

Geospatial Data Sharing Barriers across Organisations and the Possible Solution for Ethiopia*

Habtamu Sewnet Gelagay

Spatial Data Infrastructure Program (SDIP), Information Network Security Agency (INSA) of Ethiopia, habtamu103@yahoo.com

Abstract

Geospatial data sharing across organisations is a well-recognized challenge with multiple facets. Due to the absence of appropriate space for the sharing of and access to geospatial assets, these often remain scattered and locked within various economic sectors of Ethiopia; this means that datasets are not maintained or updated regularly, efforts are duplicated, finding available datasets is difficult and there is no single reliable version of the data. Exploitation of the full socio-economic benefits of using geospatial information is therefore impossible. This paper therefore aims to assess inter-organisational geospatial data-sharing challenges and the possible solutions within Ethiopia. A lack of coordination between organisations, poor data quality and compatibility, institutional, legal, policy, and technological issues are identified as major challenges. Ethiopian National Spatial Data Infrastructure (ENSDI), which has already been introduced, should be further promoted as the collaborative entity for effective cross-sectoral geospatial data sharing. A national strategy to hand over informal SDI initiatives, building on existing efforts, setting clear (top-down) ENSDI development approaches and collaborative investments in the building blocks of ENSDI are suggested to enable the successful execution of ENSDI as a cross-sectoral geospatial data-sharing mechanism.

Keywords: Geospatial data, Geospatial data sharing barriers, SDI, Ethiopia

*This work is licensed under the Creative Commons Attribution-Non commercial Works 3.0 License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-nd/3.0/> or send a letter to Creative Commons, 543 Howard Street, 5th Floor, San Francisco, California, 94105, USA.

1. INTRODUCTION

The geospatial community needs an appropriate space to share and access geospatial assets in order to be able to fully exploit their socio-economic benefits, since meeting users' needs within the geospatial community is beyond the ability of single organisation (Rajabifard et al., 2005). Geospatial data-sharing between organisations is a well-recognised challenge (Ali and Ahmed, 2013), and the role of geospatial information in support of the economy, improvements to the effectiveness of various business sectors and efficient decision-making are all still limited by the absence of geospatial data-sharing mechanisms across various sectors of the economy (Pinto and Onsurd, 1995; Østensen, 2001; Elwood, 2007; Felicia and Ernest, 2011).

Geospatial data sharing between two or more organisations can take many forms, from sharing metadata via single data layers to sharing complete datasets (Geoconnection, 2011a). In either case, the sharing of the most current and relevant geospatial data facilitates economic improvements, empowers people in general and establishes win-win situations for all actors within the geospatial data-sharing process (such as spatial data providers, service providers and final customers) (Felicia and Ernest, 2011). Data sharing avoids the duplication of efforts in data collection, curtailing the waste of resources; it also improves data quality, since data is vetted, corrected and improved by the users, increases the number of complementary data resources that may support sectors' missions, ensures that data are created once, maintained regularly, and used many times, and enables organisations to be respected as valued data producers (Nap, 2002).

However, geospatial data sharing faces a set of high-level challenges: (1) data are scattered and locked within their respective sectors; (2) efforts are duplicated within geospatial data acquisition; (3) data are not updated and maintained regularly; (4) finding available data is relatively difficult; and (5) organisations are not capable of meeting their geospatial data requirements alone (Pierre, undated; INSA,2015). Even when willing to share their data, organisations often encounter difficulties (Geoconnections, 2011a). It is far easier to advocate than to practise geospatial data sharing (Azad and Wiggins, 1995).

These challenges in geospatial data sharing are also common within Ethiopia. A large pool of geospatial data are scattered across several ministries, local agencies, research institutes and universities, and there is no central repository for access to such data (Musinguze et al., 2004). UN-DESA (2011) also claimed that the large pool of spatial data and information housed in various partner institutions

in the water sector were not being shared; since there is no central organisation responsible for data management for the sector as a whole, each partner organisation is not aware of who is doing what and where.

The particular barriers that make sectors reluctant to share geospatial data within Ethiopia still need to be better understood. Solutions for overcoming the existing barriers and establishing sound geospatial data-sharing mechanisms are yet to be identified. This paper therefore aims to review inter-organisational geospatial data-sharing challenges in Ethiopia and to suggest possible solutions.

2. GEOSPATIAL DATA-SHARING CHALLENGES ACROSS SECTORS IN ETHIOPIA

Although barriers to geospatial information-sharing have some commonalities, they differ between developing and developed countries (Ali and Ahmed, 2013). Data quality, access and legal issues are identified as barriers to geospatial data-sharing in the study conducted by the Canadian Geospatial Data Infrastructure (CGDI) (Geo Connections, 2011a). Unlike the case of Canada, the unavailability of digital datasets, the non-existence of infrastructure, the absence of skilled human resources and a lack of funding impedes geospatial data sharing in Uganda (GIC/ESRI Canada, 2011). Similarly, the absence of a national spatial data and sharing policy, data incompatibility, the security of data (implying misuse), data quality, and the absence of an organisational sharing culture are well-recognized inhibitors of geospatial data sharing in Rwanda (Felicia and Ernest, 2011). Based on a review of these and other resources available nationally, a lack of coordination between organisations, poor data quality and compatibility, policies and institutional, legal, and technological issues are identified by this study as the principal challenges to geospatial data sharing between sectors in Ethiopia.

2.1 Lack of Coordination between Sectors

Various organisations in Ethiopia are engaged in collecting the same geospatial data at the same or at different times, without coordination (UNECA, 2001). A lack of coordination in information sharing and a lack of networking between sectors have been clearly observed in the water sector of the country, and this has become an expensive venture for the sector. Under examination here is the agreement signed by various partner institutions to use the Ethiopian Natural Resource and Environmental Metadata base (ENRAMED), a metadata information base. Partner institutions agreed to contribute to the database and to share information; however, the network failed, and member institutions were unable to share information or to run the web-based metadata system (UN-DESA, 2011). Various organisational activities necessary for the metadata sets within the respective institutions were

allowed to stagnate, and instead, various activities were run in parallel by institutions outside of the Ministry of Water and Energy (the host organisation). The problems of coordination and duplication of effort were not only observed between sectors, but also within sectors.

This lack of coordination so that a duplication of effort identified between the different directorates and departments within the Ministry of Water and Energy (MoW and UN-DESA, 2008) was a typical manifestation. Stakeholders' survey on spatial data holding by Information Network Security Agency (INSA) since 2009 confirmed that duplication of effort is common in geospatial data production, processing and even in the purchasing of commercial geospatial datasets, due to poor communication between sectors in Ethiopia. One typical example was the buying of satellite images costing US\$3.2 million by the Central Statistical Agency (CSA) for the 2007 census (INSA, 2014); this dataset is still withheld by the CSA, and has never been shared with other sectors in Ethiopia due to an absence of cooperation. The primary issues here are: 1) other sectors were not aware of the available data, and were perhaps forced to purchase the same type of spatial dataset (in this case satellite images) and to invest in spatial data handling themselves; 2) the CSA will continue to purchase these satellite images every 10 years to meet its organisational demand (the population and housing census). This implies that spatial datasets are purchased many times (threatening the national economy) but used only once, which is the reverse of the "produce once and use many times" principle of SDI. Figure 1 (below) also clearly highlights the duplication of effort by the CSA and the Ministry of Environment, Forest, and Climate Change (MoEFCC) due to a lack of cooperation between these two sectors.

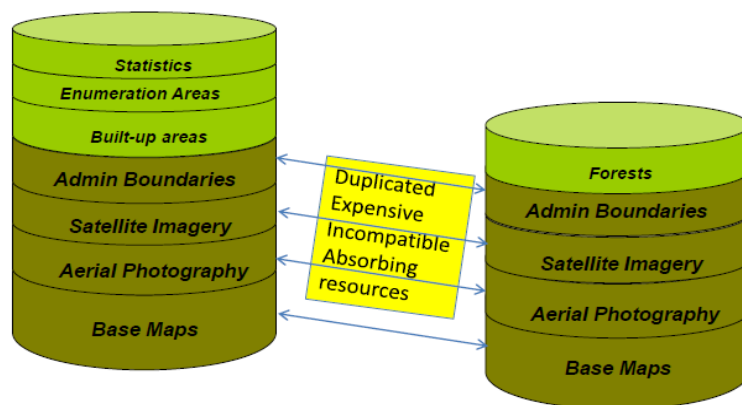


Figure 1. Duplication of effort and information silos within various sectors of Ethiopia: the case of Ministry of Environment Forest and Climate Change, and the Central Statistical Agency (INSA, 2015)

Data and information are therefore not shared between partners; instead, they are locked by individual institutions. The network supported by the Ethiopian Mapping Agency (EMA) for sharing and making accessible 1:250,000 scale topographical maps (Assefa and Haile Mariam, 2013) also failed due to an absence of inter-sector cooperation. Poor coordination between federal and regional institutions in data-sharing and provisioning services has also delayed the development of ENSDI, as shown by Gemedda (2012).

The reasons for this reluctance to cooperate and to share geospatial data were identified as a fear of loss of control of the shared data; a fear of misuse of shared data (data used for the wrong purpose without appropriate control); a fear of loss of funds (an absence of pricing policy); and concerns over quality and accuracy (NSGIC, 2011; INSA, 2015). This in turn implies the absence of a legal framework specifically relevant to the geospatial industry. Consequently, due to the fractured nature of geospatial data production, organisations in Ethiopia experience problems in realising the benefit of geospatial data sharing (Assefa and Hailemariam, 2013; INSA, 2015).

2.2 Technological Barriers

UN-DESA (2011) showed that effective applications and services that can foster geospatial data sharing and access are affected by the speed of internet connections. Geospatial data sharing between organisations is hindered by a weak network capacity for obtaining data online, networking costs (server, software, operating system and internet costs), incompatible and outdated systems, the predominance of vendor-driven GIS systems, the absence of an organised geo-portal (sound system architecture) and interface standards (lack of system interoperability) (Niles and Hanson, 2003; Onsrud, 2007; Edemba, 2012).

Similarly, INSA (2015) identified that the absence of internet availability, connectivity speeds and access mechanisms hamper geospatial data sharing between sectors in Ethiopia. A poor penetration rate (3%, which is lower than Africa's average of 4.3% and much lower than the world average of 23% (IDI, 2009)) and the average 3.96Mbps downloading and 5.65Mbps uploading rates of the current internet provision in the country reduce system performance¹. This therefore impedes web-based inter-organisational geospatial data sharing. The immaturity of e-commerce and bandwidth requirements and the absence of advanced file compression technology limit the publication and sharing of geospatial data (and particularly image data) through the internet (Nap, 2002;

¹ <http://www.dospeedtest.com/speedtest-result/country-statistics/Ethiopia>

Assefa and Hailemariam, 2013). There is no functional metadata cataloguing service within any governmental organisation of Ethiopia (INSA, 2009). The African Environmental Information Network (AEIN) stated that partner organisations of the Ethio-EIN initiative were experiencing challenges in sharing their datasets due to the absence of automated databases, online access systems and a lack of technologically equipped manpower in the areas of GIS, ICT, database administration, network administration and website development. Poor telecommunication infrastructure also limits the use of electronic media as a way of sharing environmental datasets within the Ethio-EIN institutions. The United Nations Economic Commission for Africa (UNECA) hosted the node for Ethio-EIN partner institutions, due to a lack of their own infrastructure (AEIN, undated). A lack of efficient telecommunication (ICT) infrastructure, poor computer networks and internet bandwidth and the absence of skilled manpower in the field of GIS are the potential barriers to inter-organisational geospatial data access (Musinguz et al., 2004). A study carried out by Gemedo (2012) assessing Ethiopian Spatial Data Infrastructure (ENSDI) development was based on the 16 SDI readiness indicators of political vision regarding SDI, leadership (institutional and individual), umbrella legal agreements, availability of digital datasets, human capital, SDI culture, web connectivity, telecommunication infrastructure, availability of geospatial software, open source culture, government central funding, returns on investment, private sector activity and own geo-informatics development; this study confirmed that the SDI readiness of the country is relatively low (on average 39%), due to the poor technological development of web connectivity and telecommunication infrastructure, which could provide a National Spatial Data Infrastructure (NSDI).

2.3 Poor Data Quality and Compatibility

The collection, distribution and web-based sharing of geospatial data between organisations is also impeded by a lack of application-independent standards (geometry, topology, metadata), a lack of information technology-based standards (query language, syntax, and description) (Nap, 2002) and of poor geometric representation, and the absence of common database designs and semantic heterogeneity (Barry, 2010). Inconsistent data standards or a complete absence of such standards, and incompatible or poor data quality hamper inter-organisational geospatial data sharing (Felicia and Ernest, 2011; Geoconnection, 2012). Geospatial data sharing between organisations is further obstructed by semantic differences between datasets with different definitions of features, and different models, quality specifications, datum, projections and coordinate systems (Nedovic-Budic and Pinto, 2000; Onsrud, 2007; Sebake and Coetzee, 2008), differences in project-specific data organisation (and an absence of common data classification schemes) and different data formats (Sieber, 2007). Likewise,

Sebake and Coetzee (2008) have identified that the issues of the accuracy and reliability of spatial datasets also affect an organisation's willingness to share geospatial data.

The geospatial data in many sectors in Ethiopia lacks quality, compatibility and interoperability due to the complete absence of geospatial data standards (for data and metadata) and geospatial product specification standards within the country (INSA, 2014). Zeleke et al. (2007) argued that the Ethiopian Spatial Data Infrastructure (aimed at facilitating geospatial data sharing between sectors in Ethiopia) failed in its development due to poorly organised and outdated geospatial data. Eelderink (2008) found that the impossibilities of inter- and intra-organisational geospatial data sharing in Ethiopia were due to the limited availability of digital datasets; furthermore, even the limited available digital datasets were not regularly maintained. A lack of documentation of the available datasets is another bottleneck for the sharing of geospatial data by the various sectors in Ethiopia. Due to the absence of a single reliable version, data are copied and spread across individual organisations. In particular, the absence of metadata (that is, insufficient data documentation) inhibits geospatial data sharing, since this fully describes the data's intended purpose, completeness, accuracy, resolution, limitations on use and type of data format (Ethio-GIS, 2007). Gemedda (2012) identifies a lack of digital spatial data, and the absence of regular maintenance and spatial data quality procedures as the principal problems with regard to the sharing of data and metadata by Ethiopian sectors in a networked environment. The Information Network Security Agency of Ethiopia conducted a stakeholder survey on the status of spatial data holding in order to develop a geospatial data and technology policy; this confirmed that none of the Ethiopian sectors keep metadata for their spatial data holdings. The African Environmental Information Network (AEIN) has stated that attaining the objectives of Ethio-EIN is difficult due to the absence of well-organised environmental data; non-standard, incompatible and out-dated environmental data; and the prevalence of hardcopy data which is difficult to share, integrate and disseminate in most of the member institutions (AEIN, undated). Krauer and Gete (2015) also argued that the project planning and impact assessment efforts which form part of the growth and transformation plan (GTP) of the country are now suffering from the lack of reliable national spatial datasets, the absence of standards for SDI and non-existent or contradictory administrative boundaries.

As stated by Gemedda (2012) and Krauer and Gete (2015), the availability of digital datasets is the primary issue in the country, so that users of geographic information have low expectations for the quality and compatibility of data, and are therefore content with any available data, regardless of its quality.

2.4 Policy Barriers

The absence of a national spatial data-sharing and access policy inhibits geospatial data sharing (Felicia and Ernest, 2011). In some cases, policies explicitly discourage data sharing due to concerns over the inability to prevent data misuse or liability claims, uncertainty about the accuracy or fitness for use of data, and revenue generation requirements. In other instances, the lack of a policy becomes an issue when organisational members are unclear about the data policy and are fearful of making a mistake, when they are unsure of the intellectual property implications or do not have access to tools to facilitate effective data sharing. As a result, organisations often err on the side of data protection, and withhold their data (Geoconnections, 2011a; INSA, 2015). The African Environmental Information Network (AEIN) has argued that the absence of an environmental information data access policy is a bottleneck for the successful achievement of the goal of Ethio-EIN to facilitate the sharing and development of environmental information within member institutions in the country (AEIN, undated). Gemedda (2012) found that the absence of an environmental dataset access policy was a barrier to inter-organisational geospatial data sharing through the network of the Ethiopian Spatial Data Infrastructure. Due to this absence of a geospatial data access policy, access to geospatial datasets in Ethiopia is entirely reliant on the goodwill of individuals (INSA, 2015).

2.5 Legislative Barriers

The lack of well-harmonised legislation for geospatial industries hampers information sharing within the wider geospatial market (Frank, 2001). The potential security risks of making data available, which involve misuse, a perceived liability from the use of open data and decisions based on inaccurate and unreliable data, hinder inter-organisational geospatial data sharing (Abidah et al., 2009; Barry, 2010). The absence of service charge legislation hampers web-based geospatial data sharing (Sebake and Coetzee, 2008).

Geospatial data sharing between sectors in Ethiopia suffers from the absence of a practical legal framework that would protect data providers and users from harms arising from data inaccuracy, violation of intellectual property rights (patent and copyright), custodianship, liability, data privacy and pricing related to geospatial data and technologies (Assefa and Hailemariam, 2013; INSA; 2015). The absence of legal frameworks for ownership, copyright and cost recovery issues hampers collaborative institutions in effectively sharing their data within Ethio-EIN as part of the African-EIN (AEIN, undated). The current intellectual property right (IPR) law in Ethiopia does not explicitly cover the ICT sectors (MCIT, 2105) or geospatial

technology and information (since the geospatial industry is dynamic in its nature) (INSA, 2015). Furthermore, the absence of a legal framework for geospatial data quality, accessibility, custodianship and liability means that organisations are reluctant to take part in networked environments which leverage geospatial data sharing.

2.6 Institutional Barriers

An institutional norm influences the willingness of individuals to share their data assets. A fear of releasing data of poor quality and previous difficult experiences of using data from others also mean that organisations are reluctant to share their geospatial assets. In addition, unequal commitments from organisations, conflicting priorities between institutions, institutional disincentives, differing perceptions of risk within institutions (Onsrud, 2007; Sebake and Coetzee, 2008), and an absence of an information-sharing culture (Felicia and Ernest, 2011) inhibit inter-organisational geospatial data sharing. As a result, institutions are over-protective of their data, keeping it from those outside of their respective organisations.

The absence of legalised and formal institutional arrangements in Ethiopia is another basic limitation on bringing together member institutions with a strong and full commitment in order to sustain their efforts to network and share their resources, and particularly their datasets (Gemed, 2012; AEIN, undated). A lack of an institutional budget, awareness and strong leadership are the major causes which have been identified for the failure of various initiatives and networks (including SDI) in Ethiopia (Lance, 2003). Eelderink et al. (2008) also found that institutional awareness of geospatial data sharing via the network of NSDI is relatively poor within the country. Weak institutional technological capacities and budgets for assisting automation mean that the sharing and accessibility of geospatial datasets across their borders is a common problem in Ethiopia. It is also uncommon to find institutions which fully understand that data is an asset which must be shared and made accessible (Gemed, 2012; INSA, 2015; MCIT, 2015). Institutions are also constrained by a lack of skilled manpower in the fields of ICT, GIS and remote sensing, since these are emerging areas of study (Gemed, 2012).

3. THE POSSIBLE SOLUTION

3.1 Cross-Sectoral Geospatial Data-Sharing Collaboration Through the Network of NSDI

The American National States Geographic Information Council (NSGIC) (2011) encourages governments at all levels to integrate and share geospatial data between and within organisations, both horizontally and vertically. Collaborating institutes (Spatial Data Infrastructure, SDI) principally facilitate geospatial data sharing between organisation (Groot and McLaughlin, 2000; Elwood, 2007; Ali and Ahmed 2014). Similarly, the Federal Geographic Data Committee (FGDC) stresses the significance of collaborative institutions in facilitating the access, use and sharing of geospatial data (FGDC, 2002). Many governments throughout the world, for example the governments of South Africa, Ghana, Canada, the United States of America, France, Germany, Netherlands, Argentina and England, have developed collaborative entities (SDIs) to encourage geospatial data sharing between organisations (Longley et al., 2001; Moeller, 2001). Sebake and Coetzee (2008) also recommend the implementation of data-sharing policies, the use of common standards, institutional policies, legislation and financial aspects of accessing data or pricing policies for the realisation of geospatial data sharing through an SDI. Geospatial data sharing between organisations in Armenia has succeeded due to collaboration between institutions, the use of international standards (ISO and OGC), geospatial data and associated metadata standards and the existence of geospatial data policies and legislation under the umbrella of the Armenian Environmental Spatial Data Infrastructure (Asmaryan, 2015).

The use of this collaborative geospatial data sharing entity (SDI) is therefore noteworthy as an umbrella for developing sound geospatial data policy and legislation, preparing and imposing standards and assuring the quality and compatibility of geospatial data between different sectors in Ethiopia. Of course, the SDI, as an inter-organisational geospatial data-sharing mechanism, is not a new concept in Ethiopia, and dates back to the establishment of Ethio-GIS in 1999. Various national and international NGOs, GOs, private sector entities and academia have therefore attempted to initiate formal and informal SDI initiatives in collaboration, in order to facilitate cross-sector geospatial data sharing (as briefly discussed in Sections 3.1.1 and 3.1.1.2 below). However, the development of SDI in Ethiopia is still under construction (Section 3.1.1). The current study therefore recommends the following as possible solutions for tackling the impediments to SDI development by inter-organisational geospatial data sharing: a clear national strategy for the handing-over of informal SDI initiatives and building on existing efforts (Section 3.1.1.2); that the ENSDI (top down) development approach be followed (Section 3.1.1.1); and that investment in the building blocks of ENSDI (policy, legal frameworks and standards, institutional and technological development) be carried out (Section 3.1.1.3).

3.1.1 The Ethiopian National Spatial Data Infrastructure (ENSDI) as a Collaborative Inter-Organisational Geospatial Data-Sharing Mechanism and its Development over the Last Decade

The creation of an Ethiopian Spatial Data Infrastructure dates back to the establishment of Ethio-GIS in 1999, and aimed to reduce the duplication of effort in data production and dissemination between organisations, to share geospatial data and make it accessible, and to establish partnerships with various governmental departments, NGOs, academia, international organisations and private sector entities (Gemedo, 2012). After the initial establishment of Ethio-GIS, various other informal ENSDI initiatives (described briefly in Section 3.1.1.2) were also set up collaboratively by national and international organisations.

In 2002, the Ethiopian Spatial Data Infrastructure (ENSDI) was formally created by the Ethiopian Mapping Agency (EMA) (Mulaku et al., 2006), and was defined as a framework of policies, standards, technologies and institutional arrangements that promote data sharing at all levels of government, academia and the private sector. A substantial amount of work has been done by EMA since 2009 with various national and international agencies towards the development of an ENSDI draft policy and an ENSDI organisational structure (Figure 2).

However, the EMA (the establishing body) failed to make significant progress in the development of ENSDI, due to the obstructions described above (Sections 2.1 to 2.6); the EMA has generally taken ENSDI initiatives on its own, and does not have a legal mandate for the development and administration of the Ethiopian NSDI (INSA, 2015). A reconsideration of the legal nature of SDI is one of the most important lessons from the failure of ENSDI under EMA. In this case, we can understand that although the implementation and success of NSDI may emerge from collaborative voluntary efforts, it is also necessary to have strong national legislation to enforce the proper collection, management and sharing of geospatial data.

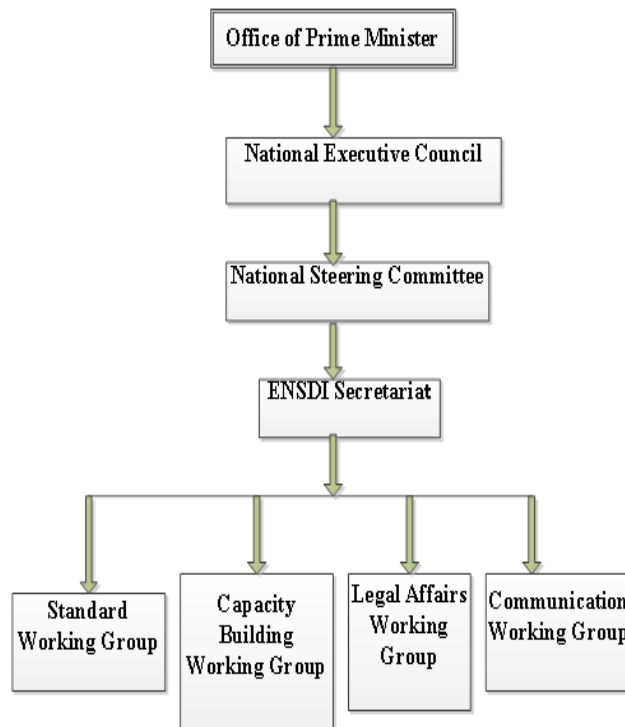


Figure 2. Former ENSDI organizational structure adapted from an ENSDI preliminary draft policy (EMA, 2009)

With the strong support of the government and its skills and expertise in systems, security and technology, INSA restarted the ENSDI initiative (Proclamation No. 808/2013) with a mandate to develop and administer the infrastructure, with the vision of a world-class infrastructure for the access, sharing and use of geospatial information in decision making at local, regional and federal levels for good governance and sustainable development. In 2014, the ENSDI programme was officially launched by INSA with a minor modification in definition from the EMA. Today, ENSDI is defined as framework of policies, institutional arrangements, standards, technologies and metadata, which promotes the sharing and accessibility of geospatial data at all levels of the government, the private and non-profit sectors, and the academic community at the national level (modified from Douglas (1997)). Subsequently, various framework activities have been carried out, such as the preparation of draft geospatial information and a technology policy (submitted to the government for approval), an ENSDI policy, an organisational structure for ENSDI, the adoption of ISO standards, the preparation of content standards for some core and thematic datasets and metadata standards, the

preparation of a long-term road map and the building of a national ENSDI geo-portal (in progress; the author is a participant in this process). The current organisational structure of ENSDI is shown below (Figure 3).

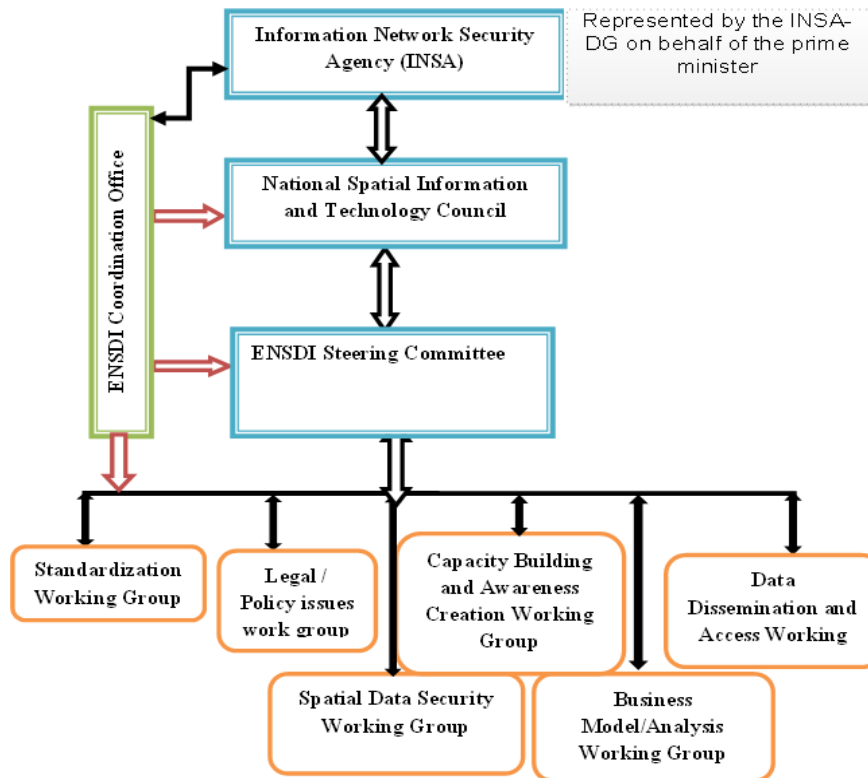


Figure 3. Current ENSDI organizational structure adopted from INSA (2015)

Although a substantial amount of work has been done so far, the progress of ENSDI development is still not as rapid as expected; the author expresses his fears for the current progress of ENSDI development, since it still needs further promotional campaigns, and recommends the following (described in Sections 3.1.1.1 to 3.1.1.3) for the better development of ENSDI as an effective cross-sector geospatial data-sharing mechanism.

3.1.1.1 Establishing a Clear (Top-Down) Approach for ENSDI Development

This paper recommends the design of a clear approach to the development of the Ethiopian Spatial Data Infrastructure, as to the author's knowledge this has not yet been established. The author also suggests a top-down approach to ENSDI

development, due to the fact that a bottom-up approach to SDI development, whereby the initiative gains full political support after the benefits are communicated in a tangible way (Makagna and Smith, 2010), cannot be realised in developing countries like Ethiopia without the full political will of the government. This is because ENSDI development has in practice suffered from a lack of buy-in and full political support from the government for the last decade under the Ethiopian Mapping Agency (EMA). EMA was the body which was responsible for the ENSDI initiative and which attempted to make use of the existing structure to cement organisational partnerships in order to make the development of ENSDI possible; however, this failed due to the absence of political will from the government. Similarly, other informal SDI initiatives (as discussed in Section 3.1.1.2) to cultivate ENSDI have arisen in the last decade in the country; however ENSDI is still under development, due to a lack of full political support. Even the current ENSDI development, under the remit of INSA, has not received full sponsorship from the government. In addition, worldwide experience has shown that the successful implementation of national spatial data infrastructure relies entirely on the political will of the government. For example, initiatives such as Infrastructure for Spatial Information in Europe (INSPIRE) are sponsored at highest level by the European Commission, and an executive order was introduced to enforce cooperation between federal and local agencies in collecting and using geographic information, the National Spatial Data Infrastructure (NSDI) of USA, signed by president Bill Clinton. This offers an example of gaining full political will from the outset as the driving force behind successful SDI development in more developed nations.

3.1.1.2 National Strategy to Handover NSDI-Related Initiatives and Build on Existing Efforts

The development of a clear national strategy to hand over the more informal SDI initiatives, so that the effort that has been invested in thematic SDI and other informal SDI initiatives does not go to waste when the initiatives come to completion (Makanga and Smit, 2010), could greatly facilitate the development of ENSDI. Various ENSDI initiatives have emerged in Ethiopia (briefly described in the following paragraphs); however, the efforts made so far by these informal ENSDI initiatives from national and international NGOs, GOs, private sector entities and academia have not been fruitful. Their efforts have been and continued to be wasted, due to an absence of clearly stated strategies for taking over their networking efforts and advocating data sharing, once the projects are terminated.

A study carried out on the assessment of SDI development in Ethiopia by Gemedo (2012) identified several national and international initiatives which have emerged through a great effort to develop an ENSDI initiative and to promote geospatial data sharing between sectors in Ethiopia. These include the United Nations Economic Commission for Africa (UNECA), the Eastern and Southern Africa Partnership (ESAPP), the Swiss Agency for Development and Cooperation (SDC), the Global Spatial Data Infrastructure, the Global Mountain Program (GMP), Ethio-GIS, the Ethiopian Environmental Information Network (Ethio-EIN), the Ethiopian Natural Resource and Environmental Metadatabase (ENRAMED), the GIS Society of Ethiopia (GISSE), and the Ethiopian Geospatial Metadata Clearinghouse Node (EGMCN).

Ethio-GIS was established in 1999 with the aim of reducing the duplication of effort between agencies and institutions, improving the quality of data and making it easily accessible to the geospatial community by a combined team from ESAPP, GMP, the Centre for Development and Environment (CDE), the University of Bern, and GISSE; a first effort was released with well-organised digital spatial data, including administrative boundaries (national, regional and districts), monthly and annual rainfall distribution, towns and villages, infrastructures (roads, railways), topography and hydrographs for users (academia and development group) (Gemedo, 2012).

UNECA developed its own effort towards the establishment of ENSDI by carrying out awareness campaigns for ENSDI, hosting a node for Ethio-EIN partner institutions (Eelderink et al., 2008), and the National Clearinghouses Node² from which more than 5000 datasets were stored (Gemedo, 2012).

Ethio-EIN has worked towards the development of ENSDI since 2004 as part of AEIN, under the former Environmental Protection Authority (EPA) of Ethiopia, to facilitate the development of environmental information sharing within the country, and advancing the concept of land information systems and SDI (Marquardt and Bekure, 2009). The major partner institutions were the Central Statistical Authority, Christian Relief Development and Aid, the Disaster Prevention and Preparedness Commission, the Ethiopian Mapping Authority, Geological Surveys of Ethiopia, the Institute of Biodiversity Conservation, the Ministry of Agriculture and Rural Development, the Ministry of Health, the Ministry of Water Resources, the National Meteorological Services Agency and Population and Housing Census Commissions office, the Ethiopian Science and Technology Commissions, Amhara Regional State, Gambella Regional State, Oromia Regional State, Southern

² <http://geoinfo.uneca.org/ethiopia/>

Nations and Nationalities Peoples Regional State, and Tigray Regional State (AEIN, undated).

GISSE was established in 2007 to support the setting up of GIS infrastructure at a national level, the standardisation of spatial data and the provision of GIS assistance through establishing a network of GIS professionals in Ethiopia (GISSE, 2011).

The Ethiopian Geospatial Metadata Clearinghouse Node (EGMCN) was established by INSA in 2011, under its remit of “Monitoring the collection, processing and dissemination of remotely sensed data and handling of geospatial databases to ensure their compliance with the country information security standards” (Article 6/5 of Ministers Regulation 2006) (Temesgen, 2011).

The Ethiopian Natural Resource and Environmental Metadatabase (ENRAMED, Clearing house by ECA) was established with the coordination of the former Ministry of Water Resources (which is now the Ministry of Water, Irrigation, and Electricity) 2003, originating from an environmental support project administered under Dutch-Ethiopian bi-lateral development cooperation. The term ENRAMED is an Amharic expression for “Let's walk together”. Various institutions participated in the collection, generation, storage and dissemination of information related to natural resources and the environment. Its main objective was to facilitate access to and exchange of data and information between users and custodians of data for the proper planning, development and management of natural resources and the environment. It also aims to avoid duplication of effort and the resulting costs of data gathering and compilation, as well as improving data management and dissemination practices between partner organisations (UN_DESA, 2011).

There have also been other ICT-related initiatives which are supportive of data sharing between organisations and making data easy to access, such as School Net and Woreda Net which, under the Ministry of Capacity Building, aim to connect 500 schools for educational purposes and 594 woredas for data collection and information exchange respectively (AEIN, undated). In addition, Health Net, Agri Net, the Ministerial Network, the ICT Business Incubation Centre (MCIT-BIC), e-agriculture, e-education, e-health, transactional and informational e-services, and unified billing system initiatives have been recorded by the Ministry of Information and Communication (MCIT, 2015).

Despite an abundance of informal SDI initiatives which have arisen to date in the country, the development of an Ethiopian Spatial Data Infrastructure for geospatial data sharing has remained in its infancy; most of the efforts (except those of Ethio-GIS) of the aforementioned initiatives were wasted, and continued to be wasted, due to the absence of clearly established hand-over strategies; projects and/or

initiatives lack the full support of the government, once their life span is over. The promotion of spatial data sharing is supported only as long as initiatives and projects exist, and terminates with the termination of the projects. This is the most persistent aspect of the problem in Ethiopia.

It is therefore important to take a lesson from previous failures, and this study strongly recommends that a clear hand-over strategy be devised for initiatives or projects that could potentially contribute for the development of an Ethiopian National Spatial Data Infrastructure. A thorough assessment of ongoing initiatives with similar goals and objectives to those of ENSDI should be undertaken, to ensure the integration of information management and alignment of policy imperatives, and to reduce the duplication of effort. The existing ENSDI-related initiatives and/or projects should not be neglected (perhaps including those discussed above) since reinforcing these as geospatial data sharing mechanisms is important in the development of ENSDI. The current ENSDI initiative under the remit and responsibility of the Information Network Security Agency (INSA) should join forces with other existing efforts such as the Ethiopian Educational and Research Network (EthERNET) (in progress to connect all universities in the country with a 10GB communication capacity to share resources, principally data, including spatial data³) EthioGIS and the National Atlas of Ethiopia⁴.

3.1.1.3 Collaborative Investment in the Building Blocks of ENSDI

There should be collaborative investment in the elements of soft infrastructure (policy, standards, technology and institution) in order to complement what is already in place for hard infrastructure.

Legal Framework: ENSDI legislation concerning the responsibility and mandate of geospatial data producers and users, including intellectual property rights (copy and patent rights), custodianship and liability should be introduced in order to tackle data-related issues such as the absence of regular maintenance, metadata, out-dated data, the availability of legacy data in analogue format, and concerns over the loss of control of data, and the quality and accuracy of data.

Technology: Telecommunication infrastructure should be well established to improve the e-readiness of organisations and to meet the need for geographic data transfer and information dissemination throughout the network of clearing houses; an effective technology transfer mechanism should also be designed. An

³ <https://www.ubuntunet.net/ethernet>

⁴ https://commons.wikimedia.org/wiki/Atlas_of_Ethiopia

appropriate ENSDI server architecture should be designed taking into account the federalist governmental structure of the country, and an open source culture should be also developed.

Standards: Product specifications, feature definitions, data management (metadata, format) ,and interface standards should be prepared by taking the ISO and OGC standards as a normative reference, and should be used as national guidelines throughout the geospatial industry.

Data: A national spatial dataset inventory, and its custody, should be developed as a preliminary initiative of ENSDI, and digitalisation of the legacy data available in analogue should be carried out by each custodian. There are also ongoing geospatial data production efforts, including aerial photographs, by Information Network Security Agency (INSA), digital soil maps by the Agricultural Transformation Agency (ATA) and census data by the Central Statistical Agency (CSA). Metadata documentation should be generated for each of the aforementioned datasets by their custodian.

Institutional Arrangements: A champion or leading institution (Ethiopian Spatial Data Infrastructure Coordination Office, Figure 3) should be set up to encourage cooperation among stakeholders in pooling their efforts (funding, datasets and technical manpower), to address organisational conflicts of interest and to enforce ENSDI as a collaborative institution, in order to ensure strong cooperation between sectors in the strategic implementation of the Ethiopian Spatial Data Infrastructure. Activities such as technical gap-filling for stakeholders in the areas of GIS and ICT, endorsement of the draft organisational structure (Figure 3), setting up clear ENSDI funding mechanisms and the sensitisation and advocacy of ENSDI concepts for all stakeholders at all levels should be carried out. In general, development of institutional operational capabilities should be the focus of ENSDI strategy.

Policy: The general draft national geospatial data and/or information and technology policy, and the ENSDI policy (involving data access, sharing and service charges, among others), should be endorsed as soon as possible, and any uncertainty about the geospatial data policy should be removed. In particular, the policy should make clear that geospatial datasets are a public asset which must be shared.

4. CONCLUSIONS

In Ethiopia, unlocking of the economic potential of geospatial information and the creation of a geospatially enabled community through a geospatially networked environment have not been achieved due to poor technological development, lack

of cross-sector coordination, poor institutional operational capabilities, the absence of policy and legal frameworks which specifically concern the geospatial industry and the poor quality of legacy geospatial data. A lack of the full support from the government (the non-existence of political will) is the underlying cause. The failures of previous networked environments which have attempted to promote inter-organisational geospatial data sharing in direct or indirect ways is one consequence of this absence of governmental support. The development of the Ethiopian National Spatial Data Infrastructure, a concept introduced 10 years ago, as a collaborative inter-organisational geospatial data sharing mechanism is still very much delayed.

However, strong promotion of ENSDI to higher officials, in order to gain their full sponsorship, is a continuing effort. Hence, clarification of a top-down approach to development of ENSDI (information management), establishing a clear national strategy to hand over informal SDI initiatives within the country and a collaborative investment in the building blocks of ENSDI are presented in this paper as possible solutions for strengthening an ongoing Ethiopian National Spatial Data Infrastructure as a collaborative inter-organisational geospatial data sharing mechanism.

REFERENCES

- Abidah, A, Shahidah, M.A., and F. Ahmed (2009). Geo-Spatial Data Accuracy and its Legal Implications in the Malaysian Context. *Eighteenth United Nations Regional Cartographic Conference for Asia and the Pacific*. Bangkok.
- African Environmental Information Network – AEIN (undated). Best Practices and Lessons Learnt from the Implementation of the Africa Environment Information NETWORK (AEIN), at: <http://www.unep.org/dewa/africa>, accessed 3 October 2016.
- Ali, A. and M .Ahmed (2013). Geospatial data sharing in Pakistan: Possibilities and problems, at <https://www.researchgate.net/261286691>, accessed 23 December 2015.
- Assefa, G. and S. Hailemariam (2013). Online Service Delivery of Geo-Information Data: The Case of Ethiopian Mapping Agency. *HiLCoE Journal of Computer Science and Technology*, 2(1).
- Asmaryan, S. (2015). Armenian Environmental Spatial Data Infrastructure Success Story, at: <http://ecocentre.am>, accessed 24 December 2015.

- Azad, B. and L.L. Wiggins (1995). Dynamics of inter-organizational data sharing: a conceptual framework for research. In Onsrud, H.J. and Rushton, G. (Eds.), *Sharing Geographic Information*. New Brunswick Centre for Urban Policy Research, pp. 22-43.
- Barry, W. (2010). The Most Contentious Issue Facing GIS Data Sharing Today. Geospatialtoday, at: <http://www.geomatics.uottawa.ca/gaw09/issuedata/sharing>, accessed 18 November 2015.
- Douglas, N. (1997). The US National Spatial Data Infrastructure, at: http://buccaneer.geo.orst.edu/myst/nsdi_ppt/sld001.htm, accessed 3 December 2015.
- Edemba, C. (2012). Challenges a developing country like Kenya faces in implementing web based mapping, at: <https://edembac.wordpress.com>, accessed 20 December 2015.
- Elwood S. (2007). Grassroots groups as stakeholders in spatial data infrastructures: Challenges and opportunities for local data development and sharing. *International Journal of GIS*, 22(1), pp.1–20.
- Federal Negarit Gazette – FNG (2014). A Proclamation to Re-Establish the Information Network Security Agency. Proclamation No.808/2013, 20th year No. 6, Addis Ababa.
- Federal Geographic Data Committee – FGDC (2002). Overview: What the Framework Approach Involves, at: <http://www.fgdc.gov/framework/overview.html>, accessed 3 December 2015.
- Felicia, O.A. and U. Ernest (2011). An assessment of the current state of spatial data sharing in Rwanda. *International Journal of Spatial Data Infrastructure Research*, 6, pp. 365-387.
- Fuziah, A.H. (2009). Malaysian Geospatial Data Infrastructure: Challenges for Effective Geospatial Information Sharing, at: <http://ngis.mygeoportal.gov.my/sites/default/files/ngis4/Paper11-MaCGDI>, accessed 3 December 2015.
- Frank, S. and U. Andrew (2001). Copyright Laws - Confusion? *GIM International*, 15(2), p. 81, GITC.
- Folger, P. (2012). Issues and Challenges for Federal Geospatial Information. *Congressional Research Service*, at: <http://www.crs.gov>, accessed 3 December 2015.
- Gemeda, D.O. (2012). Assessment of Ethiopian Spatial Data Infrastructure. Master's Thesis, Wageningen University. Netherlands

- GeoConnections, Hickling Arthurs Low Corporation (2011a). Final Report: CGDI Operational Policies Need Analysis. Ottawa: *GeoConnections*, Natural Resources Canada.
- Ghose, R. and W. Huxhold (2002). Role of multi-scalar GIS-based indicators studies in formulating neighborhood planning policy. *The URISA Journal*, 14, pp. 3–16.
- GIC/ESRI Canada. (2011). Spatial Data Infrastructure for Monitoring Development Outcomes in Uganda. Washington, D.C.: infoDev / World Bank, at: <http://www.infodev.org/publications>, accessed 21 December 2015.
- GIS Society of Ethiopia – GISSE (2011). Geographic Information System Society of Ethiopia.
- Groot, R., and J. McLaughlin (2000). *Geospatial data infrastructure: Concepts, cases and good practice*. Oxford, U.K.: Oxford University Press.
- Harvey, F. and Tulloch, D. (2006). Local government data sharing: Evaluating the foundations of spatial data infrastructures. *International Journal of Geographic Information Systems*, 20, pp. 743-768.
- IDI (2009). Measuring the information society. *ICT Development Index*.
- Information Network Security Agency – INSA (2014). Demand analysis on national spatial information and technology policy. Unpublished document. Addis Ababa, Ethiopia.
- Information Network Security Agency – INSA (2015). Stakeholders' survey report on ENSDI obstacles and benefits. Unpublished document. Addis Ababa, Ethiopia.
- Lance, K. T. (2003). Spatial data infrastructure in Africa: Spotting the elephant behind trees. *GIS Development*, 7(7), pp. 35-41.
- Krauer, J., and Z. Gete (2015). Building spatial data infrastructure in Ethiopia. Eastern and Southern Africa Partnership Program: Highlights from 15 Years of Joint Action for Sustainable Development: Centre for Development and Environment (CDE), University of Bern, with Bern Open Publishing (BOP), pp. 99-102. <http://doi.org/10.7892/boris.72023>.
- Longley, P.A., Goodchild, M.F, Maguier, D.J., and D.W. Rhind (2001). *Geographic Information Systems and Science*. New York.
- Makanga, P., and J. Smit (2010). A review of the status of spatial data infrastructure implementation in Africa. *South African Computer Journal*, 45.

- Ministry of Communication, Information and Technology – MCIT (2015). National dataset design document. Unpublished material. Addis Ababa, Ethiopia.
- Ministry of Water and Energy – MoWE and the United National Department of Economic and Social Affairs – UN-DESA (2008). Strengthening Water Sector Monitoring and Information System in Ethiopia with GIRWI Project. Final Report of the Diagnostic Phase. June 2008, Addis Ababa, Ethiopia.
- Moeller, J. (2001). Spatial Data Infrastructures: A Local to Global View, at: <http://gsdi.org/PPT/unrcc01.ppt>, accessed 25 December 2015.
- Mulaku, G. C., Kiema, J. B. K., and D.N. Siriba (2006). Assessment of Kenya's Readiness for Geospatial Data Infrastructure Take Off. University of Nairobi, Department of Surveying, Nairobi, Kenya.
- Musinguzi, M., Bax, G., and S.S. Tickodri-Togboa (2004). Opportunities and Challenges for SDI Development in Developing Countries—a Case Study in Uganda. In *Proc. 12th Int. Conf. on Geo-informatics—Geospatial Information Research: Bridging the Pacific and Atlantic*. University of Gävle, Sweden, 7-9 June 2004.
- National Academies Press – NAP (2002). Down to Earth: Geographical Information for Sustainable Development in Africa, at: <http://www.nap.edu/catalog/10455.html>, accessed 20 December 2015.
- National Sate Geographic Information Council – NSGIC (2011). Geospatial data sharing guidelines for best practice, at: <http://www.nsgic.org>, accessed 24 December 2015.
- Nedovic-Budic, Z., and J.K. Pinto (2000). Information sharing in an inter-organizational GIS environment. *Environment and Planning B: Planning and Design*, 27(3), pp. 455-474.
- Niles, S., and S. Hanson (2003). A new era of accessibility? *URISA Journal*, 15, pp.35-41.
- Onsrud, H. (Ed.). (2007). *Research and Theory in Advancing Spatial Data Infrastructure Concepts*. ESRI Press, Redlands, California.
- Østensen O. (2001). The Expanding Agenda of Geographic Information Standards, *ISO Bulletin*, July, pp. 16-21.
- Pierre, E.H.J. (undated). *Analysis of data sharing environment and major challenges currently being faced in data sharing in Rwanda*, at: <http://www.aag.org/galleries/gdest/Hitimanapaper.pdf>, accessed 9 November 2016.

- Pinto, J. K., and H. Onsrud (1995). Sharing geographic information across organizational boundaries: a research framework. In Onsrud, H.J. and G. Rushton (eds). *Sharing geographic information*, New Brunswick, NJ: Centre for Urban Policy Research, pp. 45-64.
- Rajabifard, A., Binns, A., and I. Williamson (2005). Creating an Enabling Platform for the Delivery of Spatial Information. *Proceedings of Spatial Sciences Conference on Spatial Intelligence, Innovation and Praxis*. Melbourne, Australia.
- Sebake, D. M. and S. Coetzee (2008). Barriers and Motivators of Inter Organizational GIS Data Sharing for Address Organization In South African SDI. MSC Thesis. University of Pretoria, Department of Computer Science.
- Sieber, R.E. (2007). Spatial Data Access by the Grassroots. *Cartography and Geographic Information Science*, 34(1), pp. 47-62.
- United National Department of Economic and Social Affairs - UN-DESA (2011). Strengthening Water Sector Monitoring and Information System in Ethiopia: GIRWI Project Phase II.
- United Nations Economic Commission of Africa (UNECA). (2001). The Future Orientation of Geo Information Activities in Africa: Synthesis, at: http://www.uneca.org/eca_resources/Conference_Reports_and_Other_Documents/disd/codi/docs/doc3EN.pdf, accessed 21 December 2015.
- Temesgen, A. (2011). Report on Geospatial Metadata Clearinghouse Node Establishment Project Accomplishment. Information Network Security Agency, at: <http://ethiogmcn.insa.gov.et>, accessed 20 November 2016.
- Zelege G., Alemu B., Hergarten C., and J. Krauer (2007). Consultation Workshop on NSDI and EthioGIS (2nd Release), Workshop Proceedings, November 28, 2007, Addis Ababa, Ethiopia, pp.1-73. ESAPP: Swiss Agency for Development and Cooperation SDC.