

DIGITISATION OF INDIGENOUS KNOWLEDGE FOR NATURAL RESOURCES MANAGEMENT IN AFRICA

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KEY TERMS: Afrikology, digitisation, indigenous knowledge, natural resources management.

ABSTRACT:

This paper examines digitisation of indigenous knowledge as a critical resource for the promotion of effective management of natural resources in Africa. The paper is based on content analysis of primary and secondary data. The primary data were obtained from 12 in-depth interviews conducted among stakeholders in the Nigerian cultural industries while the secondary data were obtained from relevant documents through an electronic search of databases. The paper is grounded in the Theory of Diffusion of Innovations and Afrikology with a focus on the need to intensify the preservation and propagation of African indigenous knowledge for natural resources management. The findings reveal several opportunities and challenges in attempts to promote African approaches to natural resources management since the advent of the digital revolution. Africans' experience of digital revolution is discussed with reference to success stories of digitisation of indigenous knowledge systems. Discussions suggest the need for concerted interest in digitisation of African indigenous knowledge to intensify efforts geared towards natural resources management. Such digitisation should be launched in all virtual communities and educational systems; this is to enhance its effectiveness. Also, governments and NGOs should initiate projects to develop digitisation of indigenous knowledge in order to promote cultures and enhance indigenous capacity for environmental sustainability and effective management of natural resources in Africa.

INTRODUCTION

The indigenous knowledge of Africans remains a gold mine, although it has been suppressed since the advent of cultural imperialism exemplified by harrowing scenes of devastation in the contexts of slavery, colonialism and neocolonialism. This situation affects natural resources management in Africa, the world's second-largest and second most-populous continent, after Asia. Africa embodies diverse ecology with complex biodiversity, which affects its development in all ramifications (Ogundiran, 2005). As reported by Arowolo (2010), Africa covers six percent of the earth's total surface area and 20.4 percent of the total land area with 30.2 million square kilometers including adjacent islands. The population of Africans has reached over one billion people, representing 15 percent of the world's total populations. Africa is surrounded by the Mediterranean Sea to the north, both the Suez Canal and the Red Sea along the Sinai Peninsula to the northeast, the Indian Ocean to the southeast, and the Atlantic Ocean to the west. The continent has 54 sovereign states (Asante, 2007).

Natural resources can be found in the African side of the biosphere, referring to the global ecological system that integrates all living beings and their relationships including their interaction with elements of the lithosphere (land), hydrosphere (water) and atmosphere (air) (Folke et al., 2011). An observation of the geography and topography of Africa shows that the continent is characterised by complex biodiversity and an abundant supply of natural resources including land and water. Both land and water contain a large number of other natural resources such as wildlife, minerals, freshwater and groundwater.

The above mentioned natural resources have been managed effectively through the use of indigenous knowledge in Africa for the past several centuries. Indigenous capacity for management of natural resources has been observed in several African empires since the

ninth century, particularly in the Nok, Hausa, Eze Nri (Igbo Ukwu), Ashate, Gao, Kanem, Mali and Ashanti empires (OBrien, 2005). Indigenous capacity was equally noticed in other empires at different locations such as Songhai, Oyo, Benin, Dahomey and Zulu. Eventually, a large number of Africans were enslaved and Africa was officially colonized by powerful European countries, providing a new benchmark for knowledge management on the continent.

As a result, Africans are presently behind the rest of the world in terms of ability to develop indigenous potentials for effective management of natural resources. This is evidenced by Africa's high incidence of deforestation, environmental degradation and loss of biodiversity. High levels of deforestation and irrigation have resulted in water tables rising to the soil surface, creating severe salinization problems (Folke et al., 2011). It can be observed that the capacity of local institutions is presently at variance with the speed of resource exploitation in sub-Saharan Africa.

Essentially, Africans are expected to align their indigenous knowledge with the modern reality, particularly in the areas of information technology in order to maximise the sharing of the indigenous knowledge, which can result in creative solutions to environmental problems (Were, 2011). This expectation is reinforced by the fact that the spiraling human demands for resources has weakened the capacity of the earth's natural systems, as evidenced in "collapsing fisheries, falling water tables, shrinking forests, eroding soils, dying lakes, crop-withering heat waves, and disappearing species" (Brown, 1996: 4). The above-mentioned environmental problems are common in most developing countries. The problems can be addressed through appropriate knowledge.

Thus, there is urgent need to bridge the widening knowledge gap in African societies (Kalu, 2010). While the old generations of Africans are conversant with indigenous knowledge, the new

generations largely ignore such knowledge. The new generations are now recognised as “net generations” based on their interest and dexterity in the use of technology (Roberts, 2011; Poore, 2011; Maciel and Albagli, 2009; Hessels et al, 2009). However, the next generations could be exposed to the dangers of ignorance about the traditional knowledge of their ancestral environment. There is therefore an urgent need to bridge the knowledge gap in order to intensify the preservation and propagation of indigenous knowledge for natural resources management in Africa.

Since African societies presently contend with an onslaught of digital revolution, this paper therefore examines digitisation of indigenous knowledge for natural resources management in Africa. Issues raised in the paper are contextualized within the ambit of the Theory of Diffusion of Innovations and Afrikology. Emphasis is specifically placed on the social context in which the enduring aspects of the knowledge base of Africans can be preserved and propagated with the aid of digital technology to further the cause of development in Africa and elsewhere. The paper proceeds from introduction to other sections including literature review, theoretical framework, methodology, and finding. A suitable conclusion is then advanced.

AN OVERVIEW OF LITERATURE REVIEW

Available studies on the subject matter of this paper are reviewed under the following headings: digital revolution, digitisation, indigenous knowledge, natural resources management and theoretical framework. The review reveals the widespread influence of digital revolution and its implications for societal development. It also depicts a dearth of research on digitisation of indigenous knowledge in relation to natural resources management. As shown by Bisong and Andrew-Essien (2010), many academics and development professionals are yet to appreciate the value of indigenous knowledge as a valid mode of learning, research and application for sustainable

development and socio-economic transformation of society. Consistent with this situation, Were (2011) expressed the need to promote Africans' indigenous knowledge across the world. It is believed that the need could be met through innovation and development of knowledge networks. An understanding of digitisation is relevant in this regard since it provides a basis for development of innovation in the preservation and propagation of indigenous knowledge, which can be used to promote effective management of natural resources. A discourse on digitisation therefore starts from a description of the digital revolution, which Markillie (2012) described as the third industrial revolution. The first industrial revolution, Markillie says, began with the mechanisation of the textile industry in Britain in the 18th century, while the second industrial revolution began with the assembly line and spread of mass production from America in the 20th century.

Digital revolution

The emergence of new technologies for rapid dissemination of knowledge is known as digital revolution, accompanying the development of science and technology since the wake of the Second World War (Hessels et al, 2009). Studies on this subject largely focus on the concept of knowledge society, which was first coined by Fritz Machlup in 1962 and then developed by Peter Drucker in 1968 (Maciel and Albagli, 2009). Subsequently, in the early 1970s, Daniel Bell observed the emergence of a post-industrial society, while Marc Uri Porat introduced the notion of the information society in 1976 (Maciel and Albagli, 2009). The information society has been described as a new model of development in the following words:

It followed the agricultural, scientific and industrial revolutions. The information society has developed into a global information society. [...] The basic characteristics of the society are powerfully developed sciences, information

technologies impacting on our lives, economic development and the production of knowledge. [...] Compared to the advantages we must take note of some disadvantages. First is the big gap in the applications of new information technologies between the developed and the underdeveloped countries. For example, the developed countries in the world own 85% of technology and information. Only 25% belongs to developing countries. (Vranesh et al, 2005: 101)

As a result of the digital divide, the world reflects the interest of two distinct groups, namely the generators and the users of new knowledge. Many countries are relegated to the role of users while a few countries, firms and institutions act as the main generators of new knowledge and innovations (Maciel and Albagli, 2009). Considering its history of dependency on western technology, Africa is in the group of the users of new knowledge.

In this context, digitisation of African indigenous knowledge has become increasingly necessary to prevent the erosion of our authentic African heritage. Such digitisation can be used to promote effective management of natural resources in Africa and elsewhere. In this way, the crisis of climate change can be confronted, particularly through the use of orthodox or alternative remedies.

DIGITISATION

Digitisation is defined in this paper as the codification of information or knowledge for specific purposes. It has been argued that all knowledge can be codified (Maciel and Albagli, 2009). Codified knowledge can be made globally available through digitisation. The concept of digitisation is connected with interest in the management of cultural heritage in the technological environment, although it remains in its early stage of development. Studies on digitisation of cultural heritage have been integrated into the curricula for Library

and Information Science (LIS) in Europe, particularly in the context of the Bologna process (Manžuch, Huvila and Aparac-Jelusic, 2005). The concept of digitisation has been recognised in memory institutions including museums, archives and libraries. Digitisation therefore constitutes a process by which knowledge can be preserved and propagated. For instance:

Learning and knowledge develop according to communication processes mediated by specific conceptual, cultural and institutional frameworks. [...] In this context, local learning capacity is strategic; it involves the construction of several types of knowledge, experiences, competencies and skills, and is not limited to access to information. (Maciel and Albagli, 2009: 102)

Research on digitisation has been based on two basic perspectives: a library-oriented approach and a cultural heritage oriented approach. The first perspective portrays digitisation in terms of the system of knowledge in relation to digital libraries, while the second perspective is primarily based on communication of memory. The above-mentioned perspectives on digitisation raise critical issues such as conversion, storage, protection and delivery of authentic metadata in the lifecycle of digital resources. In fact, digitisation is affected by other issues such as: concerns about ownership, poor storage, adulteration, inadequate infrastructure and profiteering (Adkins, 2010).

The issue of ownership is critical, as communities are being robbed of their heritage through conversion from artifacts to metadata. Markillie (2012) noted that digitisation will allow things to be made economically in much smaller numbers, more flexibly and with a much lower input of labour, as evidenced by the availability of new materials and completely new processes such as 3D printing, easy-to-use robots and new collaborative manufacturing services

available online. The wheel is almost coming full circle, turning away from mass manufacturing and towards much more individualised production. The digital technology can enable production of almost anything, anywhere – from America to an African village. With digitisation, everything can be processed via smarter software. The relevance of digitisation has been demonstrated in manufacturing and other industries that have gone digital, such as office equipment, telecoms, photography, music, publishing and films. It can empower small and medium-sized firms and individual entrepreneurs. The possibility of digitisation of indigenous knowledge is considered in the light of the above, especially with a focus on the need for effective management of natural resources.

INDIGENOUS KNOWLEDGE

As reported by Bisong and Andrew-Essien (2010), indigenous knowledge has been defined as community-based knowledge systems, which have developed since the inception of the community in question. The issue of indigenous knowledge has, however, been neglected in the discourse on knowledge management. The concept of knowledge management is relatively new; it gained widespread recognition as a striking feature of the information society since the 1990s (Widén-Wulff et al, 2005). Similarly, indigenous knowledge management has gained recognition worldwide, although it is less popular in literature. In her description of indigenous knowledge management, Hunter (2005: 113) submitted that:

Communities and organisations around the world are realising the value and significance of indigenous knowledge and the importance of preserving it for future generations. Indigenous Knowledge Centres (IKCs) are being established globally, but particularly in Australia, Africa, Latin America and Asia. The capture and preservation of indigenous knowledge is

being used to revitalise endangered cultures, improve the economic independence and sustainability of indigenous communities and to increase community-based involvement in planning and development.

Indigenous knowledge management refers to a process by which communities capture, control and share their ideas to meet specific local needs (Hunter, 2005). As indicated in a recent study by Finneti (2011), indigenous knowledge management includes traditional stories, songs, dances and ceremonies that reflect beliefs related to spirituality, family, land and social justice. It includes potentially patentable knowledge about traditional medicines, foods, farm practices, architecture and construction, handicrafts, artwork and folk music. It also includes knowledge about people, places, plants, animals, and historical events associated with a particular community. Essentially, indigenous knowledge management is embedded in cultures and depends on the understanding and use of local language (Akinwale, 2010).

The recent story of Chinua Achebe's disapproval of an attempt to alter his literature underscores the value of indigenous knowledge management. As reported in popular dailies, Achebe objected to the use of the title of his novel *Things Fall Apart* for a new film under production by Curtis Jackson, popularly known as "50 Cent" (The Punch, 2011). Jackson reportedly offered Achebe the sum of one million dollars (\$1,000,000) for the use of the title but he rejected the offer. Achebe's lawyer reportedly mentioned that the title would not be sold for even one *billion* dollars, stating that the book has remained invaluable to Africans since it was first published in 1958.

The relevance of indigenous knowledge for natural resources management has been well established in literature. Yet, such knowledge has not attracted adequate attention in the global race for

environmental protection. As observed by Brown (1996), hunters and gatherers were able to protect the natural environment through the use of their skills without exposing the ecosystems to dangers. The scales of human activities have, however, increased and thus affected the habitability of the earth. Overgrazing has led to degradation of rangeland in Africa, while air pollution and acid rain have contaminated forests in Europe. This situation calls for a dramatic shift in the existing perspectives and strategies being used for the management of natural resources. Knowledge of past and present innovations can be combined in this regard to ensure effective management of natural resources.

Natural resources management

The need for effective management of natural resources has been recognised by state and non-state actors in different parts of the world. Actions taken by government in various African countries include promulgation of environmental protection laws, establishment of forest reserves and monuments. The significance of natural resources management was demonstrated in the first scientific global stocktaking of the world's ecosystem services undertaken in 2005 by the UN Millennium Ecosystem Assessment (Folke et al., 2011).

In line with the directives of the United Nations, a number of state actors have established environmental protection agencies in order to ensure effective management of natural resources such as land, water and air. As reported by Folke et al (2011), the focus of governance is slowly moving from conventional, sector-based resource management to more integrated approaches for managing landscapes and seascapes and the ecosystem services that they generate. Other researchers equally observed that any ecosystem-based management operates in a global context and requires collaboration and collective action in much more complex

institutional settings than previously acknowledged in studies of local natural resource management institutions (Mahon et al., 2009; Galaz et al., 2008).

The UNESCO's Man and the Biosphere Program (MAB) links global environmental governance with place-based ecosystem management and spans local-regional, national, and international scales. The MAB programme was launched in 1970 to promote the importance of the relationship between people and the natural environment. The programme specifically focused on the need to promote sustainable development and conservation of biodiversity. From 1976 to the present, UNESCO has created up to 500 biosphere reserve sites in different countries, creating international networks of protected natural sites including Yellowstone National Park (in the United States), Uluru-Kata Tjuta National Park (in Australia), the Sundarbans (in India), Mount Kenya (in Kenya), and the Mount Olympus National Park in Greece.

The need for natural resources management has also been reinforced through the establishment of the World Heritage Sites by the World Heritage Committee, operating under UNESCO's directives since 1972. Available literature indicates that 182 countries have indicated support for the World Heritage Sites where a number of places of natural importance have been preserved. At least 800 World Heritage sites have been found in 138 countries. These include the Island of Goree in West Africa, indicating the locations from where the enslaved Africans were transferred to the Americas from the 17th to the 19th centuries. Apart from the above mentioned actions, it is important to note that:

A new research arena called Earth System Governance is developing focusing on the formal and informal rule systems, institutional architectures, agency beyond the state, and actor-networks at all levels of human society [...]

A key challenge yet to be realized in relation to Planetary Stewardship and Earth System Governance is to combine emergence of multi-lateral institutions and regime formation with mechanisms for incorporating biosphere understanding and capacity of responding to ecosystem dynamics into such efforts. This combination is particularly challenging as it includes elements of equity, legitimacy and self-determination of peoples. (Folke et al., 2011: 731)

Actions by the non-state actors include public and political awareness campaigns, voluntary monitoring schemes and informal pressure directed toward protection of natural environment. Loosely connected non-state actors operating in different countries have been able to complement the roles of states in the management of natural resources. Addressing climate change through forest plantations, for example, may replace ecosystems targeted by the U.N. Biodiversity Convention (Lambin & Meyfroidt, 2011). Following the launch of International Platform on Biodiversity and Ecosystem Services (IPBES), there has been an important opportunity to integrate knowledge systems, learning and policy support, on social–ecological interactions in relation to climate change and ecosystem dynamics. An observation of the array of actions taken to ensure effective management of natural resources suggests the relevance of a polycentric decision-making structure, which allows for testing of rules at different scales and aids resource users at multiple levels in the crafting of new institutions to cope with changing situations. This is based on recognition of the fact that meeting challenges requires transformations of world views, institutions, approaches, and methods (Folke et al., 2011).

Previous research by Folke et al (2011) focused on the necessity and challenge of reconnecting humanity to the biosphere. They argued that this is a fundamental prerequisite in the search for planetary opportunities that meet both global sustainability criteria

and human development needs. They equally discussed governance challenges of social–ecological systems from the local to the global, focusing on the challenges of reconnecting to the biosphere. At the core of the global sustainability challenge is extending the human favorability period of relative stability of the last 10,000 years that has allowed countless species to flourish (Steffen et al., 2011). As observed by Westley et al (2011), the challenge can be overcome through the ability to govern for persistence with change as well as transformations at local and regional scales. The present focus on digitisation of indigenous knowledge for natural resources management can be justified in the light of the foregoing.

Theoretical framework

The issue of digitisation of indigenous knowledge for natural resources management requires further explanation. Thus, this section presents the assumptions and implications of relevant theories, such as the Theory of Diffusion of Innovations and Afrikology. While the Theory of Diffusion of Innovations primarily applies to social change in western society, Afrikology is geared towards promoting the authenticity of African heritage. A combination of both theories is suitable for a better understanding of digitisation of indigenous knowledge for natural resources management in Africa.

Theory of Diffusion of Innovations

The Theory of Diffusion of Innovations was refined by Everett Rogers in 1962 based on his study of the propagation of hybrid corn among the Iowa farmers in the United States of America in the 1950s and 1960s (Minishi-Majanja and Kiplang'at, 2005). The theory dwells on the process of adoption of an innovation and how the adoption affects social change. Innovation refers to improvement on and creation of a new product or process for public consumption (Kvam and Stræte, 2010). As observed by Valkonen (1970: 165), “the diffusion of innovation is usually a part of the process of social change.” Various

stages of adoption of an innovation were mentioned by Minishi-Majanja and Kiplang'at (2005: 213) in the following order:

Potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reaffirm or reject) the decision to adopt the innovation.

As argued by Valkonen (1970), the process of adoption of an innovation by an individual requires three sub-processes, namely awareness, interest and adoption. Attention is given to divergence in people's reactions to the process of adoption, explaining differences in their levels of awareness, interest and actual adoption of innovations. Awareness of innovations depends on several factors including mass communication, observation of nature, work environment, social interaction and personal contacts. Also, interest in adoption of innovations depends on existing attitudes among the potential adopters. The forms and levels of education coupled with perceived relevance of innovations are relevant since they affect human behaviour. An illustration of the social context of the willingness or refusal to adopt an innovation is presented thus:

It is important to notice that the relative advantage of an innovation is very often different for different individuals. For example, a milking machine is very advantageous for people with many cows, less advantageous for people with one or two cows, and quite useless for people with no cows. (Valkonen, 1970: 169)

The above illustration exposes the scope of the theory, dwelling on why individuals may not be equally interested in adoption of innovation. As argued in the Theory of Diffusion of Innovations, the literates are more likely to adopt innovations compared to the illiterates. Similarly, Valkonen (1970: 167) asserts that: "those who are

likely to adopt innovations tend also to consume mass communication more than others". Conceivably, the actual adoption of innovations could be influenced by the difficulty of and cost of adoption. Knowledge, skills and abilities can also affect the actual adoption of innovations. From the canons of the Theory of Diffusion of Innovations, it is clear that digitisation of indigenous knowledge constitutes an innovation, which can be adopted on the basis of its relative advantage. However, contrary to the basic assumptions in the Theory of Diffusion of Innovations, corporate organisations, governments and NGOs usually take responsibilities for digitisation of indigenous knowledge. Another theory is required in this context to strengthen the Theory of Diffusion of Innovations, as summarised herewith:

Too much attention is paid to correlational relations between variables, at the expense of causal interpretations and propositions which are theoretically more important. [...] Instead of natural social systems, only segments of systems are studied. This makes it difficult to combine the results of diffusion research with theories of social change. (Valkonen, 1970: 177)

Based on the above mentioned issues, the Theory of Afrikology is equally adopted to strengthen the arguments on digitisation of indigenous knowledge for natural resources management, focusing on social change in African society. Both theories provide a basis for adequate explanation of adoption of innovations in an African context and elsewhere.

Afrikology

Afrikology is an all-inclusive epistemology of knowledge generation and application that has roots in African cosmology; it transcends

earlier perspectives on African development. This theory was propounded by Nabudere (2011) based on his recognition of the fact that mainstream scientific knowledge is unable to fully explain the crisis facing humanity. He therefore called for development of new knowledge that can be applied to contemporary needs, given the shortcomings of the old epistemologies of knowledge inherited from the Enlightenment. In his words:

The task of African scholars is to explore, trace and investigate the role ancient African knowledge systems contributed in laying the ground for the institutions of knowledge creation and their application to human needs throughout history. [...] This can help us to overcome the current malaise by creating a new 'synthesis' in which the original African contribution makes a further contribution based on new understandings, called 'Afrikology' (Nabudere, 2011: 2)

Afrikology seeks to initiate and promote a long-term solution to the African crisis through production of knowledge based on an African heritage. With its status as the cradle of humanity, Africa is reputed as the original source of knowledge; Greek philosophers including Thales, Pythagoras, Democritus, Plato and Aristotle were reported to have been educated in Egypt, where they were students and researchers. These Greek philosophers laid a foundation for the development of knowledge in Europe. Nabudere (2011) emphasised the continued relevance of Afrikology for the creation of a better society. A key focus in Afrikology is the need to establish a new science for generating and accessing knowledge for sustainable use. The need for digitisation of indigenous knowledge for natural resources management can be recognised in this context.

Digitisation is a relatively new science which can support integration of the traditional and modern systems of knowledge

creation and application. Ultimately, Africa's indigenous knowledge is collectively managed through oral traditions, encompassing various forms of knowledge about different aspects of the society. With digitisation, oral traditions and other forms of indigenous knowledge can be preserved and applied to meet the needs of contemporary societies. A description of the contemporary relevance of Africans' knowledge of divination is instructive here:

In African conditions, divination plays an important role even in contemporary conditions in the lives of the people, and is maintained within the memories of the practitioners as a coherent system of knowledge. The practices help to cure the sick, easing their anxieties and helping them to come to terms even with challenging circumstances posed by modernity. (Nabudere, 2011: 42)

Contrary to expectations, research on divination remains inadequate, while emic perspective is largely ignored in available studies on the subject. Following their studies on the manifestations of divination among Africans, Asians and American Indians, Winkleman and Peek (2004) argued that divination attracted limited scholarship. Thus, Africans' competence in divination is due for digitisation to promote its relevance in the contemporary society. The need for digitisation of indigenous knowledge has been clearly demonstrated in India through the establishment of Traditional Knowledge Digital Library (TKDL) in 2001 and National Biodiversity Act of 2002 (Thomas, 2010). The Indian TKDL has been promoted officially through agreements with international patent organisations such as the European Patent Office (EPO), the United Kingdom Trademark and Patent Office (UKTPO) and the United States Trademark and Patent Office (USTPO). The Indian experience implies the significance of digitisation in the preservation and propagation of indigenous knowledge for natural resources management. **Research methods**

Qualitative research design was adopted due to the nature of the issues under investigation. Apart from the use of relevant documents, several in-depth interviews were conducted to explain digitisation of indigenous knowledge and its implications for natural resources management in Africa. Both primary and secondary methods of data collection were used. The primary method of data collection was obtained through unstructured in-depth interviews with stakeholders in the Nigerian cultural industries including Centre for Black and African Arts and Civilisation (CBAAC), National Theatre, Nollywood, museums, and mass media. The choice of these areas is based on the fact that cultural industries worldwide have adapted to the digital revolution. Twelve participants were purposively selected based on their profession and involvement in the preservation and propagation of traditional cultures.

Specifically, a total of 12 in-depth interviews (eight for men and four for women) were conducted among different groups of participants such as artists, curators, community leaders, journalists, actors and directors. The interviews were conducted via telephone based on the need for instant connection with participants, who may have otherwise declined to participate in academic discussions due to their busy schedules. This approach was possible with the use of hitherto established social connections with the participants. The data from each interview were noted and recorded appropriately. Each interview session lasted for 60 minutes and was conducted between June and September 2011.

The length of each interview did not extend beyond 60 minutes since the interview was conducted via ICT (mobile phones) and the participants were experts on the issues addressed in the study. Some interviews were rescheduled due to network failure and agreements reached with participants. Call credit was exhausted and interview ended abruptly after two sessions. The discussions in each of the interview sessions were primarily based on digitisation of

indigenous knowledge and its implications for preservation and propagation of the knowledge for natural resources management. The list of the questions addressed in each interview is presented as follows:

1. What are the existing methods for preservation of indigenous knowledge?
2. How has indigenous knowledge enhanced or hindered natural resources management?
3. Can indigenous knowledge be propagated through digitisation?
4. How can digitisation of indigenous knowledge affect natural resources management in Africa?

The above questions were equally addressed though the secondary data obtained from electronic search of databases including SocINDEX, IK Notes, Computers and Applied Sciences Complete, Communication and Mass Media Complete, and Academic Source Complete. Each of these databases provides several thousands of relevant up-to-date documents. The outcomes of the search were scrutinized and due consideration was given to only documents that directly relate to the issues of digitisation, indigenous knowledge and natural resources management. Over 50 documents were downloaded and reviewed in this process, focusing on several cases of digitisation of indigenous knowledge and natural resources management in relation to African experience of digital revolution.

The data obtained from both primary and secondary sources was subjected to narrative and thematic content analysis, which provides a basis for description and interpretation of frames from data, theory and literature (Grbich, 2007). The data generated from in-depth interviews was transcribed, summarised and harmonised to indicate convergence or divergence of different frames associated with the subject matter under investigation. Based on participants'

responses to each question, the data was transcribed selectively consistent with the process of transcription, which Davidson (2009: 37-38) described thus:

In common are views of transcription as a process that is theoretical, selective, interpretive, and representational. [...] The process is a selective one whereby certain phenomena or features of talk and interaction are transcribed. [...] Because it is impossible to record all features of talk and interaction from recordings, all transcripts are selective in one way or another. Selectivity needs to be acknowledged and explained in relation to the goals of a study rather than taken to be unremarkable.

Original transcripts of the interview data were analysed to ensure authenticity of meaning. The data generated from secondary documents were equally summarised and analysed accordingly. The validity of data was established through cross-referencing of facts. This approach is in consonance with the conventional recognition of validity in research regardless of whether the research is quantitative, qualitative or combined (Lewis, 2009).

Findings and discussions

Findings and discussions presented in the next sections are based on a combination of data obtained from documents and in-depth interviews. It is clear that attention has been devoted to digitisation of indigenous knowledge in a number of countries. However, several issues about digitisation are yet to be adequately addressed in Africa given the interplay of social, economic, political and technological factors. African societies need to devote more attention to digitisation of their indigenous knowledge in order to promote effective management of natural resources.

Preservation of African indigenous knowledge

African indigenous knowledge has been preserved by traditional institutions and a number of cultural industries such as museums, mass media, and cinema. Oral tradition has been used as a key method of preservation of African indigenous knowledge for centuries. In his discourse on indigenous knowledge, the strengths and weaknesses of oral tradition were summarised by Carraway (2011: 9) as follows:

In the distant past all knowledge was memorized and passed from one generation to the next within an oral tradition. The continuity of knowledge could be broken by the simple death of the memory keeper before the information was passed onto the next generation. By its very nature, knowledge within the oral tradition would be of limited geographic expanse.

Apart from oral tradition, other methods such as drama and records have been used to preserve indigenous knowledge in Africa. As mentioned by members of the Nigerian Association of Theatre Arts Practitioners (NANTAP), theatre has contributed immensely towards the development of African indigenous knowledge. Concerning the use of digitisation as a resource for preservation of indigenous knowledge management, narratives from various discussants showed that the rate of digitisation of indigenous knowledge is low. In his response to the question about digitisation of indigenous knowledge, an informant from a national theatre passed the following comment:

I am not an expert on the issue of digitisation of indigenous knowledge but I can refer you to our staff in another department. He is in charge of the audio-visual and other technical matters. He is the appropriate person, who will tell you everything you need to know. (Male IDI, September 2011)

Based on awareness of digitisation of indigenous knowledge, the informants from private organisations were more expressive than those from the public sector. All the informants from the mass media mentioned several instances of digitisation of indigenous knowledge, citing television programmes such as African Cuisine, Back to the Roots, Travel Guides and a number of festivals – Argungu, Osun, Ofala, Eyo, etc. – that have been recorded on videotape for wider circulation. Another informant mentioned that:

We have embarked on a project that will eventually lead to digitisation of cultures. We have started with FESTAC 77. Some cultural issues have been selected. We have artifacts, dances, and other cultural symbols. [...] Yes, the project has been in progress since the past several years. It is not easy to convert cultural symbols into digital technology. It takes time. But our major challenge is lack of funding. [...] We pay in dollars. About \$15,000.00 is required to produce a tape, which can play for up to two hours only. (Male IDI, September 2011)

FESTAC 77 is an acronym for the second Festival of the World Black and African Arts and Culture, which was organised by the Nigerian Government in 1977. FESTAC historically emerged in 1956; it was endorsed in France by the Pan African Cultural Society, which resolved to propagate the values and originality of the Black and African Arts and cultures. The first FESTAC was celebrated in Senegal and it lasted for two weeks. The second and latest FESTAC 77 was celebrated in Lagos, Nigeria, in 1977; focusing on the need to document the authentic records of Africa and peoples of African descent throughout the world. Its objective was achieved through a colloquium, which was divided into ten groups dealing with different aspects of African indigenous knowledge such as follows: Black Civilisation and Arts, Philosophy, Literature, African Languages, Historical Awareness, Pedagogy, Religion, Science and Technology.

Propagation of African indigenous knowledge

A number of social institutions are responsible for the propagation of African indigenous knowledge; these include the family, the school, religious organisations and the mass media. The role of the mass media is very critical in this regard, especially through its primary functions such as information, education and entertainment. They also expressed concerns for the changing nature of the society, indicating the need to promote digitisation of African indigenous knowledge. A journalist recalled that many cultural symbols had been converted into PDF and stored in the central server for interested readers, pointing to the fact that several cases of African indigenous knowledge can be downloaded online. The journalist gave an instance of his experience in the process of digitisation of indigenous knowledge as follows:

There was a time I went to Iragbiji to cover an event, which is a festival. That was in 2009 and everything I covered in the events was processed, published and eventually stored in the central server for online viewing. Copies were sent to the people in Iragbiji. Later, they invited us again because they know that we are helping them to promote their culture.

From the perspectives of the informants from the Nigerian film industry, everybody is now expected to be abreast of the rapid change in technology. It was mentioned that directors and film producers cannot continue to rely on old tactics in film production due to the dawn of a new era in which everything has changed (Kalu, 2010). It was noted that the change in technology is a welcome development, as it adds colour to the works of artists. A few informants, however, remarked that a lot of practitioners in the Nigerian film industry are still living in the past, claiming that it is important for all Africans to come to terms with the new technology so as not to miss the opportunities that are now available in that

channel. Similarly, Bisong and Andrew-Essien (2010) observed that an interaction could occur between the pre-existing knowledge and the new information and communication technology (ICT) when it is interpreted. Further illustration regarding the propagation of indigenous knowledge was provided by an informant as follows:

Our museum is very busy. A lot of people come here daily and weekly. There is no day that we do not receive students, starting from those in kindergarten and primary schools to students from secondary schools and tertiary institutions. A lot of students from tertiary institutions usually come for research purposes. Many of the students at lower levels are more interested in the museum for recreation. We receive an average of three schools daily. Researchers come here daily for one study or another. (Male IDI, September 2011)

Surprisingly, a lot of studies at primary, secondary and tertiary educational institutions does not reflect African reality and are yet to be used for developmental policy formulation. Nwagwu and Iheanetu (2011) observed that policymakers in Nigeria have not been able to adequately access valuable information—theses, dissertations, reports, and abstracts—in research institutes and universities. The Nigerian experience is similar to the situation in several African countries given Were's (2011) observation that universities that generate most of the research information are still operating on outdated policies of closed access. Many useful publications such as theses, dissertations, and other research reports are under closed access and in manual form.

African experience of digitisation of indigenous knowledge

Cases of digitisation of indigenous knowledge have been recorded in several African societies including Kenya, South Africa, Mozambique,

Nigeria and Egypt. With the assistance of the World Intellectual Property Organisation (WIPO), some cultural traditions of the Massai community of Laikipia, Kenya, were designed for digitisation in 2006 (Wendland and Van-Weelde, 2008). The Kenya case occurred in the light of a WIPO expert mission to the Massai community followed by establishment of a pilot training programme, as part of the WIPO's creative heritage project aimed at empowering indigenous communities to make informed decisions about documentation of their cultural heritage. Members of the Massai community, with an expert from the National Museum of Kenya, travelled for training at the American Folklife Centre and the Centre for Documentary Studies in the United States. The WIPO then provided necessary materials to promote digitisation of indigenous knowledge management in Kenya; the materials include a basic kit for field equipment, computers and software (Wendland and Van-Weelde, 2008). Based on the WIPO's training programmes, digital cultural products that could be produced include videos, tapes, digital photography and discs. While images can be converted into digital photography, dances and songs can be converted into videos and discs.

Apart from the Kenyan experience, community mapping projects have been undertaken in southern Africa, particularly in Mozambique where the technologies and methods used by indigenous communities have advanced from basic compass and tape with hand-plotted maps to modern-sophisticated GPS mapping and the use of portable digital assistants (PDAs), digital cameras and GIS software to produce community maps (Hunter, 2005).

A number of organisations have indicated interest in promoting digitisation of indigenous knowledge in South Africa. For instance, Google has offered to digitize all Mandela-related records including an account of his imprisonment for 27 years (Adkins, 2010). Also, the University of Michigan has offered to provide support for effective management of 'born-digital' records of proceedings of the

Truth and Reconciliation Commission. Moreover, the South African Apartheid Museum, established in 2001, accommodates several digital records.

Indigenous perspectives on Natural Resource management

All the participants expressed their awareness of indigenous approaches to natural resources management and they mentioned a diversity of customary practices such as religion, taboos, mores, and caution in human interaction with the natural environment. Consistent with the views expressed by the participants, the accumulated knowledge from archaeological studies confirms the existence of a wealth of experience from indigenous knowledge in connection with the local infrastructure of natural resources management for socio-economic development of society. An illustration of the indigenous approach to effective management of natural resources was given by Ogundiran (2005: 159) as follows:

Rather than being mere farmers, the stone-tool users of the last two millennia B.C. were hunters and fishers, who practiced strategic foraging as their modern descendants still do, especially in rural hinterlands. They also raised cattle, sheep, and goats wherever the ecology permitted. The immense challenges involved in scheduling and coordinating these multiple food-sourcing activities in unpredictable environmental and climatic conditions testify to the ingenuity of the LSA populations in mastering not only the short- and long-term climatic patterns, but also in developing sophisticated understanding of the water-table levels, the use values of the surrounding fauna and flora, and in devising creative ways of combining sedentarism with mobility in order to cope with the changing environmental conditions. All these must have affected sensibilities about space, land, material property, and knowledge production among LSA communities.

The above excerpts reinforce the Folke, et al (2011) discovery that people and societies are integrated parts of the biosphere. It is noteworthy that societies are interconnected through the earth's biophysical life-support systems. Human action alters ecosystem support not only locally and regionally but also globally. In a globalized society, there are no ecosystems without people, who depend on ecosystem functioning. They are intertwined and thus, ecosystem services are generated by social-ecological systems. Social-ecological systems are dynamic and connected from the local to the global, in complex webs of interactions subject to gradual and abrupt changes.

But unfortunately, this all-important strategy for natural resources conservation and management based on these religious belief systems and socio-cultural practices have almost been completely eroded away by the acculturation and enculturation of almost all African communities by the coming of Christianity with their western type of education. This Christian way of religion, worship system and education saw nothing good in African traditional religious practices (Eneji et al., 2012: 34)

Closely related to the above is the fact that current perspectives and worldviews mentally disconnect human progress and economic growth from the biosphere, while people and nature are treated as two separate entities. Human actions are often viewed as external drivers of ecosystem dynamics. As a result, many of the serious, recurring problems in natural resource use and environmental management stem precisely from the lack of recognition that ecosystems and the social systems that use and depend on them are inextricably linked.

This situation suggests the need for a shift in perspective in attempts to ensure sustainable protection of the natural environment

and effective management of natural resources. The shift from people and nature as separated parts to interdependent social–ecological systems will provide exciting opportunities for societal development in tune with the biosphere; this is what Folke et al. (2011) called a global sustainability agenda for humanity, reflecting the Stockholm Memorandum signed by Nobel Laureates on May 18, 2011 at the conclusion of the Third Nobel Laureate Symposium on Global Sustainability, held in Stockholm, Sweden. The above-mentioned agenda stipulates that human development and progress must be reconnected to the capacity of the biosphere. Folke et al (2011: 727), however, observed that “the implications of a connected world where the economy and the biosphere are linked in complex ways have not been sufficiently addressed.” In recognition of continuity and change in indigenous socio-cultural practices and their implications for natural resources management, it is necessary to preserve the existing indigenous knowledge in digital forms.

CONCLUSION

The present article is based on the need for a digital revolution of African indigenous knowledge and its implications for effective management of natural resources. Without compromising the continued relevance of the traditional interpretation of cultures, digitisation of indigenous knowledge is required for the promotion of natural resources management in African societies. In the light of digitisation of indigenous knowledge, the younger generations of Africans can acquire authentic knowledge of their heritage from the older generations. Otherwise, the future generation may be deprived of the opportunity to acquire authentic knowledge of their pedigree. This situation can be addressed through digitisation aimed at bridging the existing generation gap.

Experience has shown that digitisation of indigenous knowledge is highly complex and that great caution and resources are

required to ensure its effectiveness. Based on the experience of digitisation of indigenous knowledge in several countries, the first steps in indigenous knowledge projects involve identifying the material to be preserved and then capturing it in a digital form so that it can be systematically documented (Hunter, 2005). The pressing problems against digitisation of African indigenous knowledge include inadequate funding, lack of technical know-how, and inadequate infrastructure. Therefore, there is a need to promote an integration of science and society. This can be articulated within existing public private partnerships and town-and-gown interaction. The need for adequate interest on the issue of digitisation of indigenous knowledge for natural resources management cannot be over-emphasised.

Governments and NGOs should primarily exhaust local ideas in proffering solutions to societal problems. Also, due consideration should be given to received knowledge in order to enhance the development of African indigenous knowledge. The question of ownership of indigenous knowledge should be clearly addressed through policies. Moreover, adequate interest in e-knowledge is urgently required in African society, especially in rural communities. Further research is therefore needed in the following areas: rural infrastructure, digital literacy, cyber-community, cybernetics, and alternative approaches to natural resources management.

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