Is GIS a small talk in the era of SDIs? The Case of Pakistan

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Key words: GIS, SDI, Policy, Governance, Pakistan

SUMMARY

Benefiting Geographic Information System (GIS) for various disciplines is obviously not new in Pakistan like many other countries in the world. Government of Pakistan (GoP) has recently announced to establish national Geographic Information System (GIS) instead of Spatial Data Infrastructure (SDI) for the country. Most GIS applications cannot be developed with a single dataset. For that, multiple spatio-temporal datasets collected, maintained and locked by various organizations are required. This implies that sharing of the geospatial datasets is crucial for developing reliable GIS applications to support policy making process for efficient decision making in the areas such as exploration and monitoring of natural resources, climate change as well as managing and mitigating natural disasters that are a constant threat to food and fuel resources of the country. However sharing of dataset need establishment of SDI. Therefore, the main objective of this paper is to address those aspects that make Spatial Data Infrastructure (SDI) different from Geographic Information System (GIS). The paper also explores possible implications of GoP's approach and rude awakening towards G-Pakistan.

SUMMARY

خلاصہ

دنیا کے بہت سے دوسرے ممالک کی طرح پاکستان میں بھی مختلف شعبوں کے لیے جغرافیائی اطلاعی نظام (GIS) سے مستفید ہونا کوئی نئی بات نہیں ہے۔ حکومتِ پاکستان نے حال ہی میں ملک کے لیے قومی جغرافیائی اعداد و شماریاتی ڈھانچے (SDI) کی بجائے قومی جغرافیائی اطلاعی نظام (GIS) کے قیام کا اعلان کیا ہے۔ بہت سی GIS ایپلیکیشنز صرف ایک اعداد و شماریاتی مجموعے سے نہیں بن سکتیں بلکہ بہت سے اداروں کے پاس موجود ذخیرہ شدہ مختلف زمانی جغرافیائی اعداد و شماریاتی مجموعوں کی ضرورت ہوتی ہے۔ اس سے واضح ہوتا ہے کہ جغرافیائی اعداد و شمار کا تبادلہ اور ساجھے داری پائیدار GIS ایپلیکیشنز بنانے کے لیے بہت اہم ہے جو اچھی پالیسی بنانے میں کارگر ہوتی ہیں تاکہ بہت سے معاملات جیسا کہ قدرتی ذرائع اور تغیر پزیر موسم کی تلاش اور دیکھ بھال، اور قدرتی آفات جو ملک کی غذا اور توانائی کے لیے مسلسل خطرہ ہیں کے انتظام اور اس سے نمٹنے جیسی صورت حال میں بہتر فیصلہ سازی کی جا سکے۔ لہذا اس مقالہ کا بنیادی مقصد ان پہلوؤں کا جائزہ لینا ہے جو SDI کو GIS سے مختلف کرتے ہیں۔ یہ مقالہ حکومتِ پاکستان کی G-Pakistan کی لیے مختلف سرگرمیوں اور غیر سنجیدہ کوششوں کو بھی آشکار کرتا ہے۔

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1. INTRODUCTION

Governments need data for planning and development. That's why data collection is basically a public funded activity. Data can be broadly categorized as spatial and aspatial. Spatial data (also referred to as geospatial, geographic or location-based data) are data that relate to a location on the Earth (Rajabifard et al., 2003), whereas aspatial or non-spatial data do not have a location component though it can be linked to spatial data. As spatial data can be collected through various means ranging from field surveys to air and space borne platforms therefore, the need to have a system to handle and integrate spatial data produced by various platforms was realized as finds Masser (2005). In mid 1990s GIS was introduced as a decision support system. However, it was meant for specific application domains like GIS for wetlands, GIS for agriculture and GIS for health etc. Dessers (2012) also points out "At first, GIS were developed as closed applications, with their own specific software packages, data structures and programming languages". This scenario posed serious questions including data interoperability because data produced by one GIS system was seldom compatible with other GIS system. But now in the recent era, spaghetti information systems such as Geographic Information System (GIS) seems to be over as the system approach is being transformed into information infrastructures such as Spatial Data Infrastructure (SDI) as argue Asmat (2009). Meha et al. (2014) has pointed out too, the need to "move from the current state of disparate GIS systems to an integrated and harmonized infrastructure for sharing spatial data".

Presently, both approaches i.e. GIS and SDI are still in practice. Although review of literature indicates that some researchers like Bishop et al. (2000) and Georgiadou et al.(2005) tried to address the confusion between two approaches. Bishop et al. (2000) argue that GIS cannot be built without SDI, whereas Georgiadou et al. (2005) argue that SDI requires strong GIS installed base. We argue that if GIS cannot be developed without SDI as argue Bishop et al. (2000) then how early GIS developments took place. On the other hand, the argument by Georgiadou et al. (2005) seems valid that SDI requires strong GIS installed base. But Masser (2009) underscored "SDIs are needed for effective GIS implementation". We believe that all above arguments should be seen and evaluated in the temporal context. SDI is now changing from data to service delivery (Williamson**,** 2004). We find that SDI is a bigger picture as compared to GIS however focus of both differs. SDI is an infrastructure so it never stops at the jurisdictional and application specific boundaries just like highway infrastructure, whereas GIS is similar to link roads that join the highway. SDI is needed for strategic planning whereas GIS is good for analysis and operational planning.

2. COMPARISON OF GIS AND SDI

In order to better understand, we present a comparison of GIS and SDI. The comparison is based on their components defined in the literature. Considered SDI components are geospatial data, metadata, clearinghouse, standards, framework and partnerships (https://www.fgdc.gov) whereas GIS components are data, software, hardware, humans and set of organizational

protocols (Bolstad, 2005). Table 1 displays value of GIS for SDI whereas Table 2 displays value of SDI for GIS.

Table 1: Value of GIS for SDI

GIS Component	Value for SDI
Data	This is one of the core components of any SDI. Without data in digital format, SDIs can never be developed.
Software	Data needs to be processed and manipulated for decision making which is not possible without software.
Hardware	Data or information once generated needs to be stored, exchanged and shared among SDI stakeholders. To capture, store, share and exchange the data, hardware resources such as computers, servers, network technologies and storage media are considered vital. Therefore, hardware resources are essential to embed sharing, accessibility and retrieval of data that will ultimately increase operational efficiency of SDIs and lower response time in provision of data and services to potential users.
Humans	Although GIS is developed by a group of experts. However, it demands input from people of diverse disciplines which also serves as foundation for SDI development. The degree of success of SDI can be accessed by the degree of participation of organizations and user groups. Hardware and software resources require humans to interact and operate these technologies.
Set of organizational protocols	Organizational protocols are essential not only for GIS but the same can be scaled up for SDI development.

Table 2: Value of SDI for GIS

SDI Component	Value for GIS
Geospatial Data	SDI enables access to multiple ineteropable spatiaotemporal datasets without which, no GIS can be developed.
Metadata	Metadata helps GIS developer to select right dataset of desired spatial and temporal resolution.
Clearinghouse	Clearinghouse makes data available 24/7 to GIS users.
Standards	Standardized datasets facilitate GIS application development.
Framework	Institutional, technical and legal framework helps the GIS user to get rid of procedural delays in getting desired data.
Partnerships	Partnerships help to reduce GIS data cost as well as to get various types of spatial and aspatial data/services.

3. GIS PROJECTS IN PAKISTAN

In Pakistan, hundreds of GIS projects have been completed in the past and many are still being developed by various public and private sectors to help decision making in planning processes. However, we failed to get answers to the following questions from almost all the organizations regarding their completed GIS projects:

- Who is the custodian of data that was produced during the project?
- Was the data prepared on certain standards?
- How much money was spent on data collection?
- Was metadata prepared during the project?
- Is any document avaiable to get information about the project?

In order to get answers of these questions, we googled a lot, too. Unfortunately, a little information about only few such projects is available online. The detail of organizations involved in GIS projects is listed in Table 3.

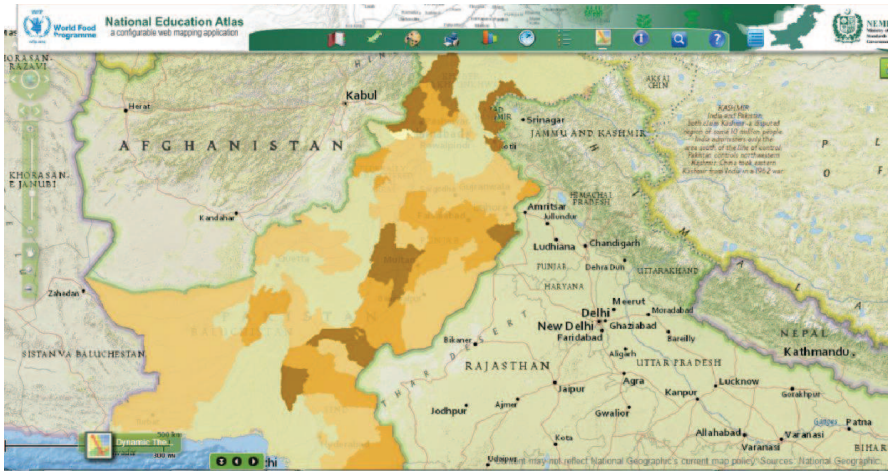
Table 3: Some organizations involved in GIS projects in Pakistan

Organization	**Web link**
Survey of Pakistan	http://www.surveyofpakistan.gov.pk
WWF-Pakistan	http://www.wwfpak.org/gis/
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO)	http://www.suparco.gov.pk/pages/gis-projects-list.asp?gisplinksid=1
PITCO Pakistan	http://www.pitcopk.com/gis-services
National Engineering Services Pakistan (Pvt) Limited (NESPAK)	http://www.nespak.com.pk/projects/major.asp?Ar=2&sector=9
City Pulse	http://citypulse.com.pk/projects.html

Some important GIS projects recently completed by public and private sector organizations in Pakistan are explored and depicted below:

3.1 Pakistan Education Atlas

For efficient dissemination of educational statistics as well as indicators by exploiting GIS technologies, Pakistan Education Atlas project in collaboration with the World Food Programme, the Ministry of Education and Training and the Academy of Educational Planning and Management (AEPAM) was initiated in 2010 and completed in 2013. The project was developed to strengthen educational planning, monitoring and evaluation (Geospatial World ,2013a and Pakistan Education Atlas ,2010).



Pakistan Education Atlas Project (Source: http://www.atlas.edu.pk/)

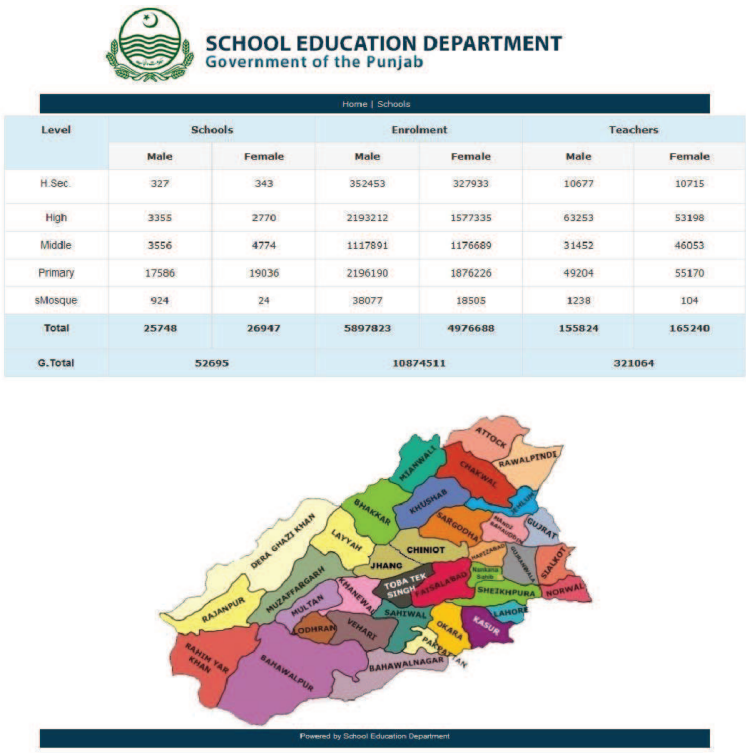
3.2 National Environment Information Management System (NEIMS)

To compile and integrate environmental data in Pakistan, National Environment Information Management System (NEIMS) was started in 2013 in collaboration with United Nations Development Programme (UNDP), Ministry of Climate Change and the Royal Netherlands Embassy. On February 26, 2013 at the launching ceremony of the National Climate Change Policy (NCCP) a prototype version of NEIMS web portal was presented. NEIMS was feeded by the data captured through a remote sensing satellite. However data was not ground verified due to limited financial and human resources. NEIMS portal shows key environmental indicators during the years 2000, 2005 and 2010 alongwith information on glaciers, natural disasters as well as land use (Geospatial World, 2013b and Waqas ,2013).

National Environment Information Management System
(Source: http://neims.com.pk)

3.3 Census of Schools in Punjab, Pakistan

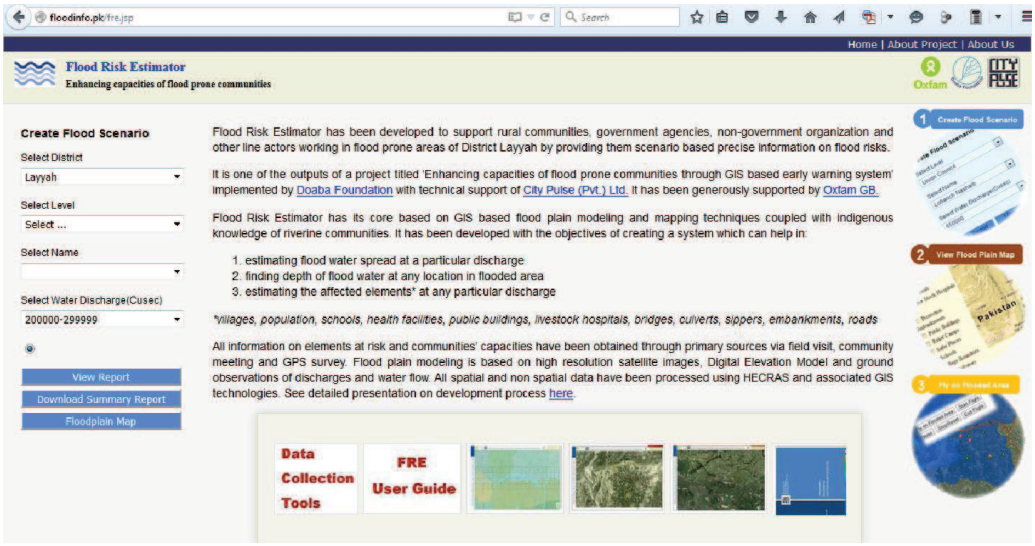
Census of Schools was conducted by Schools Education Department, Government of Punjab to develop online database of educational facilities in all districts of Punjab with comprehensive information including locational information. The school portal contains information about almost all governmental schools of Punjab to facilitate users and planners to get information related to education sector in Punjab, Pakistan (http://schoolportal.punjab.gov.pk/).



Census of schools in Punajb (Source: http://schoolportal.punjab.gov.pk/)

3.4 Flood Risk Estimator

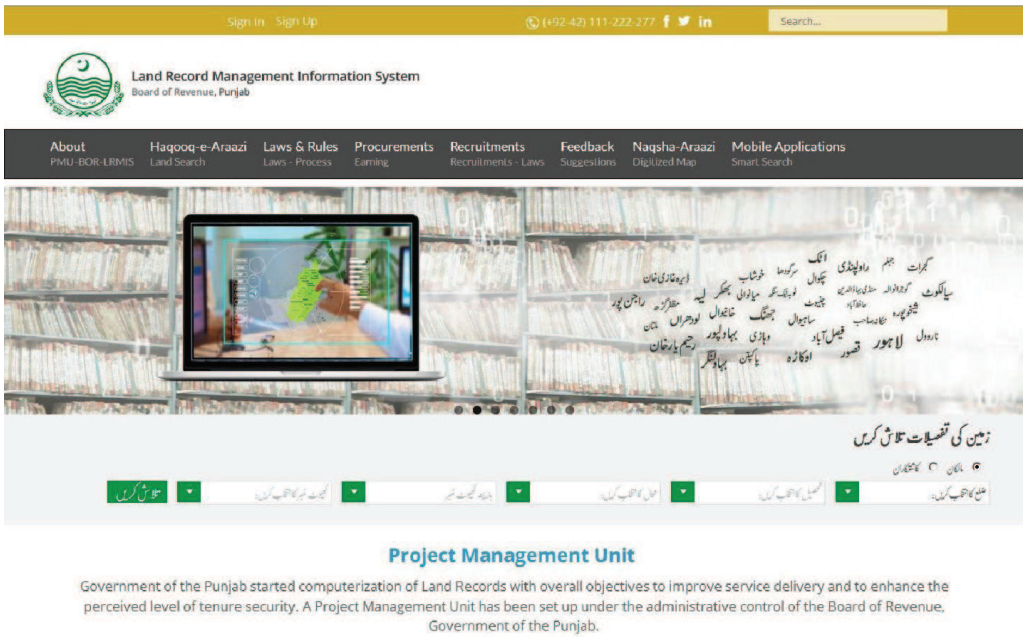
GIS based online application called as Flood Risk Estimator was developed by incorporating flood plain modeling and mapping techniques along with native knowledge of relevant communities. Flood plain modeling was carried out with the help of ground observations of water flow, high resolution satellite imagery and DEM. The application provides specific information on flood risks to the government as well as non-government organizations and rural communities of District Layyah and Bakker. The data was collected through primary means of field surveys, interviews as well as GPS surveys and processed using HECRAS and GIS technologies (http://floodinfo.pk).



Flood Risk Estimator (Source: http://floodinfo.pk)

3.5 Land Record Management Information System (LRMIS)

Computerization of Land Records was started by the Government of Punjab aiming at better service delivery and improved tenure security. The project is funded by World Bank. The project has many components that include data entry, legacy records, software development, business process reengineering and automation, and establishment of service centers. The project is not completed yet. (LRMIS-P, 2015 and http://lrma.punjab-zameen.gov.pk/)



Land Records Managemnet Information System
(Source: http://lrma.punjab-zameen.gov.pk/)

3.6 Value of Projects for SDI

It is evident that the projects described above do not comply with SDI requirements. Investigation of the projects while considering SDI components is described below.

3.6.1 Geospatial Data

GIS can not be developed without geospatial data. All the projects listed above are based on geospatial data as well as aspatial data.

3.6.2 Metadata

Metadata is the core component of SDI and it helps to discover the right data/information that fits for the purpose. Exclusive data discovery coupled with metadata catalogue has not been found in all the projects. However little legacy land record discovery mechanism has been found in Land Record Management Information System (LRMIS) project.

3.6.3 Clearinghouse

Clearinghouse is a distributed hub of data providers that offer its resources (maps and data) to the users. For data discovery in clearinghouse, data providers publish metadata of resources to describe its data quality, characteristics, and accessibility mechanisms. As no exclusive metadata catalogue was found in the projects, so presence of clearinghouse in such projects could not be established.

3.6.4 Standards

Standards are helpful in the development, sharing, and use of geospatial data. Information about the standards to develop, process and utilize the geospatial data in these projects has not been found on the relevant websites.

3.6.5 Framework

The framework is a crucial building block of SDI. Frameworks are shaped to aid cost effective data production and use by employing encouraging business practices and institutional relationships while considering technological and procedural aspects. Institutional, technical, organizational, financial and legal frameworks are usually developed for SDI. No exclusive framework for the projects has been found on the relevant websites, except legal matters pertaining to Land Record Management Information System (LRMIS).

3.6.6 Partnerships

Partnerships are essential to reduce cost and deliver efficiently. In most of the projects partnership among national/international public as well as private sector organizations has been seen.

Value of projects for SDI components is summarized in Table 4.

Table 4: Value of Projects for SDI

SDI Component	P1	P2	P3	P4	P5
Geospatial Data	√	√	√	√	√
Metadata	X	X	X	X	X
Clearinghouse	X	X	X	X	X
Standards	X	X	X	X	X
Framework	X	X	X	X	X
Partnerships	√	√	X	√	√

P1. Pakistan Education Atlas
P2. National Environment Information Management System (NEIMS)
P3. Census of Schools in Punjab, Pakistan
P4. Flood Risk Estimator
P5. Land Record Management Information System (LRMIS)

4. CONCLUSION

Is GIS a small talk in the era of SDIs? The answer is "Yes". Although GIS and SDI approaches complement each other, however they also contain important contradictions. The infrastructures such as SDIs can be seen as information systems as they contain everything you find in an Information System (IS). But an infrastructure is something more than an IS. SDIs can be seen as an extension, combination, substitution and superimposition of the bits and pieces that already exist in the form of GIS. Therefore, Government of Pakistan (GoP) should focus on establishing SDI rather than GIS to avoid duplication of efforts as well as wastage of public money and time.

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BIOGRAPHICAL NOTES

Munir Ahmad is data management coordinator at Survey of Pakistan and Ph.D. Scholar at Preston University, Islamabad-Pakistan. He joined Survey of Pakistan in 1999 and dedicatedly contributed his services for seven years in the discipline of Geospatial Data Production. In 2004 he got his Master Degree in Computer Sciences (MCS). He earned post graduate diploma in Land Survey in 2007 from Survey Training Institute, Islamabad-Pakistan and since then he in involved in Geospatial Data Management using proprietary as well as open source tools . In 2013 he got Master of Science Degree in Computer Sciences (MSCS) from AIOU, Islamabad-Pakistan. Presently he is working on geospatial metadata profiling and standards in Survey Pakistan. He is adding geospatial knowledge as practitioner, developer, and researcher.

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In 2008, he earned Master of Science Degree in Geo-information Management from ITC, The Netherlands. Presently he is working as Central Database Administrator in Survey of Pakistan. He has been identified by SDI-Asia and Pacific as focal point for SDI in Pakistan. He is contributing towards geospatial knowledge and technologies as developer, researcher and author.

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