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Reviewing the phenomenon of indigenous knowledge within natural resources management from an information systems perspective

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Abstract:

Perspectives from the existing indigenous knowledge (IK), information systems and innovation studies approaches are brought together with the aim of exploring the phenomenon of IK within natural resource management (NRM). The relevant aspects of the field of NRM have been outlined before turning to a review of the literature on the characteristics of IK and its relevance to NRM practices. The efforts currently being made to preserve IK as well as the problems faced by IK as a body of knowledge have been critically reviewed. It is believed up to 80 percent of the world's population depends on IK to meet their medicinal needs, and at least half rely on it for food supplies. IK is neglected but it is central to the livelihood and well-being of the majority of people. There is need to address IK as an important part of co-evolution for generating workable development dynamics.

Key Words: Indigenous Knowledge, information system, innovation studies,Community, co-evolution, development

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1.0 Natural Resource Management (NRM*)*

There is an extensive literature on NRM, for example Norfolk et al (2003) and Pritchard & Sanderson (2002), but two particular issues are relevant to this study: firstly, the importance of participatory development and, secondly, the importance of knowledge management. There is widespread recognition (Bessette, 2004; Servaes, 2003; White, 2003) that participatory development is critical for achieving sound resource management but this means empowering local communities. Information describing the natural resources forms the base upon which sustainable development is built (Tabor & Hutchinson, 1994) and hence it is important to manage knowledge resources effectively. However, the local knowledge resources in many communities in developing countries are not codified in Western scientific terms but instead comprise what is known as 'indigenous knowledge'.

According to a World Bank report (1997), natural resources refer to a broad spectrum of 'environmental assets', including air, water, land, plants, animals and micro-organisms. Integrated individual assets are not isolated; they are linked together to form natural systems of varying scale such as rivers; lakes and wetlands; forests; fields; geological systems and resources.

NRM reflects these linkages within and between natural systems. It integrates the management of social, economic and environmental values by involving the community in planning and other activities. NRM is fundamentally about people as its success is ultimately determined by the level of community involvement and the adoption of ecologically sustainable practices across the community (Ashley, 2000).

NRM aims at improving livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services. In other words, it aims to augment social, physical, human, natural and financial capital. It does this by helping solve complex real-world problems affecting natural resources in agro-ecosystems (CGIAR, 2007).

According to Beagle (2001) NRM is concerned with the management of ecosystems for human purposes. However, Merchant (2003) has identified three ethical frameworks for explaining the relationship between people and their non-human surroundings – egocentric, homocentric, and eco-centric. According to Merchant, a person exercising an egocentric ethic seeks to maximize individual self-interest when making decisions concerned with environmental matters, seeing him or her-self as separate from their surroundings. On the other hand, a person using eco-centric ethics considers their duty to the ecosystem, and considers herself or himself as an integral part of that ecosystem.

Homocentric ethics emphasize the social component and focus on duty to other humans, ensuring the greatest good for the greatest number of people, while recognizing that interactions with the non-human components of the ecosystems on which we depend for survival are also critical to these human-centred concerns. The long-term outcomes of NRM are therefore decidedly homocentric, constituting a mix of egocentric and eco-centric perspectives (Merchant, 2003).

1.1 Sustainable natural resources

NRM is central to the achievement of most of the Millennium Development Goals (MDGs) as natural resources provide food and a wide range of other goods (fuel, medicines, building materials, inputs to industries, etc). Natural resources provide services on which all human activity depends (including watersheds, carbon sequestration and soil fertility).

Natural resource exploitation provides the livelihoods for a high proportion of the world's population (Pimental, et al. (2002). This includes not only agriculture in rural areas but also about 1.6 billion people rely on forest resources for all or part of their livelihoods (Mayers & Vermeulen (2003), while around 150 million people count wildlife as a valuable livelihood asset (LWAG, 2002), and 200 million derive part or all their livelihood from fishing (IUCN, 2003). Natural resources also provide opportunities for income generation through jobs and small enterprises (e.g. in forestry, tourism and wildlife trade).

Moreover, numerous studies have found that it is often the poorest people and households that are most dependent on these resources (Wynberg, 2002). Of the 1.2 billion people estimated to live on less than US$ 1 a day (i.e. those that are the target of MDG1), 70 per cent live in rural areas with a high dependence on natural resources for all or part of their livelihoods (LWAG, 2002).

However it is not just the rural communities and the poor who are reliant on natural resources – food, medicines and ecosystem services such as clean water supply also serve urban populations, and hundreds of millions of urban dwellers derive part of their income from urban agriculture (Smit et al., 2006) or from industries or services that depend on agriculture, forestry or fishing (Tacoli & Satterthwaite, 2003).

This dependency brings with it a theoretically strong incentive to conserve natural resources. But, in practice, given the weak access and tenure rights of many poor people, there is a strong potential for local overexploitation. Moreover, it means that the impacts arising from the loss of natural resources and ecosystem services fall most heavily on the poor (Bishop & Mainka, 2002), even though the cause of degradation may lie with richer or more powerful groups.

Despite the close inter-linkages between resource conservation and poverty reduction, there is still considerable polarization between the conservation and development communities. On the one hand, because the goods and services generated by natural resources are generally unaccounted for in national statistics, development agencies have often undervalued the potential role they can play in poverty reduction – as shown by the decreasing emphasis on environment in the project portfolios of many donors and the limited integration of natural resource and environmental issues into national poverty reduction strategies.

On the other hand, conservation organizations have viewed poverty concerns as outside their core business.

One study on wildlife and poverty linkages noted that:

> "*Much conservation money is still invested with only limited consideration of poverty and livelihoods concerns, despite a growing consensus that poverty and weak governance are two of the most significant underlying threats to conservation"* LWAG (2002).

1.2 Emergence of NRM issues

The emergence of 'natural resource/ecosystem management' as a domain in international agricultural research has been paralleled by the appearance of new tools and instruments for data storage and processing through IT related technologies. At the same time, worries about food production and global hunger have been modified by increased public concern about the rapid deterioration of the

Earth's ecosystems (particularly since the 1992 Earth Summit in Rio) and increasing levels of poverty.

In response to these worldwide concerns, and in recognition of the fact that agriculture depends on and affects the natural resource base (often causing side effects and environmental externalities), and competes and interferes with other sectors using natural resources, the international agricultural research community has broadened its research agenda (Janssen, 1995).

With new thinking on issues such as sustainability and poverty alleviation, a leading international agricultural centre, CGIAR, has altered its mission from a primary focus on agricultural productivity and commodity research to one that encompasses a more '*integrated natural resource management*' (TAC, 2001).

As human activity is the major destructive force in nature, improving NRM primarily requires changing human behaviour at 'grassroots' level (Röling, 1994, 1996, 2000). Today it is widely agreed that local people's perspectives need to be at the centre of research efforts for development and that innovations need to be 'owned' by the local land users, if changes in decision-making and behaviour leading to impact are to be achieved.

Such ownership can be created effectively through development and implementation of innovations by local people themselves in cooperation with outsiders (Hagmann & Chuma, 2002). As a result, over the last few decades, a wide variety of participatory research (PR) approaches, concepts and methods has evolved.

2.0 Indigenous knowledge (IK)

Various scholars (Murdoch & Clark, 2005; Norgaard, 2003; Ulluwishewa, 1999) have argued that IK plays an important role in the sustainable management of natural resources and can also have an impact on issues of global concern. This recognition is directly related to the growing realization that scientific knowledge has contributed little to the development of certain communities and societies; rather it may have sometimes hastened the depletion of their social and natural resources (FAO 1997).

In Ethiopia for example there has been a longstanding tradition that the governors of the time collected information and this information was used to record customary patterns of land tenure and crop and livestock ownership. Since 1997 however, contemporary interest was revived to some extent by an Ethiopian local NGO, the Association for Promotion of Indigenous Knowledge (APIK), and by the Ethiopian Ministry of Agriculture (MoA). The data collected by an Ethiopian NGO showed that local people's knowledge and skills can be an effective means to increasing "deveopment agents" sensitivity to local needs, and stimulating meaningful dialogue between all actors in community based NR management activities.

However, what is meant by `indigenous knowledge' is by no means clear, and Table 1 shows the various terminologies and definitions available.

Term, synonyms	Meaning, salient aspect, implicit significance, antonym
Indigenous knowledge (internationally the most widely used term)	Culturally integrated knowledge; knowledge of small marginal /non-western groups
Endogenous knowledge	Of internal origin, as opposed to exogenous or external knowledge
Native knowledge /expertise	Expertise implies knowledge of a natural character, closeness to nature
Local knowledge	Knowledge rooted in local or regional culture and ecology
Sustainable knowledge	Sustainable within the natural and cultural environment
Traditional knowledge	Handed down, old, oral (implying static, low level of change)
Autochthonous knowledge	Of internal origin, culturally integrated
People's knowledge	Broadly disseminated knowledge, knowledge as potential for political resistance, as opposed to elite knowledge
Folk knowledge, folk science, folk competence	Traditional, rural (in industrial societies)
Little tradition	Tends to denote oral knowledge, as opposed to great tradition
Community knowledge	Related to small social units
Cultural knowledge, cognition (in the restricted sense)	Culturally integrated and practice-oriented
Ethnic knowledge	Related to an ethnic "we"-group (ethnicity)
Culturally specific knowledge	Specificity, singularity, particularity
Ethno-science (used here to denote local knowledge; previously used to denote the field of research)	Scientific (systematic) character; examples are: ethno-botany, ethno-sociology, ethno-medicine, ethno-pharmacology, ethno-epidemiology
Cultural knowledge system	Systematic character, generating rules (if x then y) and structures
Cultural belief/meaning system	Means the same as "knowledge system" but implies a less scientific character
Everyday/practical knowledge, mundane cognition, vernacular, common sense, generalist	Informal, practical, applied, as opposed to academic, specialist, expert knowledge or as opposed to ritual knowledge
Science of the concrete	Based on that which actually exists/is visible
Experiential knowledge	As opposed to theoretical knowledge, speculation or trial-and-error, as opposed to controlled experiment
Farmers' knowledge	Knowledge relating to the farm as an economic unit
Peasant knowledge	As opposed to elite knowledge; implies experiences of dependency

Table 1*: Diversity of terms for indigenous knowledge and their various connotations. Compiled from the literature of the 1960s to 2000 –* ***adapted from: Antweiler (2004)***

As summarised in the above table, the terms are often used interchangeably, but there is arguably enough overlap between their meanings to recognise the existence of a shared inter-subjective understanding with some related knowledge within a community that permits a sufficient degree of common-sense engagement to allow that they refer to the same focal semantic meaning.

Sillitoe & Marzano (2009, p14) find that IK "varies within and between societies, comes from a range of sources and is a dynamic mix of past tradition and present innovation. It is heterogeneous and complicated which is an inconvenience for development." It is also diffused 'skills as

knowledge', held by various people within a society and communicated through various symbols, myths and rites in an apparently piecemeal everyday fashion. They argue that "it is neither static nor uniform but ever-changing and subject to continual negotiation between people … it is a process featuring the acquisition and integration of current information and experience" (p15).

Berkes & Berkes (2009) emphasise the relationship between IK and the local natural world and note that IK comprises institutions, in terms of rules and norms, about how to treat the environment, as well as comprising a particular worldview that influences how they make sense of this natural world. They also emphasise the holistic nature of IK, compared to Western reductionism. Thrupp (1989) points out that, while at first IK was seen as a potentially useful source of mere 'technical ideas', it also extends to "non-technical insights, wisdom, ideas, perceptions, and innovative capabilities which pertain to ecological, biological, geographical and physical phenomena" (p.15).

One must not forget that IK is local knowledge that is unique to a given culture or society. It is the information base for a society which facilitates communication and decision-making. It is therefore important to understand that IK is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture.

An IK system therefore provides the basis for decision-making, which is operationalised through indigenous organizations, and they provide the foundation for local innovations and experimentation. IK systems are therefore adaptive skills of local people, usually derived from many years of experience, which have been communicated through oral traditions and learned through family members and generations. Local people, including farmers, landless labourers and rural artisans are all stakeholders of IK systems.

Dewalt (2007) identified the following features of IK, which have relevance to NRM:

- *locally appropriate*: IK represents a way of life that has evolved with the local environment, so it is specifically adapted to the requirements of local conditions.
- *restraint in resource exploitation*: production is for subsistence needs only; only what is needed for immediate survival is taken from the environment.
- *diversified production systems*: there is no overexploitation of a single resource; risk is often spread by utilizing a number of subsistence strategies.
- *respect for nature:* a "conservation ethic" often exists. The land is considered sacred, humans are dependent on nature for survival; all species are interconnected.
- *flexible*: IK is able to adapt to new conditions and incorporate outside knowledge.
- *social responsibility*: there are strong family and community ties, and with them feelings of obligation and responsibility to preserve the land for future generations.

Furthermore, Grenier (1998) pointed out:

- IK is considered parochial, confined to a small area, and limited to what rural people can sense, observe, and comprehend using their own terms and concepts.
- IK is not uniformly spread. Individuals vary in their aptitude for learning, storing, and generating knowledge. Specialized knowledge often belongs to certain groups or individuals; for example, male elders, midwives, traditional healers (Eythorsson 2000).
- IK includes both explicit and implicit knowledge, some of it intuitively practiced through cultural rituals or revealed through stories and legends. .

- IK is embedded in culture
- IK systems can be complex. Attempts to "scientize" IK by removing it from its owners will tend to compromise the subtle nuances of this knowledge (Thrupp 1989).

Turnbull (2009), quoting a position paper from the World Summit on the Information Society in Geneva in 2003, argues that IK is the basis of people's cultures, identities, institutions and value systems and cannot be separated from their spiritual and material relationships with their lands. Furthermore, these cultures provide the rules for sharing and applying this knowledge.

However, it is very difficult to discuss different systems of knowledge and different cultures without considering the realities of political and economic power. Bryan (2009, p24) notes that "the very concepts used to identify certain kinds of knowledge as indigenous remain steeped in colonial power relations". He discusses the production of maps and, in particular, the difficulties of 'indigenous mapping' where the traditional relationships between a people and the land are often considered to be 'unmappable'. Nevertheless, he argues that indigenous people are in the position of having to "map or be mapped" (p24). Maffie (2009) critiques the notion that Western hegemony, reflected in the triumph of the Gatling machine gun, somehow demonstrates the superiority of Western epistemology. As he argues: "indigenous knowledges have been defeated, not disproven, by Western technology" (p56).

IK is seen to be different from scientific knowledge and conventional wisdom has been that scientific knowledge is somehow more advanced and global than IK. However, the onset of 'global warming' and adverse climate change raises questions as to how advanced Western science actually is. Turnbull (2009) makes the point that scientific knowledge itself is 'local', based on the sociological notion that science is 'what scientists do' and is based on highly situated practices. Both knowledges are based on observation, some form of experimentation and the desire to create order out of apparent disorder (Berkes & Berkes, 2009) and "in some sense we are all indigenous and all knowledge including science is local" (Turnbull, 2009, p.3). Similarly all knowledges are "the product of human movement, actions, practices and protocols. … [they] are dynamic, heterogeneous, social and distributed" (p.3).

The knowledges have different epistemologies, with science based on evidence, repeatability and quantification while IK is often more related to spiritual and religious practices. However, there is no meaningful meta-theory to compare the different varieties. IK may be lacking in terms of scientific (positivist) epistemology but it rests on a very different epistemology. Furthermore, Sillitoe & Marzano (2009) argue that the distinction between IK and science is 'misleading' as, in practice, they borrow from each other.

In trying to 'square the circle' between IK and scientific knowledge, authors offer various solutions in terms of providing a space for different knowledges. Green (2009) talks about a 'duality' of IK and science, suggesting that different epistemologies, based on different 'moral economies' should be accepted, such that different knowledges are not seen as mutually exclusive. She argues for a 'reflective equilibrium' to compare the different epistemologies. Berkes & Berkes (2009) note a similarity between IK and 'fuzzy logic', a form of science proposed by Zadeh (1965) which is seen as being highly legitimate within, for example, the artificial intelligence community.

Sillitoe & Marzano (2009) argue for a model comprising 'linked spheres of knowledge', in the absence of a single theory of knowledge that would link IK with science, while Maffie (2009)

proposes a 'polycentric global epistemology' that would accept such practices as dance, song and ritual performance as legitimate knowledge mechanisms.

As may be the case in all developing nations, modern scientific knowledge of thought and lifestyle, exists alongside the traditional/indigenous knowledge systems in Ethiopia. The indigenous knowledge/traditional systems and the modern/scientific system are common in almost all sectors of Ethiopian society, including agriculture, health, education, culture and even lifestyle.

In addition to NRM, IK is widely used in medicine and, according to Kaya (2009), 65% of poor people in sub-Saharan Africa depend on traditional medicine for basic health care. Furthermore, the commercialisation of traditional medicines is an important part of pharmaceutical research and development with world sales of herbal medicines reaching $30 billion in 2000 (Kaya 2007). This raises difficult issues concerning the division of profits and intellectual property rights.

During the early years, interest in the role of IK in development focused on the knowledge itself and how it could be used across taxonomies (World Bank, 1998). Today there is a growing recognition of the role that IK plays in local decision-making, the manner in which indigenous organisations facilitate the identification and prioritization of community problems, and the importance of searching for solutions which result in local-level experimentation and innovation

Although, from the Second World War onwards, the introduction of modern systems has tended to neglect IK , the majority of the Ethiopian population – especially those who live in rural areas - still heavily rely on IK systems. Thus the readily available IK continues to provide the building blocks for development in Ethiopia, while at the same time seeking cooperation with modern knowledge for the mutual benefit of the two systems.

The above definitions of IK may be relevant in certain contexts, for this research however it was defined as:

> ***A body of knowledge indigenous people have accumulated over time, which allows them to live in balance with their environment.***

This matches the view of Berkes & Berkes (2009), who see IK as "a body of knowledge built up by a group of people through generations of living in close contact with nature" (p7). IK is therefore understood to be the starting point for NRM and a host of other activities in rural communities.

Many authors (Mathias, 2005; Labatut & Akhtar, 2005; Warren, 1995) have stressed the value of IK for development. But IK has its limitations (Bebbington, 1999; Reijntjes et al., 2005; Leach & Mearns (1988) and is not in itself capable of addressing all the issues related to sustainable development (Murdoch & Clark, 2005).

Sustainable development may well be better served by a system that incorporates both indigenous and scientific knowledge systems (Icamina, 1999). Organizations, like the International Union for Conservation of Nature and Natural Resources (IUCN, 1997) and the World Commission on Environment and Development (WCDE, 1987), also stress that the sustainable management of natural resources can only be achieved by developing a science based on the priorities of local people, and creating a technological base that includes both traditional and modern approaches to problem-solving (Johnson, 2005).

Incorporating indigenous and scientific knowledge could mean integrating information collected from farmers with scientific information and technology. This means that one has to find a process relevant to indigenous information in the same way as scientific information (Lawas & Luning, 2005).

2.1 IK for sustainable NR management

As may be the case in most developing countries, the overwhelming majority of the population in Ethiopia for example are small-scale farmers, each working less than one hectare of land. In most instances, the knowledge systems of these farmers have never been recorded systematically in written form; hence they are not easily accessible to agricultural and NRM researchers, extension workers, and development practitioners.

While to some extent remaining invisible to the development community, many indigenous organizations (e.g. farmers' associations) are operating in rural communities to identify solutions to community problems. Therefore one needs to closely look at recent studies of IK reflecting the changes in attitudes of policy makers and NRM planners in recent years, which have led to renewed interest in this type of knowledge.

NRM planners and policy makers and other stakeholders are beginning to recognize the need to understand existing knowledge systems and decision-making processes (WCED, 1997). There is a general agreement that agricultural innovations based on IK have been tested through time (Warren & Rajasekaran, 1993). IK is a science that is user derived and experimented over a long period of time and its utilization in development efforts provides long-term advantages that complement the contributions of conventional top-down agricultural technologies.

Despite all the evidence available, there is scepticism about the relevance of IK for NRM – this is partly because indigenous communities never record their accomplishments, never attach their names and patents to their discoveries and inventions. As a result, in most cases the history of natural resources development is written without reference to the main stakeholders (Kajembe & Wiersum, 2004).

According to FAO (1999), NRM has been much more concerned with conserving the resource without local communities. Protection of natural resources has at times been seen as necessitating disruption of the traditional ways of life of local communities. An effort has therefore to be made to incorporate social values into NRM systems and this incorporation has to be effective. It is through this incorporation that IK has a chance to be recognised and valued.

2.2 The dangers of disregarding IK systems

As documented by the International Federation of Agricultural Producers (IFAP), neglecting IK undermines farmers' confidence in their traditional knowledge and that in turn forces them to become increasingly dependent on outside expertise (Richards, 1985; Warren, 1997). IFAP also asserted that small-scale farmers are often portrayed as backward, obstinately conservative, resistant to change, lacking innovative ability, and even lazy (IFAP, 1990).

According to IFAP the reasons stated for these perceptions includes:

- a lack of understanding of traditional agriculture which further leads to a communication gap between promoters and practitioners giving rise to myths;
- the accomplishments of farmers often are not recognized, because they are not recorded in writing or made known;
- poor involvement of farmers and their organizations in integrating, consolidating, and disseminating what is already known.

One of the greatest consequences of the under-utilization of IK systems is the loss of indigenous acquired knowledge which results in the inefficient allocation of resources and manpower to inappropriate planning strategies which have done little to alleviate rural poverty (Atte, 2004). With little contact with rural people, planning experts and state functionaries have attempted to implement programs which do not meet the goals of rural people, or affect the structures and processes that perpetuate rural poverty.

Human and natural resources in rural areas have remained inefficiently used or not used at all. There is little congruence between planning objectives and realities facing the rural people. Planners think they know what is good for these 'poor', 'backward', 'ignorant', and 'primitive' people (Atte, 2004).

2.3 Preservation of IK

IK which has generally been passed from generation to generation by word of mouth, is in danger of being lost unless it is formally documented and preserved. According to Warren (2004), the future of IK, that reflects many generations of experience and problem solving by thousands of indigenous people across the globe, is uncertain. The loss of IK would impoverish society because, just as the world needs genetic diversity of species, it needs diversity of knowledge systems (Labelle, 1997).

The rapid change in the way of life of local communities has largely accounted for the loss of IK. Younger generations underestimate the utility of IK systems because of the influence of modern technology and education (Ulluwishewa, 1999).

If IK is not recorded and preserved, it may be lost and remain inaccessible to other indigenous systems as well as to development workers. Development projects cannot offer sustainable solutions to local problems without integrating local knowledge (Warren, 1991). IK is the key to local-level development (Schoenhoff, 1999) and ignoring people's knowledge is likely to ensure failure (Brokensha *et al*., 1997).

Hence, one should not expect all the expertise for Third World development to come from developed nations, academic institutions, multinational corporations or NGOs. As Atte (1989) noted, in the face of dwindling resources available to African countries, and noting that even the industrialized nation governments cannot provide for all the needs of the people, it has been suggested that IK, and the technical expertise developed there from become vital tools for rural development.

Since IK is essential to development, it must be gathered, organized and disseminated, just like Western knowledge (Agrawal, 1995; Gonzalez, 1995; Warren *et al.*, 1999). The main challenges to the management and preservation of IK are issues related to methodology, access, intellectual property rights and the media 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.

Some scholars (Ulluwishewa, 1999; Warren, 1999) recommend *ex situ* conservation strategies, i.e. isolation, documentation and storage in international, regional and national archives. In the 1990s, this strategy was used to document the healing practices of the Fulani pastoralists in the north-west province of Cameroon (Nuwanyakpa, 2006). On the other hand, those who advocate maintaining distinctions between scientific knowledge and IK have supported *in situ* preservation of IK (Agrawal, 1995). The merits and demerits of the debate surrounding the methodologies of preserving IK are however beyond the scope of this discussion.

The question of whether or not we can ever fully articulate knowledge, as posed by Tyler (1978), is equally subject to further discussion. According to Tyler, if the said consists of the saying itself, the construction of what was said and what remains unsaid, then knowledge cannot be isolated, transmitted, received, stored and translated. Collectors of IK and designers of knowledge management systems have demonstrated that knowledge neither eludes nor defies cognitive narratives.
Lawas & Luning (1996) point out that the collection of indigenous information is time-consuming and costly. Thus, proper storage and management must be provided if the information is to be made available for the benefit of the wider national and global communities. The major challenges to the management and preservation of IK identified by their study are collection development policies, accessibility, storage and preservation media, and intellectual property rights.

They argue that library and information professionals should design collection development policies for IK . However, it could be argued that the collection of IK in the field should be left to ethnographers, anthropologists, oral historians and related professionals. Instead information professionals should collaborate with national IK resource centres to enhance access to IK.

The prime role of national IK resource centres is to collect, document and disseminate IK (Ulluwishewa, 1999). Such centres include the Ethiopian, Kenyan, South African, Tanzanian and Zimbabwean resource centres for IK .

According to Ngulube (2002), library and information professionals should only become part of the IK management equation in so far as organizing the information and making it usable and accessible. However, most librarians who attended the fifteenth Standing Conference of Eastern, Central and Southern African Librarians (SCECSAL) did not seem to agree (SCECSAL, 2007).

They contended that they should be involved in the whole process of gathering, evaluating and organizing IK. However, one might question whether they have the necessary skills and resources. The work of collection as well the training of personnel in gathering IK has cost implications that would overstretch their already scanty resources.

Moreover, Ngulube (2002) asserted that without a collection development policy one wonders where library and information professionals would start. Are they going to collect everything they perceive to be IK ? Collecting for what clientele? If library and information professionals are not involved in directing the publishing of the journals and other materials they organize, why do they want to have a different approach when it comes to IK ?

A major contentious issue in the management and preservation of IK is the protection of intellectual property rights, where these are the legal rights that can attach to information emanating from the mind of a person if it can be applied to making a product that is made distinctive and useful by that

information (Posey & Dutfield, 2005). There is an emerging debate on how to protect the intellectual property rights of IK practices.

In this regard, 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 pertaining to their sciences, technologies, seeds, medicines, knowledge of flora and fauna, oral traditions, designs, art and performances (Valsala & Kutty, 2002). In the same vein, the Economic Commission for Africa recommends that oral tradition and IK in African communities should be exploited in all their forms of expression, giving cognizance to the protection of intellectual property rights (UN, 2007).

Although most IK is held in the minds and practices of people, and is commonly held by communities rather than individuals, intellectual property rights that are intended to protect the ownership of the intellectual content of the works of an individual can be applied. In the Western tradition the intellectual property must be tangible, taking the form of a written document, a recording of music, a painting or drawing, and the like. Sometimes IK is tangible. For instance, there are songs, stories, music, statues, paintings, designs, processes and drawings that embody traditional knowledge. These areas of IK are capable of being protected either individually or communally.

Traditional medicines also come to mind when thinking of protecting intellectual property. Who can claim that traditional healers share their medicinal secrets with the whole community? Equally, who can deny for example traditional healers within Ethiopia could easily apply their unique skills and knowledge of medicine to treat their cattle? There is currently a debate on whether pharmaceutical companies should pay traditional healers royalties for using active compounds of medicinal plants that they have always exploited.

Traditional medicines also come to mind when thinking of protecting intellectual property. Who can claim that traditional healers share their medicinal secrets with the whole community? Equally, for example in deny that traditional healers in Oromo and Southern Ethiopia were among the few people who could easily acquire cattle because of their unique skills in and knowledge of medicine? There is currently a debate on whether pharmaceutical companies should pay traditional healers royalties for using active compounds of medicinal plants that they have always exploited.

In spite of the fact that sharing is the main means of disseminating IK, there is IK that is unique to certain individuals, although they use that knowledge for the benefit of the whole community. Upholding intellectual property rights should benefit indigenous communities by the commercial use of their traditional knowledge. This could be an area where information professionals could contribute.

2.4 Challenges and Limitations of IK

Although the knowledge of indigenous communities has been found to be very useful, the spread of industrialization threatens the preservation and continued development of IK systems (Sherpa, 2005). Industrialization, along with its attendant processes of urbanization, exploitation of NR, and increased competition for employment, has set off a problematic chain of events. This modernisation has influenced indigenous traditional African society in many ways and Ethiopia is no exception.

IK can also be eroded by wider economic and social forces. Pressure on indigenous peoples to integrate with larger societies is often great and, as they become more integrated, the social structures which generate IK and practices can break down. Added to this is the commercial pressure by multinational agrochemical companies eager to break into new markets (Thrupp, 1989).

As Grenier (1998) puts it:

> *"the growth of national and international markets, the imposition of educational and religious systems and the impact of various development processes are leading more and more to the "homogenisation" of the world's cultures. Consequently, indigenous beliefs, values, customs, know-how and practices may be altered and the resulting knowledge base incomplete."*

As with scientific knowledge, however, IK has its own limitations and drawbacks and these must be recognized as well. IK is sometimes accepted uncritically because of naive notions that whatever indigenous people do is naturally in harmony with the environment. Thrupp (1989) argues that we should reject "romanticized and idealistic views of local knowledge and traditional societies" (p15). There is historical and contemporary evidence that indigenous peoples have also committed environmental sins' through over-grazing, over-hunting, or over-cultivation of the land. It is misleading to think of IK as always being 'good', 'right or 'sustainable'.

Quite often the overlooked feature of IK, which needs to be taken into account, is that, like scientific knowledge, sometimes the knowledge which local people rely on is wrong or even harmful. Practices based on, for example, mistaken beliefs, faulty experimentation, or inaccurate information can be dangerous and may even be a barrier to improving the wellbeing of indigenous people.
As Thrupp (1989) said, sometimes IK that was once well-adapted and effective for securing a livelihood in a particular environment becomes inappropriate under conditions of environmental degradation. Although IK systems have a certain flexibility in adapting to ecological change, when change is particularly rapid or drastic, the knowledge associated with them may be rendered unsuitable and possibly damaging in the altered conditions.

2.5 Importance of researching IK

For quite convincing reasons, timely attention is being paid to incorporating the IK of local people into the overall environmental and NRM processes in the developing nations. Before this, such knowledge was widely used by rural people for sustainable resource management. Over time, however, it was displaced by western-based knowledge but interest in its use has revived over the past decade due to the growing debate over environmental degradation of large development projects.

In North America, for example, indigenous perceptions of land-use and landscapes were transcribed in the form of maps, discourses on taxonomy and community economic base studies: areas of use and occupancy and sensitivity were formally mapped and indigenous interpretations of landscape and environment were once more seen to have value and relevance (see, for example, Brody (1982) and Reed (1997b)).

As Nakashima & Reed (2005) have also noted, IK has been applied to historical climatic research, geophysical research, rural land use and resource management planning. Indeed, the IK of local flora and fauna often exceeds that of western scientists both in geographical and temporal extent. However, while indigenous peoples have profound knowledge of local human ecology that is of

great importance in identifying rural land-use, resource management and environmental priorities, the apparent informality of such information does not sit comfortably with the western scientific tradition.

This tradition underpins the conventional planning and resource management practices, and a major challenge facing environmental resources management planning in the developing nations is that of identifying the appropriate use of IK of local human ecology in NRM and developing a culturally sensitive framework for its utilization.

Sustained knowledge about the land identifies issues of immediate significance and encodes information about the environment in a language people at the grassroots level understand (Ramisch, 2002). Although scientific land-use information is essential, it is not easily communicated, perhaps fails to capture the true nature of the various issues, and often reflects 'alien' attitudes towards resource values and use.

As documented by Fenge & Rees (1987) the application and utilization of rural resource management planning calls for an organised approach to dealing with IK . The importance of the role of Canadian native indigenous populations in planning was acknowledged in agreements introducing the Northern Land Use Planning Programme and environmental assessment processes. Fenge & Rees (1987) go on to note that in practice, expectations that native perceptions of land use and environment and perspectives on resource management would play a central role in planning have not been fulfilled. This is partly attributable to the political context and partly to a failure to develop adequate frameworks for dealing with indigenous land-use knowledge.

Although a considerable amount of IK of local human ecology regarding rural resource management has been transcribed in the course of use and occupancy studies, land claim negotiations, research projects, indigenous language projects, consulting work, and community economic base studies, there is no proper or adequate inventory of this material. Equally, although some imaginative approaches to incorporating cultural values into a holistic perspective on planning have been suggested there is no rigorous or accepted way of incorporating IK of local human ecology regarding NRM into planning processes.

As can be seen from the above review of the IK literature, much of the debate is normative, political and pragmatic. This can be useful in making quick improvements to NRM but adds little to our deeper understanding of IK. Very little of the existing literature has much of a theoretical base and it is conjectured that progress could be made by exploring IK from the perspective of relatively modern disciplines, such as information systems, knowledge management and innovation studies.

2.6 Indigenous knowledge and information systems

Apart from knowledge management, discussed in the next section, IK has been explored a little within IS research and development projects, in particular geographical information systems (GIS), many of which have been concerned with NRM (Mbile et al., 2003).

There are important spatial aspects to IK and GIS offer the opportunity to facilitate the management of IK and enhance its usefulness and its inclusion in local decision making (Lawas & Luning, 1996). Furthermore, Tabor & Hutchinson (2004) and Gonzalez (1995) describe the advantages of using GIS to document IK. Examples of the combination of IK and GIS include the Phillipines (Lawas &

Luning 1996), American Indian reservations and New Zealand (Harmsworth 1995). Moreover, such tools can complement traditional IK systems, whereby an important role is reserved for the relationship with individuals, places, cultural activities, experience and the spoken word (Harmsworth, 1998).

However, as argued by Walsham & Sahay (1999), the use of GIS in developing nations provides a classic example of the utilization and transfer of technology problem, which typically involves the introduction of Western technical systems into developing countries. Furthermore, Sahay & Walsham (1997), in discussing the use of GIS in India, highlight various problems; for example the development of systems that are not considered relevant by users; the lack of continuity in project management practices; and inappropriate co-ordination between the various agencies.

Many approaches to integrating IK into GIS have been participatory in nature. These include Waldron & Sui (2003), Gonzalez (1995) in the Philippines and Rundstrom, (2006) and Jordan & Shrestha (2005) in Nepal. McConchie & McKinnon (2003) pioneered a technique called Mobile Interactive Geographic Information System, developed for integrating IK to produce community-based maps for collaborative NRM.

The method has been successfully tested in Thailand, China and Cambodia, is presently being used in Bangladesh and was to be tested in India (McConchie, 2003). While there is an increasing interest in using GIS in a participatory context (Abbot et al., 1998), there are fears that it could be misused, wrongly interpreted, or not used at all and, if poorly designed, it could dis-empower underprivileged groups (Jordan & Shrestha, 2005).

The major advantages and disadvantages of participatory GIS (Jordan & Shrestha 2005) are listed in the table below:

Advantages	**Disadvantages**
Viewed as a participatory process it can empower the community by involving them in the decision making process.	If the participatory process is not well structured the community does not feel to be a part of the decision making process
It can be used to effectively combine quantitative and qualitative approaches to community development	There is a potential risk of the focus getting shifted mainly towards extractive data collection
Spatial data in the form of maps and other resource information can be utilized by the community in their decision rather than having access to GIS making process	There is a likelihood of sensitive spatial information like cadastral maps being subject to unintended misuse if held centrally
Natural resource information can be easily put together, analyzed and returned to the community for use	Excluding disadvantaged groups from the 'mapping' process can have a disempowering effect on them
Useful information can be returned to stakeholders for informed decision making	Availability and knowledge of the technology itself encourages a centralized approach

Table 2: *Advantages and disadvantages of Participatory GIS*

Another benefit of GIS is that it can narrow the information gap between professionals and resource users by making indigenous information more transparent, understandable, and accessible to a wider audience. In one project, a GIS was taken into a remote field area in southwest China and data was collected, encoded, manipulated, and analyzed (Lawas & Luning, 1996). The results were immediately presented back to the villagers, who then checked the data, validated any translations, provided credibility to the database, and reviewed and critiqued the findings.

However, rather than within information systems, where IK can mostly only be found in GIS literature, it is within the field of knowledge management that IK can be more readily discussed.

2.7 IK in the context of knowledge management

The notion of knowledge management grew from the early predictions that we were entering a post-industrial society (Bell, 1973; Drucker, 1968) which would feature a knowledge economy (Reich, 1992; Prusak, 2001; Toffler, 1990). This, in turn, suggested that organizations should carefully manage their knowledge, much of which was beginning to be reflected in the growth of intangible assets appearing in company balance sheets (Spender & Scherer, 2007). Companies accordingly began to implement various knowledge management initiatives.
One of the most influential theorists in early knowledge management was Nonaka (Nonaka, 1994; Nonaka & Takeuchi, 1995) who built a theory of organizational knowledge creation, based on Polanyi's (1967) distinction between tacit and explicit knowledge.

According to Polanyi, tacit knowledge was based on experience, behaviour and skills, which is held in the brain of the person, whereas explicit knowledge is articulated and can be documented and stored on paper or electronically. Nonaka (1994) argued that knowledge was created within the firm through modes of interaction between tacit and explicit knowledge and these different modes acted together dynamically to form a spiral of knowledge creation. These modes of interaction are described in more detail in the following chapter.

Nonaka's model implicitly views knowledge as an object (Thompson & Walsham, 2004) that is constructed and can then be shared by others. This led to definitions, such as the one by Brooking (1997): "knowledge management is the activity which is concerned with strategy and tactics to manage human centred assets". However, Thompson & Walsham (2004, p.726) argue that "the meaning of any objective 'knowledge' will always remain the subjective product of the person in whose mind this is constituted, always relationally defined, and therefore does not transfer easily to others in a form which may be operationalized to the benefit of the organization". They also point out that Polanyi himself regarded explicit knowledge as self-contradictory.

The alternative approach to knowledge as object is to take a practice-based view (Blackler, 1995) where objective *knowledge* is considered more as an inter-subjective process, resulting in the recipient *knowing*. This also fits better with Weick's (1995) notion of sense-making and Lave & Wenger's (1991) situated learning. Thompson & Walsham (2004) emphasise the importance of the organizational context for these processes and they view *knowing* as "mediated, situated, provisional, pragmatic and contested" (p.743).

Habermas (2003) dismisses the notion of knowledge as the representation of reality but regards it rather as a competence to do something successfully in practice.

From an actor-oriented perspective, both scientific and IK are fragmentary, partial and temporal. Both scientific and IK are constantly being generated and constructed as products of dynamic processes of interaction between various actors with different cultural backgrounds and understandings (Katani 2005). Advocates of an actor-oriented perspective recognise that multiple actors do exist in NRM and rural development at large.

Knowledge is not just a commodity which can be transferred from one actor to another but the outcome of a process which is a result of negotiation on the 'social interface' between multiple actors (Long & Villareal, 1994). From this perspective, local stakeholders (individuals or groups) should be seen as situated agents (Kajembe, 2003). Within the limits of existing information, uncertainty and other constraints (e.g. physical, social and politico-economic), local actors are knowledgeable and capable (Chambers et. al., 1989). They attempt to solve problems, learn how to intervene in the flow of social events around them, and monitor continuously their own actions, observing how others relate to their behaviour and taking note of various contingent circumstances. Human agency, or the capacity to devise ways of coping with life, plays an important role in the way actors create new possibilities.
McAdam & McCreedy (2000) compare what they call the 'social paradigm' of knowledge construction, using Lave & Wenger's (1991) and Demerest's (1997) models, which emphasise practice, interaction and communication, with the 'scientific paradigm' (equivalent to knowledge as object), which produces a "canonical body of facts and rational laws" (p.158). For them, the social paradigm seems more useful within the business context. Sutton (2001) concludes that "knowledge may be codified into texts and artefacts but only functions in people" (p.87).

Alavi & Leidner (2001) discuss the various conceptualizations of knowledge and go on to develop a framework (described in more detail in the next chapter) comprising four sets of 'socially enacted knowledge processes':

- knowledge creation
- knowledge storage/retrieval
- knowledge transfer
- knowledge application

Lave & Wenger's (1991) work led to a growing research interest into 'communities of practice' (Amin & Roberts, 2008). According to Lave & Wenger, a community of practice is "a system of relationships between people, activities, and the world: developing with time, and in relation to other tangential and overlapping communities of practice" (1991, p.98). Such communities are seen as being hugely important for knowledge creation as they provide the interaction, the shared basis of understanding and the propagation channels for the creation and sharing of knowledge (Wenger, 1998).

These different conceptualizations of knowledge suggest different epistemologies and Spender & Scherer (2007), among others, argue for a tolerance of these differences and a 'pluralistic conversation' between them. Similarly, Schultze & Leidner (2002) argue that the ambiguity regarding the nature of knowledge, and the different types of knowledge, imply the need for different 'discourses' and they propose the adoption of the four discourse types of Deetz (1996) – normative, interpretive, dialogic and critical - in order to examine knowledge management.

The fact that indigenous people also hold a wealth of knowledge and experience that represents a significant resource for sustainable development is slowly dawning. According to Warren (1991) however, IK has been ignored in the management of information in Africa. IK pertains to experiential, locality-specific knowledge and practices of medicine, as well as healing, hunting, fishing, gathering, agriculture, combat, education and environmental conservation developed by indigenous people over the years.

Thus, IK is local knowledge that is unique to a given culture or society (Warren, 1991). According to CSOPP[1] (2001), some 80 percent of the world's population depend on IK to meet their medicinal needs, and at least half rely on IK and crops for food supplies. Essentially, this means IK affects the well-being of the majority of people – especially in developing countries.

Although IK is derived from observation of the environment in a particular context, it can be widely applied in many scenarios. As Warren (1991) and Ulluwishewa (1999) point out, the utility of IK is not confined to the locality in which it evolves, but is useful to scientists and planners alike in designing development programmes. However, library and information professionals have not been at the forefront in terms of managing IK, in spite of the fact that it is becoming an important resource in planning and managing sustainable development projects.

The dominant information management model has been based on acquiring, organizing and preserving recorded and codified knowledge, which is largely generated by researchers, laboratories and research institutions.

Such a model of managing information has little room for IK, which is not formally codified and resides wholly in the minds of local people. Nevertheless, the growing importance of knowledge and knowledge management implies that IK should be accorded a suitable place in the pluralistic conversation of Spender & Scherer (2007).

2.8 IK and Systems of Innovation

Innovation studies is a fast-emerging multidisciplinary field within the social sciences (Fagerberg & Verspagen 2009) and innovation is high on the agenda of most governments in their attempts to reinvigorate flagging economies. The literature is usually traced back to the work of Schumpeter (1934) who saw innovation as the driving force behind economic and social change. His work, which formed much of the foundation of evolutionary economics (and also evolutionary dynamics), was continued by Arrow (1962), Freeman et al (1982) and Nelson & Winter (1982).

Mytelka & Smith (2002) emphasise the shift over the years from viewing innovation as a process of discovery to seeing it more as 'a non-linear process of learning', based largely on the evolutionary ideas of Rosenberg (1976, 1982). Rogers's (1962) theory of the diffusion of innovation, based on an S-curve, is regularly referred to within the information systems literature.

Amabile et al (1996) define innovation as "the successful implementation of creative ideas within an organization" and this reflects the management literature that seeks to enhance and increase the innovative capacity of individual firms. According to Schumpeter (1934) innovation includes the introduction of new products, new methods of production, new markets, new sources of supply and new forms of organization.

Another strand of innovation research refers to national systems of innovation (Edquist, 2004; Freeman, 1987; Lundvall 1992; Nelson 1993), which is more concerned with the political economy of innovation at the regional, national and supra-national levels. Lundvall (1992) defines them as "elements and relationships which interact in the production, diffusion and use of new and

economically useful knowledge … and are either located within or rooted inside the borders of a nation state".

However, most writers (e.g. Niosi 2002) regard them more specifically as networks of firms, universities and government agencies. These networks include Triple Helix and Globelics, which have grown over the last seven years or so with the purpose of sharing and refining knowledge, learning and development, as well as linking the 'helices' of university-industry-government. It is this stream of research that has largely driven innovation policy and it has little to say about IK or community innovation.

Fagerberg & Verspagen (2009) categorise the innovation research community into five clusters:

- Management
- 'Schumpeter crowd'
- Geography & policy
- Periphery
- Industrial economics

Baskaran & Muchie (2008) offer a 'unified conception' of innovation systems which includes both the various ways of examining innovation systems (according to geography, type of firm, sector/technology and type/complexity of innovation) as well as the various factors (e.g. global, political, and economic) that influence them. Various authors (e.g. Ernst 2002; Kraemer-Mbula & Muchie 2005) have discussed innovation systems in developing countries mostly focusing on the networks of formal institutions.

There is clearly a considerable overlap between knowledge management and innovation studies. Swan et al (1999) offer a framework that maps process and product innovation against 'cognitive' and 'community' knowledge management. McAdam (2000) views knowledge management as a 'catalyst' for innovation within organizations and he goes on to fit innovation 'drivers' within a framework based on Demerest's (1997) model of knowledge management.

Sorensen & Lundh-Snis (2001) suggest that knowledge classification and codification are means for organizational learning and innovation. Chang & Chen (2004) distinguish between three approaches to national systems of innovation (culture and politics-bounded; technological/sectoral; and regional/local) in terms of knowledge links while Popadiuk & Choo (2006) discuss the relationship between knowledge creation and innovation.

A recent link between innovation and information systems research is the growing interest in 'open innovation', based on the ideas of Chesbrough (2003) and stemming partly from the success of open source development of software (Weber 2005). Open innovation refers to the notion that, rather than relying on internal sources, organizations should seek innovative ideas and projects externally, particularly through joint ventures and other partnerships with universities, small businesses and individual entrepreneurs. Such partnerships are facilitated by knowledge sharing and improved communication using the Internet. Industrial leaders in open innovation include IBM and Procter and Gamble and these ideas have spread to many industry sectors (Christensen et al 2005).

Despite the use of the term 'indigenous innovation' by Lazonick (Lazonick & Mass 1995, Lazonick 2004) in discussing the economic development of Japan and China, there is very little mention of IK

within the innovation literature. As noted above, the emphasis is mostly on formal networks of institutions or the more radical open innovation.

A rare exception is Kaya (2009) who discusses IK and innovation systems in public health in Africa, as well as noting the complementarity between traditional food and traditional medicine. He describes various research and development projects and initiatives in IK and innovation and repeatedly uses the phrase 'IK and innovation systems', suggesting that innovation is an inherent part of IK. He goes on to refer to the process where large multinational pharmaceutical, agricultural and biotechnological corporations patent IK techniques and products as turning "the owners of traditional knowledge into beggars" (p.103).

In adapting to changes in their environments, local people in the Sub-Saharan Africa not only vary products that they use, but also the practices they employ, the amount of labour they expend, as well as other socio-economic factors. The sources of the changes are not invariably 'outside' pressures or influences alone, but also changes engendered by the local people's own subsistence activities and experimentation.

A little recognised aspect of IK is its experimental and innovative nature. The term IK may create an impression of knowledge that is static, having been handed down through countless generations. However, in reality this knowledge is constantly evolving and being updated with new information. Various authors (e.g. Muchie, 2006) emphasise the importance for developing countries to build their own innovation capabilities, rather than relying on the West for innovations that may not be appropriate for the local context.

Rhodes & Bebbington (2001) identified three kinds of indigenous farmers experiments: c*uriosity experiments* (where farmers experiment simply out of curiosity to test new numbers and sizes of crops); or p*roblem solving experiments* (where farmers carry out experiments to solve problems); or *adaptation experiments* (where farmers can either test unknown technology in a known environment or test known technology in a new environment).

Studying experiments undertaken by rural people gives an understanding of their 'sense making' activities (Brouwers 2002). Scientists tend to regard an experiment as an enquiry during which all the variables are highly controlled except those under study. Local people differ from the scientific way in the sense that the experiment has to be included in daily circumstances (Kajembe, 2003). Richards (2002) concludes that in recent literature the experimenting, innovative, adaptive indigenous farmer is now accepted as the norm, not the exception. His own work has made a substantial contribution to this change of attitude. He has given numerous examples from West Africa, including labour organisation and rice cultivation in swamps.

Conclusion:

This paper provided a summary of the relevant literature from NRM, which serves as the context for understanding the role and status of IK. The paper deliberately focussed on IK as the focus of the research, particularly highlighting the practical and problem-centred literature from which the issues relevant to the lives of indigenous people emerge.

The literature suggests that IK is important in terms of supporting sustainable NRM for large numbers of communities – especially in the developing countries. Furthermore, it may offer

promising solutions to many NRM problems as a complement to scientific knowledge although, as a body of knowledge, it is rather different from science. However, much of the IK literature lacks a solid theoretical base from which to seek a clearer understanding. Information systems itself has little to offer in this way but the literatures of knowledge management and innovation studies are more promising.

Knowledge management is largely concerned with knowledge processes at the level of the individual firm while innovation studies has two 'arms': the firm level and the national (institutional) level. However, neither literature has much to say about IK, which operates at a more local level but without the structures of an organization. In fact, it could be argued that there are significant 'gaps' in both literatures regarding IK.

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