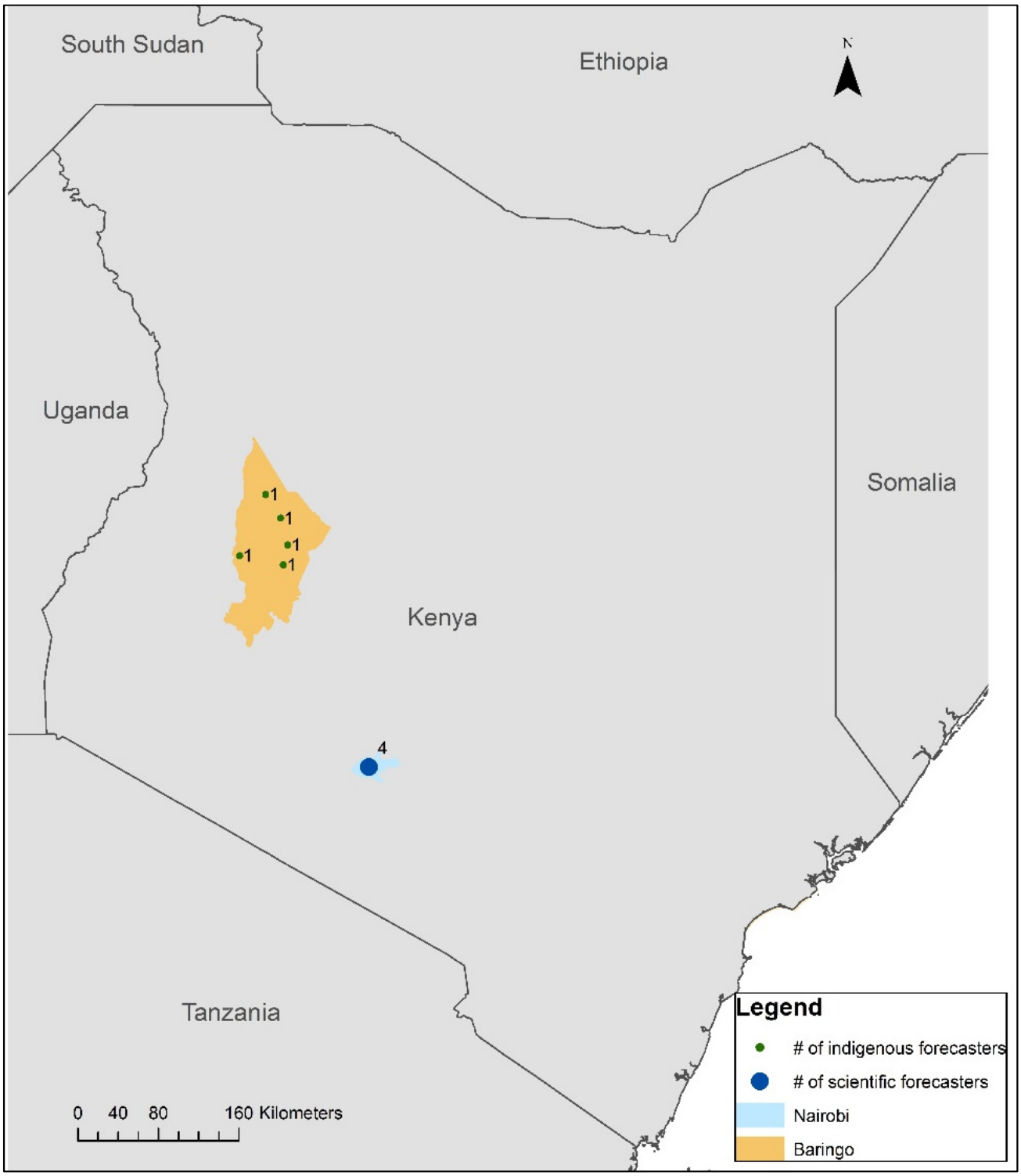

Figure 5 Geographic location of the in-person interviews with IKFs and SKFs

In terms of education, the IKFs in Baringo are generally measured using the formal education standard, and not the informal education in obtaining their IK. Only one of the six IKFs had "*formal education*", i.e. institutional education. Over a dozen informants described the IKFs as "*illiterate*", "*uneducated*", "*unschooled*" and "*not learned*". Only one

researcher quantified the description with "*per western education standard*". All six IKFs indicated that they had learnt forecasting through watching their fathers practicing in informal settings. The IKF with formal education revealed that the demanding school schedule made it very challenging for him to continue studying IK at the same time. In the end, he persevered by focusing less on certain formal education subjects and making time to observe stars at night. In addition to the IKFs, several informants, including one researcher, indicated that they had some degree of informal IK education. The researcher indicated that after a short stay in rural areas, he could predict and validate some indigenous forecast indicators.

The IKFs' ability to communicate is considered from two distinctive angles: collaborating with "outsiders" and disseminating forecasts to their own communities. In collaborating with "outsiders", several informants stated that the IKFs spoke their own tribal language, did not typically speak English and had very limited vocabulary in Swahili. In addition, one researcher pointed out that most of the scientific forecast terminology is so technical that it would be difficult to translate. This inability to communicate reversed when it comes to EW dissemination. One NGO informant gave the reasoning that the advisories are typically simplified versions of the weather forecasts and did not contain technical details, so it is easy for the IKFs to present, and easier to translate into the local languages. Furthermore, the IKFs deliver EW messages using expressions and parables that communities could easily understand. This contrast in communication outwards and inwards of the communities was confirmed by one IKF, "*It is good to work with the community rather than working with the government because it is easier with the language.*"

4.1.3 Recognition

There was an agreement among the informants that IK has a lower standing than SK in the Kenya/Baringo government or mainstream context. Two informants traced this back to the fact that the British colonized Kenya for 70 years, during which period "*everything traditional was considered backwards*". Both religion (Christianity) and western education reinforced this ideology by calling traditional practices superstitious and by dissuading people from learning IK. A national governmental official admitted that the general attitude towards IK has been suspicion and the officials did not take IK seriously. It was recognized that after 50 years of independence, Kenya is "*only now shedding what the colonial government has impacted on us*". One development practitioner commented that there were only limited opportunities to integrate IK into the formal process of policy formulation.

In contrast, SK is accepted and utilized by the KMD, the sole legitimate weather forecast provider in Kenya. The present KMD started as a small colonial service in 1929 and became

a Kenyan national department in 1977 (Mukabana, n.d.). As part of its core functions, the KMD provides weather-related early warning information to virtually all sectors that are sensitive to weather anomalies using current technology (Shilenje & Ogwang, 2015). One researcher commented that the formal forecasting process starts with the SKFs at the KMD receiving international and regional forecast information with support from intergovernmental agencies. In contrast, the IKFs "*have been operating under the table, (and) the MET fellow is more open and they have been in the public media*". One county government informant pointed out, "*even if at times their (KMD's) predictions are wrong nobody punishes them because of climate complexity*".

In contrast to the government and mainstream perspectives, there is significantly more recognition and practice of indigenous forecasting knowledge in Baringo rural communities. It was noted that IK forecasting has been in the community "*since the time of memorial*". Over half of the informants stated that communities trust IK more with reasons ranging from IKFs being part of the communities and the communities trusting their own people, to the communities understanding the IKFs better, to IK forecasts being more correct. One informant indicated that in East Pokot, a region in Baringo, "*every village has one (indigenous forecaster)*". With the communities' preference for IK, the IKFs' knowledge makes them stand out and well respected in the communities. Several government informants described IKFs as "*opinion leaders*" and "*role-models*" in the communities. In contrast, scientific forecasts are "*normally not used by the common men in the villages when it comes to planning these activities*". Another informant recalled that initially the communities had distrusted scientific forecasts and did not take them seriously, "*the use of modern forecast is improving, but the communities still rely more on the indigenous forecasters*". However, one IKF noticed a troubling trend for the reliance on IK in the communities. He observed that "*people are shunning away from the cultural ways*" due to education and Christianity, *"others doubting our work almost makes me shun away from this work because we are not paid by anybody."* By comparison, the KMD 2010/2011 budget was about USD 12 million (Mukabana, n.d.).

4.2. Incorporation Process

This section provides findings on how IK was incorporated in the Baringo County's EWS. It started with a national development programme, Agriculture Sector Development Support Programme (ASDSP). With the mandate to improve food security in rural communities, the programme has a social inclusion component to establish inclusive sector-wide coordination covering all Kenyan counties (ASDSP, n.d.). The Baringo county ASDSP coordinator indicated that the programme began engaging local IKFs in Participatory

Scenario Planning (PSP) workshops in 2014. PSP was a concept developed in 2011 by CARE International, an NGO and ASDSP development partner. It was a multi-stakeholder approach to user-based climate services, which enables regular access to and use of seasonal climate information at the sub-national level (CARE International, 2011). Figure 6 show that the PSP process followed 5 steps including design, preparation, workshop, disseminating advisories and feedback. From the outset, PSP workshops are conducted typically over two days twice a year in Baringo in sync with the rain seasons; once before the "Long Rains" season (March-April-May) and once before the "Short Rains" season (October-November-December). Selected IKFs are invited to PSP workshops to conduct weather forecasts. The IKFs are commonly referred to as "ITK" by the PSP coordinators and participants and it stands for "Indigenous Technical Knowledge".

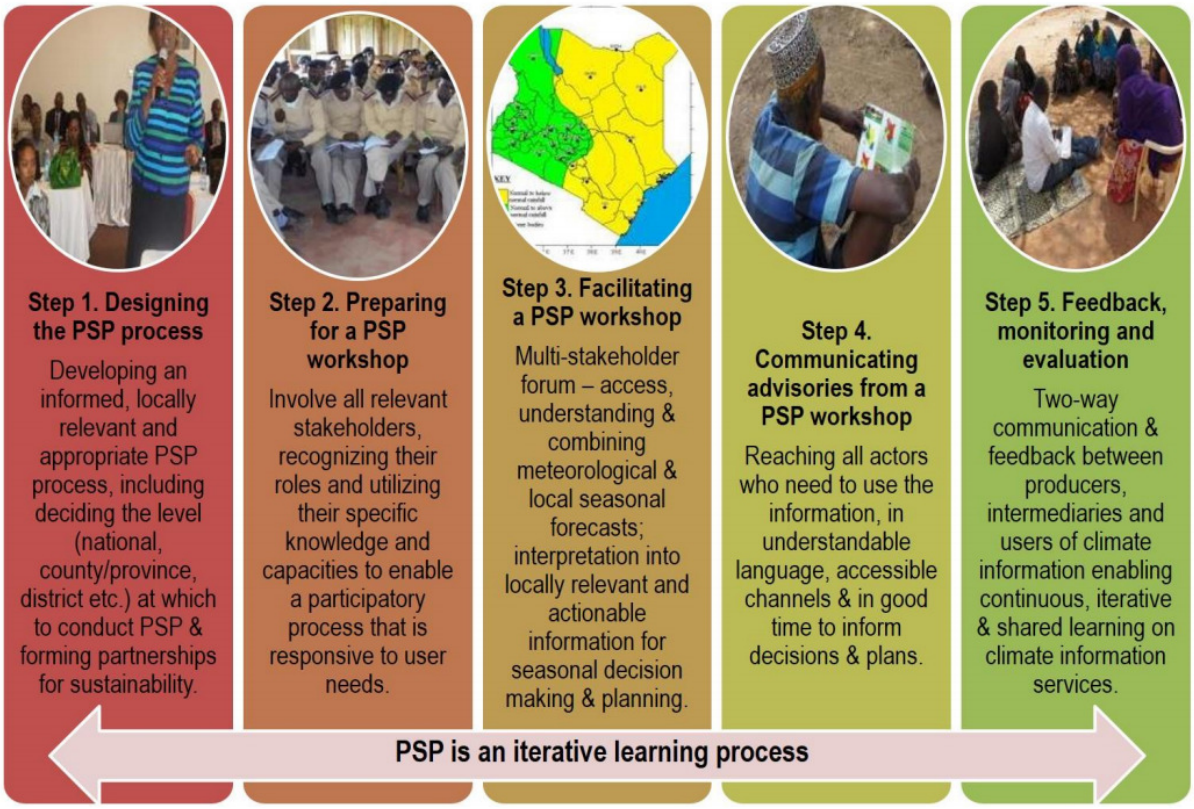

Figure 6 PSP Process as illustrated in CARE International's policy briefing

At the PSPs, a combined weather forecast message was developed by the KMD and IKFs based on their respective forecasts, which served as the basis for advisories to the users. The ASDSP county coordinator described the PSP workshop in April 2015: first the workshop participants went outside of conference room and watched three IKFs give forecasts using stars and the intestines of a slaughtered goat, then the participants went back inside and watched the KMD presentation of the scientific forecast. The KMD rep and IKFs then discussed and combined both forecasts into one forecast message. At the same workshop,

government technical officers from different sectors, including agriculture and water, developed sector-specific advisories based on the unified weather forecast message.

After the PSP workshops, the forecast and advisory messages were disseminated with assistance from the KMD and the IKFs. In some cases, the ASDSP coordinator took the IKFs to the county's radio stations to broadcast the forecast message in the forecasters' languages. The forecast advisories were also disseminated to the farmers in communities with the KMD and the IKFs present at public forums ("barazas" in Swahili). In addition, the advisories were taken to the county administration at the County Steering Group meetings, which were high-level meetings with all the county's department heads. The IKFs were not involved in this part of the process. A report on the September 2015 PSP workshop is included in Appendix C.

The PSP seasonal forecast was conducted with a different approach in October 2016. In the backdrop of a La Niña early warning (FAO, 2016), the NDMA Baringo office incorporated the ASDSP PSP into an expanded 5-day Baringo county drought scenario building and response planning workshop. The NDMA Baringo Response Officer explained, "*this time we decided to add more value by extending how the scenarios would inform how we deal with drought eventuality*". As captured on the cover photo, three IKFs were invited to the workshop where they gave their forecast to the county drought response partners including BCG and county commissioner's sector technical teams, national and county NDMA and NGOs.

4.3. Driving Factors

Given the Kenyan government only started engaging the IKFs in recent years, a natural question is what factors are driving the activities? The interviews revealed the following key factors from social, political, legal, economic, technical and environmental points of views.

Over one third of the informants pointed out that the intensification of disasters and climate changes in the region prompted the government to engage the local IKFs as a resource for DRR activities. Several government informants referred to the effect of more and frequent droughts in semi-arid areas on the government, "*there is more urgency in finding solutions, there is more pressure to look at it from all possible perspectives.*" Specifically, in the case of October 2016 forecast event where the PSP scenario building was incorporated into a bigger workshop, the NDMA county drought response coordinator noted that the decision was the direct result of reacting more seriously to the La Niña alerts. Another informant pointed out that the nature of disaster effect is that "*disasters happen in a small area. It doesn't happen in the entire world*". It provided more accurate local forecast information

when the IKFs interpret using local indicators as they "*really react to the changes in their environment like wind speed and solar energy, and that is why the animal intestines can indicate the weather changes*".

One third of the informants believed that the government's development strategy changes were critical in engaging IK in dealing with food security and DRR issues. To this effect, the most important trends include changes from disaster response to preparedness, from community capacity obliviousness to recognition, and from community isolation to inclusion. In the first aspect, an economic adviser for the County Governor indicated that the county's DRR policy underwent a paradigm shift from response, i.e. "*waiting until disaster happens*" to preparedness, i.e. "*effectively manage the characteristics and understand the causes of disasters, so that it is more sustainable*". The use of IK and SK together provides more insight on this in delivering an effective EWS. In the second aspect, two government informants commented that the sectoral technical team's perspectives of the communities have changed after years' working with communities and they realized that communities also have their own EWS, which "*is clearly objective and functional*", and it is important for the government to tap into this capacity. The third aspect reflects the Constitution and PSP's social inclusion mandate. Regarding security strategies, the government realized that "*when we use force, the (cattle rustling type) conflicts may not end. The village elders can assist in making peaceful resolutions*". It is also worth mentioning that several informants credited the Sendai Framework for influencing Kenyan's government to promote the use of IK in their development activities.

About one fifth of the informants recognized government devolution as a turning point in empowering the IK incorporation activities legally and politically. Devolution was in the centre of the Kenya Constitution to achieve a dramatic transformation of the Kenyan state through new accountable institutions and inclusive approaches (World Bank, 2012). One county official noted, "*formerly, everything was centralized in Nairobi … once you go to Nairobi, you forget about the village*". This resulted in a large operational disconnect between Nairobi and the local level. The newly established BCG was a new layer of government that is "*innovative and willing to consider anything that may take us to the next level, even looking outside the traditional government box*" per one informant. The KMD and NDMA also developed county-level structures to address local communities' needs. In addition, the Constitution mandated DRR as a shared function between the national and county government, which allowed the BCG to develop the county's own DRR policy promoting DRR mainstreaming in the county's development programme.

One fifth of the informants highlighted the EW dissemination challenge the KMD has faced in the past was another reason for the IKF engagement. The KMD county director described

that "*we have been disseminating climate and weather information but it has not been reaching the communities".* He indicated the reason for that was possibly due to the technical language barrier the KMD had with the communities, who the IKFs understood very well. An ASDSP national coordinator indicated that engaging IKFs addresses a gap in downscaling weather information to the local level, "*downscaling means discussing with stakeholders and understanding what the forecast means, particularly for them*". Two NGO representatives added that with the IKFs' influence in the communities, their presence enhance the interest of local communities in the activity, "*the government can tap into the indigenous forecasters' dissemination channels by joining up with them*".

4.4. Impact to Interface Between Government and IKFs

Driven by the previously mentioned factors, the IK incorporation activities took place at workshops such as the one illustrated in the cover photo. This section provides findings on how such activities have impacted the relationship between the government and the IKFs.

4.4.1 First Impression

For many government participants, the drought preparedness workshop in Baringo County was the first time they had experienced IK incorporation in government-led activities. When asked about their initial impression of the activity, the informants gave two types of reactions: some considered it positive and used words such as "*impressive*", "*astonished*", "*amazing*", "*very nice*" and "*good*"; some were more neutral and used words such as "*different*", "*interesting*" and "*fascinating*". In the former case, the informants were generally based locally and felt that IK had been long ignored, "*perhaps that is why we suffer this much because we ignored how the indigenous people used to cope*". A few informants echoed each other's sentiment, "*I was even asking myself, 'Why didn't this happen much earlier?'*" Another informant indicated that the experience was "*amazing for me because I could see the gaps (between SK and IK), and linkages we need to build*". In the latter case, the informants were generally from outside the county, and they stressed the differences between indigenous and scientific forecast practices, and typically went into lengthy description about how the IKFs at the event conducted their forecast. One NGO informant commented "*They exposed me to their culture, to different ways of thinking. It changes the way I work, it was a learning experience for me*". Another informant indicated that he had doubts before the activity, but when he recognized that indigenous forecasts were accurate, he became interested and developed confidence in IK.

As for the IKFs' reaction to the government's engagement, it was a mix of appreciation and reservation. The IKFs felt they were appreciated and respected by the government for their

forecasting work. One IKF who participated at the workshop said he felt good that his talent was recognized and that his experience could be of help to the government. Another IKF thought "*the government has done good work by attaching us to work together*". In contrast, the IKFs also appeared reserved regarding the level of respect that they receive. One IKF observed that "*the government does not trust someone who has not gone to school (even though) the same person is saying the truth.*" This thought was shared by another IKF who commented that the government did not perceive the IKFs to be educated and, hence was not interested in them. Interestingly, a government informant noted, "*the indigenous forecasters are unschooled men, but we bring them to the same conference room to sit and reason together, so this has built their self-esteem, made them feel that they have a place*".

4.4.2 Combining indigenous and scientific forecast messages

For the most part, the IKFs and SKFs provided similar weather forecasts, which allowed a seemingly smooth consensus-building process. Informants agreed that the IKFs and SKFs typically arrived at the same forecast conclusion despite the different forecast instruments. Several government informants commented that there seems to be some relationship between the two, which they were sceptical prior to the experience. A researcher commented that the local knowledge helps fine-tune KMD information with county-specific

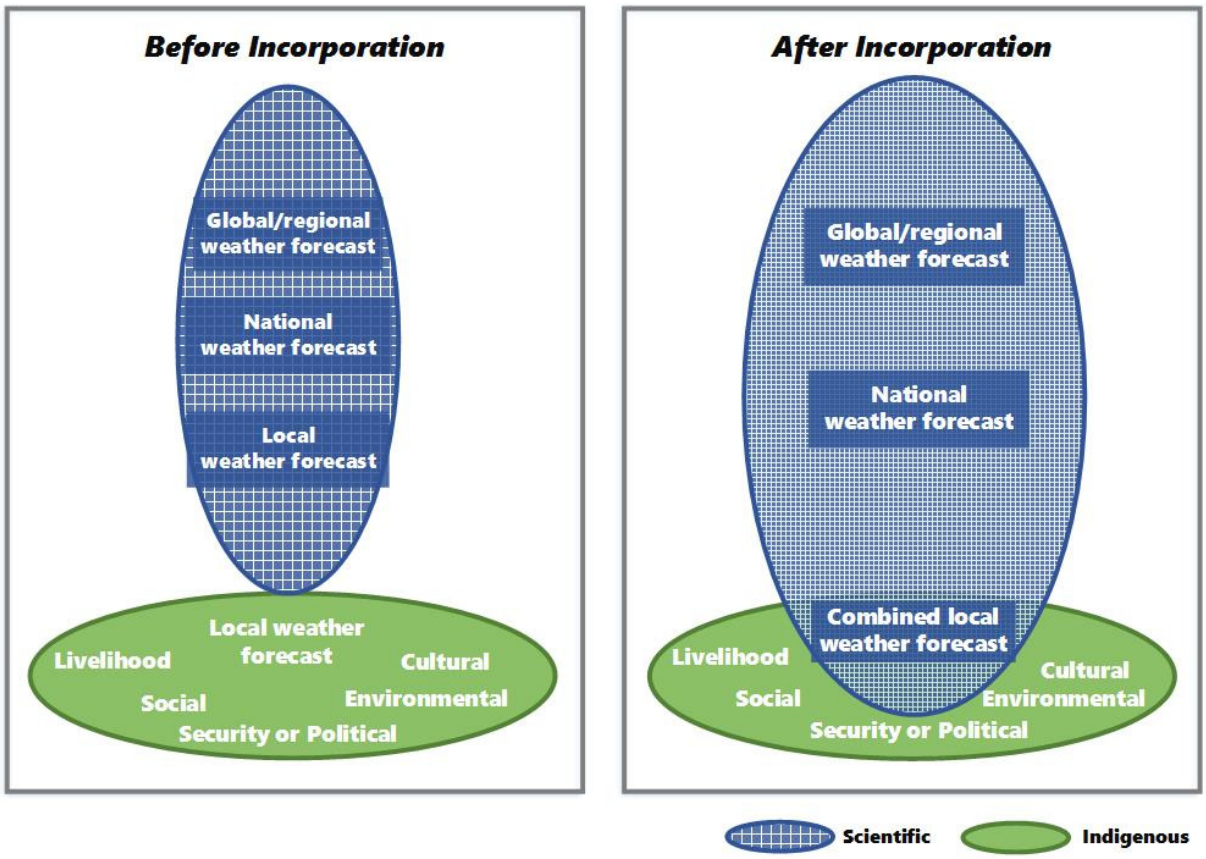

Figure 7 Local weather forecast before and after incorporation

information, and believed that this is the way to improve Kenya MET forecast (see Figure 7). A KMD informant agreed, "*we appreciate the indigenous forecasters after realizing that they got it right. Initially people thought that they are witch doctors and not getting it right, but now they got it right, there is more confidence in our joint forecast. As a result, we have better forecasts than before.*" The similarities in forecasts made several informants believe the IKF and SKF interface is good, "*we are seeing a strong marriage*".

When it was challenging to combine divergent forecasts, the government typically adopted the scientific ones. A KMD officer indicated, "*We wait for verification from the season based on the actual events*". In one case, a national ASDSP coordinator recalled that in the first Baringo PSP for March-April-May 2014 season, the IKFs predicted "*El Niño like enhanced rain for longer period*" whereas the KMD predicted slightly above normal precipitation, *"the traditional forecasters stood their ground as did the scientific forecasters. It was a bit difficult to reconcile."* During the season, Lake Baringo flooded past its normal shoreline, and many people living along the shoreline were displaced due to the event (Obando et al., 2016; Sunday, 2014). In hindsight, the coordinator admitted, "*we should have put in place a mechanism in case his prediction came true*". In a second case, the IKFs predicted slightly above normal rainfall during the September 2015 PSP; whereas the KMD forecasted significantly enhanced rain based on an El Niño alert. The combined advisory informed the communities to move as the coordinator acknowledged, *"the meteorological services are supported by the government and the world meteorological organization who were able to say so much, so we did not want to go against it"*. During the season, Baringo had slightly enhanced rain as the IKFs predicted. The ASDSP county coordinator noted that even though it was better to be safe than sorry, it was costly to involve so much effort when there was nothing serious. This revealed an "unequal marriage" between the IKFs and SKFs, "*it's like they (IKFs) are playing second fiddle*".

The IKFs and SKFs had noteworthy scepticism towards each other, while developing measured mutual acceptance through the process. From SKF's side, one NGO informant questioned how much respect they have for the IKFs, "*if it is convenient to them (SKF), they will. But most often it is not taken seriously*". One KMD officer commented, "*we are scientists and these guys are not, so we are not reading from the same page. It is only when we bring them in (that we realized that) even though we may read from different pages, we have the same book, therefore we cannot just dismiss them.*" One KMD officer clearly questioned IKF's credibility, "*indigenous forecasters lie from my experience*" and "*the indigenous forecasts are based on the scientific forecast that they have access to (prior to the activity)*".

In comparison, three of the IKFs indicated that they believed in scientific forecasting because they saw the forecasts matching. A fourth IKF indicated that he believed that SKFs and IKFs are equal, and his forecasts are more accurate, "*the meteorological people are very cunning people. They don't tell the truth. They say the rain will come, but it doesn't come. They are cheating people. When we went to the workshop, I defeated the MET people by saying the truth about rain.*" As one SKF pointed out the interface is still in the early stage and most likely will improve with similar future activities.

4.4.3 Responses to combined forecast messages

As indicated in the introduction, one key aspect of an EWS is the response capability of authorities and those at risk to take timely and appropriate actions. Most of the informants thought the IK incorporation activity had a small and gradual, but limited and hesitant, positive impact. Several informants indicated that the government had taken the indigenous forecasts into consideration e.g. conduct DRR planning at County Steering Group meetings. A government informant observed that the technical working groups had more confidence in the combined forecast, "*we are more convinced of the predictions than before after connecting the scientific predictions with the indigenous predictions*". The consideration aside, not everyone in the government was willing to take IK into consideration. In one anecdote, a senior county government official was very critical of the technical teams allowing the IKFs to participate in an event that was supposed to inform government planning. However, when the prediction came true later, the official admitted he was wrong and indicated that he would apologize to the IKFs. That aside, it was not clear from the informants exactly to what extent the IK forecast had informed government's decision-making. At least two informants were reluctant to comment if IK has enhanced the government's capacity. One SKF indicated that the KMD released forecasts to line ministries prior to the joint forecast activity, so the IK input was not factored in for government planning at all. Still, as the NDMA county drought response coordinator observed that the IK incorporation at October 2016 workshop was a first time for a lot of the participants, and it was a first in Kenya to expand it to response planning, therefore "*in terms of capacities, we could anticipate that there would be gaps in the different stakeholders which can be worked on going forward*".

At the community level, the informants agreed that the combined forecast messages were more accepted and prompted actions from the farmers. The ASDSP county coordinator and a NDMA county officer recalled that as an outcome of a 2015 PSP, the combined forecast predicted enhanced rain and the population prepared themselves according to the advisory, e.g. the at-risk population moved from areas prone to landslides. The NDMA officer noted that the communities have become more receptive to the report and have prepared for

different types of hazards, "*this helps ensure communications going from government to the communities and back*". It was also reported that the communities were more mobilized to attend the public meetings where the forecast messages were disseminated. This observation was shared by a KMD national officer who pointed out that "*our (KMD) county directors have realized the importance of it. They cannot (avoid including traditional forecasters). And even if they try to run away from it, the locals will still ask the same*".

4.4.4 Other impact

In addition to forecasting, the IK incorporation contributed to the government's DRR mainstreaming activities. One NDMA officer indicated that the county took a multi-disciplinary approach to *"take information from different sources and incorporate them in their planning*". As an example, in the October 2016 workshop, after the IKFs provided forecast forecasts, they were involved in the peace and security technical working group to provide feedback on mitigating and response interventions, "*The cooperation worked well because the indigenous forecasters know when and where the livestock would start migrating. They were able to share that with the technical working group, and the input found its way into the response plan.*" Another government informant agreed, "*Previously the thinking is that it is only government-led projects that can bear fruits, but here we have a joint approach, which makes it possible for communities to input in such development.*"

Trust building is highlighted as an important output from the incorporation activities, specifically with increased understanding about different forecast knowledge. Several informants indicated that many officers are developing trust in IK since the forecasts came true. One informant pointed out that engaging IKFs as stakeholders helped decision-makers, policy-makers and development partners appreciate the rich IK the people have. An NGO informant also noticed a similar reservation when engaging communities in Kenya, "*at first when we invited the "opinion-shapers" in the communities, like sheikhs, religious leaders (to PSPs), they wouldn't come because they were saying that they didn't believe in scientific forecasts*". Several informants noted that the IKFs increased understanding of the SK that the government relied on. In addition, others noted that engaging three IKFs from three different communities helped develop trust between communities that traditionally conflicted with one another. One IKF shared that he had not previously met any forecasters from other communities, and from the PSP workshops, he realized that they "*used the same things*", and they showed an agreeable front to different communities during dissemination.

4.5. Future Scenarios

Reflecting on the IK incorporation activities to-date, the informants projected three possible future scenarios in Baringo County in the long term. It was noted that some informants discussed more than just one scenario while most only one.

Scenario 1: Increased IK incorporation

Recognizing the importance of indigenous forecasts and their roles in the communities, the majority of the informants stated that they would like to see more IK incorporation and recognition.

A government informant noticed that the IK and SK forecasts did not "*mesh*" and the IK forecast is not used for its potential to achieve a harmonized forecast message. A researcher echoed the view of developing a framework to allow the IKFs and SKFs to address the differences in forecast messages. Furthermore, several informants indicated the need of documenting and validating IK forecasting by engaging them more frequently with suggestions ranging from four times annually to daily. Moreover, the government-issued early warning material did not specify if/which input is from IKFs. An NDMA officer suggested that the IKFs would feel recognized if given credit for their contribution.

In addition to the EWS, there were many suggestions for the government to promote and even mainstream IK in the county's DRR and development activities. Many informants agreed that education was key. Several informants recognized a need to sensitize government officials to reduce scepticism in IK and the social inclusive approach. Two informants noted the importance of national, county and KMD leadership in IK recognition and future IK incorporation. Others suggested including an IK component in children's school curricula, not just as a way of raising environmental awareness, but also "*heading back to our original value system*". Researchers suggested to introduce IK elements in the meteorology university level education so the scientists would be aware of more than the "purely classical scientific" approach and be more open-minded to work with other knowledge systems. A second suggestion is changes in the capacity development approach. Impressed with the indigenous forecasts, several government informants suggested that the government needs to consider building on and borrowing existing DRR or food security capacities in the communities instead of bringing in new ones. A third suggestion was to extend IKF involvement beyond forecasting to environmental conservation. Several informants expressed concerns with environmental degradation in the county/country, and the IKFs engagement can provide a platform to receive input and address issues at the grassroots' level.

From the IKF's side, all six IKFs, including those had never worked with the government, gave a positive response to such activities, and most expressed a willingness to collaborate with scientific researchers. One IKF indicated an interest in working for the government to provide weather information and advising people how to respond to hazards. The ASDSP county coordinator indicated that there is an initiative to formalize the IKF practices as a school of practice within the near future, which may help protect the IK property as well as giving them more legitimacy. Moreover, several government informants supported the idea of developing the IKFs' language and knowledge skills so that collaboration with SKFs could be more effective.

Scenario 2: Maintained IK Incorporation

Four informants expressed a more conservative view on IK incorporation: they see the current effort maintained and IK forecasts continuingly monitored. A county DRR officer indicated the expectation is for national agencies such as ASDSP and NDMA to continue organizing IK incorporation activities. The county's work plan was to observe indigenous forecasts for 5-7 years first to confirm the forecasts were "*good and real*". A NDMA officer indicated that he did not see a basis for regular engagement because of the DRR cycle of response and recovery, "*there is no good reason to involve them because the activities are mostly development, recovery and construction*". Instead he considered more value in IK engagement in the case of increased disaster risks. One SKF did not think the current engagement level would likely change because to make decisions with financial impacts, governments require "*facts written down on paper*", which is lacking in indigenous forecasts.

Scenario 3: Reduced or Diminished IK Incorporation

Five informants provided several factors on why it is likely that the IK incorporation effort would be reduced or phased out in the long run. One factor is the increased accuracy in scientific forecasting. Two SKFs and one researcher expressed confidence that scientific weather forecasts would become finer and more accurate with more sophisticated forecasting models, so the KMD would "*slowly disregard the linkage and need to refer to the IK*". Another factor is the change in communities' technical capacity. Two SKFs pointed out that with the county MET officers reaching out to the communities and bridging the gap, it is only a matter of time before the communities embrace new tools that work better. A researcher indicated a third factor of IK loss might be too great and fast, since many custodians were aging and there isn't enough drive to revive IK.

5. Discussion

This chapter highlights the similarities and incongruences between the interview results and findings from the Literature Review. The value and meaning of the results are assessed together with a consideration of research limitations.

5.1. Forecast Knowledge Characteristics

The findings showed a distinctive contrast between the IK and SK from forecasts, forecasters and recognition perspectives. The findings on differences in forecasts generally agreed with the literature specified in. In terms of accuracy, instruments and knowledge base. The responses highlighted the implication of forecast accuracy for different types of users: livelihood for farmers and pastoralists, and credibility for government officials. This implies that the weather forecast accuracy has a direct impact to Baringo's rural communities' DRR and food security issues. In that sense, it is evident that the EWS provided a level of power to the forecasters to be the supplier of such important information. One question that needs to be asked is: how much do the forecast users care about the source of information as long as the forecast is accurate and reliable?

The results revealed that IKFs were both producers and consumers of forecast information as their livelihoods were directly impacted by the forecast accuracy. In contrast, the SKFs were generally only producers of forecasts, not consumers as their livelihoods did not directly depend on the forecast accuracy. There was more at stake for the IKFs to give accurate forecast information or they would not be able to retain respect from their community members. This is an important factor to consider given the potential impact to the indigenous indicators with climate change and environmental degradation. Should the indigenous indicators become less reliable, a possible scenario would be that the IKFs might need to lean on SK forecast to maintain their "role model" reputation in their communities.

Based on the findings in areas of forecasters and recognition, one criticism of the existing literature is that there is a tendency to focus on forecasts, specifically indicators and accuracy. This may stem from a reductionist view where the EWS is just a function, and is taken out of its context. In other words, there may be contextual gaps between the environment in which the forecasts are produced, and the environments they are utilized. In comparison, taking a holistic view should be beneficial to understand the value system of the communities and contextualize the EWS. In the case of weather forecasting, it is performed at ceremonies and is an important part of the cultural heritage that brings communities together in rural areas. In these cases, one important aspect is to go beyond the

technical functions of early warnings themselves, by bridging possible social and cultural functions with indigenous early warning messages and IKFs.

The findings indicated a gap in IK recognition at different levels: it was valued significantly by the rural communities in Baringo, but very little by the mainstream/government practices. Many informants observed that this gap was caused by a systematic marginalization of IK, which started with colonial influences and continued with religious influence and western education. Due to the physical remoteness of the rural communities, IK is still very much at the core of the communities' culture norm and value system. The acknowledgement of the gap would be critical for EWS design and other DRR/development practices in the rural communities.

Another interesting finding was the significant, mutual bias and distrust for IK and SK between urban and rural communities. From one side, there was an exhibition of bias from government informants including SKFs towards IK and IKFs, e.g. "uneducated". This could be explained by the colonial history with western education and Christianity religion that suppressed and marginalized IK. Difficulties for IK arise, however, when this trend is projected to continue in Kenya in the future. Another explanation could be the lack of education and understanding of each other's knowledge systems, or even worse, misassumption and misunderstanding. In either case, the bias and distrust led to a perception that one's own knowledge was superior, which may lead to cooperation challenges. There is a lack of discussion in existing literature on the bias that scientific communities have towards IK and vice versa, which will require more research.

An intriguing observation was that even though IKFs had very good knowledge of IK forecasting practices, there was a lack of understanding and interest in why their own forecasting works. As one informant summarized, "*we scientific people don't know how indigenous forecasting works. The indigenous forecasters don't know why their forecasting works*". This shows some different criteria in knowledge acceptance as indicated by Agrawal (1995): the usability of IK is determined by its accuracy in rural communities, but it must pass a scientific criterion of validity before being recognized as usable knowledge by scientific communities. This may remain an obstacle for IK acceptance and recognition in future similar programmes.

5.2. Incorporation Process

The results indicate that the incorporation process was a top-down strategic partnership initiated by the national government and embraced by the local government and development partners. The ASDSP was guided by a strategy of multi-stakeholder

engagement with the goal of addressing food security issues. The IKFs were recognized as a stakeholder with specific expertise, who could provide additional forecast information and help reach a goal that benefits the communities. In this sense, the IKFs were treated as one of the partners in the initiative. However, this was not an equal partnership with the government providing most of the resources such as funding, workshop platform and dissemination channels. In addition, the KMD is an official institution whereas the IKFs come from different communities and do not have any formal structure.

The PSPs adopted a participatory approach based on a similar incorporation framework as identified in Literature Review. It was inclusive and recognized the community's buy-in as critical for effectively enhancing their resilience. Comparing Figure 2 and 6, the latter appeared more practical and highlights the process as an iterative learning process. One reason is likely the NGOs' practical experience in working with communities at a grassroots' level, and researchers might have limited exposure to the complex human dimension of IK incorporation.

There is a general mixture of usage of the words "incorporation" and "integration" both in literature and interview responses. To that extent there was no obvious alignment among UN agencies nor researchers (UN Inter-Agency Support Group, 2014; UNISDR, 2015c). Furthermore, there is little consensus on the meaning of these two terms, and lack of discussion of the two terms. While both exist, there seems to be an opportunity in future research to define the terms and align their applications.

Having said that, the interview results and literature seem to suggest that "incorporation" implies IK is included as a part of a greater knowledge body to support SK. IK appears more as an add-on that is included when convenient and excluded when diverging. In contrast, "integration" points toward blending IK and SK into a unified knowledge body, with systematic efforts in merging them into new hybrid knowledge. In the Baringo case, the indigenous and scientific forecasts were combined into one with limited analysis, and not blended, therefore more of an incorporation and less so of integration. An IK integration process would involve more time and effort from both researchers and IKFs, and be carried out in a smaller setting to allow open analysis and discussion.

Several different terms were used to describe "indigenous knowledge" by the informants and literature, with the most common being "traditional knowledge" or "local knowledge". Among the informants, the terms were often used interchangeably and without precision. Roncoli et al. (2002) avoided using the term "indigenous knowledge" as it connotes colonizing discourse and policies and preferred the term "local knowledge", which evoke the performance element of the knowledge and contextual aspect of its practice. It is worth noting that the ASDSP programme chose to use the abbreviation "ITK", which is shorthand

for "indigenous technical knowledge". The term ITK had a more modern feel and could be an effort to counter the associated "backwards" perception.

The development of the IK incorporation in Baringo over the past few years was, in part, a result of mainstreaming crosscutting issues such as IK and DRR. The IK engagement started as a national agricultural sector initiative, and the October 2016 workshop brought the IKFs to a larger audience from other sectors and disaster response partners. This was evidence of an increased interest in mainstreaming IK in other sectors beyond agriculture. In addition, the DRR workshop adopted a development practice by leveraging the PSP process. In turn, the workshop incorporated the communities' voices in developing sectoral response plans including that of the agriculture sector. This highlights the strong connection between DRR and the development agenda. Therefore, it should be considered that mainstreaming crosscutting issues might lead to mutual benefits such as sharing good practices between DRR and development initiatives.

5.3. Driving Factors

All four key driving factors listed in the results were mentioned in Literature Review. The first factor was the worsening disaster and climate change profile in Baringo County. These events with negative consequences give rise to the urgency in addressing disaster risks with all possible resources. Surprisingly, the dire situation gives reasons to recognize previously invisible communities and their capacity, in this case, IK in forecasting.

The second factor stemmed from development approaches promoting inclusion and disaster preparedness. It is interesting to point out the impact of international frameworks and guidelines on the national and local governmental practices. This insight gives weight to the power of international guidelines and research findings in influencing country governments' strategies and policies.

The third factor of government devolution is relatively unique to Kenya and was often indicated as a positive game-changer for the country's development. In Baringo, the findings indicated BCG and other county agencies were motivated to take the DRR seriously and actively connect with the communities. In terms of results' validity, selection bias was a potential concern because the interview informants might have a more positive view of the devolution since most of them were directly involved in government activities. However, given the increase in localized government functions such as DRR and weather forecasting, the findings provided strong evidence that the local governments were closer to the communities and served as an effective bridge between the national government and the communities.

The fourth factor was the documented challenges with EWS dissemination in rural areas, and the hypothesis that IKFs would help improve dissemination. This gives rise to the question of the effectiveness of IKFs in improving the dissemination, and how this would be measured and evaluated. In contrast, the informants did not indicate better accuracy as a direct driving factor

Given there are a myriad of driving factors behind the IK incorporation, there is a possibility that the activity would cease if one or several of the driving factors change. The study would have been more useful if the degree of influence could be assessed so that it would be possible to consider the long-term sustainability of the driving factors, and thus IK incorporation.

As indicated earlier, the IK incorporation process was more of a top-down process focused on technical aspects. The literature review highlights the CBON approach that let IK and communities be in the driver seat with the ability to define which observations are relevant and should be made. This is a more bottom-up participatory approach, in contrast with the Baringo case of engaging a handful of IKFs participating at SK-driven workshops. Complementary to the PSP process, there may be an opportunity to pilot the CBON approach in Baringo County, or Kenya at large, to extend the EWS network and improve community resilience.

5.4. Impact to Interface Between Government and IKFs

There is a general lack of discussion on the relationship between governments and IKFs in existing literature. Overall, the research findings indicate that IK incorporation activities are valuable catalysts for developing the interface, improving DRR community engagement and reducing communities' vulnerability.

The researcher found the first impressions shared by the government officials quite surprising. Even though at a personal level, many of them were aware of IK's existence, seeing the IKFs practicing at a government-led workshop had a significant impact. In a sense, the government sent the participants a subtle message that not only was IK's existence recognized, it might be considered useful in government activities. There is evidence that this first-hand experience served as a sensitization mechanism and elevated the legitimacy of IK in Baringo/Kenya. On the other hand, the IKF were more reserved to the engagement. This could be explained by years of systematic marginalization of IK in the region. Thereby, it should be recognized that the IKFs need to be treated with extra sensitivity to gradually dissolve decades/centuries of incommunicado.

The challenges in dealing with different forecast messages revealed the competitive nature between the IKFs' and SKFs' work. On the surface, the workshop was a technical cooperation between the forecasters, but when differences in opinions arose, both parties were sure of their own opinions and not willing to compromise over what they consider as technical "truth". In the end, the scientific forecasts were chosen over indigenous ones mainly because they are considered more legitimate by the government. In those situations, the conflicts were only avoided, but not resolved, since both parties waited to compare the forecasts after the actual seasons were over. This was possibly an indication of power inequality between the two parties of forecasters. The marginalized position of IK became obvious during the disagreement and was possibly re-enforced by the decisions. Given this evidence, it is highly likely that similar situations would occur in future IK incorporation activities. To this extent, the PSP and other incorporation frameworks appear quite theoretical and linear: they are generally based on the assumption that the participants are considered equal and cooperation is conflict-free. One possible research area is to address the conflicting situations that may arise during such collaborations, so that the IKFs and communities are not alienated further.

In addition, favoring SK forecasts over IK ones when there are differences may not lead to effective disaster preparedness measures, as evident in the two anecdotes described in Results section of combining diverging forecasts. In the first case where enhanced rain predicted by IK forecasts was ignored, but came true, there was not enough mitigation measures to prepare for potential flooding and it resulted in significant flooding damages and displaced people around Lake Baringo. In the second case, the SK forecast predicated enhanced rain, which didn't materialise, but the government carried out mitigation measures for potential flooding and landslides with associated costs. While it is difficult to find the balance, the worst-case scenario should be taken into consideration, as one informant indicated, "better safe than sorry".

While the combined forecasts were more accepted by the communities, it was not clear if and how much influence it had on the government's decision-making process. The study would have been more relevant if there was more convincing evidence to understand how the IK forecast was taken into consideration. This inconsistency in findings may be due to two factors in addition to research limitations: scepticism and reluctance in IK recognition. However, further research may be necessary to assess the level of IK incorporation in the government's decision-making process.

It appeared that with the IKFs' involvement in the sectoral response planning, the benefits of IK incorporation were extended beyond EWS. It was possible that the IKFs could contribute owing to their local knowledge on multiple issues of importance from a community

perspective. It is important to point out that even though the IKFs were not formally community representatives, they certainly had the capacity to represent the communities. Thereby, this type of collaboration in a low-pressure environment facilitated trust building between the government and traditionally marginalized stakeholders.

5.5. Future Scenarios

The future scenarios described by different informants showed a significantly varying degree of incorporation. The most likely cause of this was the different knowledge and perspectives the informants have of the various factors that may influence future IK incorporation. Research shows that the following three factors may impact the strategic partnership: the initial strengths and weaknesses of the partners, how they change over time, and the potential for competitive conflict (Mehta & Samanta, 1996). It is shown in the same study that generally the partner with either more resources or greater learning power prevails in the long run.

In Scenario 1, it was evident from the informants' responses that they recognized the IK's strengths in improving combined forecasts and increasing community's capacity in disaster preparedness. The suggestions of more IK recognition and sensitization reflected the limitation in the current level of IK incorporation. In addition, it echoed the informants' wish to utilize the potential of IK more frequently and publicly. There was also recognition of the other benefits with IK incorporation that include restoring traditional value systems, dealing with food security issues with indigenous coping mechanisms, and facilitating environmental conservation. The IKFs showed a high level of willingness to cooperate with the government, and this may also benefit their status and recognition. The institutionalization of IK knowledge would greatly empower the IKFs to have more leverage in the cooperation. Interestingly, there were more informants describing this scenario than any other. This could be explained by an ulterior motive of the informants to highlight the situation in hope of improvement, which would represent a potential bias in the data presented.

In Scenario 2, the informants were more reserved in terms of the IKF's involvement. The informants cited needing time to observe the IK accuracy in Baringo County before expanding the scope of IK incorporation beyond the seasonal forecast. However, instead of a county-level effort, a more effective approach may be for international and national meteorological services to recognize this from a top-down approach given existing literature on IK accuracy as indicated in Literature Review. Another factor that contributed to their reservation could be that IK was not accepted by the mainstream/government and

therefore its lack of legitimacy. Given that the workshop was a new and unique initiative in Kenya, this wait-and-see approach is expected and understandable.

In addition to the IK characteristics, Scenarios 3 considers the long-term changes with the SK's development and the changes in the communities. There is likely far-reaching development implications to rural communities given that the country's robust structural and economic reform in the past decade is projected to continue (World Bank, 2017). However, even with rural communities becoming more technical and modernized, it may be valuable to have IK forecast knowledge as supplementary, as well as an educational tool to raise awareness among community members.

Although not conclusive, the research findings give strong indications that IK incorporation provides real benefits in communities and should be continued in the long-term development plan. The IK conservation and SK advancement are not two conflicting agendas, but can go hand-in-hand to strengthen overall forecast accuracy and improve communities' EW responses. First, IK incorporation can benefit risk communication and supplement ideas on how to reduce disaster risks in rural communities. Secondly, in the case of the formal EWS communication failures, it is possible for the communities to use IK forecasts as a redundant system. Thirdly, IK and IKFs are valuable DRR capacity that exists in the communities and should be leveraged for future community-level DRR activities. This study suggests that without the government's support, the influence of IK may be highly limited to the immediate surroundings of individual IKFs, and non-existent at a higher or broader level.

6. Conclusion

The study set out to understand how IK was incorporated in the local government's EWS using Baringo County as a case study. Corresponding to the research questions in the Introduction, the most significant findings to emerge from the study are:

1. There was a stark and complex contrast between the IK and SK. First, there were strong perceptions that indigenous forecasts were more accurate and reliable than the scientific ones, as well as cover other hazards such as security conflicts. Secondly, the IKFs had reliable and detailed knowledge at local level even despite the general bias that they were "unschooled", whereas SKFs had more homogenous knowledge across different levels. The IKFs demonstrated a stronger ability in communicating within the communities than with "outsiders". Thirdly, IK had a lower standing than SK by government and mainstream society due to historical, social, technological and religious reasons. In contrast, there was a significantly stronger recognition of IK in the Baringo rural communities, which may be changing with religious and western education influences.

2. The IK incorporation in Baringo County was initiated by a national programme addressing agricultural and food security issues in 2014. Selected IKFs participate in the seasonal workshops twice a year to provide forecasts using environmental indicators, along with the KMD who give scientific weather forecasts. The two weather forecasts were then combined into one weather forecast, which was used to guide sectoral advisory development and then disseminated to the government and communities. In October 2016, due to the threat of La Niña, several government agencies teamed up to include the weather forecast in an extended scenario building and response planning workshop.

3. The key driving factors behind IK incorporation in Baringo include the need to tackle the increased disaster risk and vulnerability using all available resources, changes in development and DRR strategies to be more inclusive and to promote preparedness, increased DRR initiatives by the newly-established county-level government structure, and the past EWS dissemination challenges in rural communities.

4. In examining the impact of the IK incorporation on the interface between the government and IKFs, the government participants were generally positive; whereas the IKFs reflected a mix of appreciation and reservation. The cooperation was a smooth consensus building process with most of the forecasts in agreement. However, when

there were forecast differences, the cooperation became challenging with typically the scientific forecasts adopted over indigenous ones. The IKFs and SKFs showed mutual scepticism concerning each other's knowledge systems. Most of the informants considered that the IK had a partial positive impact on the government's decision-making process, while a few thought it was not factored in. However, the combined forecast messages were more accepted by the communities. In addition, the IKFs contributed to activities other than forecasting from the community's perspectives, and the activities increased understanding and trust between the government and the IKFs.

5. The informants projected three possible future scenarios: scenario 1 was to have more IK incorporation and mainstreaming given the importance of the indigenous forecasts in the communities. Scenario 2 was to maintain IK incorporation while continuing to monitor and evaluate IK accuracy. Scenario 3 was to reduce or diminish IK given the SK advancement and increased technical capacity in the communities.

Taken together, the findings suggest that the IK incorporation is only in its initial stage in Baringo County. It had benefits to the EWS knowledge, analysis and dissemination, as well as encouraging community participation and local preparedness. The study contributes to the existing knowledge on IK incorporation by providing an extensive review from both the government and IKFs' perspectives.

6.1. Recommendations

This research has attempted to understand the process and identify gaps in the case of IK incorporation in Baringo County. These recommendations are intended to be used to improve the process and address the gaps as indicated in the Discussion section. They may be considered by national or local Kenya government, as well as members of the international community, for future early warning, DRR, and development programmes in Kenya. These may include NDMA, KMD, national and county DRR offices, international development institutions and NGOs.

1. Plan for long-term conservation and promotion of IK through community engagement and DRR capacity development. Conserving IK helps its strategic integration into SK. However, it takes time to develop trusting relationship with indigenous communities for the effort to be effective. The seasonal workshop engagement served as a solid starting point to build trust with the IKFs, but it needs to be long-term for the trust to take roots. Promoting IK can ben seen as a recognition to the communities' own DRR capacities, and also develop the trust before government and communities.

2. Expand the IK incorporation process or framework to address the issues of technical disagreements, power imbalance, bias and distrust that may arise among SKFs, IKFs and other representatives. To resolve the forecast divergence, it may be more effective to anticipate worst case scenario instead of having preference for the official forecasts. This would help prevent the situations where indigenous forecasts of hazards were ignored when not predicted by scientific forecasts.

3. Develop a pilot programme using the CBON approach to allow communities to define weather forecasts. This serves as a bottom-up approach, supplementing the top-down PSP approach. It would empower communities to embrace their own forecast capacity in knowledge and forecasters, as well as government to harness the capacity further by utilizing the existing IKF network. The initiative can also strengthen the interface between the communities and government for other disaster preparedness and response activities.

4. Legitimize IK further in supporting IKF organizations. The 2010 Constitution of Kenya was a driving force in giving power to IK, and it can do more in legitimizing IK. One suggestion is for the Kenyan government to provide legal and financial support to the IKFs in forming their own organizations. Such organizations would help develop IK identities, protect rights to IK, and develop communities' EWS technical network further.

5. Sensitize government officials and SKFs to ensure mutual understanding, respect and trust between the IKFs and government. Along with SK, IK can benefit the government's decision-making if it is better recognized by the government.

6.2. Future Research Areas

This research has thrown up many questions in need of further investigation:

- How can the participatory framework guide the potential conflicting forecasts in addition to cooperation during the IK incorporation activities?
- How does the Baringo case compare with the cases in neighbouring counties, given each county has varying context, e.g. social, political and economics?
- What is the long-term effect of the IK incorporation in government's decision-making process since this is still a relatively new initiative?
- Other than the EWS, which other areas can IK be incorporated into within the DRR, climate change and sustainable development programmes?

- What are effective ways to invest and conserve IK so the strategic partnership can continue to enrich the goal of reduced vulnerability in the communities?
- Greater efforts such as sensitization are needed to ensure mutual understanding, respect and trust between the IKFs and government.

Knowledge is power. In reducing increased disaster risks, it is not only complementary but necessary to recognize the existing knowledge and capacity that the rural communities deem valuable, overcome our biases to different knowledge systems, and find common ground that incorporates all the knowledge systems into our DRR activities. The Kenyan and Baringo County Government have embarked on an important incorporation process between the indigenous and scientific knowledge systems, which are proving to be significant and beneficial for the government's EWS, and ultimately, the safety of the people for many future decades.

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Appendices

Appendix A: Interview Guide

The following are questions that will help guide our conversation on the research topic below. This interview is planned for about an hour.

Research background and topic:
In October 2016, the Baringo County Government engaged three indigenous forecasters in a government-led drought preparedness activity, specifically a goat was slaughtered and the goat entrails were read by the indigenous forecasters to provide early warning information. The indigenous forecasters were previously identified through the social inclusion sector of the Agriculture Sector Development Support Programme (ASDSP) project funded by the Government of Kenya and Government of Sweden. The researcher would like to understand the various aspects that led to the activity, if/how the indigenous knowledge (IK) is incorporated in the scientific forecast, the impacts to the county's resilience and any challenges for future vision of such incorporation.

Note: In the following questions,

- *The activity* refers to the activity of incorporating indigenous early warning forecasting at a Baringo county-level preparedness activity, and
- *This type of activities* refers to activities that incorporate IK in government-led DRR activities.

Section 1: Basic information of respondent

- Which organization do you work for?
- What is your job title?
- How many years have you been practicing in your line of work?
- What do you do in relations to disasters management?

Section 2: Understanding of past experiences related to *the activity*

- Have you participated in *this type of activity* in the past?
- In your experience, is *this type of activity* one-off or repeated?
- If repeated, is *this type of activity* regular or ad-hoc?

Section 2: The enabling aspects of *the activity*

- According to you, which aspects led to the indigenous forecasters to be involved in *the activity*?
- What influences do you think the various stakeholders (including county government, indigenous forecasters, communities and scientific communities) have for *the activity*?
- What influences do you think the recent disaster or climate change trends have for *the activity*?

Section 3: The impacting aspects of *the activity*

- How do you think the IK has been incorporated with the scientific EW forecast?
- How does *the activity* impact the overall vulnerability or resilience of the Baringo County?
- How do you think *the activity* impact the stakeholders in terms of capacity, power, image, etc.?

Section 4: Future vision and challenges

- What is your future vision of incorporating IK in the disaster risk reduction activities at the county level? For example, more or less activities? In which ways?
- What challenges would impact the future activities as such?

Appendix B: List of Interview Informants

Interview format: F – Face-to-face; T – Telephone; X – Translator assistance.

#	Name	Organization/Location, Title/Role	Format	Date of interview
1	Akeno, Moses	BCG, Sub county administrator	F	10 November 2016
2	Chebon, Isaac	BCG, Food security advisor	F	14 November 2016
3	Chelimo, Daniel	Barwessa area, IKF	FX	12 November 2016
4	Chemwei, Nelson	BCG, DRM coordinator	F	11 November 2016
5	Cherutich, Reuben	ASDSP, Baringo County coordinator	F	11 November 2016
6	Kibiwot, Stanley	NDMA, County officer	F	15 November 2016
7	Kipkemoi, Shadrack	ASDSP, National coordinator	F	5 December 2016
8	Kiporir, Emmanuel	Moi University, Professor	F	11 November 2016
9	Lentupuru, Caroline	BCG, County executive for agriculture, livestock and fishery	F	8 November 2016
10	Lochoria	Komolion area, IKF	FX	16 November 2016
11	Lokabel, Evans	BCG,	F	9 November 2016
12	Maina, Joel	BCG, Director of agriculture	F	10 November 2016
13	Micheni, Valerian	World Food Programme,	F	23 November 2016
14	Mosomtai, Reuben	BCG, Education officer	F	14 November 2016
15	Mutai, Samuel	KMD, County director	F	27 November 2016
16	Mwangi, John Kihiu	NDMA, National officer	F	1 December 2016
17	Mwesigwa, Jasper Batureine	IGAD Climate Prediction and Applications Centre (ICPAC), Agro-meteorologist	F	28 November 2016
18	Ndole, Gedion	BCG, Livestock officer	F	18 November 2016
19	Njeru, Peter	NDMA, County officer	T	21 November 2016
20	Nyakeyo, Amos	NDMA, County drought response coordinator	F	18 November 2016
21	Ouma, Gilbert	University of Nairobi, Lecturer	F	30 November 2016
22	Pariyo, Titus	Unknown area, IKF	TX	3 December 2016
23	Rotich, John	KMD, County director	T	2 December 2016

24	Sikayang, Kakuko	Nginyang area, IKF	FX	16 November 2016
25	Songok, Charles	Researcher	F	22 November 2016
26	Sumukwo, Jepkosgei	BCG, Education coordinator	F	14 November 2016
27	Tarakiteng, Geoffrey	Marigat area, IKF	FX	15 November 2016
28	Titiang	Maron area, IKF	FX	17 November 2016
29	<Anonymous>		F	7 November 2016
30	<Anonymous>		F	10 November 2016
31	<Anonymous>		F	14 November 2016
32	<Anonymous>		F	14 November 2016
33	<Anonymous>		F	28 November 2016
34	<Anonymous>		F	28 November 2016
35	<Anonymous>		T	7 December 2016

Appendix C: Indigenous and scientific forecast knowledge characteristics

Categories		Indigenous forecast knowledge	Scientific forecast knowledge
Forecasts	**Accuracy**	"*comes true*" or "*comes closer to the actual events that happen*"	"it has failed the government many times"
	Area of forecast	A wide range of local knowledge areas including weather, cultural, social, security, economic, etc.	Weather only but at different levels (international, regional, national and local)
	Instruments	• Animal intestines, stars, birds, etc. • More physically-demanding work that could be dirty or difficult.	• Machines • Physically-undemanding or "clean" desk work
Forecasters	**Distance to users**	• They conduct forecast at local level	• Forecast from "far places" • Do not consume forecast information as end user
	Knowledge area	• IKFs are farmers or pastoralists themselves. • Extensive local knowledge over a wide range of topics	• Homogenous meteorology knowledge at different levels
	Education	• Most have "no formal education"; typically have informal education through family. • Considered as "illiterate", "unlearned", "uneducated", "Unschooled"	Formal school education
	Knowledge area	• Farmers or pastoralists themselves. • Receive "honour" or small tokens in the community for forecasting.	Typically, government payroll.
	Ability to communicate	• Challenges with "outsiders" due to language barriers • Ease with local communities	• Ease of communications for governmental collaborations • Challenges with local communities
Recognition	**By government or mainstream**	• Old-fashioned, backwards, traditional • No formal structure or institutions	• Modern, conventional • Has legitimate institution and resources
	By communities	• Widely accepted and common practice • IKFs are well-respected as "opinion-leaders" and "mentors" • Changing social dynamics due to religion and western education	• Challenges to be accepted by the communities

Appendix D: September 2015 Baringo PSP Workshop Report

Courtesy of Mr. Reuben Cherutich

4TH PSP WORKSHOP REPORT.pdf (Command Line)