

A meta-Analytical Review of the Role of Indigenous Knowledge on Environmental Conservation and Climate Change in Kenya

Vol. 5 No. 2

December 2020

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Abstract

Rationale of Study – This paper examines how indigenous environmental knowledge (IEK) can be applied in the conservation and management of natural resources in Kenya. It also explores how IEK can be captured, coded, stored and integrated into climate studies and conservation efforts.

Methodology – Due to the lack of consensus on the nature of IEK whether ecosystem management, stewardship, natural resource management or environmental conservation practices, the study used a meta-analytical approach to review scientific publications, papers and published journals in order to develop an overarching framework that would guide the capture, documentation, repositing and archiving of the local IEK. The integration of indigenous knowledge systems into mainstream knowledge offers great potential in strengthening socio-ecological resilience.

Findings – The study identified several themes that include environmental stewardship, natural resource management, environmental conservation practises among others that relate to the IEK resources, its effectiveness on environmental management and the integration of IEK into climate change. The findings show that IEK has been applied in environmental conservations efforts in several countries such as the traditional resource usage models, the rain-making tradition of the Luhya Community, resource conservation practices of the Maasai among other practises. The study concludes that IEK can be drawn from several indigenous communities in Kenya that include, the Maasai, Sengwer, Pokot, Samburu among others and with the aid of the information science discipline which leads to the development of an IEK repository in Kenya.

Implications – The study recommends that national institutions in Kenya such as Kenya Forestry Research Institute, Kenya Forest Service, and Kenya Wildlife Service be involved in the search for alternative solutions to climate change concerns.

Originality – The study is advocating for the formalization and mainstreaming of the communal IEK among the communities in Kenya.

Keywords

Indigenous environmental knowledge, indigenous knowledge systems, natural resource management, conservation and climate change, meta-analysis, Kenya

Citation: Guto, R. (2020). A meta-Analytical Review of the Role of Indigenous Knowledge on Environmental Conservation and Climate Change in Kenya. *Regional Journal of Information and Knowledge Management*, 5 (2),65-84.



Published by the

**Regional Institute of
Information and Knowledge
Management**

P.O. Box 24358 – 00100 –
Nairobi, Kenya

1 Introduction

One of the dominant global environmental conservation approaches is the creation of protected areas. This strategy reflects the western idea of separation between pristine nature and human-modified habitats that has led to the proliferation of environmental conflicts involving traditional people and local communities (Anaya & Espírito-Santo, 2018). For example, in Tanzania, the establishment of Serengeti, Manyara, Tarangire national parks and the Ngorongoro Conservation Area and other protected areas has restricted access to important resources for the Maasai in northern Tanzania (Woodhouse & McCabe, 2018). Thus, conservation efforts should focus not only on protecting biodiversity but also the erosion of biotic interactions (Wali *et al.*, 2017).

Thus, conventional conservation planning and management face difficulties arising from goal incompatibility with local stakeholders and institutions. This is most important when the local rules are more concerned with the allocation and use of resources as well as conflict management than preservation per se (Berkes, 2004). This situation arises due to the complexity of the social-ecological system existing at any level with the links between social and environmental systems being distinctly different at the community and the national levels instead of being analysed as a complex socio-environmental system. The current rapid climatic changes threaten the balance of the overall ecosystem and therefore introduce significant challenges to the policymakers on the choice of the appropriate mitigation measures (Vadigi, 2016). On one hand is the modern scientific knowledge system which is prestigious, specialised, centralised, systematic and is discordant with the social structures and practices of indigenous communities. On the other hand, is the ancient paradigm of indigenous knowledge systems that are scattered and embedded in the social-cultural systems of a particular community (Barnhardt, 2005).

The western knowledge systems incorporate modern climate science that is often blamed for ignoring the inequality, existing ecological problems and the stakeholders in the social-ecological systems. Its application is limited to addressing climate change through either mitigation or adaptation (Ubisi, Kolanisi & Jiri, 2019). Further, some entities have accused it of negatively contributing to the underdevelopment of local communities by hastening the depletion of their social and national resources (Ford & Martinez, 2000). However, the integration of indigenous knowledge systems (IKS) into contemporary scientific systems provides a great potential to toughen socio-ecological resilience through the development of sustainable environmental management strategies (Vadigi,

2016). Further, the integration of indigenous knowledge into climate change policies can lead to the development of effective mitigation and adaptation strategies that are cost-effective, participatory and sustainable (Robinson & Herbert, 2001). Therefore, indigenous knowledge should complement, rather than compete with global knowledge systems.

IEK used in conservation efforts arises due to the following: First, it maintains the intricately connected, global cultural and biological diversity; second, it contributes invaluable information and fill the gaps in the scientific knowledge systems and lastly, it is synonymous with social justice, sovereignty, autonomy and identity of indigenous peoples (Bohensky & Maru, 2011). Further, IEK has been recognised and accorded equal status with scientific knowledge by the United Nations Environmental Programmes (UNEP) (Ford & Martinez, 2000). Thus, in the Sahel region, IEK has enabled inhabitants to develop and implement extensive mitigation measures (Nyong *et al.*, 2007) and introduce sustainability in natural resource management (NRM). Desta and Smithson (2016) noted the extensive literature on NRM highlights the importance of participatory development and knowledge management. Berkes and Berkes (2009) emphasised the relationship between IKS and the local natural world and noted that IKS comprises institutions and systems.

The opinion on the integration of IEK into environmental conservation is divided (Smylie *et al.*, 2004) with the debate being based on the soundness of the traditional knowledge in the management of the natural resources. The Indonesian state has partially accepted its validity (Li, 2000) while in Namibia, local communities use indigenous classification of land units for natural resource management (Verlinden & Dayot, 2005). In Australia, the Aboriginal seasonal knowledge is increasingly contributing to more resilient social-ecological outcomes in NRM (Prober, O'Connor & Walsh, 2011). In other instances, IEK has not been fully accepted and is considered inadequate and outdated to global ecological change (Berkes, 2009). In Australia and New Zealand, it has limited input or is subsidiary to biophysical technical knowledge (Carter & Hill, 2007). In North America, it is not fully accepted but some scientists are now attempting to integrate traditional ecological knowledge into existing knowledge frameworks (Cruikshank, 2012). Empirical studies in Egypt suggest that IEK is provisional and dynamic (Briggs *et al.*, 2007). These examples show that the application of IEK is contextual to the geographical location of the inhabitants (Briggs, 2005).

Thus, the confluence between the social and environmental systems generates the IEK which is used to manage complex natural systems through traditional practices founded on important social mechanisms (Bohensky & Maru, 2011). In many instances, IK is the overall traditional knowledge system and offers a holistic perspective of the natural world context (Agrawal, 1995). IEK is considered a subset of IK; an inseparable aspect of IK and takes similar meaning to traditional ecological knowledge (TEK) as well as indigenous ecological knowledge (Green, 2008). The TEK is an interdisciplinary field which is composed of a sophisticated array of institutions, processes and partnerships that integrate existing knowledge.

Kwanya (2015) defined IK as the knowledge, innovations and practices held by indigenous communities in matters relating to agriculture, environmental management, medicine and health, art and language. IEK encompasses several fields such as indigenous technologies, soil classification and management methods, water conservation techniques and indigenous woodland management (Briggs, 2005) and is likened to empirical knowledge gained from careful observations in a natural world context over long periods of time (Aikenhead & Ogawa, 2007).

In Kenya, the research and documentation of the IK is hindered by several challenges such as marginalisation (Ocholla & Onyancha, 2005); lack of legal structures and mechanisms to promote its adoption, growth and usage (Chepchirchir & Kwanya, 2019); and absence of national databases to support the research output on IK (Njiraine, Ocholla, & Onyancha, 2010). However, the growing interest in IK research and its documentation has been driven by its recognition as a knowledge domain (Ocholla & Onyancha, 2005). It is slowly gaining traction with special emphasis on cultural studies, health and medical research, environment among other disciplines (Njiraine, *et al.*, 2010). In the field of climate change, Kwanya (2014) examined the traditional approaches used by societies in dealing with climatic changes and concluded that certain practices such as rainmaking should be adopted and applied as a mitigating measure against climate change. Guthiga and Newsham (2011) compared the differences between IEK and modern weather forecasts while Speranza *et al.* (2010) focused on the perception of communities towards IEK.

2 Statement of the Problem

The existence of IEK has been continuously denied by state institutions such as forestry departments which have intensified state control to bring in development projects such

as forestry, parks, mining and energy to the resource-rich areas (Uberti, 2014). This has seen the creation of protected areas such as game reserves and parks with little involvement of the local indigenous people or communities (Cox & Elmqvist, 1994). For instance, the establishment of Serengeti, Manyara, and Tarangire National Parks and the Ngorongoro Conservation Area and other protected areas has restricted access to important resources for the Maasai in northern Tanzania, thus impacting the prevailing pastoral communities on the usage and management of land and natural resources (Woodhouse & McCabe, 2018). Due to the application of these conservation approaches, there is a need to improve the capacities of the government officials to appreciate the ecological, economic and cultural values of the forest to the community (Li, 2000). These entities need to see the value of incorporating indigenous knowledge to the development of sustainable climate change mitigation and adaptation strategies (Nyong *et al.*, 2007).

The UN convention on desertification requires parties to protect, integrate, enhance and validate traditional and local knowledge to promote the use of relevant tradition and local technology. Other initiatives include the Intergovernmental Forum on Forests (IFF) which has reviewed traditional forest-related practices and adopted several elements in the Leticia Declaration and Plan of Action (Ford & Martinez, 2000). This broad consensus proposes that IEK should be integrated into the climate studies but very few ecological studies have attempted a pragmatic and deep integration of this knowledge source (Vadigi, 2016). Apart from knowledge management, IKS has been explored less within information science research, with the possible exception of geographical information systems (GIS) and as the main concern in NRM (Desta & Smithson, 2016). Based on the impact of the IEK on the management of natural resources, this paper develops a framework for studies on the contribution of IEK in the management of environmental and climatic changes. The study therefore focused on the following research questions:

RQ1: What constitutes indigenous environmental knowledge in the context of conservation and management of natural resources in Kenya?

RQ2: How can indigenous environmental knowledge be captured, coded, stored and integrated into climate studies and conservation efforts in Kenya?

3 Methodology

A meta-analysis is an analytical technique of data and/or information aggregated from more than one source, either a single study review or a highly structured systematic review of literature (Depoy & Gitlin, 2011). The key aspect of this meta-analytical approach was to seek evidence from the literature or draw out key issues in IK/IKS/IEK which answer the research questions: What is indigenous environmental knowledge? How does indigenous environmental knowledge relate to the conservation of natural resources in Kenya? How can it be captured, coded and stored? As a way of developing a framework based on knowledge management, this paper completed the synthesis by considering the research questions alongside the opportunities to promote indigenous community well-being and sustainability in the management of natural resources. In particular, the paper considered the relationship between indigenous tribes and forests, ways in which the tribes impacted the social and ecological systems and how tribal stewardship practices foster sustainable management of natural resources.

In order to prepare the synthesis, the author used Google Scholar to search for relevant publications. The researcher opened the www.scholar.google.com, then entered the following words: 'indigenous knowledge', 'indigenous environmental knowledge', 'indigenous ecological knowledge', 'indigenous knowledge systems', 'conservation', 'climate change', and 'natural resource management'. Once the search engine had delivered the results, the author reviewed scientific publications that examined relationships between indigenous social-ecological systems and conservation and forest resources. The review identified literature on IK, IKS, IEK and TEK, their contribution to natural resource management, their impacts to the sustainability of forest resources and associated forest ecosystems and strategies used by the communities in addressing resource management and conflicts. The use of Google Scholar for research has been bolstered by a study carried out by Onyancha and Ocholla (2009) which indicated that it is an appropriate academic-based search engine that covers more publications and citations than other sources including Institute for Scientific Information (ISI) and Scopus databases.

The review was limited to the publicly available peer-reviewed sources so that any individual or public could also examine the findings. A causal search of the term 'indigenous environmental knowledge' listed 2530 articles, 'indigenous ecological knowledge' listed 4,220 articles, 'indigenous knowledge systems' listed over 37,000 articles, 'indigenous environmental knowledge, climate change' listed 2,680 articles, while

'indigenous environmental knowledge, climate change' listed 1,440 articles. Thereafter, 220 articles were drawn from published scientific journals and they included journals, publications, theses, dissertations and research papers that considered emerging issues that were insufficiently addressed in journal articles. From the review, the researcher examined key findings from the larger synthesis related to the concept of social-ecological systems and strategies for promoting sustainability in natural resource management. The review was based on the following schematic diagram illustrated in Figure 1.

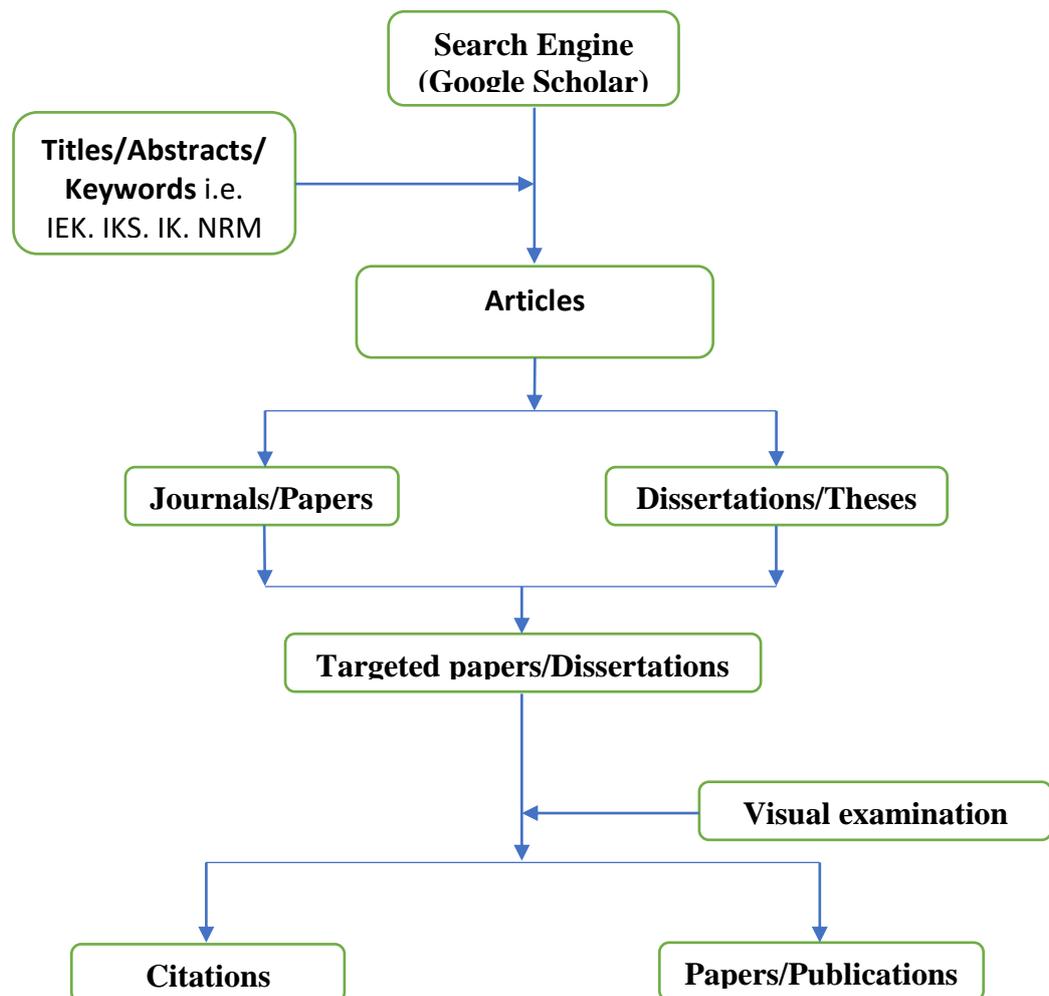


Figure 1: Schematic illustration of the literature review

4 Theoretical Review

The theoretical framework underpinning the paper is the knowledge worldview model as advocated by Fler (1999). Worldviews serve as mental lenses through which individuals perceive the world (Hart, 2010) and provide a non-rational foundation for thought, emotion and behaviour. A worldview endows a person with presuppositions about what

the world is really like and what constitutes valid and important knowledge about the world (Cobern, 1996). These knowledge worldviews are cognitive, perceptive and affective maps used by individuals to make sense of their environment and directions (Hart, 2010) and are classified into either indigenous or scientific knowledge systems (Fleer, 1999).

Indigenous knowledge systems are founded upon the traditional worldviews and serve a specific purpose in that particular society; science is founded on civilisation perspective. Although there are distinctions between indigenous and scientific knowledge, the sets of knowledge interact and influence each other (Kwanya, 2014). Indigenous worldviews emerged as a result of the indigenous people's relationship with their environment (Absolon, 2010) and hold a relational worldview where people and entities come together to support one another (Hart, 2010). Indigenous knowledge is dominated by cultural approaches that focus on worldviews, collateral learning, and border crossing (Quigley, 2009).

The worldviews can change slowly over time (Hart, 2010) because of the world is a combination of both local and global spaces and both spaces are a concurrent part of people's lives (Quigley, 2009). On one hand, local spaces represent the indigenous knowledge which is only applicable to a specific location while global spaces have arisen because of colonisation. Due to globalization arising from the uniformity in communication, indigenous knowledge systems are being continuously assimilated as a mainstream knowledge system just like the scientific knowledge system (Quigley, 2009). In this way, indigenous knowledge will complement and fill the ethical and knowledge gaps in scientific knowledge (Aikenhead & Ogawa, 2007).

The knowledge worldviews are applied in the study to provide clarity in the meaning of the construct indigenous environmental knowledge. In this manner, the researcher challenges the readers to adopt the IEK in matters dealing with natural resource management, weather patterns and climate.

5 Empirical Review

Many studies have apprised that indigenous environmental knowledge contributes to improved returns in ecosystem management and environmental conservation (Schulz *et al.*, 2019). This fact is illustrated by several studies which indicate that IEK contributes to environmental stewardship (O'Flaherty, Davidson-Hunt & Manseau, 2008; DeRoy & Darimont, 2019; Eckert, Ban, Tallio & Turner, 2018; Holmes & Jampijinpa, 2013; Long

& Lake, 2018), natural resource management (Pyke *et al.*, 2018; Turner & Spalding, 2013; Karki & Adhikari, 2015), environmental regulations and standards (Harmsworth, Awatere & Robb, 2016; Sirima, 2015; Waller & Reo, 2018), and conservation practices (Prober, O'Connor & Walsh, 2011; Marquardt *et al.*, 2013; Sayles & Mulrennan, 2010; Quaempts *et al.*, 2018).

The environmental stewardship has been applied in several contexts that include stewardship of terrestrial and marine systems by the First Nations in Canada (DeRoy & Darimont, 2019), customary stewardship approach of Pikangikum people (O'Flaherty, Davidson-Hunt & Manseau, 2008), resource stewardship practices in the coast of British Columbia, Canada (Eckert, Ban, Tallio & Turner, 2018), the indigenous tribal stewardship of forest in Wisconsin, USA (Waller & Reo, 2018), as well as the traditional land stewardship activities that support the well-being of communities and maintains ecological integrity in the Pacific Northwest USA (Long & Lake, 2018). The indigenous knowledge systems position indigenous communities as leaders in contemporary resource management and ecosystem stewardship and the affirmation of cultural and management rights (Eckert, Ban, Tallio & Turner, 2018). The stewardship model also manages fundamental social-ecological properties (Holmes & Jampijinpa, 2013). The arrangements have aided the overall improvement in conservation outcomes with significant impact in the overall weather and climatic conditions.

IEK, as a knowledge system, provides the basic frameworks, rules and regulation that aid natural resource management by contributing to place-based, fine-scale spatial and temporal information, management techniques and institutions (Butler *et al.*, 2012). Moreover, indigenous institutionalised forest management rules and regulations tend to create conservation awareness, resource usage and enforcement (Sirima, 2015). For instance, the Warlpiri aboriginal community in Australia use the *ngurra-keurlu* framework as a form of a complex cultural IEK system (Holmes & Jampijinpa, 2013). The application of IEK standards, rules and regulation have been validated in different contexts including the use of Māori IEK for co-management and co-planning strategies in New Zealand (Harmsworth, Awatere & Robb, 2016) as well as the application of tribal laws to control the herbivore numbers and resource management in USA (Waller & Reo, 2018). The Aborigines of Australia use the principle of collective responsibility as one of the approaches for natural resource management. The approach sees individuals, families and clans being held responsible for the management of specific wetlands systems (Pyke *et al.*, 2018).

These spatial-temporal approaches to sustainable resource use include traditional rotation grazing arrangements by herders in Africa and rotation of hunting and fishing grounds by Amerindians (Prober, O'Connor & Walsh, 2011). They also include specific agroforestry practices that help restore soil productivity and generate diverse assemblages of trees and shrubs (Marquardt *et al.*, 2013); Aboriginal purposive modification practices that include clearing of trees, burning of berry patches and construction of fish weirs (Sayles & Mulrennan, 2010); the sustainable harvesting practices of natural resource among the Umatilla community (Quaempts *et al.*, 2018); as well as the aboriginal *Nyul Nyul* communities of Australia place harvest restriction practices on valuable natural resources to prevent overexploitation (Pyke *et al.*, 2018). Within the African context, the common IEK practices include ethnobotany, agroforestry, integrated pest management, fodder management and agronomic practices, soil and water conservation and anti-desertification practice (Lalonde, 1993).

IEK is a valuable knowledge system where the existing customary natural resource management prevails in any contemporary situation (Turner & Spalding, 2013). These practices include the Aboriginal systems of wetland management in Australia (Pyke *et al.*, 2018) and community-based natural resources management (CBNRM) practices in Nepal (Karki & Adhikari, 2015). In Canada, IEK plays a significant role in the management of wildlife and the conservation of biodiversity (Henri, Jean-Gagnon & Gilchrist, 2018).

The positive outcomes from the application of the IEK have been validated in various contexts among them, the indigenously managed forest in Wisconsin, USA, where Waller and Reo (2018) observed that these are often more mature with higher tree volume, higher rates of tree regeneration, more plant diversity and fewer invasive species than nearby nontribal forestlands. Porter-Bolland *et al.* (2012) also compared protected areas and community-managed forests in the Southern hemisphere forest systems and found that community-managed forests are less likely to be deforested when compared to the protected forest. Studies have shown that environmental stewardship, natural resource management, institutional environmental regulations, standards and conservation practices positively influence the environment by establishing the conservation agenda through stewards, introducing institutionalised rules and regulations to govern environmental management, strict enforcement of environmental code and encouraging environmental conservation.

6 Discussion

The discussion on how IEK contributes to positive in climate change is based on the notion that specific facets of communal IEK have been applied and have been validated by research. The empirical review has examined how IEK have contributed to the positive outcomes in environmental and natural resource management. These studies attest to the application of IEK for conservation in several different contexts which have been documented and deposited in online databases. The IEK studies within the Kenyan context have emphasised more on highlighting the perception of communities towards IEK (Guthiga & Newsham, 2011; Speranza *et al.*, 2010), and documentation of single communal IEK (Kwanya, 2014) in addressing emerging climate issues. The information in the studies captures IEK singularly and does not offer much detail on the practises as shown in the empirical studies in the literature review section where authors have listed several approaches, frameworks and practise that are considered to be IEK. The following discussion elaborates how local IEK can be captured, coded, published, stored and archived to help in mitigating climate change in Kenya.

6.1 Identification of indigenous knowledge resources

The identification of what constitutes indigenous knowledge systems begins with the appreciation that an individual holds tacit knowledge of his/her social and physical environment (Li, 2000). Several circumstances interact for the indigenous knowledge resources to develop. First, the indigeneity of local knowledge as a way of living in a particular ecosystem which is generated through relationships established by repeated observations over time (Aikenhead & Ogawa, 2007). Second, the construction of indigenous knowledge systems occurs through the traditional education processes of observation and experiencing the natural world and processes (Barnhardt, 2014). Third, the knowledge generated is dynamic and adaptive as it is founded on adaptive processes of learning and knowledge construction (Barnhardt, 2005). It therefore enhances the resilience of socio-ecological systems because it is accumulated through experience, learning and inter-generational transmission (Bohensky & Maru, 2011). Fourth, indigenous knowledge is institutionalised. Therefore, it can serve as a basis for local-level decision-making in many rural communities (Nyong *et al.*, 2007).

6.2 Description of indigenous environmental knowledge resources

Literature on the IKS indicates that IEK takes distinct definitions based on the context. IEK has several definitions among which include the science of annual cycle of subsistence activities with a great deal of knowledge on flora and fauna and its

classification systems and versions of meteorology, physics, chemistry, earth science, astronomy, botany, pharmacology, psychology and the sacred (Barnhardt, 2005). IEK takes several formats which include multiple species management, resource rotation, succession management, landscape patchiness management and other ways of responding to and managing pulses and ecological surprises (Berkes *et al.*, 2000). IEK also takes several formats including environmental stewardship and ethno-biology (Donovan & Puri, 2004). Lastly, IEK holds notions of energy conservation, pattern irregularities and anomalies in form and force. In some instances, it concerns itself with the knowledge of the biotic relationship involving rare plants or animals offering potential benefits for sustainable natural resource management and preservation (Desta & Smithson, 2016).

6.3 Repositing of indigenous environmental knowledge resources

The capture and preservation of indigenous knowledge resources are important in the identification of best practices that are handy in their application. For instance, the capture and preservation of IEK are critical for natural resource management. These local knowledge resources in developing countries are not codified (Desta & Smithson, 2016) in that IK originate from unfamiliar oral accounts that do not easily fit within conventional frameworks (Cruikshank, 2012). In some instances, IEK does not provide the necessary processes of selection, filtering and articulation. Therefore, the documentation of the TEK is a long process (Huntington, 2000).

For IK resources to be formally accepted and integrated and applied in climate change studies, the following steps must be taken. First, the indigenous knowledge systems must be acknowledged as a form of knowledge system that confers the communities with the capability to deal with past and present vulnerabilities to climatic extremes and other stresses. Second, adopt the bottom-up participatory approach that encourages the highest level of local participation. Third, ensure that the local communities are viewed as equal partners and provide leadership in the development process. Fourth, indigenous practices should be considered complementary to conventional scientific practices (Nyong *et al.*, 2007). Other issues are the legal mechanism to protect traditional knowledge, cultural practices and by extension guarantee genuine participation of communities (Li, 2000).

There is adequate evidence to warrant the capture, coding and preservation of IK resources as illustrated by inquisition by both international and national institutional

sponsors which have attempted to incorporate issues related to indigenous knowledge in their financial activities while publications such as newsletters and journals have emphasised the significance of indigenous knowledge (Agrawal, 1995). Lawas and Luning (1996) have pointed out that the collection of indigenous information is time-consuming and costly. The authors further argued that library and information science professionals should design collection development policies to offer guidance on the same. It could be argued that the collection of IK in the field should not be left to ethnographers, anthropologists and related professionals but rather information professionals should collaborate with national IK resource centres to enhance access to IK resources.

Since IK is essential to development, it should be gathered, organised and disseminated just like Western knowledge (Agrawal, 1995). This raises issues related to methodology, access, intellectual property rights and the medium and formats in which to preserve it (Msuya, 2007). Underlying these challenges is the dilemma of whether to use the Western paradigm for collecting and preserving IK (Desta & Smithson, 2016). Another contentious issue in the management and preservation of IK is the protection of intellectual property rights. Given this, the United Nations Draft Declaration on the Rights of Indigenous Peoples underscores the fact that indigenous peoples have the right to own and control their cultural and intellectual property.

6.4 Effectiveness of indigenous knowledge resources in natural resource management

In discerning the effectiveness of IEK in resource management and conservation efforts, previous theoretical, conceptual and empirical literature shows that IEK has a significant impact on the environment. First, indigenous people with the aid of IEK have been able to manipulate natural vegetation with significantly better results for several millennia (Donovan & Puri, 2004). Second, IEK enhances the resilience of socio-ecological systems because its knowledge is accumulated through experience, learning and inter-generational transmission and survival in a complex ecosystem (Barnhardt, 2014). Maila and Loubser (2003) consider IK as part of the global heritage that can be utilised for the benefit of all humanity and directly connects people to their environment and the climatic changes occurring within it (Nyong *et al.*, 2007). Due to this, advocates have supported the use of IEK in natural resource management and conservation (Huntington, 2000) as illustrated by empirical evidence gathered from different regions of the world such as USA, Canada, New Zealand and many others, where TEK/IEK has been extensively applied.

TEK has been applied in New Zealand to understand climate change issues (Berkes, 2009) while in Western Samoa, it is applied in the preservation of communal lowland rainforest (Cox & Elmqvist, 1994). In Australia, it is applied in a range of natural resource management initiatives (Hill *et al.*, 2012) while in the USA integration of TEK is widespread among community-based forestry groups (Ballard, Fernandez-Gimenez & Sturtevant, 2008). Other IEK initiatives include the integration of TEK into innovative and effective fisheries management in Melanesia regions of Australia (Butler *et al.*, 2012), integration of TEK in marine and social science in the Caribbean (Aswani & Hamilton, 2004), and the collaboration of the First Nations with the provincial government in northern Ontario to develop a cross-scale planning approach (O'Flaherty, Davidson-Hunt & Manseau, 2008). IEK is manifested in India by the Bhotiya society which established various traditional institutions which take decisions regarding resource sharing and utilisation (Farooquee, Majila & Kala, 2004).

These examples have shown that IEK resources have aided the management and conservation of natural resources. Therefore, what is required is a more and deeper partnership of traditional indigenous knowledge and science to solve conservation problems and emerging climatic change issues while strengthening the network of community conserved areas and the engagement in ecosystem-based management (Berkes, 2009).

6.5 Integration of indigenous knowledge resources in climate change

The current environmental challenges ranging from conservation to climate change in some instances do not lend themselves to the conventional, rational approach of analysis (Berkes, 2004). Therefore, it calls for the application of all available and possible sources of ecological knowledge. The integration of IK into climate change studies is based on the notion that local populations possess highly detailed and richly complex ecological information (Agrawal, 1995). Therefore, they are better placed in effecting knowledge exchange and collaborating with outsiders through joint learning mechanisms (Carter & Hill, 2007).

Much has been said on the adoption of IEK in the conservation of forest and natural resources based on the following reasons: The validation and recognition of indigenous knowledge as a comparative knowledge system, the shortcomings of the present scientific systems in conservation measures and the diversity of the IEK in providing solutions to the environmental challenges (Mauro & Hardison, 2000). The integration of

indigenous knowledge and modern science has been accelerating in recent years (Bohensky, Butler & Davies, 2013) and is seen as a complement to the existing formal western knowledge. Due to this increased recognition and use of IEK, Nyong *et al.*, (2007) observed that it adds value to climate change studies in the following ways. First, it identifies an individual within a cultural context thereby improving the decision-making processes. Second, indigenous knowledge is more and more exhibiting a similarity with scientific methods. Third, indigenous knowledge systems provide mechanisms for participatory approaches which is a major requirement for sustainability. Fourth, indigenous knowledge systems share the concerns of sustainable development framework (economy, equity and environment) and therefore facilitate the integration of IK into climate change policy. Fifth, IEK can improve the understanding and effective communication by increasing the rate of dissemination and utilisation of climate change mitigation and adaptation options. Accordingly, IEK systems continue to develop and can sustain the communities and their cultural ways while maintaining the genetic resources vital for the survival of the community (Barnhardt, 2005). However, incorporating IEK into climate change concerns should not be done at the expense of modern/western scientific knowledge (Nyong *et al.*, 2007).

7 Conclusion

The concept of IEK is based on the holistic nature of IKS which views the socio-ecological system not as individual parts but as a unified whole, thus it considers humans as part of the whole universe. Any imbalance arising from a component of the socio-ecological systems tends to introduce disequilibrium in the socio-ecological system and these calls for the appreciation of the IKS as a comparative and alternative knowledge system. In particular, a qualitative study on IEK can help to replace overt and simplistic underscoring of its contribution to environmental and natural resource management and climate with notions of sustainability, co-evolution and reciprocal relationships between communities and their environment. The scientific publications have increased the emphasis on climate change studies but they have not been able to resolve some of the underlying changes in the environment. They have therefore recognised the impact of the indigeneity of the knowledge derived from the natural ecosystems and have validated its use in natural resource management and sustainability in the efficiency, diversity and resilience of social and ecological systems.

8 Recommendations

The concept of IEK has been applied in several contexts as indicated in the review with few cases of application within the sub – Saharan context. The studies have shown the positive outcomes of the IEK on the conservation efforts and natural resources management in the USA, Canada, Australia and other regions. In Kenya, research into the IEK only highlights individual IEK features with little emphasis on the conservation efforts and tackling of climatic change. The scientific publications have increased the emphasis on climate change studies. However, they have not been able to resolve some of the underlying changes in the environment. Therefore, this paper recommends:

Library and Information Professionals should develop a comprehensible collection development policy on capture, coding and preservation of IK resources.

Information professionals should work in collaboration with other National institutions involved in environmental matters such as Kenya Wildlife Services (KWS), Kenya Forest Services (KFS) and Kenya Forestry Research Institute (KEFRI) to understand, develop, capture, code and integrate the IEK into the knowledge management systems.

9 Proposed IEK Framework

This paper proposes the following framework for mainstreaming IEK into climate change in Kenya.

The framework in figure 2 below, proposes that the mainstreaming of the IEK in climate change requires the examination of the present IEK practises that have been validated by the communities in Kenya over longer periods of times. In order to achieve this, the paper proposes that the researcher first should identify the specific communities whose indigeneity is still persistent. In Kenya, certain communities like the Maasai, Sengwer, Samburu, Ogiek among others still keep to their indigenous ways. The next phases involve the profiling of the knowledge sources from the communities after which data is captured and recorded by the information science professionals. Henceforth, the examined, transcribed, evaluated, structured, reviewed and then validated. The information generated is then classified and its intellectual property secured before being published.

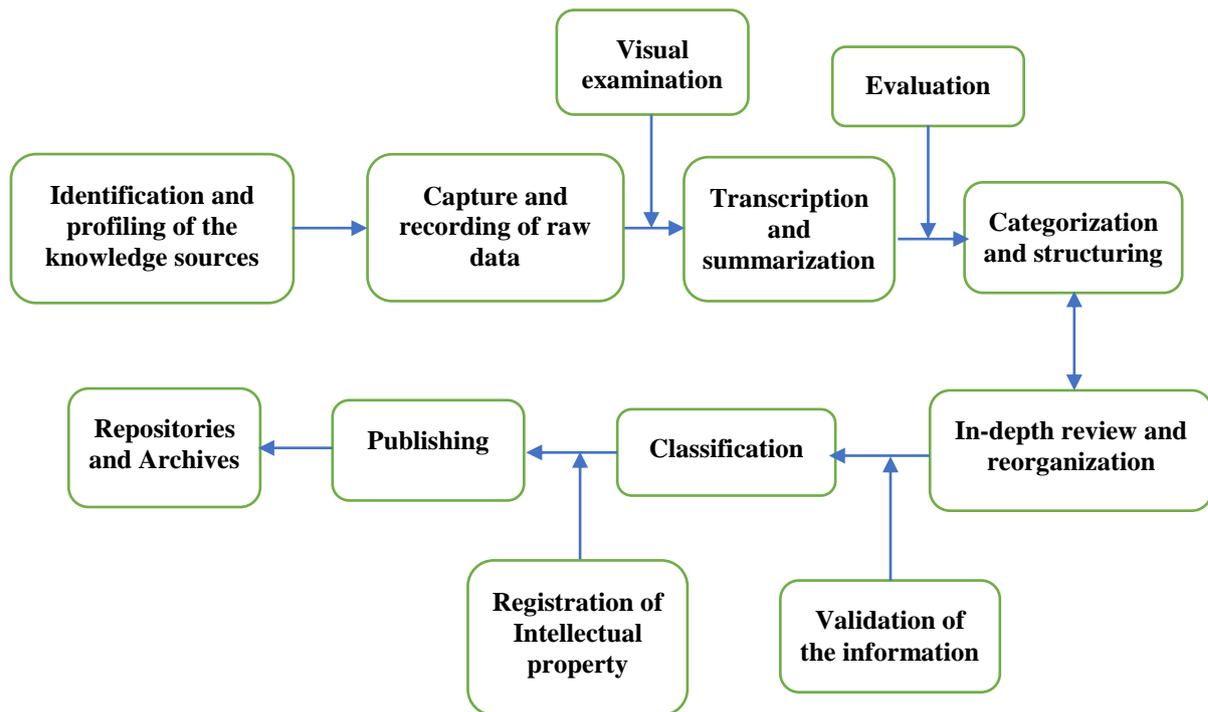


Figure 2: Proposed Framework

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