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Innovative use of Geo-informatics Technology in e-Governance for District Urban Development Agency (DUDA), Narmada District, Gujarat State

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Abstract In order to make the process of monitoring government schemes and municipal activities more rational and transparent, geo-informatics based Municipality Decision Support System (DSS) has been developed by creating the database of all the municipal activities. The municipality DSS is a dynamic web-based system aimed at supporting decision makers take optimal decisions on various municipality activities such as resource prepositioning, gap analysis, prioritization, and resource optimization along with the day-to-day tasks to be accomplished by concerned officials. The main purpose of this software was to help the municipal authorities for various operations like: i) planning and development, ii) transparency of operations, iii) equal distribution of public funds, iv) implementation of various schemes under direct supervision of the municipal authorities. In the present study, Indian Remote Sensing Satellite (IRS) LISS-III (24 m resolution) and LISS-IV (5.8 m resolution) data covering the study area have been used for preparation of various thematic layers. Good governance is being recognized as an important goal by many countries across the world. Gujarat is a frontline State in the implementation of e-governance policies & projects and setting up of key infrastructure for e-Governance. The major vision of e-governance in Gujarat state is Minimum Government, Maximum Governance and institutionalizes 'Digital Gujarat' – towards the fulfillment of the larger vision of 'Digital India'. Every urban area needs GIS – a comprehensive map-based Geographical Information Systems (GIS) that powers urban planning and urban management. Therefore, the major vision of DUDA GIS was to develop a decentralized Ward Level e-Governance System and Web Based Monitoring System for the Municipality. For this purpose municipality needs a detailed and reliable digital database in Geographical Information System (GIS).
Keywords *e-Governance; Digital Gujarat; Decision Support System (DSS); dynamic web-based system; Indian Remote Sensing Satellite (IRS) LISS-IV (5.8 m resolution); sustainable development and inclusive growth of the State*

1. Introduction

In India during next decade, nearly fifty per cent of the population will be living in urban areas which will have a great challenge for urban development and management. This large scale urbanization will require to plan and develop urban areas in a systematic manner for improved quality of life in the urban areas. One of the major requirements for urban development is to have the accurate and timely information in geospatial forms that allows generation and use of different maps, GIS data and applications. Information of urban areas that characterizes the Social and Economic environment, Physical environment, services and amenities are critical in planning and development of urban areas. At the same time, the urban area also requires Urban Management as details of town planning or municipal functions – especially, regulation of land uses, building by-laws for management activities in urban planning, taxation and revenue, urban amenities planning, urban infrastructure management etc. Every urban area needs GIS – a comprehensive map-based Geographical Information Systems (GIS) that powers urban planning and urban management. The GIS must meet the needs of the city – at different levels of administration/planning/management, be based on modern data sources such as satellite and GIS databases, provide GIS-Decision Support System (DSS) for urban planning/management (www.mapmyindia.com). An overview of DSS in the area of solid waste management with specific reference to their development and applications in India has concisely been presented by Ohri and Singh, 2010.

1.1. Developments in the area of e-Governance in India

Among developing countries, India has been an early adopter of e-governance. The first wave can be considered to have evolved bottom-up. The Gyandoot project in Dhar district, which begun in 2000, and the successful effort during 2000-05 of e-governance in India, was Rural e-Seva in West Godavari district of Andhra Pradesh, were considered the forerunners in this direction. The second phase of e-governance in India started with inauguration of the National E-Governance Plan (NeGP) in 2006. Decentralization, right to information and community monitoring, as other three key areas of governance reform in India apart from e-governance, all aim at greater bottom-up participation, and accountability (Singh, 2012).

1.2. Citizen Centric e-Governance for India

Good governance is being recognized as an important goal by many countries across the world. These countries have taken up specific initiatives for open government. Freedom of information is being redefined and supported by detailed guidelines. The Internet revolution has proved to be a powerful tool for good governance initiatives. An important dimension of the Internet potential is the possibility of providing anytime-anywhere services. e-Governance has to be citizen friendly. Delivery of services to citizens is considered a primary function of the government (Abdul Kalam, 2014).

The ambitious Direct Benefit Transfer (DBT) system of the Government of India has been envisaged as a radical transformation in service delivery that bypasses the inefficiencies that traditional service delivery mechanisms have faced. Under the system, funds are transferred by banks directly to bank accounts of beneficiaries. These accounts are Aadhaar-enabled, in that they are linked to the beneficiary's Aadhaar number. Beneficiaries can link their existing bank accounts or open new accounts, even no-frill ones, using their Aadhaar number. The entire process of fund disbursal to beneficiary accounts is instantaneous (Abdul Muheet Chowdhary, 2014.)

1.3. e-Governance Activities in Gujarat State

Awarded for best e-Governance, Gujarat is a frontline State in the implementation of e-Governance policies & projects and setting up of key infrastructure for e-Governance. Gujarat Government focuses

on growth and development of new & emerging technology areas. It has been increasingly using the ICT (Information and Communication Technologies) to offer citizen based service as per convenient location with an initiative to improve the reach, make services more transparent and reduce response time with reducing costs. The Government is also proactive in its Initiatives and ranks first state in the country to have made e-Governance functional in all its Municipalities and Municipal Corporations (www.gujaratindia.com/).

The major vision of e-governance in Gujarat state is Minimum Government, Maximum Governance and institutionalizes 'Digital Gujarat' – towards the fulfillment of the larger vision of 'Digital India'. It also aims at ICT-enabled all-round sustainable development and inclusive growth of the State; to provide transparent, affordable and efficient public service delivery closer to the doorstep of citizens; and to ensure the socio-economic empowerment of all through Digital Inclusion (www.vibrantgujarat.com/).

On June 23, the Chief Minister's Office (CMO), Gujarat, won the prestigious 2010 United Nations Public Service Award (UNPSA) for innovative use of information technology to address public grievances. Major eGovernance and reach of initiatives include: i) Implementation of IT strategies to accomplish effective eGovernance, ii) Integrated Workflow and Document Management System (IWDMS) is implemented across the Government Secretariat, which increases Accountability, Transparency and Effectiveness in Government administration, iii) State Wide Attention on Public Grievances by Application of Technology (SWAGAT), etc. (www.csinihilent-egovernanceawards.org/publications/SectionIII.pdf).

1.4. Concept of District Urban Development Agency (DUDA) GIS for Rajpipla

For effective implementation of a considerable number of infrastructure and social sector programs by the Urban Local Bodies, it has become essential to develop a proper mechanism at the district level to oversee and monitor the implementation of the programs by the Urban Local Bodies. Therefore, the major vision of DUDA GIS was to develop a decentralized Ward Level e-Governance System and Web Based Monitoring System for the Municipality. For this purpose municipality needs a detailed and reliable digital database in Geographical Information System (GIS). This will help the municipality to identify deficiencies both quantitatively and geographically in the field of physical infrastructure, health, education, shelter and economy, enabling the municipality to plan in a holistic manner. For proper planning and monitoring the Municipality activities the DUDA GIS System (DGS) was inaugurated by Chief Minister of Gujarat State. The main purpose of this software was to help the municipal authorities for various operations like: i) planning and development, ii) transparency of operations, iii) equal distribution of public funds, iv) and v) implementation of various schemes under direct supervision of the municipal authorities.

1.5. Key Functions of DUDA GIS

Rapid urbanization has led to basic infrastructural issues in urban areas. To mitigate these problems and facilitate urban populace with the superior quality of Infrastructure as well as to materialize the Dream of "Clean Gujarat - Nirmal Gujarat" - the Integration & coordination of various urban development polices and schemes was quite essential. Municipal GIS for DUDA provides information to about the wards and facilities available, various schemes executed by the government, grievances redressal system besides facilitating administrators/planners to have a one stop online planning tools towards better governance.

For effective implementation of a considerable number of infrastructure and social sector programmes by the Urban Local Bodies, it has become essential to develop a proper mechanism at the district level to oversee and monitor the implementation of the programmes by the Urban Local Bodies. Accordingly, DUDA GIS was conceptualized by the Narmada Collector through technical support from

the Bhaskaracharya Institute of Space Applications and Geo-Informatics (BISAG), Department of Science & Technology, Govt. of Gujarat, Gandhinagar. The key functions of DUDA GIS are as follows:

- ❖ To allocate grants to Municipality of the district under various urban development schemes.
- ❖ Ensure quality standards of development and infrastructural works in municipal areas.
- ❖ Regular reviews and evaluation of various urban development schemes and works at district-level.
- ❖ To follow orders and instructions from State-level Nodal Agency for Urban development.
- ❖ To check progress of the infrastructural works at regular interval.
- ❖ To coordinate and correspond with banks for speedy sanctioning of loans/subsidies to urban poor.
- ❖ To ensure effective and efficient utilization of allocated grants and resources in achieving desired outcome with respect to various urban development schemes.

1.6. Location of the Narmada District

Narmada district is situated in the south of Gujarat State and surrounded by Vadodara, Bharuch and Surat districts. The district is spread over 2775 sq.km, having four talukas with 552 villages, two town and 221 panchayats. The four talukas are Sagabara, Dediapada, Nandod and Tilakwada. All four taluka predominantly tribal areas and overall tribal population of the district is 78%. Nearly 90 percent population resides in villages. Nandod (Rajpipla) is the only urban centre of Narmada district which is spread over 15 km with municipal corporation class "C" as Urban Local Bodies. The Location map of the study area in Narmada district is given in Figure 1.

2. Objectives of the Study

The major objectives of development of DUDA GIS for proper planning and monitoring the Municipality activities using Geo-informatics Technology are follows:

- ❖ To create detailed and reliable database of entire municipality activities in GIS.
- ❖ To provide comprehensive e-governance solutions for facilitating and tracking the municipality activities.
- ❖ To identify deficiencies both quantitatively and geographically in the field of physical infrastructure, health, education, shelter and economy, enabling the municipality to plan in a holistic manner.
- ❖ To monitor allocation of funds to different areas, avoid duplication of grants, and organize the work in a comprehensive manner for balanced development.

3. Methodology

3.1. Satellite Data Used

In the present study, Indian Remote Sensing Satellite (IRS) LISS-III (24 m resolution) and LISS-IV (5.8 m resolution) data covering the study area have been used for preparation of various thematic layers of settlements, transport network, drainage, water bodies, thematic land use / land cover etc. The details of Satellite data products are given in Table 1.

Table 1: *Indian Remote Sensing Satellite (IRS) LISS-IV and LISS-III Data used for Rajpipla Town in Narmada District*

Satellite (Sensor)	Spectral Bands (µm)	Resolution (m)	Swath (km)	Path / Row	Date of pass
IRS LISS-IV	0.52 – 0.59 0.62 – 0.68 0.77 – 0.86	5.8	70 X 70	94 /57	17Mar-2015
IRS LISS-III		24	140 X 140	94/57	17Mar-2015
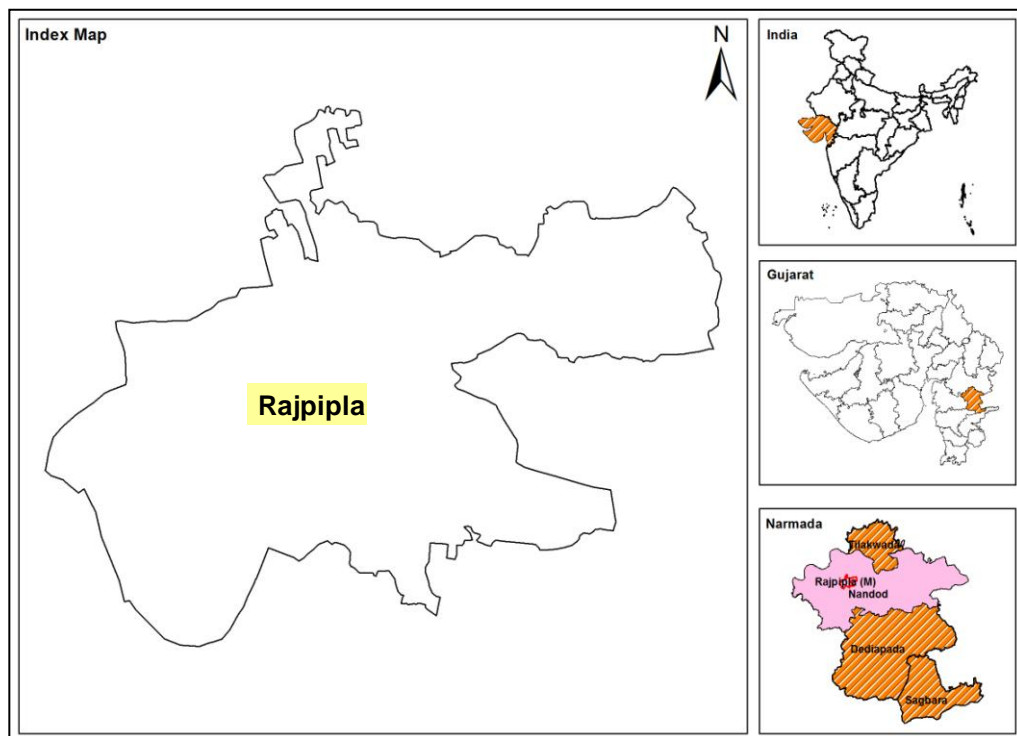
Figure 1: *Location of Rajpipla Town in Narmada district, Gujarat State*

Google image covering Rajpipla town in Narmada district was also used to study the land use pattern. The Goggle image covering Rajpipla in Narmada district is given in Figure 2 and IRS LISS-IV image covering Rajpipla town is given in Figure 3.

Figure 2: Google image covering Rajpipla Town, Narmada District

3.2. Departmental Data used

The municipal data related to various amenities and services, infrastructure etc. was collected from Rajpipla Municipal Corporation. Transport network and details about road conditions was collected from the Road and Building Department. The census data was also collected from the Rajpipla Municipal Corporation.
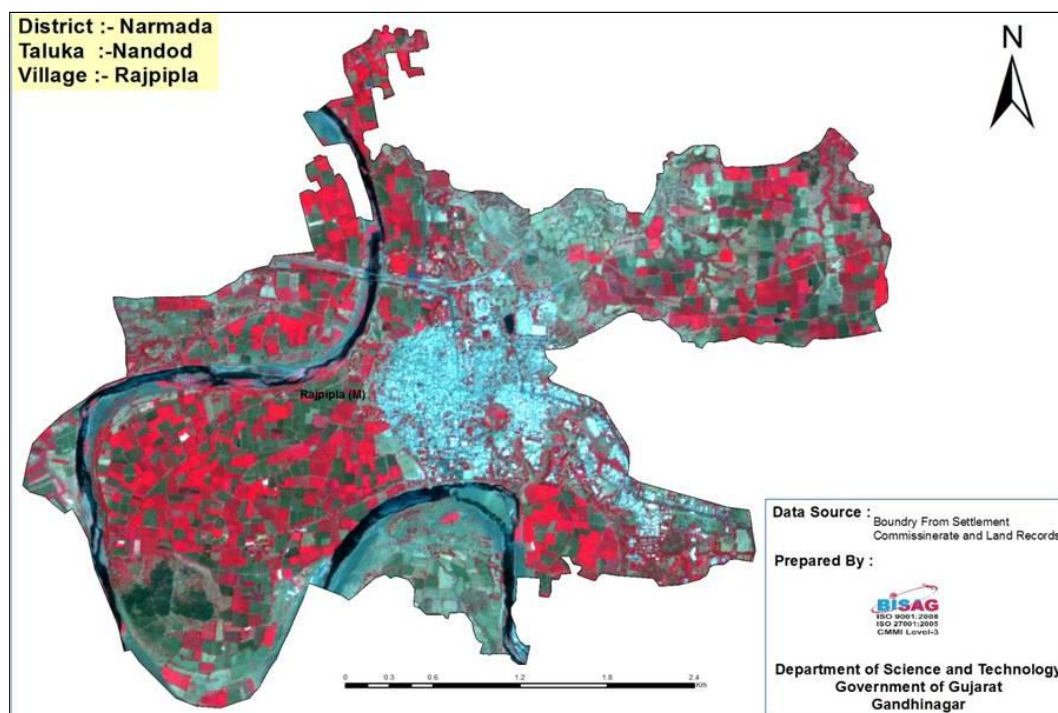

Figure 3: IRS LISS-IV image covering Rajpipla Town, Narmada District

3.3. Generation of Various Thematic Layers

Geographic Information System (GIS) is an important and efficient tool that can be used by local administrations for monitoring the Municipality developmental activities. In order to monitor the implementation of various town development schemes and to monitor the progress of various municipality activities, GIS layers and other associated thematic maps have been created for each of the wards and development activities in the Rajpipla town. The list of various GIS layers created as base administrative layers and other dependant layers for generation of Decision Support System for Rajpipla Municipality is as follows:

Taluka/ Block administrative boundary ii) boundary layers of various wards in Rajpipla town, iii) main road and minor roads road networks, iv) locations of villages, with their names, v) mapping of residential, commercial and industrial built-up areas, vi) census population data (2011) vii) Geographical locations (latitude, longitude) of various ongoing operational municipality works viii) demarcation of development plans and ongoing repairs or developmental works from the municipal corporation.

3.4. Concept of Decision Support System (DSS)

Decision Support System (DSS) is a computerized information system that supports decision making activities in a logical way based on scientific database. The useful information is compiled from the raw database to identify and solve problems and suggests appropriate decisions. The basic structure of a DSS consists of three components: database management, model base management, and user interface (Bani et al., 2009).

In order to make the process of monitoring government schemes and municipal activities more rational and transparent, geo-informatics based Municipality Decision Support System (DSS) has been developed by creating the database of all the municipal activities. The municipality DSS is a dynamic web-based system aimed at supporting decision makers take optimal decisions on various municipality activities such as resource prepositioning, gap analysis, prioritization, and resource optimization along with the day-to-day tasks to be accomplished by concerned officials. Using these geo-spatial databases, various municipality on-going and completed functional activities can be visualized and progress of the work can be monitored by the municipal authorities. The DSS is the state-of-the-art and is the most suitable solution for municipality activities. This is a Web based application built using .NET Framework 3.5 utilizing the GIS capabilities of an open source GIS Platform. This is an Object Oriented Programming model with loose coupling between various layers, which provides support for query and render the spatial data view, query and update capabilities so that users can update database. This also provides the facility to view and query the outputs in a tabular format as well as thematic map generator to visualize the various municipal activities on the thematic maps.

4. Results and Discussion

4.1. Satellite Data Analysis

The IRS LISS-IV data along with departmental maps was analyzed for creation of GIS database base of various thematic using open source GIS software. These maps were prepared on 1:5,000 scales for Rajpipla town. In the present study, two scenes of IRS-P6 LISS-IV (5.8 m resolution) data of January 2011 and March 2011 have been used for various thematic interpretations. The IRS satellite LISS-IV data have been extensively used for base map updating of settlement, transport network, drainage, water bodies, etc. in the town. The satellite data was also geo-referenced with the various departmental maps for urban land use classification like identification of residential, commercial, industrial areas etc. in the Rajpipla town.

4.2. Development Decision Support System (DSS) For DUDA

The major vision of the DUDA GIS was to develop a decentralized Ward Level e-Governance System and Web Based Monitoring System for the Municipality. This helps to monitor various activities of the municipality in dynamic and transparent mode. The DUDA GIS portal and boundaries of various wards and their numbers are given in Figure 4. This DUDA GIS portal includes all the GIS layers of most of the municipality activities which can be visualized as well as monitoring just by clicking the specific icons created on this portal.

4.3. Monitoring of Road Condition

Various infrastructures, amenities and services etc. was digitized using the data collected from Rajpipla Municipal Corporation. Transport network along with type of the road i.e. cement concrete and tar roads and details about road conditions was collected from the Road and Building Department. The roads with bad condition as well as work in progress and completed on these bad roads was also monitored using the DUDA GIS. The type of the road and condition of the road mapped from departmental data is given in Figure 5 and Figure 6.

4.4. Monitoring water Supply pipe lines and Source of water

The water supply sources like tube-wells and Elevated Storage Reservoirs (ESR) along with the location of sluice valves in the Rajpipla town were mapped from the data collected Rajpipla Municipal Corporation. The status of pipeline in terms of its diameter size, its length and their connectivity to water supply sources as well as sluice valves were also mapped in GIS environment. The status of pipe lines along with damage to pipe lines and the status of progress of repair work were mapped. In case of failure of water supply from one of the ESR to a particular locality, the alternate connection to nearby ESR along with diversion of water supply through another pipe line connection and alternate sluice valve locations were also mapped. The water supply sources, pipeline size along with location of sluice valves is given in Figure 7.
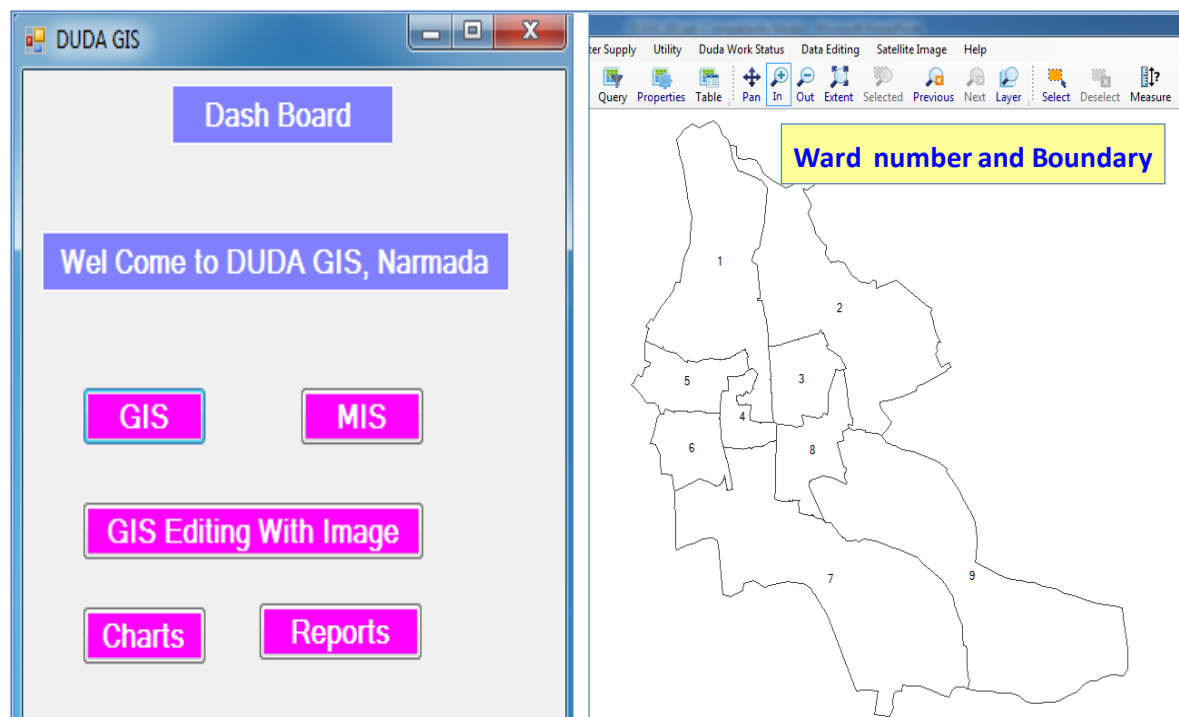

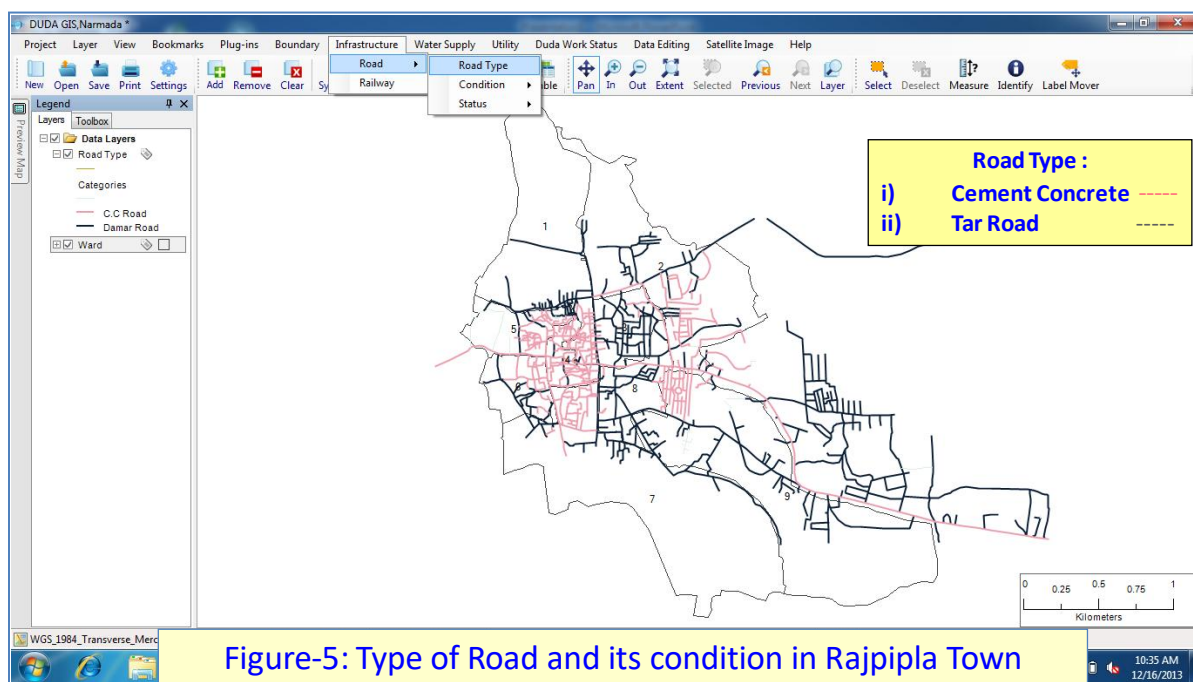***Figure 4:*** *DUDA GIS Portal and Ward boundaries of Rajpipla Town*

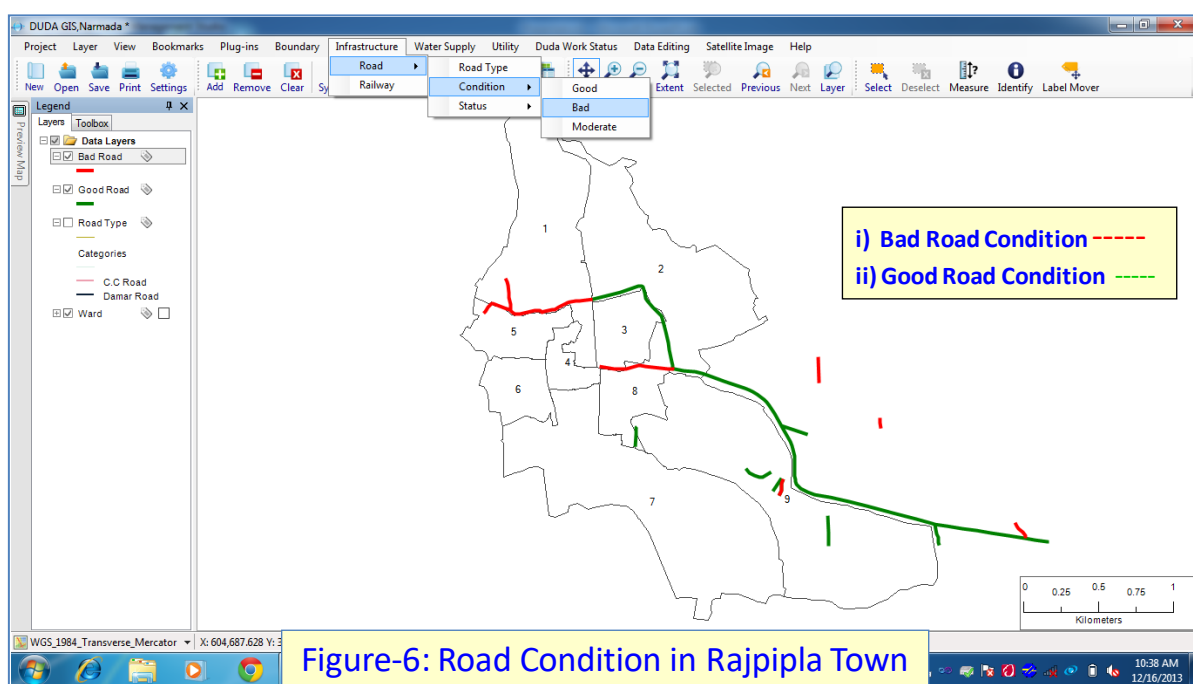Figure-5: Type of Road and its condition in Rajpipla Town

Figure 5: *Type of Road and its condition in Rajpipla town*

Figure-6: Road Condition in Rajpipla Town

Figure 6: *Road condition in Rajpipla town*

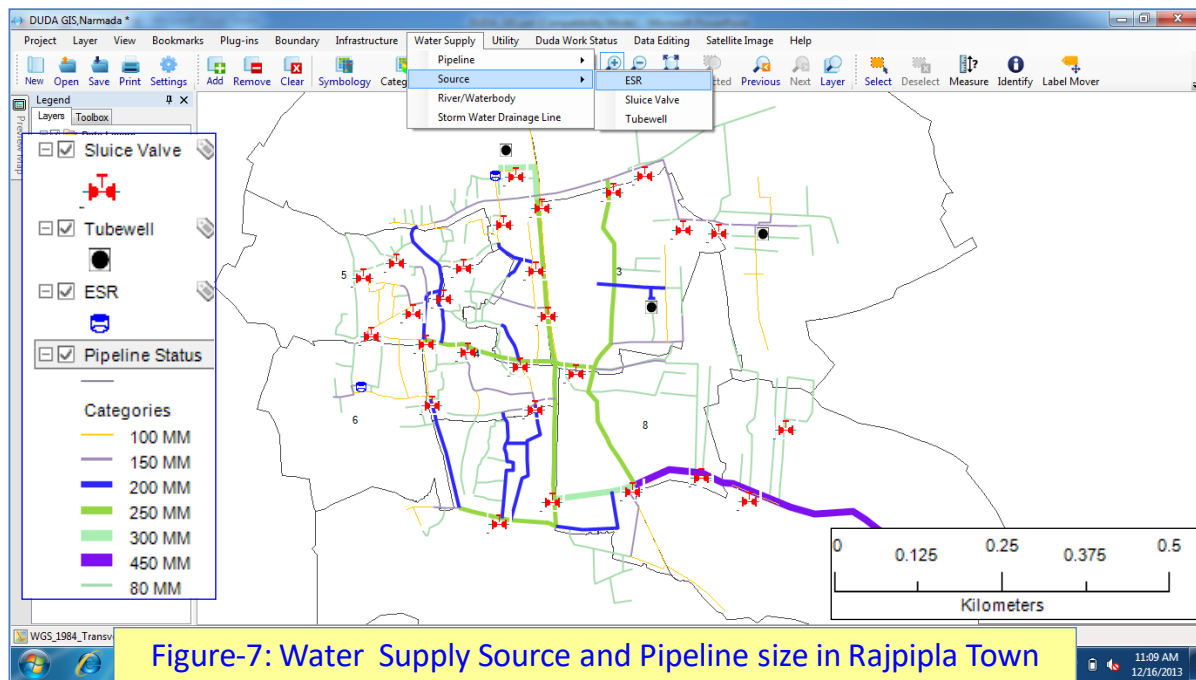Figure-7: Water Supply Source and Pipeline size in Rajpipla Town

Figure 7: Water Supply Source and Pipeline size in Rajpipla town

4.5. Urban land use classification and Mapping for Tax Assessment

The urban built-up area in Rajpipla town was classified into residential, commercial and industrial areas in each Town Planning (TP) scheme and mapped along with the transport network. This classification was carried out essentially to assess the property tax which depends on the use of that particular built-up area. The city survey numbers were also linked with each of the built-up area. This has helped in accurate tax calculation depending on the type of property. This database has also helped to enumerate the properties based on query builder having tax dues more than certain cash limit during the particular financial year. The map of the classification of built-up area into residential, commercial and industrial areas is given in Figure 8. The results of query builder the properties having tax dues more than Rs. 1800 during financial year of 2013 is given Figure 9.
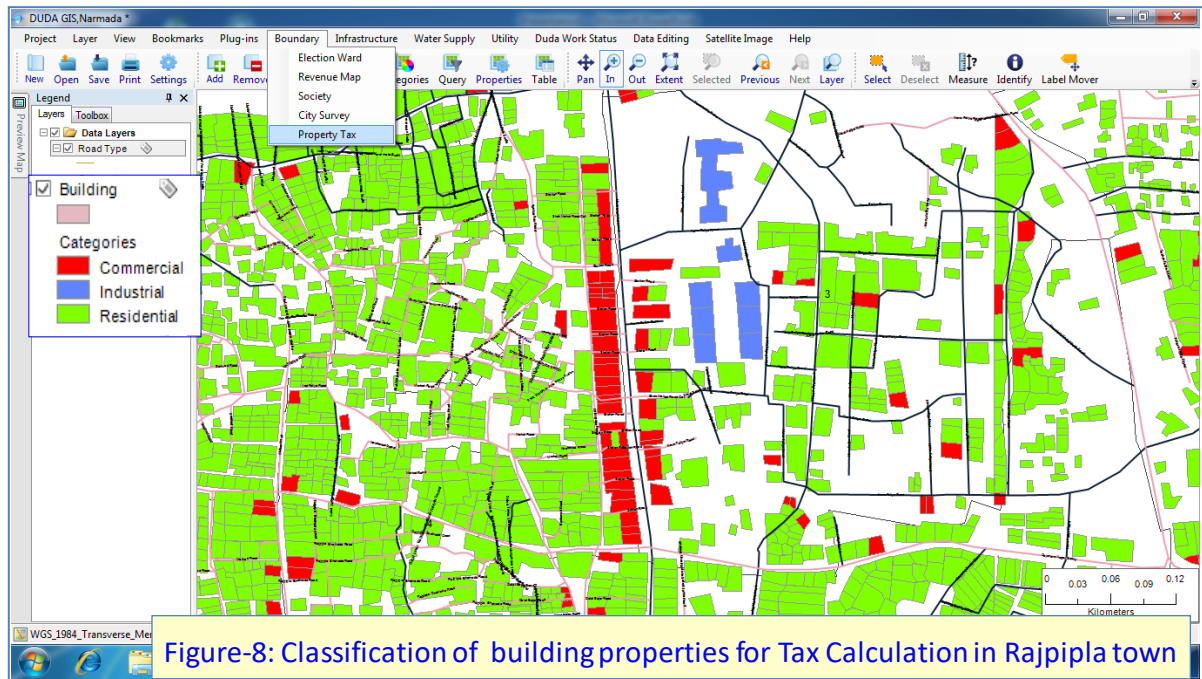
Figure-8: Classification of building properties for Tax Calculation in Rajpipla town

Figure 8: *Classification of building properties for tax calculations in Rajpipla town*
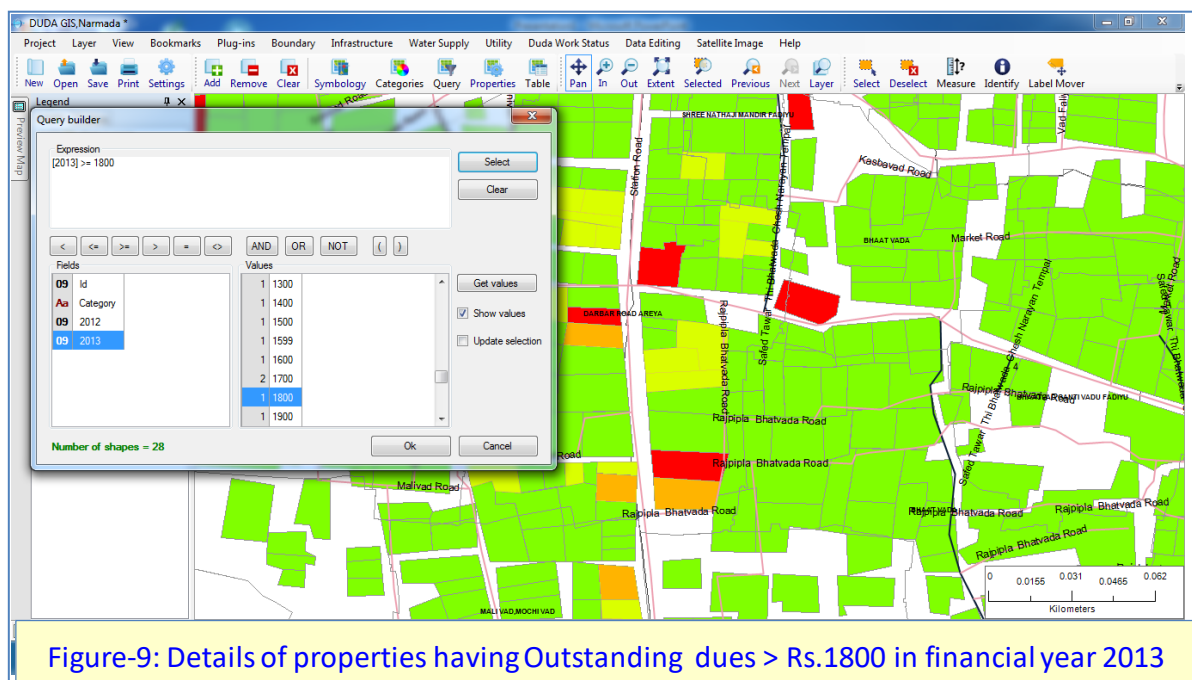

Figure-9: Details of properties having Outstanding dues > Rs.1800 in financial year 2013

Figure 9: *Details of properties having outstanding dues> Rs. 1800 in financial year 2013*

4.6. Location based utility Mapping

The location of various utilities like primary health centers, educational institutes, Aanganwadies, Public Distribution govt. Shops etc. in various wards of Rajpipla town were mapped. Apart from these public utilities other utilities like location of solid waste containers, pay-and use toilets, waste dumping

sites and location of slum pockets were also mapped. The location of various public utilities in Rajpipla town is given in Figure 10.
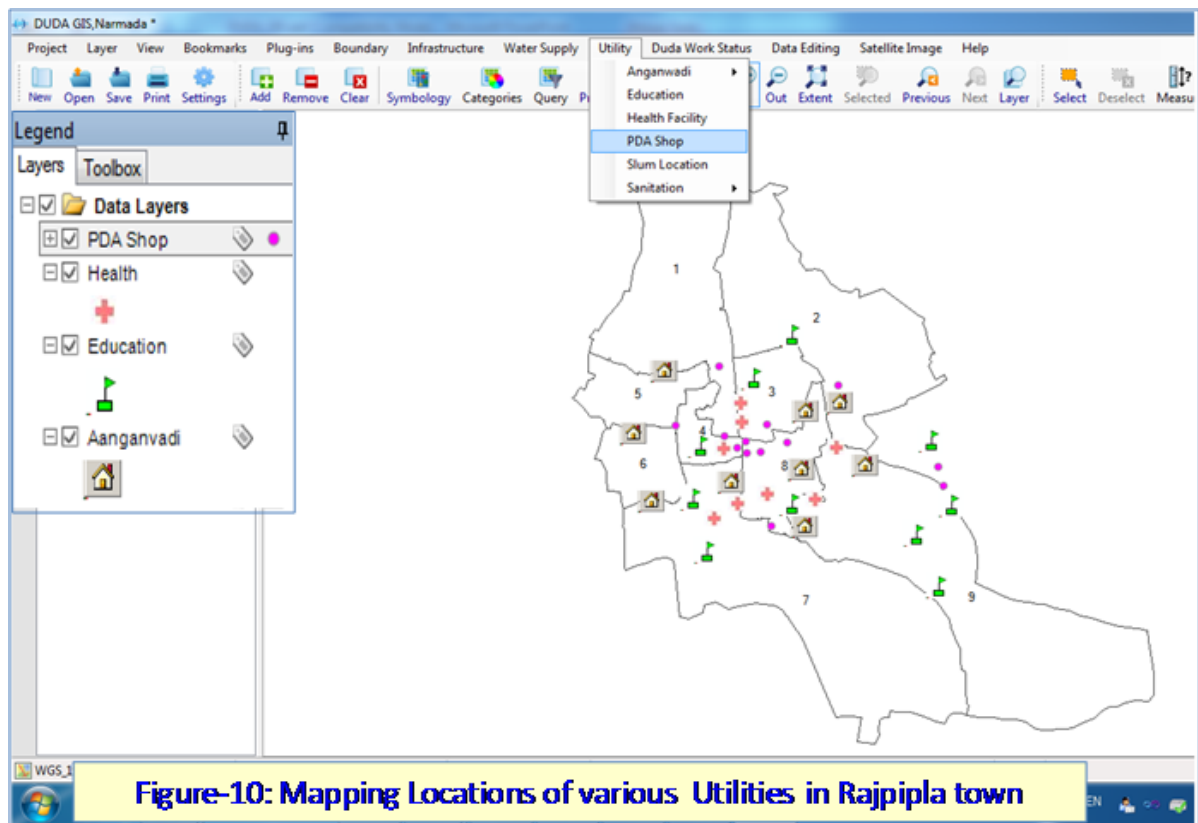

Figure 10: *Mapping locations of various utilities in Rajpipla town*

4.7. Monitoring Progress of Work and Fund Allocation Status

The DUDA Decision Support System (DSS) can effectively be used for monitoring the progress of the various works undertaken by the municipality. The query-cell developed in DSS can also be used to visualize status of funds allocation related to various municipal schemes and activities in various wards of the Rajpipla town by the concerned officials. Figure 11 shows the locations of sites in various wards where work is in progress and grants allocation status can be visualized by using the query-cell shown in Figure 12.

4.8. Major Achievements and Value added Services of the Project

The GIS Cell in DUDA is now effectively monitoring the various schemes, their completion schedule by the contractors and payment based on the satisfactory and timely completion of the work. This has helped to bring transparency in various activities of the municipality. This is one of the successful softwares for communication and dissemination of information related to municipality activities. The team work and participation of various levels of officials makes it sustainable and long lasting for monitoring activities of the municipality. The major achievements and value addition delivered to the beneficiary of the project are as follows:

❖ Linking of maps with Government Scheme has helped in development and
Control of various municipal activities;
❖ It has effectively controlled duplication of work by bringing transparency;
❖ It has ensured equitable distribution of works and funds for various schemes;

❖ This effectively helped to Identify under developed areas by visualization of various developmental schemes and online supervision;

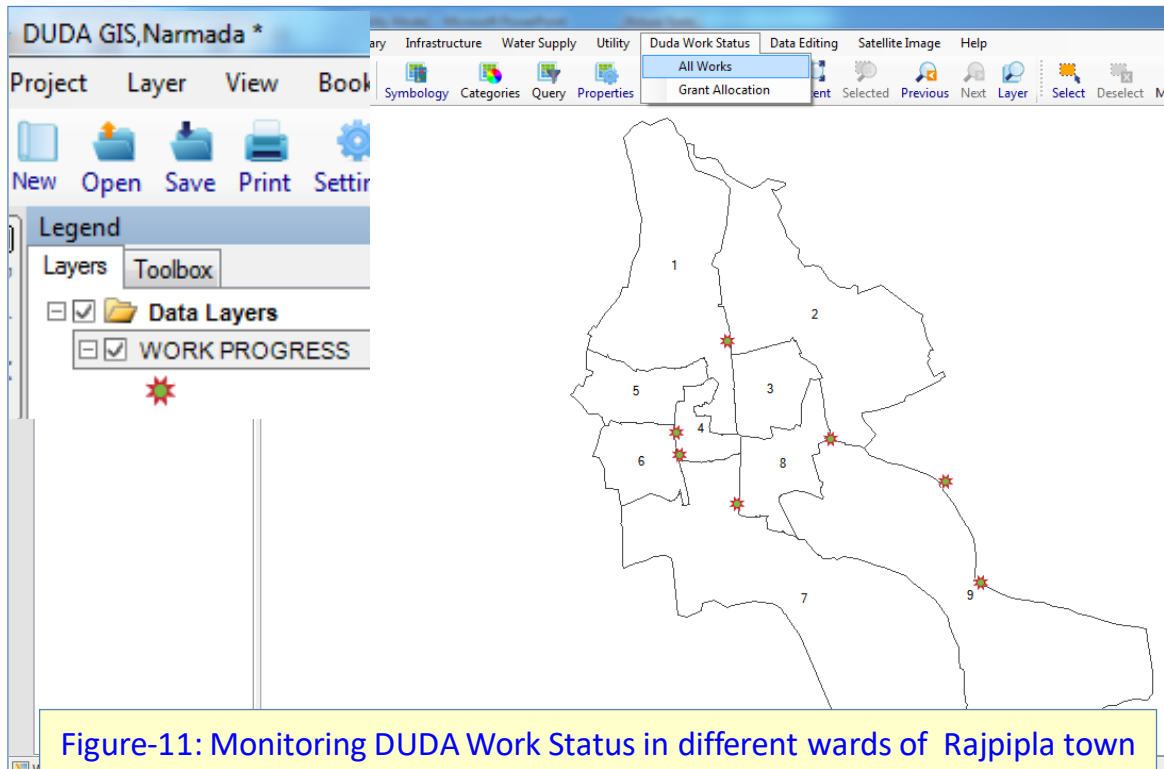❖ It has helped in planning various future developmental activities.

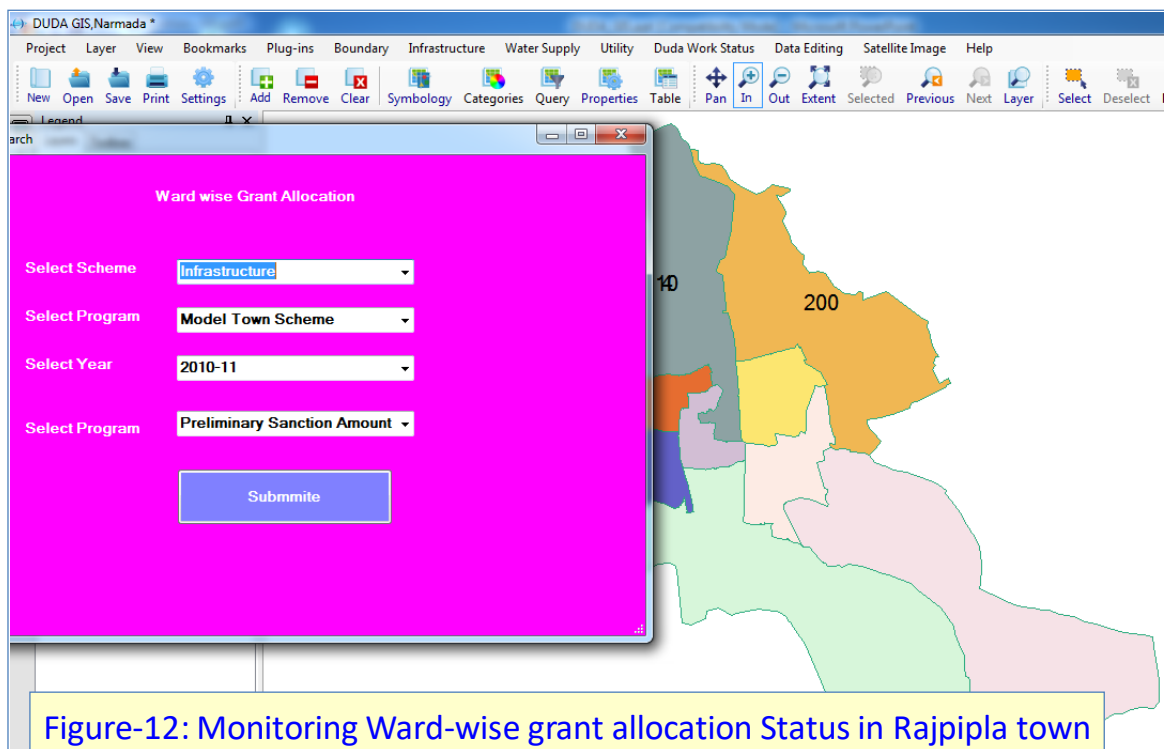Figure-11: Monitoring DUDA Work Status in different wards of Rajpipla town

Figure 11: *Monitoring DUDA work status in different wards of Rajpipla town*

Figure-12: Monitoring Ward-wise grant allocation Status in Rajpipla town

Figure 12: *Monitoring ward-wise grant allocations status in Rajpipla town*

4.9. Adaptability of DUDA GIS

- The DUDA has proactively decided to utilize this technology for the benefit of the people of the municipality with developing a well-defined institutional mechanism.

- The understanding of problems of middle level functionaries of various activities has helped to articulation of their needs and development of suitable GIS system.

- In addition to providing operational services to the departments for geospatial technology based information, developmental planning support and decision making tools for efficient utilization have also been developed in DUDA GIS.

4.10. Accountability of DUDA GIS

- DUDA GIS and MIS systems have been developed as per the specifications and requirements through understanding of various functionalities of municipal management functions.

- This DUDA GIS has helped to bring awareness from top level to bottom level functionaries of the department that has helped the directives from top level being successfully implemented.

- Essentially it has a 3-tier system of monitoring from top-level officials, middle-level and lower level functionaries bringing accountability at each level with transparency. This ensures continuity of services even when some of the officers are transferred.

4.11. Scalability of DUDA GIS

The major vision of the DUDA GIS was to develop a decentralized Ward Level e-Governance System and Web Based Monitoring System for the Municipality. This helps to monitor various activities of the municipality in dynamic and transparent mode. The system developed for the municipality of a town can be replicated for the larger towns and big cities with the help of detailed dataset from these towns using Geographic Information System (GIS). This will help the municipality to identify deficiencies both quantitatively and geographically in the field of physical infrastructure, health, education, shelter and economy, enabling the municipality to plan in a holistic manner. Even this system can be implemented in any other state of India for efficient management of the Municipality using e-Governance along MIS system.

Acknowledgments

References

Abdul Kalam, A.P.J. 2014. A Vision of Citizen-centric e-Governance for India. Compendium of e-Governance Initiatives in India, pp. 3-7.

Abdul Muheet Chowdhary. 2014. Case Studies on e-Governance in India, 2013–2014. National Institute for Smart Government, www.nisg.org.

Bani, M.S., Rashid, Z.A., Hamid, K.H.K., Harbawi, M.E., Alias, A.B. Aris, M.J. 2009. The development of decision support system for waste management: a review. *World Academy of Science, Engineering and Technology*, 49, pp.161-168.

eGovernance Policy for the State of Gujarat (2014-2019). Department of Science & Technology, Government of Gujarat, November 2014, vibrantgujarat.com.

Ohri, A. and Singh, P.K. 2010. Development of Decision Support System for Municipal Solid waste management in India: A Review. *International Journal of Environmental Sciences*, 1(4), pp.440-453.

Parminder Jeet Singh, 2012. e-Governance in India: Existing context and possible scope for UNDP programing over 2013-18. IT for Change, July, 2012.

Urban Development Solutions. MapmyIndia, www.mapmyindia.com.