The Need for Assessing Costs of Inefficient Access to Fundamental Spatial Datasets in Least Developed Countries

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Abstract

Awareness on the benefits of a Spatial Data Infrastructures (SDI) for sustainable development is strategic in convicting Policy Makers and administrators to accept it and support its development. Contemporary formal approaches of raising SDI awareness have not been successful enough to convince decision makers especially in developing countries to accept and support SDI development initiatives.This paper suggests a slight shift from formal approaches used for raising awareness among policy makers which are based on evaluation of benefits of SDI. Basing on studies from fields of human psychology and economics, the paper argues that negative information such as the damage caused by failing to put in place an SDI is much more effective in convincing decision makers to accept and support SDI than positive information regarding tangible benefits of SDI. The paper reports on how the ability to evaluate costs that spatial data intensive government organizations incur as a result of inefficient access to fundamental spatial datasets would be an important step towards development of the National Spatial Data infrastructure (NSDI). The paper further identifies and clarifies issues that influence these costs and how such assessments can benefit government organizations.

Keywords: Spatial Data, Spatial Data Infrastructure, SDI Assessment, Cost Benefit Analysis

1. Introduction

Inadequate and unreliable information is a serious constraint to sustainable development. Planning cannot achieve development that is sustainable without readily access to quality information about the environment in which development would take place. This is due to the fact that accurate assessment of constraints to development and identification of the opportunities for effective intervention requires accurate and relevant spatial (geographic) information. With growing populations, economies and changing environments, governments are increasingly relying on fundamental spatial information for services such as environmental management and planning, land registration, disaster response, public health programs, agricultural marketing, biodiversity conservation and the design and development of physical infrastructures (Stevens et al 2005). Fundamental spatial datasets refers the minimum primary set of data that cannot be derived from other datasets, and that are required to spatially represent phenomena, objects, or themes important for the realization of economic, social and environmental benefits. These include; geodetic control network, Imagery, Topographic, Cadastral, Land use and administrative boundaries maps.

Most organizations need more fundamental spatial data than they can produce themselves (Rajabifard and Williamson, 2002a) and it is usually cheaper to acquire spatial datasets from another party than it is to produce the dataset oneself (Chukwudozie, 2000). Thus, organizations should not duplicate work that has already been completed by another party. However, insufficient knowledge on available fundamental dataset in possession of different organizations, unwillingness of organizations and individuals to share data, poor data access technology and incompatible data formats hinder access to and sharing of information and often lead to costly duplication (El-Sayed et al, 2006).

Effective sharing of spatial data at all levels of government requires that organizations and individuals are able to determine whether data has already been collected by others, whether that data is fit for their intended use, how it can be accessed and be integrated with other information. This requires a framework of policies, institutional arrangements, technologies, data and people that makes it possible to share and use effectively geographic information. The term Spatial Data Infrastructure (SDI) encapsulates such a framework (Onsrud and Rushton, 1995; Craglia and Johnston, 2004). The rest of the paper describes the concept and core components of SDI together with a brief discussion on current approaches in raising awareness about SDI benefits and describes why bad (negative) information about SDI could be more effective in raising SDI awareness than good (positive) information. Also it discusses how the ability to assess costs that government organizations incur due to poor access to fundamental spatial data could help increase awareness to decision makers on the need and importance of developing SDI's. The paper identifies and briefly discusses issues that must be considered when trying to assess such costs.

2. Spatial data infrastructures

Spatial Data Infrastructure can be viewed as an umbrella of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management and production of geo-spatial data (Ottichilo 2005). Rajabifard (2002) views a SDI as an initiative intended to create an environment that will ensure that a wide variety of users who require coverage of a certain area will be able to access and retrieve a complete and consistent datasets in an easy and secure way. Also a tool to provide a proper environment in which all stakeholders both users and producers of spatial data can co-operate with each other and interact with technology in a *cost-effective* way to better achieve the objectives at the corresponding political and administrative level. With reference to existing definitions for SDI, the main components of SDI can be categorized as people, policy, standards, access networks and data (Rajabifard et al, 2002). Figure 1 below shows the general SDI model including the SDI core components.

The nature and relationship between the components can be summarized as follows; People (data producers, value-adders and data users) can access and use spatial data by means of technology through well defined policies on standards and access networks. SDI core components have a dynamic nature due to the fact that technology which affects all the components changes from time to time. Likewise, people's requirements on spatial data change with time as well as jurisdiction. See Rajabifard et al, (2002) for a detailed treatment of SDI components.

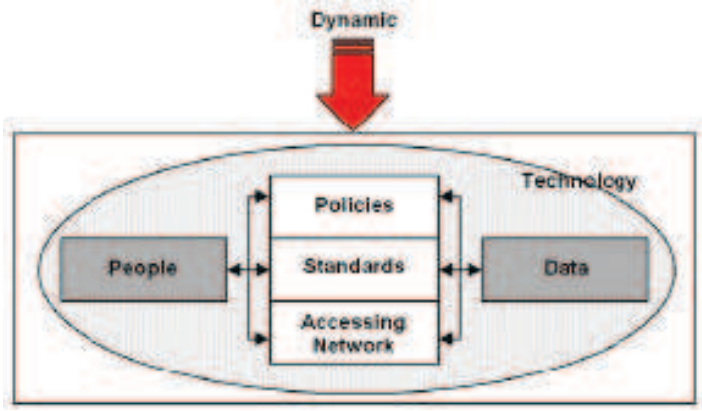

Figure 1: SDI core components (After Rajabifard et al, 2002)

The benefits of SDIs have been well documented in Rajabifard and Williamson (2002b) and in the SDI Cookbook (2004) as improving data access and sharing which can lower the operational costs of organizations and increase the use and value of spatial datasets. However, despite the publicized positive results in terms of relevance, efficiency and effectiveness, the SDI concept to share spatial data resources has received low acceptance among many policy makers. One of the main reasons for low awareness and hence low acceptance of SDI is insufficient empirical evidence of the short and medium term benefits of SDIs to the nation's economy and sustainable development (Omran et al, 2006; Stevens et al, 2005; Rajabifard and Williamson, 2002b).SDIs are mainly established by government bodies and require long term commitment of large amounts of money resourced from public funds (Grus et al, 2007). However, chances to obtain funding for SDI is very limited especially in Africa where there are scarce financial resources amidst many competing needs such as health, education, combating HIV/AIDS and poverty reduction programs. Therefore sufficient empirical evidence of the benefits of a SDI to the nation's economy and sustainable development is needed in order to justify investment in SDI's. Fig 2 below shows how under productivity of countries relates to poor adoption of SDI.

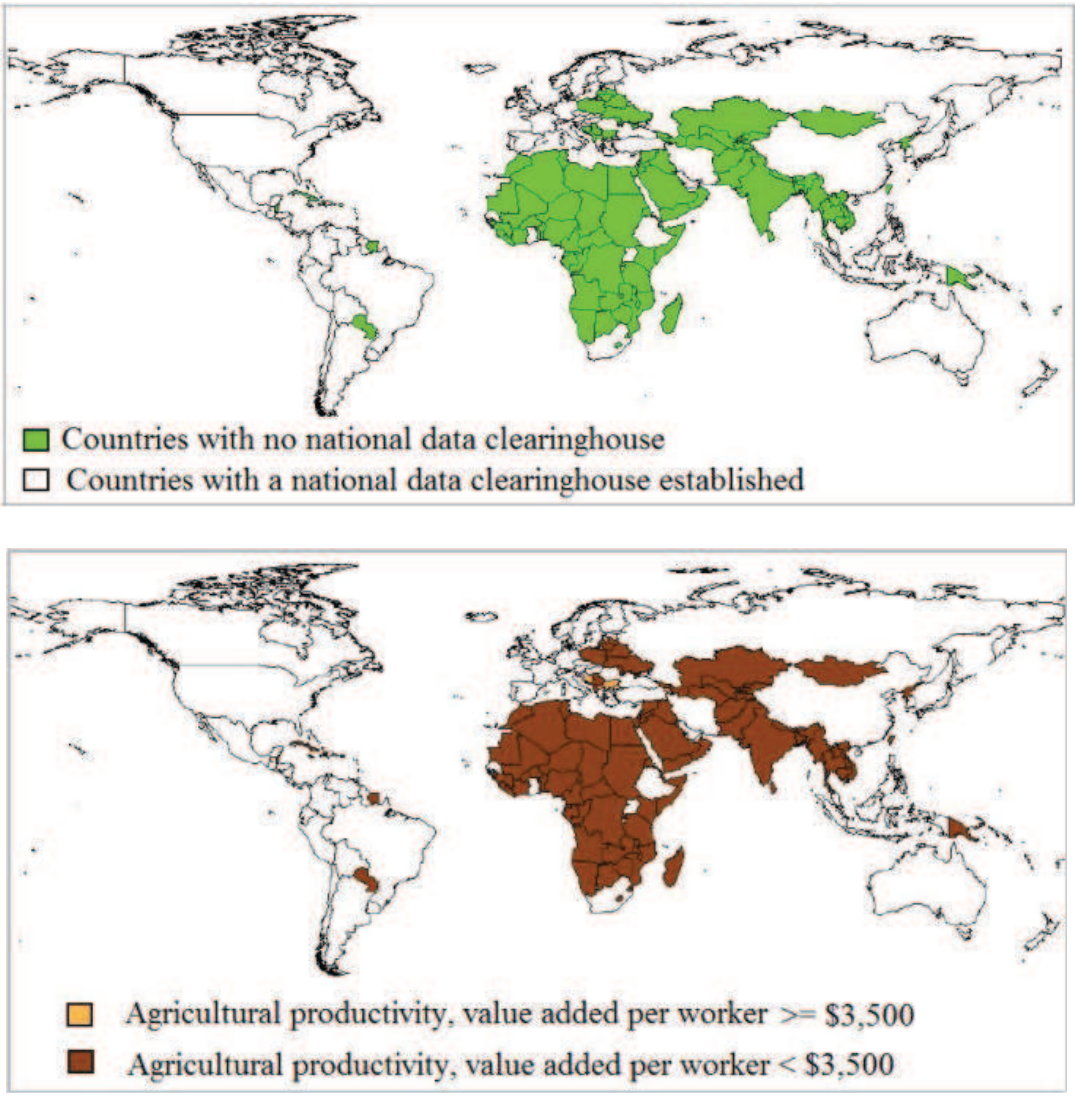

Figure 2. Countries with no established national clearinghouse in 2002 compared with agricultural productivity, value added per worker. Countries with established clearinghouse presented in white. Adopted from Crompvoets (2006)

In recent years studies have embarked on efforts to establish tangible benefits of SDI by assessing the socio-economic impact of existing Spatial Data Infrastructure initiatives using methodologies based on Cost-Benefit Analysis (CBA) (INSPIRE ,2009; Craglia & Johnston, 2004; Halsing et al, 2004; Boaz, 2005; Crompvoerts, 2006; Craglia & Nowak, 2006; Grus et al, 2007; Genovese1 et al, 2009). CBA based approaches have been very useful for quantifying both tangible and intangible costs and benefits of SDI, however, their main setbacks are that they are based on many assumptions whose validity has not yet been tested. Moreover, they are very expensive and time consuming to undertake since SDI benefits accrue over a long period of time and the benefits are often gained in places other than where the costs occur. But perhaps the most important setback that this paper wants to address is that, CBA approaches are not sensitive to the costs caused by failing to put in place an SDI (Tóth and Smits, 2010), it has not been possible to see directly the costs of failing to implement the project. Consequently, there is lack of understanding regarding the

nature and magnitude of costs that government organizations, incur in the tedium of searching for and accessing spatial datasets needed to perform their duties efficiently and effectively and achieve their objectives.

3. Positive and negative news about SDI

The few studies available that seek to establish tangible benefits of SDI initiatives have concentrated on quantifying the positive social-economic benefits of existing SDI projects (Craglia & Johnston, 2004). Publicizing good news about SDI's is expected to attract attention of policy makers and motivate them to accept and support initiatives to develop and sustain SDI's. However, contrary to this belief, studies from both psychology and economics suggest that bad (negative) news is more likely to draw the attention of people than good (positive) news. Psychologists have long established that human mind is geared primarily towards figuring out bad things. People think more about bad things than good ones (Klinger at al, 1980) and are more concerned about finding explanations for bad events than for good events (Weiner, 1985). A good example of the validity of this theory is observed in the mass media. Journalists know that bad news will attract more attention than good news. From the economic point of view, the prospect theory of Kahneman and Tversky (1979, 1984) suggests that investors are inclined to give more weight to losses than gains. An experimental study by Cianci and Falsetta (2008) reported that unfavorable information is weighted more heavily and has a much greater impact on individuals' attitudes than does positive information (Soroka, S. ,2006). Similarly, unfavorable information regarding damage (in terms of costs and other social-welfare losses) that government sustain as a result of failing to establish SDI is expected to draw more attention from decision makers than information on only positive benefits that accrue from SDI initiatives.

The need to identify, quantify and publish costs that accrue due to poor access to spatial datais in agreement with recommendations of the workshop organized by the Joint Research Centre of the European Commission held in Ispra, Italy in 2006 which supported the need to develop a theoretical framework underpinning the identification of, tangible and intangible benefits (both positive and negative) which we expect from an SDI. There are some important issues regarding spatial data access that have to be considered when trying to identify and quantify costs arising from poor access to spatial data. These are discussed hereunder.

4. Issues influencing assessment of costs of access to spatial data

Access to spatial datasets can be viewed as involving the ability to locate, view, evaluate, retrieve and use spatial data held by another entity (Williamson et al, 2003). The Businessdictionary (2011) defines a process as a sequence of interdependent and linked activities which consume one or more resources (employee time, machines, money) to convertinputs into desired outputs. Processes involved in accessing

fundamental spatial datasets include data discovery, retrieval and exploitation (Yawson et al, 2011). How difficult it is to accomplish these processes not only raises costs but also means that data does not arrive in time to meet operational requirements of organizations.

4.1 Data Discovery

Data discovery activities consist of locating/searching, viewing and evaluating spatial data. Also it involves determining if data is fit for intended use and establishing the costs and conditions for acquiring the dataset. Data discovery constitutes most of the activities in the process of accessing spatial data. These activities include searching for the contact person in case information is not transparent, searching for and communicating with the responsible person and this may include a physical visit to the premises of the data provider (Poplin, 2010

4.2 Data Retrieval

Data retrieval is the actual process of obtaining spatial data. Activities include using mail services (email/postal) or paying physical visit to the source to obtain data, which may include added activities such as printing, tracing or producing copies.

4.3 Data Exploitation

Data exploitation activities make use of the acquired dataset for the intended purpose. Ability of data to integrate with other information and systems is a very crucial factor for effective use of the data. Added costs may be incurred if acquired data needs further processing, or handling data that is not compatible with the user's systems.

4.4 Institutional and Policy Issues

Apart from the technical issues discussed above, institutional frameworks of government organizations that produce and/or use spatial data also influence the process of accessing spatial data and the associated costs. The organization's existing policies and legislations govern the procedure to be followed for data acquisition and use. The policies and legislations determine which data to access and may restrict its use for example due to security reasons and therefore have a direct impact on the costs that organizations incur in the process of acquiring spatial data.

Table 1. Processes of accessing fundamental spatial datasets

Process	Cost factors
Discovery	Time and staff needed for data discovery/time spent waiting for inquiry or request
Retrieval	Time spent on sending / collecting datasets (e.g. cost of retrieval media)
Exploration	Time, cost of resources needed for pre-processing and use of data (staff, machines)
Policy Compliance	Institutional restrictions (e.g. data accessible during work hours only)
	Time and cost to comply with bureaucratic procedures such as access permits

Cost assessment approaches must therefore address the above-mentioned processes, and the main challenge is that different organizations operate differently as regard to how they discover, retrieve/supply and exploit spatial data. Also organizations have different institutional arrangements and operate with different policies and legislations, all these issues must be taken into consideration.

5. The need for assessing costs of poor access to spatial data

Previous studies that have assessed costs of poor access to spatial data have reported substantial losses. For example, van de Hyge & Mnmo (2005) reported that the total cost of poor data access and use was about Euros 100-200 million per year for private companies undertaking Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) in Europe. The cost of poor data access and use was also investigated by ANCIL, (2008) in a study of economic impact of spatial information to the Australian economy in the year 2006-7. The study found out that the effect of inefficient access to spatial data was to lower the productivity between 5-15%. The main strengths of these studies are that they have managed to provide tangible evidence on the benefits of SDI, and also they employed well-established methodologies. Despite these strengths, major drawbacks of these studies are that they have concentrated only on existing SDI in developed countries. As a result the studies overlooked the equally important aspect of economic welfare loss due to absence of SDI (the costs caused by not implementing SDI's) which is prevalent in Africa and other developing countries. Therefore, generalization of results from such studies to developing countries might not be realistic due to a big social-economic difference between south and north countries. Also, the studies have not gone further to providing a model for assessing such costs. It is therefore important to develop formal models to study and assess these costs in order to increase our understanding of the nature and magnitude of social-economic welfare loss arising from inefficient access to and use of spatial datasets as a way of justifying spending in development of National Spatial Data infrastructure.

6. Conclusion

It is important to understand the costs that organizations incur as a result of inefficient access to fundamental spatial data as this will provide the basis for justification of investment in development and effective utilization of SDI's. This is so because it is believed that negative information about poor access to fundamental spatial data will help to market SDI among African nations and draw the attention of policy makers to appreciate and support SDI development initiatives. The ability to quantify costs due to poor access to fundamental spatial data will also help to identify areas within an organization where most of these costs are happening and thus enable corrective measure to be taken. Also, this information will act as a baseline data upon which future costs assessment can be compared, and thus support efforts to study and monitor the cost-effectiveness of spatial data access mechanisms for countries with and without formal spatial data infrastructures. The next step of this study will be to develop a

model for assessing costs that organizations incur due to inefficient access to fundamental spatial datasets. The case study will be the Ministry of Lands, Housing and Human Settlement Development, the mandated organ responsible for collection, storage and distribution of fundamental spatial datasets in Tanzania.

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