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Advocating for Spatial Data Implementation at the Lower Tiers of Governments in Developing Countries: The Case of Africa

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Abstract This study focuses on the spatial data implementation in the developing countries, with specific interest in an African case. It advocates for the implementation of spatial data at the lower tiers of governments in the developing countries, the case of Africa. A subjective study of texts on regional spatial data implementation and web survey of geoportals of some twenty African countries form the basis for analysis and discussion. Studies on regional spatial data implementation showed that, most of them have standards and policy monitoring regional bodies while Africa has none. It was observed that out of the twenty countries surveyed, only five of them have functional geoportals through which spatial data can be easily and readily viewed and accessed, the rest are in one form of partnership/donor agreements. It was also observed that spatial data implementation at the national levels have not achieved much in terms of data production, exchange and sharing. This study believes that, as a result of these failures at the national levels, the advocacy for the implementation of spatial data at the lower tiers of governments would effectively enhance the production of spatial data applying the bottom-up approach as against the traditional top down-approach.

Keywords Advocating, Spatial Data, Implementation, Lower tiers

1. Introduction

1.1. Background

According to the current world population figure, 5.9 billion out of the 7.2 billion of the world population live in the developing countries, and this is expected to rise with time. Developing countries are countries whose human development index (HDI) is low compared to others, some define developing countries based on low gross domestic product (GDP) [24, 44]. From the statistics above, it is obvious that the global spatial data infrastructure pursuit would achieve its goal if spatial data (SD) is implemented at the lower tiers of governments in the developing countries, lower tiers of government in the context of this paper, are the federating states and the subsidiary of the states and may also be called national sub governments [21].

The joy of every country is to see her citizens engage in a productive economy, such productive economy can only come about through careful and well laid down plan. This plan would involve a mechanism for decision support and management through which information would be readily made available for the management of her natural and human resources through the provision of SD. SD has two components, the geometric representation of the real world and the characteristics or attributes of this georeferenced world [20], it provides the location, the extent, the use and temporal changes of our natural and artificial habitats. Most of the development plans in modern societies focus on planning at the lower levels of governance aimed at bringing the people closer to the government at a higher level.

Current trends in the developed world show a high level of SD availability and uses for decision support and management of resources, through the various national data clearinghouses, which is an electronic facility for viewing, archiving, transferring, searching, advertising and ordering of SD from various sources via the Internet [13].The emergence of the notion of the digital earth has also encouraged efforts in having a spatially enabled society, for instance in Europe, INSPIRE's directive on spatial data infrastructure (SDI) is being vigorously pursued with some countries like Canada and Australia providing free access to spatial data information for public participation. Research has shown that while the countries of Europe, America, Canada and Australia to mention a few, have maximized the use of SD as seen in the advances made in SDI, the developing countries, especially in Africa, are still struggling with establishing geographic information science (GI SC)

and Geographic information system (GIS) outfits, with no serious commitment from government and low public and private sector cooperation participation [7-46].

At the regional level in Africa, not much has been done in terms of the effectiveness of the SD and SDI; this is evidenced in the United Nations global geospatial information management (UNGGIM) annual report. In contrast to the developed countries report of successes and gains made in SD and SDI implementation and application, Africa is reporting failure and gains made in counterpart funding and efforts made in attracting donor agencies to assist in SDI realization [30, 45]. Thus, at the individual national levels only a few countries have made attempts, and with little or no success.

Europe and America's success story is not only in the provision of a framework for the exchange and sharing of data alone, but in the provision of standard SD that is usable and sharable. Fears have been expressed about the difficulties being experienced in the formation of national spatial data infrastructure (NSDI) and the national spatial data clearinghouses (NSDC) due to lack of manpower in geographic information science and GIS on which lays the foundation of SD [9, 10].

This paper advocates for the implementation of SD at the local levels of governance in developing countries, an African case, as a mitigation measure to curtail constant failures of SDI at the national levels.

2. The Problem

The issue of SD has become imperative for the attainment of modern, sustainable development through access to spatial information to cater for decision support making and planning needs of the society. The availability of spatial information is vital in the current dynamic world for information on land, economy, and security and for the mitigation of natural and artificial disasters to mention but a few, this information is needed for rapid response and mitigation measures against any unexpected demanding occurrence. SDI at the global, regional, and national levels have been talked about so much as vital for sustainable economic growth, butthe availability of SD is very vital for accessing the performance of an SDI [25, 39]. These SDIs are at different levels of development in the different regions and nations. In some quarters, fears have been expressed about SDI reaching a maturity stage of saturation where SD is collected when needed, and queried what the future holds for SDI [5-28], that is to say, others have achieved their projected aims, others have not. Those lagging behind are cheered to catch up. It is widely noted that a lot of problems exist with the implementation of SD at the national levels due to lack of awareness of the benefits of spatial data, political and economic factors, lack of the will and commitment from government at the national level and so on [27]. Most countries in Africa, operate the top-down approach to SDI and are at the preliminary stage of the first generation of SDI, that is the 'product' component aspect of SDI as against a bottom-up hierarchical approach that involves the production of more accurate fundamental datasets for the local, state and national level [29].

Thus, the advocacy for SD implementation at the local levels of governments is occasioned by the following;

- Failure of the national governments to properly coordinate NSDI that could touch the lower level governments, as observed in some countries paying lips service to NSDI.
- States and local governments in some countries are autonomous of the national government and handle issues of SD based on the peculiarity of their problems.
- Local level governments are in a better position to take inventory of their resources for planning and decision making geared towards self-sustainability.
- Training is required in GI SC and GIS which can be better coordinated at the lower or local levels.

This paper believes that the problem of failure in NSDI could be mitigated if the fundamental datasets, the driving engine for NSDI is tackled from the lower tiers of governments for effective peoples' cooperation and participation.

3. An Overview of Spatial Data Implementation

3.1. Global Spatial Data

SD implementation across the globe deals with implementing the respective regional and or national governments standards for spatial information production, presentation, storage, sharing and or exchange. These implementation processes are at different levels in different regions and or countries, depending on the available technologies and the needed financial resources. For those that have made tremendous progress in implementation due to these advantages, it is an era of taking a holistic approach at improving interoperability standards. Regions who still lag behind in SD production, presentation, storage, sharing and or exchange would need to retrace their steps and try to have a cursory look at what had been the impediment to SD implementation. Such countries fall in the developing economies like Africa.

3.2. Regional Spatial Data

Regional SD implementation encompasses the implementation of policies and standards that enhance rules and regulations involved in the SD availability and access. The various organs involved in the implementation of these standards do so through the establishment of regional and or national bodies whose responsibility is the maintenance of these standards for and on behalf of the entire geospatial

community that constitute the stakeholders.

In Europe, for instance, it is not possible to discuss SD implementation without involving the regional body, INSPIRE, Infrastructure for Spatial Information in Europe. Directive 2007/2/EC of the INSPIRE in 2007 is one of the implementation policies that provided the standards framework for the participating countries of Europe with regards to SD for various uses. This directive, concerns itself with policies relating to the impact of the kind of SD produced for the management of the environment. The benefit is to have SD that is interoperable, by combing interactive spatial datasets that are unambiguous for environmental monitoring and management [40, 43].INSPIRE directive 2012 has as its mandate the implementation of regulation 2009 (c) of the INSPIRE, which tries to modify the implementation of 2007/2/EC. The target is for public sector information orientation and general environmental protection reforms for the management and sustenance of SD for European Union environmental policy needs and the entire geospatial community. The INSPIRE SD implementation initiatives as laudable as it may look has its own peculiar challenges, Abugessaisa and Ostman in their study of the implementation of INSPIRE in Sweden expressed the difficulties encountered in transforming from one system to another, due to language and other cultural barriers [1]. As a result of the various problems of interoperability encountered, a mapping project, known as ATLAS of INSPIRE was launched to map out the challenges faced in the implementation of INSPIRE's standards in the participating European Union (EU) countries. In order to encourage the exchange and sharing of SD in a digital format, individual governments are encouraged to float online portals for viewing, accessing, exchange and sharing of spatial information from the metadata for public input and participation [16, 35]. The trends in the EU'S INSPIRE and the developed countries, so far, shows that SD availability is maturing to a critical stage of SD as at when you need them [6] towards the fulfilment of the notion of Al Gore's digital earth [11].

In the Asia, the Australian Consortium for the Spatial Information and Network Analysis (ACASIAN) handles the issue of spatial information monitoring and implementing standards for the region. ACASIAN, a former research based institute, in collaboration with individuals and other spatial information bodies like the Australia and New Zealand Information Council (ANZLIC) are involved in exploring opportunities for the enhancement of the SD base of the region [2]. The regional mandate of ACASIAN and ANZLIC is to promote SD production based on standard interoperability for information exchange and sharing through the provision of metadata on SD, viewed and accessed online for public participation and consumption. Availability of SD in Australia for instance can be accessed online through the available repositories with maximum ease [47], with spatial information report provided by the Australian Spatial Data Directory [38]. Studies have shown that the Japanese are involved in the Japanese-specific type of spatial information management through prototyping from other SD models [32]. In China, the peculiarity of the challenges posed by natural disasters and the need to have reliable SD for environmental monitoring has pressured the National Geomatics Center of China (NGCC) to adopt a provisional-municipal approach to spatial information [8]. As at 2011, there have been collaborative efforts by the Korea and the United Nations Information for Development (InforDev) for SD projects aimed at the harnessing of spatial information for decision making not only for Korea, but for the benefits of other geospatial information communities [15, 22]. Comparative studies about the viability of SD accessed from repositories also show Malaysia at the fore front of implementing SD policies and standards [19].

A critical review and observation of the SD implementation in the developed countries of Europe shows that its implementation is in line with the global spatial data infrastructure (GSDI) standard of having a spatially enabled society as a result of available technology and the needed expertise. In the Asia, it is a case of others cueing up to benefit from the advances made in spatial information by other regionally strong SDs. In order to advance the case of Africa, the study intends to carry out a web survey of the performance of some African countries based on their ability in developing online geoportals to show case their SD potentials.

3.3. Spatial Data Implementation in Africa

SD implementation in Africa can be largely classified as individualistic, in the sense that both the sub-regional and national governments approach the issue of SD from individual perspectives.

In order to discuss the implementation of SD in Africa the role of the sub-regional SD coordinating bodies must be highlighted. The formal quest for SD in Africa began with the efforts of the United Nations Economic Commission for Africa (UNECA). In 1972 the Regional Centre for Training in Aerospace Survey (RECTAS) under UNECA was established at Ile-Ife, in Nigeria for the purpose of training and consultancy services for SD production [37], it is an intergovernmental sub-regional body owned by some West African countries actively involved in spatial information sourcing for planning and management. A similar body was also established for the East and Southern Africa participating countries, the Regional Centre for Mapping of Resources for Development (RCMRD), it is a body with the mandate for the provision of an up-to-date SD to service Africa and the entire geospatial community, it also goes into a partnership agreement for and on behalf of the participating members [18, 36].

SD implementation factor, according to [10] is characterized by lack of adequate knowledge based foundation in geographic information science at the national, subnational levels and institutions in most African countries. It is worst affected by the fact that most African countries rely on donor agencies and external aids, amidst poor

economy [42]. Thus SD coordinating body for the entire Africa is absent although there has been efforts in trying to have a unified reference system, the African Reference Frame (AFREF) [23]. At the individual country's level, SD implementation is on course based on individual's policy on SD. South Africa for instance has functional geoportals for viewing and accessing SD, with a community based clearinghouse strategy for public input and participation [17].

In Nigeria, SD implementation was started by the federal government in 2003, with the launch of the Abuja Geographic Information System (AGIS) to cater for spatial information needs of the federal capital territory [4], this resulted in the 36 states establishing geographic information systems to cater for their respective SD needs. These various GIS outfits are currently at different levels of implementation aimed at having access to information on land and housing development [3]. Some researchers have blamed the national coordinating body, the National Space Research and development Agency (NASRDA), for spatial information failure in Nigeria, for the slow pace of SD implementation and coordination in the country. They attributed these failures to the system, the structure of governance and complexity of the Nigerian polity [33, 34].

SD implementation in many African countries is still faced with the challenges of lack of geographical information skills, misconception of the terms applied in SDI and GIS, ignorance about the benefits of spatial information and using models that are not specific to the project's needs [26-30]. Although SD implementation is extremely expensive for the poorest countries in Africa, running into millions of pounds [14]; the benefits derived from having reliable spatial information cannot be quantified. According to [7] financial independence plays important role in SD pursuit, these challenges, however, can be surmounted if handled properly using the bottom-up approach.

Table 1. Selected Countries in Africa

S/N	North Africa	Southern Africa	East Africa	West Africa
1	Egypt	South Africa	Kenya	Nigeria
2	Libya	Gabon	Ethiopia	Ghana
3	Morocco	Rwanda	Tanzania	Cote D'Ivoire
4	Algeria	Botswana	Uganda	Senegal
5	Tunisia	Zimbabwe	Somalia	Liberia

4. Methodology

In order to understand the critical issues of the advocacy, a random sample study of some selected countries in Africa was made to find out the level of implementation of their SD at the national level based on the provision of geoportals for viewing and accessing of SD. Although the selection method was random, it took into consideration some big names among the African countries. Five countries each was selected from the North, South, East and West of the continent (Table 1).

The online survey of these countries were done by typing 'country name geoportals' on the web and whether at random the geoportals of such country can easily and readily be accessed, for instance 'Botswana geoportals'. Aside from this, evidence of partnership and or collaboration with some foreign agencies was also looked into.

Data was also drawn from previous empirical studies on efforts made in promoting SD availability by the individual countries, either through spatial information science training by partner agencies or the establishment of geographic information science institutions.

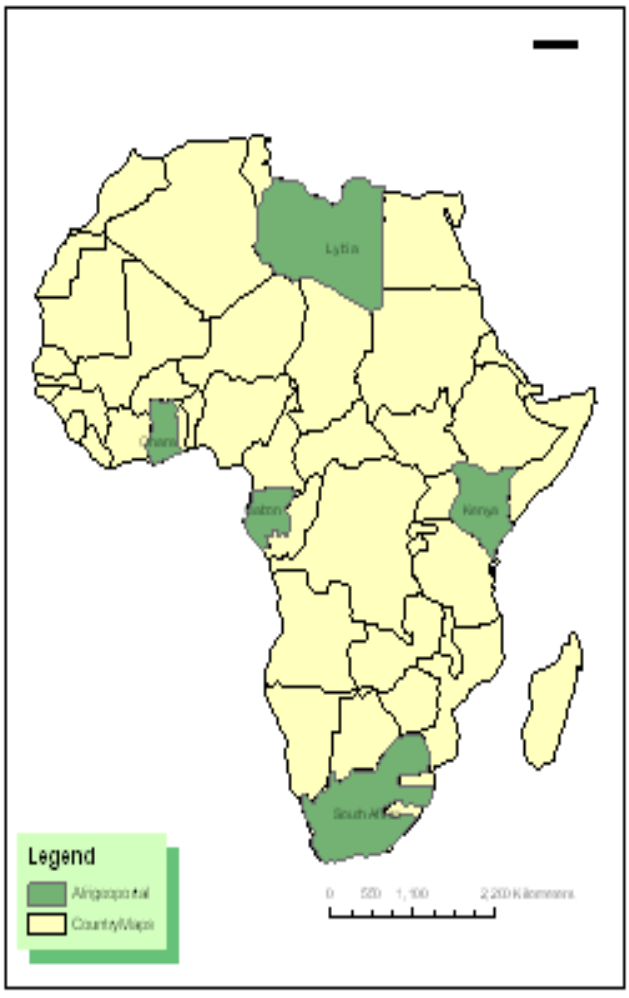

Figure 1. African Countries with Readily Accessible Geoportals

5. Results

The result of the web survey shows that of the twenty counties surveyed, five out of them have standing geoportals through which spatial information can be easily and readily accessed, with one country benefiting from United Nations

geoportals. These four countries are South Africa, Libya, Gabon and Ghana. Kenya benefits from the United Nations Environmental Programme (UNEP) geoportals, the GRID Africa geoportals (figure: 1).

Table 2. Result of the sampled countries

S/N	Country	Geoportals	Established Date	Services
1	South Africa	AISA	2001	General geospatial information
2	Gabon	Gabon geoportals (Sky to Earth)	2013	GIS, Remote Sensing, Cartography
3	Ghana	VBA geoportals	2010	General spatial information/training
4	Libya	Alkan CIT	2005	GIS and Telecom
5	Kenya	DEWA/GRID (UNEP owned)	Not certain	General environmental monitoring
6	Egypt	P	P	P
7	Morocco	x	x	x
8	Algeria	x	x	x
9	Tunisia	x	x	x
10	Rwanda	P	P	P
11	Botswana	x	x	x
12	Zimbabwe	P	P	P
13	Ethiopia	P	P	P
14	Tanzania	x	x	x
15	Uganda	x	x	x
16	Somalia	x	x	x
17	Nigeria	P	P	P
18	Cote D'Ivoire	x	x	x
19	Senegal	x	x	x
20	Liberia	x	x	x

P -Have initiated some form of training and partnership agreements on geoportals, but are not fully functional.

X- Are still at one form of coordination or have not started at all.

The web survey also revealed some efforts of collaboration between partnership agencies from Europe and the United States for floating geoportals for some countries, for instance the Federal Geographic Data Committee (FGAC) of the US has had geoportals metadata training for Ethiopia and Nigeria towards activating and establishing functional geoportals. Under this program the expansion and initialization of geoportals in Rwanda and Zimbabwe respectively is being done (P). Some of the other countries are in partnership with UNESCO or European Geoinformation service on how to start (X).

Previous studies also show that Africa's geographic information science education is not encouraging despite the high number of tertiary institutions in the region. The rankings of these institutions per country shows that South African institutions are higher in ranking in the top hundred (100), that is, when considering the total number of institutions in a country and their ranking among top 100 (Figure 2). Nigeria has the highest number of institutions, but in ranking can be compared to Algeria having almost the same top 100 ranking.

Previous independent research by Coetzee and Eksteen shows some disturbing finding on the participation of Africa's tertiary institutions on the teaching of some form of geographic information science courses in the various institutions across the region [10], which points to the extent to which they can actively participate in SD production and implementation (figure 3).

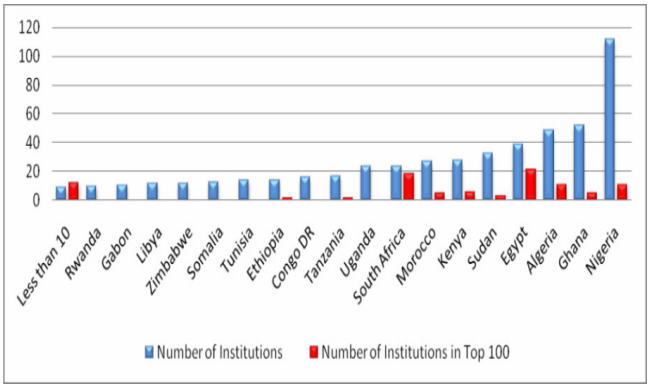

Figure 2. Number of Institutions and their rankings in Africa [10]

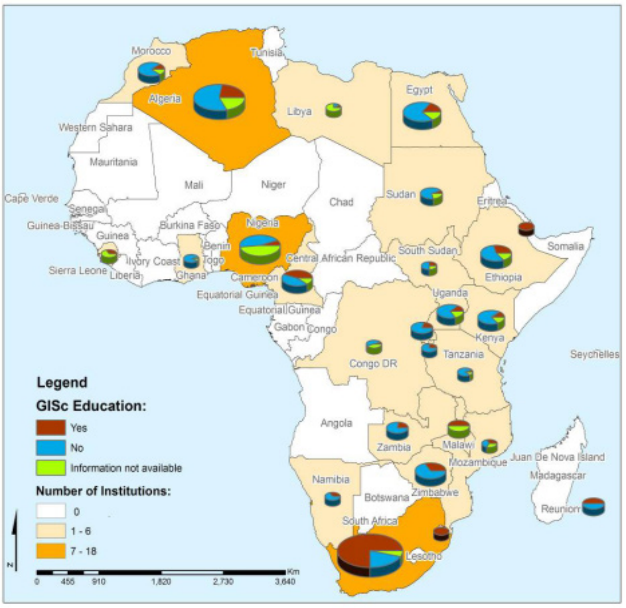

Figure 3. Tertiary institutions in Africa having some form of GISc education [10]

6. Discussions

6.1. The Necessity for the Advocacy

The reviewed texts and the web survey carried out have

shown that SD implementation quest at the national levels in Africa have not yielded the desired results, towards creating the necessary environment conducive for the exploitation and enhancement of spatial information. In the twenty (20) countries sampled, only five out of the lot can be said to have floated functional geoportals, where spatial information can be readily viewed and accessed online with ease.

Currently, there is no regional established body that is in charge of coordinating and monitoring of standards like the likes of INSPIRE for the African region, what we have are the sub-regional institutions who play different roles far from implementing a particular SD standard. On the average, not many countries in the continent have fully converted from the analogue format of SD to the digital format as revealed by empirical studies carried out, where data format and sharing is still at its lowest point [31]. In some cases, conversions have not started, except for some form of local volunteered geographic information (VGI) producing digital maps for research and academic purposes.

On the issue of the NSDI, there is evidence to show that most of the countries have established or at least are at the formation stage of establishing a NSDI, however apart from a few countries, most are still at the crawling stage.

The advocacy, therefore becomes necessary due to the fact that the NSDI have not yielded the much desired result as observed from the studies in developing countries especially Africa. Secondly, the top-down approach is gradually becoming a thing of the past, since improved web sensor GIS is fast adopting the bottom-up approach [41] which is VGI friendly. Thirdly, it encourages people's participation at the local-state level who understands their SD needs better.

6.2. Challenges of the Advocacy

Challenges faced in SD implementation globally are tasking, more so if it is the developing SDIs like Africa. The fact remains that African countries are not as developed as their counterparts taking into perspective the entire geospatial community; this in itself translates into technology incapability, one of the pressing problems of SD implementation. This could be a serious impeding factor to SD implementation in the available tools for mining spatial information, this also brings to bear the financial capability of the country or organization that intend to invest in spatial information. In some cases, where there are no financial constraints, political and or social awareness may be lacking, this often happen when inept leaders are in leadership positions. Aside from the above mentioned factors, there is also the problem of available manpower and training for SD users and producers. This notwithstanding, the expected derived benefits surpass the challenges attached to it.

6.3. Prospects of the Advocacy

Current trends in spatial information issues have shown that the geospatial community is beginning to appreciate the bottom-up approach to the traditional top-down approach to propagating spatial information. This move is occasioned by the slow pace and rigorous processes of the top-down approach, where governments at the national levels are in charge of formulating guidelines for SD standards and production, thus, neglecting the bulk of the participants at the local-state levels. The wind of change across the geospatial community and the high demand for spatial information for planning and decision making for the management of spatial information on a regular basis, especially in environmental monitoring have forced this rethink for the bottom-up approach. Most important too is the emerging era of VGI where geoinformatics specialists produce geographic data for stakeholders and users. This advocacy will enhance the production of SD at the local tiers of governments, since the phenomenon being investigated for which spatial information is required can easily be handled by the affected geospatial community.

7. Conclusions

SD implementation successes worldwide follow an inherent pattern that is synonymous to the level of modern spatial technology and the ease and access to modern information communication technology. For the developing countries, especially in Africa, SD implementation has long been at its ebb. This study highlights on the SD implementation at the lower tiers of governments in developing countries, the African case. A systematic study of SD implementation in other regions with respect to Africa were carried out and subjected to analytical review. A web survey of African countries was carried out for their spatial enablement, through the online geoportals. Among the twenty countries sampled, only five of the countries had functional geoportals through which spatial information can readily and easily be viewed and accessed. A subjective analysis of the implementation of the NSDI shows that most of the countries in the region lack the technology, the expertise, the political leadership and will to vigorously pursue NSDI at the national levels. The case for advocating SD implementation at the lower tiers of governments arose due to these failures and partly due to the current trends of the volunteered geographic information (VGI) which hitherto had been suppressed in most cases by the guide lines or rules operated as a result of the top-down approach to spatial information. The peculiarity of SD needed for planning and decision making can adequately be understood and addressed by the demanding society or local-state governments. This study believes, this advocacy would enhance SD production and sharing for the local-state and national needs for the much desired NSDI.

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