Spatial Data Infrastructure for Metropolitan Bangalore: Opportunities and Challenges

S. Gopi Prasad, B. Shankar

Abstract:- ***The Spatial Data Infrastructure (SDI) at the metropolitan level isdescribed as the "implementation of a framework comprising of geographical data, the technology, human resources, Policies and standards". The objective is to allow the use of spatial data in an efficient and flexible way for the identified stakeholders in the Metropolitan area to achieve the better planning and city management. The Bangalore Development Authority (BDA had initiated the implementation of the Metropolitan Spatial Data Infrastructure (MSDI) within the jurisdiction of Bangalore Metropolitan Area early 2003. The overall goal of the initiative was to enable BDA to effectively carry out urban planning , assist in decision making, regulation and enforcement, as well as to host the spatial data for other stakeholders , by becoming a nodal base mapping agency or centre. The formal implementation of the initiative has been in co-terminus with the approval of the Revised Master Plan 2015 in the year 2007. Subsequently, there were various additional initiatives that have been taken up based on the needs of BDA and other Stakeholder. The paper traces the important follow-up initiatives for implementation of MSDI by illustrating cases. An attempt is made to highlight the opportunities and challenges for effective of metropolitan spatial data infrastructure as a platform for all the stakeholders.***

Keywords: Spatial Data, Infrastructure, Metropolitan, Land Use, Water Bodies

I. INTRODUCTION

The Spatial Data Infrastructure (SDI) at the metropolitan level is also similar to SDI in literature, it can be described as the "implementation of aframe work comprising of geographical data, the technology, policies, standards, human resources, and related activities necessary to acquire process, distribute, use, maintain and preserve spatial data."(1), metadata, users and tools that can enable interaction and to connect. This is to allow the use of spatial data in an efficient and flexible way for the identified stakeholders in the Metropolitan area for achieving the planning and management objectives. For the Metropolitan Spatial Data Infrastructure (MSDI) implementation, one of the key principles is that data and metadata should not be managed centrally, but by the data originator and/or the owner. The resulting tools and services connect via computer networks to the various sources. A Geographical Information System (GIS) is central platform for deploying individual nodes at the stakeholder level within an SDI. The challenges for successful implementation of MSDI and its sustenance over a period of time include several factors. Pramod (2006), et al highlight the technical, financial, organizational, and a detailed account of institutional and policy-level challenges. In the context of the National Spatial Data Infrastructure (NSDI), describe the missing link between the National Map Policy (NMP) and SDI(2). The relationship with the various initiatives such as the MSDI developed at the city level and under NIUS schemes with the overall national initiatives are found to be missing. Based on the problems of developing countries and based on the Bangkok experience of the Land Information System (LIS) implementation, Ian Bishop, et al (2000) point out that simple, low cost, project oriented, easily maintainable, user-friendly spatial information technologies have the best chance of success (3).

II. METROPOLITAN SPATIAL DATA INFRASTRUCTURE INITIATIVE IN BANGALORE

Bangalore is the fifth largest metropolitan city in India with a population of 8.5 million (Census of India:2011) and has witnessed growth of 44.60 % in the last decade. Pre-empting such a rapid growth and development of the city, the Bangalore Development Authority (BDA) as the statutory planning authority for the Bangalore Metropolitan Area (BMA) with an area of 1307 sq.km had initiated the implementation of the Metropolitan spatial data Infrastructure (MSDI) and the revision of the Master plan for the BMA in the year 2003.

The MSDI initiative (Oliver et al: 2007,) by BDA includes:

a. Revision of the Comprehensive Development Plan for 2015 (now termed as the "Revised Master Plan 2015" to address growth, sprawl, infrastructure, housing and environment within a realistic land use development objective.
b. Creation of a Digital Urban Spatial Repository(DUSR) for BMA which comprises of a digital base-map for BMA area relevant for planning and sharing of data with other stakeholders. It needed to be updated regularly and be enabled to share across the various stakeholders of the city.
c. Development of digital tools for the visualization of data such as the MSDI Visio™, KIOSK and subdivision/Layout management tools.(Vivian: 2007).The VISIO- land use/ cadastral/ satellite image overlay visualization tool (named as Drushti tool)
d. Capacity building programme to enable the staff of BDA to use and maintain the MSDI.

The overall goal of the exercise was to enable BDA to effectively carry out urban planning , assist in decision making, regulation and enforcement a well as to host the spatial data by becoming a nodal base mapping agency or centre for all stakeholders of BMA. The formal implementation or completion of the exercise has been in co-

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terminus with the approval of the Revised Master Plan 2015 in the year 2007. The important follow-up initiatives to the MSDI initiative and its components are highlighted in the following sections.

III. COMPONENTS OF MSDI

A. Revision of Master plan 2015

The Revision of the Master Plan (RMP)2015 uses the spatial data, mainly of the high resolution satellite imagery, NRSA Ariel photographs and derived base maps. While thesalient features and the conceptual components of the revised master plan has been reviewed in various papers and official documents of the BDA such as the Vision document, the themes of the master plan such as road infrastructure development, environmental management, development controls in from of constraints and dissemination of the above information to the various actors of city development has utilized the MSDI in a significant manner.

B. Digital Urban Spatial Repository (DUSR)

This component had to be maintained by BDA as nodal mapping centre. Data sharing was to be made possible through a common base map and numerous data sets created by BDA for its revision of the Master plan. Though, the BaseMaphas been shared with the other stakeholders the dynamic and updation of data and upgradation of the data has not happened. In addition National Informatics Commission (NIC) was involved with the creation of base mapping at the scale of 1:500 initiatives. However these have not yielded the desired outcome of setting up the common spatial repository. Administrative and institutional challenges in setting up the nodal centre mainly in the procedural and day to day management along with the financial support are missing. Apart from the technical constraints, human resources required to man the centre require training and a conducive working environment similar to the private sector for its efficient functioning.

C. Layout Management Tool

This is a subdivision planning tool, thathas enabled collection of data related to the various land developments such as group housing, sites and services projects of both the Public authority and the private sector. This tool has not been utilized fully as it requires constant updation and use for planning new developments. BDA , since the incomplete formation of Arkavathy layout in 2005 has not executed any new developments.

D. KIOSK

The KIOSK was intended to showcase the various landmarks in the city and assist in a guided tour. This has not been updated nor maintained. The emergence of new tools like Google earth, Street view has superseded the potential benefits from this tool. The technological obsolesce is observed for this tool. The poor interest shown by BDA and incomplete implementation has led to non-usage of the tool.

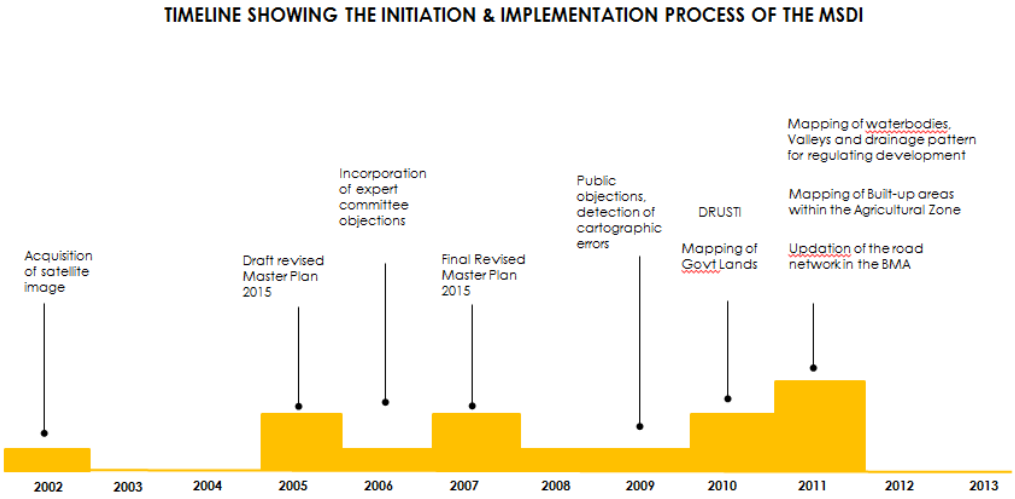
E. Visio/ Drushti

Besides these projects BDA has also taken significant steps towards making the MSDI more accessible and usable by the BDA personnel and well as the citizens. While data sharing was one of the most important objectives of the MSDI, knowledge dissemination and visualization were also important aspects of the project. The original MSDI Visio – a spatial query tool was expanded to form an online tool named “Drushti”. The tool is hosted in the BDA website which enabled querying and extraction of data from the MSDI. Data in the form of Existing land use (ELU), proposed land use (PLU), Zoning Regulations and information from the satellite image could be queried. The application comprises of information about the private layouts, the exact position of the civic amenity sites, parks, playgrounds, roads, telephone towers, drains, railway lines and railway stations, bus stops and many other facilities in Bangalore. The application helps in faster and accurate retrieval of information

Fig. 1: Application of MSDI in Bangalore Source: BDA, Bangalore, 2014

The tool works with a registered user login and password on a client server model. There have been over 1647 registered users on the website with an average over 1800 hits or queries per month since 2010. The updation of the MSDI and the various

initiatives across the timelines are shown below:



IV. INITIATIVES IN BANGALORE METROPOLITAN AREA

A) Mapping of Government Revenue Lands, 2010

BDA initiated the mapping of government land to identify and locate the land belonging to the Government within the BMA area. This initiative is assisting BDA in regulation, enforcement and explores the potential of using the lands for its own affordable housing as well as infrastructure. The land parcels owned by the Government land parcels were listed from the revenue department of the Karnataka government. The revenue department has online tool and platform called the "Bhoomi" which enables citizens to access the Rights Tenancy certificates (RTC) as well as the property information.

The entire area of the BMA was carved as sectors and the lands were mapped by using total station surveys, remote sensing and overlay of cadastral information, followed by the field visits and matching with the revenue records. This initiative has assisted mainly BDA and the various stakeholders to understand the land resource in BMA and for suitable planning and implementation of projects.

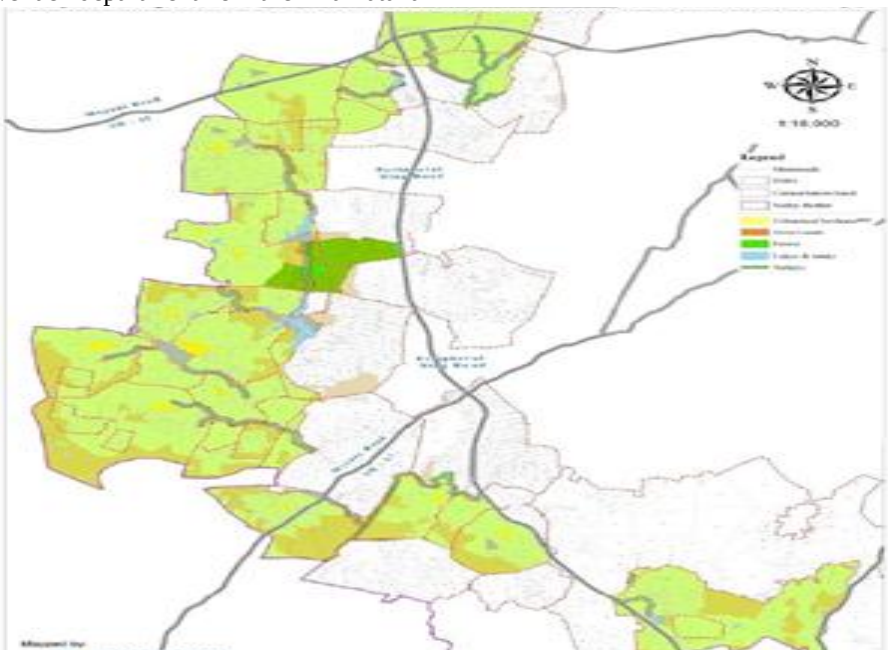


Fig.2: Map Showing Government Lands, Urbanized Settlements, Forest Water bodies and Villages Source: Sky Group, Bangalore, 2011

B) Mapping of Water bodies, Valleys and Drainage Pattern for Regulating Development, 2011

The RMP 2015 has identified the environmentally sensitive land areas in the BMA such as the water bodies, valleys, drains and Nallahsin an attempt to protect the natural drainage system.The identification of the features were at a macro scale on scale of 1:5000 and 1:10000 maps. This level of information is inadequate to address the enforcement required during the approval process for development. BDA had initiated the two step process of detailed mapping at larger scales and then deriving corresponding ownership information through the cadastral and revenue records to issue notices. The areas falling under the Tanks and Valleys within the BMA were mapped through use of

remote sensing and cadastral information. Automated notice was generated for the entire survey number coming under the "buffer" or constraint area.

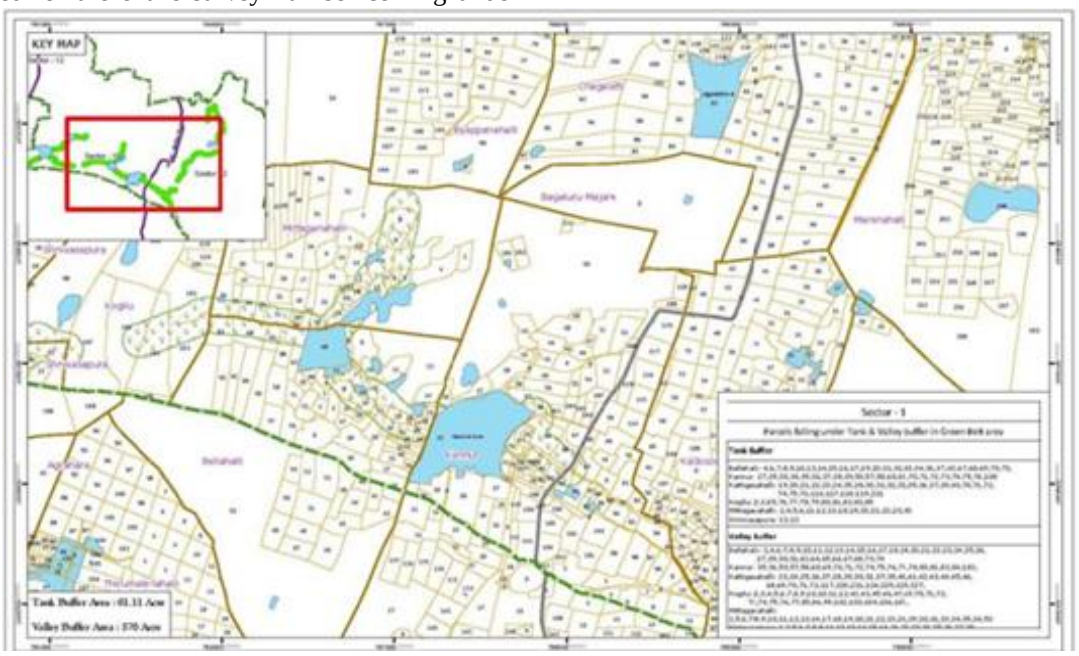


Fig.3: Built-up Areas, Agricultural Areas and Water Bodies; Source: Sky Group, Bangalore, 2012

A total of 72,105 notices were generated (26,853 for tanks and 45,252 for valleys) (3) through an automated programming process. This resulted in all parcels identified getting a notice irrespective of the extent of the area coming under the buffer or if the parcel has further undergone mutation. Various objections to the "identification" of parcels and the notices were reconciled within the database. This initiative has brought about a widespread awareness amongst both the stakeholders and the public at large.

C) Mapping of Built-Up Areas within the Agricultural Zone, 2011

The RMP 2015 delineates an agricultural zone (419.5 sq.km), with restrictions on potential development. A limited and less intense landuse is proposed mainly serving the agricultural activity. During the course of the master plan and the aftermath, several changes on the ground were detected, thereby calling for a thorough mapping of the developments in the agricultural zone.Remote sensing techniques were utilized to assess the built up area on 2010 dated imagery. The exact outcome in form of changes in policy or recommendations for changes in the regulation is not well understood. This data is not available in the public domain or published by BDA.

D) Updating of the Road Network in the BMA, 2011

The RMP 2015 classifies the proposed transport network as 'existing roads', 'roads to be widened' and 'roads to be created'. A project on Revision of Road Network in BMA was undertaken to update the road inventory and propose new roads. This was carried out by the mix of topographic surveys, on field reconnaissance visits and the remote sensing techniques. It facilitated the feasibility of constructing the new roads in the peripheral areas of the conurbation and identification of the survey numbers (land parcels) impacted by the proposed road developments. The projects helped the development authority in regulating the proposed developments and helping citizens to have a clear picture of the future road networks.

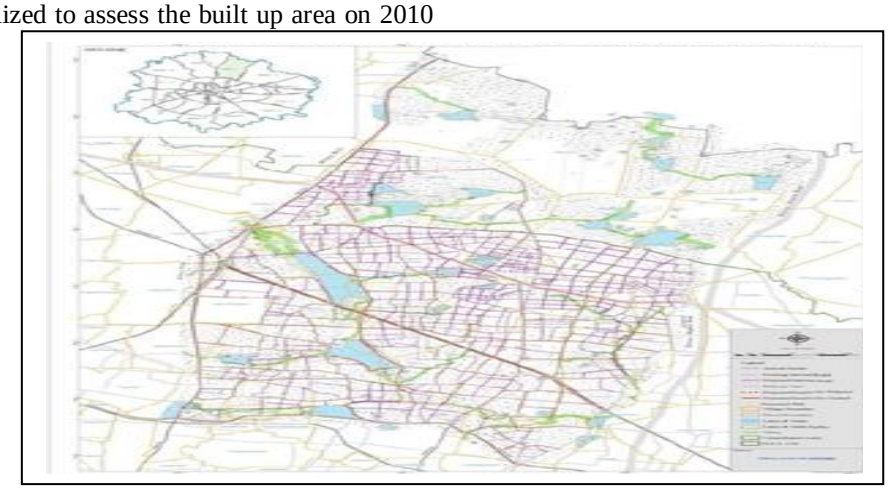


Fig.4: Networks of Roads; Source: ides consulting, Bangalore, 2011

V. OPPORTUNITIES

While the sharing of the MSDI data was consistent between the stakeholders in the early stages of the implementation, the MSDI is yet to be established as the central and common working platform for exchange among the various departments /agencies in Bangalore. The exchange of data is on need basis and larger exchange/sharing policy and protocol is not available. As the usage of data is intermittent, with very little integration to the existing business process, BDA has chosen to source support services from external consultants. Most of the information is historical and the real-time operations are yet to be integrated. Capacity building among government personnel during the implementation has enabled the understanding of the needs for sustaining the digital tools and its potential usage (5). (Anjali,2010).The use of GIS in their data formats are widely used in other stakeholders, such as the ULB for property taxes, water supply, Transport and the Power Corporation.

VI. CHALLENGES

The integration of the tools and the spatial data usage within the business process is one of the key goals for the MSDI in the future. The tools such as the Drushti can be interlinked with internal management applications for effective monitoring and enforcement. The other initiatives taken up the stakeholders such as the Bruhath Bangalore MahangaraPalike (BBMP) and Bangalore Metropolitan Regional Development Authority (BMRDA) can be brought under the spatial cell. Integrating transportation information to avoid congestion, environmental features, on ongoing projects need to be taken up for real time monitoring and control. However in the context of institutionalizing the initiative, policy decisions related to the setting up of the cell with capacity and adequate budget is required to be put in place. In the context of collection of data and through crowd sourcing and volunteer networks, challenges are how to incorporate the initiatives, expand the SDI concepts into practice and lower level of the BDA's working. By reducing duplication and facilitating integration and development of new and innovative business applications, SDIs can produce significant human and resource savings and returns (6)

VII. CONCLUSIONS

The rapid growth of new tools such as satellite imagery viewers, participatory mapping and mobile applications have begun to provide citizen access to geospatial tools as well, making some of the SDI core/framework data themes readily available for use by government, business and citizens.In light of the smart city initiatives, the data repository can be opened for the development of applications. The potential for the fuller use of the MSDI initiative is promising.

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REFERENCES

1. The White House, Office of Management and Budget (2002) Circular No. A-16 Revised, August 19, 2002, https://en.wikipedia.org/wiki/Spatial_data_infrastructure,
2. Pramod K Singh, Spatial Data Infrastructure in India: Status, Governance Challenges, and Strategies for Effective Functioning-International Journal of Spatial Data Infrastructures Research, 2009, Vol. 4, 359-388.
3. Ian Bishop, et al, Spatial data infrastructure for developing cities: Lessons from Bangkok experience, *Cities*, Vol. 17, No. 2, pp. 85–96, Pergamon, 2000 Elsevier Science Ltd.
4. VivianRaiborde, 2007, Metropolitan Spatial Data Infrastructure Empowering Government Authorities Through Modern Spatial Tools and Techniques, accessed at http://www.gisdevelopment.net/application/urban/overview/ma06_83.htm.
5. Anjali Karol Mohan, ChampakaRajagopal, Outsourcing Governance? Revising the Master Plan of Bangalore, 46th ISOCARP Congress 2010, Pg.8t http://www.isocarp.net/Data/case_studies/1810.pdf.
6. Abbas Rajabifard, Ian P. Willamson,SPATIAL DATA INFRASTRUCTURES: CONCEPT, SDI HIERARCHY AND FUTURE DIRECTIONS, http://csdila.unimelb.edu.au/publication/conferences/SDI_concepts_Iran.pdf.
7. Olivier Toutain and S. Gopiprasad, Planning for Urban Infrastructure, India Infrastructure Report, Oxford University Press, 2006.
8. Gopi Prasad S and Shankar B: " Land Use Planning for Social Infrastructure in Bangalore Metropolitan Area: Issues and Policies", International Journal of Recent Technology and Engineering, Volume-2, Issue-5, Nov. 2013
9. Gopi Prasad S and Shankar B: "Transitioning Cities: Choices And Agenda To Address Growth And Management: The Case of Bangalore", International Journal of Modern Engineering Research, Vol. 3, Issue. 6, Nov - Dec. 2013.
10. Bangalore Development Authority, Revised Master Plan 2015- Vision Document, 2007.
11. Bangalore Development Authority. www.bdabangalore.org
12. Interview with BDA EDP cell and Town Planning Department, Engineering department, With Private sector technology vendors M/s. Sky group M/s. ides consulting private ltd. M/s. Geogo technologies.
13. www.esri.com/sdi
14. https://en.wikipedia.org/wiki/Spatial_data_infrastructure
15. www.csdila.inimel.edu.au
16. http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/download/138/224
17. www.elsevier.com/locate/cities

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