Case Study

Remote Sensing and GIS Based Mapping for Water Supply and Sanitation (WSS) using High Resolution Satellite Data

Use of Geospatial technology for effective planning, construction, execution & monitoring of the drinking Water Supply schemes in the State of Maharashtra

Maharashtra Remote Sensing Application Centre (MRSAC) - An Autonomous Body under Department of Planning, Government of Maharashtra & Water Supply and Sanitation Department (WSSD), Government of Maharashtra

URL - http://www.mrsac.gov.in/

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I. Executive Summary

The objective of this project is mapping of all water supply schemes from the source to the stand post using Remote Sensing (RS), Geographic information system (GIS), Global Positioning System (GPS) & Mobile technologies and to evaluate and standardize the Water Supply Schemes, Geo-spatial database. It is aimed to design, develop and implement GIS based Mobile application for field level water source locations and its allied asset data collection, in a standardized and integrable format and to store and maintain Geo-spatial database on a central server of State Data Centre (SDC), Mumbai, Government of Maharashtra. It will develop a web browser based GIS application in Geo-portal, for seamless accessibility in G2G and G2C domain and to integrate existing Management Information System (MIS) database of WSSD and the geospatial technology based Geodatabase with Natural Resources and Administrative Database available with Maharashtra Remote Sensing Application Centre through Web Services. It aims to design and develop an online mechanism of water quality data collection, laboratory analysis and map preparation using mobile and web technologies and to design and develop an online redressal system for monitoring and management of the water supply schemes using mobile and web technologies.

The unique and maiden approach of using RS & GIS in association with the GPS & mobile mapping technology has yielded tremendous success in the area of introduction of modern geospatial technology in the day to day working of the conventional Government Department. Entire scope of this project is being concentrated on the rural and village setups, the same effort can be replicated for the urban enclaves in the country also.

1. INTRODUCTION

Water, the most precious natural resource requires judicious planning. The management of water source and its distribution to all habitations is a challenging task. In this endeavour, the latest innovative technology of Remote Sensing, GIS, GPS and mobile has opened up new vistas of adopting Geo-spatial database for effective planning, construction and execution of Drinking Water Supply Schemes. The decision support system can perform the Government process reengineering to effectively support the decision/policy makers as a centralized tool depicting the resources scenario in the State of Maharashtra.

The principal objectives of the project are:

a) Mapping of all water supply schemes from the source to the stand post using RS, GIS, GPS & mobile technologies.
b) To evaluate and standardize the Water Supply Schemes Geo-spatial database.
c) To design, develop and implement GIS based Mobile application for field level water source locations and its allied asset data collection, in a standardized and integrable format.
d) To store and maintain Geo-spatial database on a central server of State Data Centre (SDC), Government of Maharashtra, Mumbai.
e) To develop a web browser based GIS application in Geo-portal, for seamless accessibility in Government to Government (G2G) and Government to Citizens (G2C) domain.
f) To integrate existing 'Management Information System (MIS)' database of WSSD and the Geospatial technology based Geodatabase with Natural Resources and Administrative Database available with Maharashtra Remote Sensing Application Centre through Web Services.
g) To design and develop an online mechanism of water quality data collection, laboratory analysis and map preparation using mobile and web technologies.
h) To design and develop an online redressal system for monitoring and management of the water supply schemes using mobile and web technologies.

2. OVERVIEW OF THE CHAMPION AND THE TEAM

Dr. Vivek M. Kale is an Associate Scientist in Maharashtra Remote Sensing Application Centre (MRSAC). He is presently working actively for use of Geospatial technology in e-Governance application. Mr. Kale has 22 years of professional domain experience in Remote Sensing and GIS application projects, which he executed as coordinator and team leader. He is identified as "Guardian Scientist" in the field of Water Supply and Sanitation by Government of Maharashtra. He contributes to scientific discipline by way of publication of his articles in Journals, preparation of technical reports and manuscripts.

Other team members of the project include Shri Sham Lal Goyal, Additional Chief Secretary, WSSD, Govt. of Maharashtra; Dr. Shailesh B. Kanade, Water Quality Expert,WSSO, Mumbai; Dr. Subrata N. Das, Director, MRSAC; Dr. Satish D. Umarikar, Director, WSSO; Mrs. Sangita P. Rajankar, Associate Scientist, MRSAC, Mumbai and Shri Ruchesh Jivanshi, Dy. Secretary & Director, WSSD.

3. PROJECT OVERVIEW/HISTORY OF THE PROJECT

Despite the fact that there are well defined rules set up by the Government for construction and maintenance of rural drinking water supply schemes, the technology for effective implementation of the rule sets was missing. The situation before the execution of the present initiative was challenging as the time delays and decisions in pending cases were proving as bottlenecks in the Government machinery. Construction and maintenance of rural drinking water supply schemes carried out by various departments varied in its own way and lack of coordination amongst the offices of the Department further aggravated the situation. The conventional approaches using the human dependencies and age old methods of planning and execution of rural drinking water supply schemes have their own limitations.

Government machinery was on outlook for any technology solution to overcome the above situations and speed up the overall process of maintenance, monitoring, and management of the schemes.

In this endeavour, the latest innovative technology of Remote Sensing, GIS, GPS, Mobile and WebGIS has opened up new vistas of adopting geospatial database for effective planning, execution, and management of drinking water supply schemes. Thus, there was a strong need for a decision support system, which can perform the Government process re-engineering to effectively support the decision/policy makers as a centralized tool depicting the resources scenario of the cases under consideration on desktop, thus bringing transparency.

Moreover, the quality of the drinking water is always an issue for health. Timely monitoring of the water quality and its deterioration, if any, will allow the administration to take appropriate step. The present system takes long time for integration and analysis.

Realizing the potential of the Geo-spatial database, the Water Supply and Sanitation Department (WSSD) decided to entrust the work of integrated approach of designing, i.e. development of geospatial technology based activities in mapping of Drinking Water Sources, its related Assets, Linkage with Water Quality Monitoring and MIS database for the entire State to the Maharashtra Remote Sensing Application Centre (MRSAC), an autonomous body of Planning Department, Government of Maharashtra.

4. SITUATION IN CHAMPION'S STATE/DISTRICT

4.1. Problems Identified:

The known issues in the existing system were identified as below -

a. Database was not stored in centralized and standardized manner which gave problems in data accessibility and reproduction for multiple usage needs.
b. The representation of the database was in hardcopy maps and different for each district. This caused problems of unification and universal usage of the data.
c. The database was lacking spatial domain which affected the decision making capabilities of the officials of the Department.
d. Reporting of the data and its usage and status was not possible and easy.

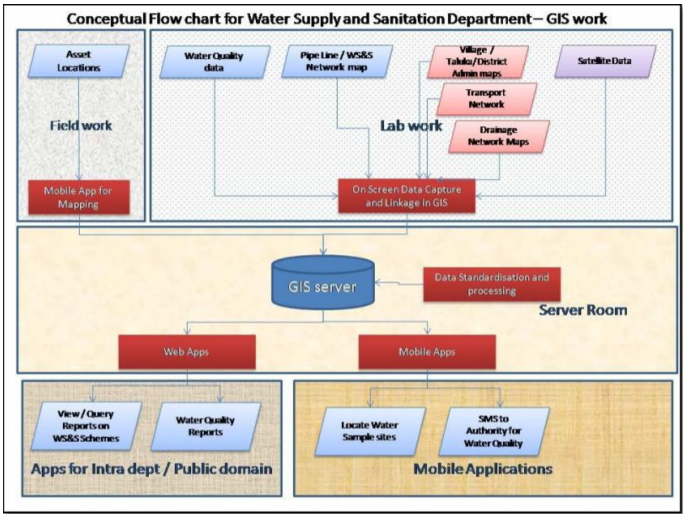
4.2. Strategy Adopted

4.2.1 Implementation model

The pipelines network from source to sink for utilization of the limited water resource was a challenge. The aging systems of earlier laid down pipeline network, its orientation below the subsurface, encroachments of the pipeline corridors by the unauthorized structures were the key points to be monitored for rollout and implementation of the ambitious task.

No other method but RS, GIS & GPS technologies were the solution in conjunction with the Mobile communication technology. However the utilization of the technology in independent formats was also getting difficult. Sporadic and isolated efforts were carried out by private companies. The exercises proved futile and no concrete results were achieved in the absence of the standards.

MRSAC with its strong hold of base geospatial database and the expertise in usage of RS & GIS technology for various domain areas came to the rescue of this challenge. The expertise of MRSAC helped in development of a unified approach of use of mobile mapping tools and integrating it with RS & GIS database. The roll out method which utilized the modern technology is spelt out in the flow chart below:-



The highlight of the effort was the method of mapping the WSS schemes using traverse method of GPS with the air valve as reference. Mapping of pipelines is very difficult and tedious job as pipeline survey is to be carried out by traversing on the pipeline.

The various items in the flow chart and their importance are as follows -

- Drinking water supply schemes and their related assets were mapped from the field using the android based mobile application *Jalsuraksha*.
- The captured field data was send to the server, processed & integrated in GIS environment.
- Water sample were collected using android based mobile application using Geofencing concept.
- Web based water quality data entry form was provided in digital mode.
- The water quality data was further processed to generate water quality map based on BIS 2011 standards.
- Web based management information system was developed to facilitate the following:

    - Generic query builder - based on water supply schemes, assets, scheme category, scheme functionality, etc.
    - Report generation on day-to-day basis.
    - Online generation of digital key plan and export to *.pdf format.
    - Online generation of Water quality maps, certificate, and reports.
    - Development of complaint redressal system for Citizen.

The entire activity provided a comprehensive Dashboard to manage the WSSD operations from a single server location as a unified system. The entire hierarchy from Secretary to ground level staff is now aligned in a single decision support channel.

No miscommunications and duplication of the tasks will happen. Redundancy is avoided.

Fair and transparent decisions are now visible.

4.2.2 Communication and dissemination strategy and approach used.

The data dissemination process include:

- All planning and information dissemination for execution of the work in the field is being done online through a “Schedulers” on Web.
- All three mobile applications are available in the MRSAC Web Geoportal (web based management system) and can be downloaded from the link.
- The asset mapping and water sample collection is being done using android mobile applications.
- The data is made available in the geoportal (https://mrsac.org.in/wssd/).

The various tools and utilities of the web geo portal are –

- Overlay of Base maps (raster data).
- Availability of base layers - Administrative boundaries, Transport network, Water Resources Layer, Landuse/Landcover, etc.
- Navigation tools.
- Identification tool.
- Departmental queries.

- Mobile based water sample collection and handing over to water testing laboratory.
- Web based provision has been made to enter the water quality analysis data.
- Web based provision has been made to –

  - Generate drinking water supply scheme digital key plan.
  - Abstract and detail report for drinking water sources and related assets.
  - Water quality maps, certificates and reports.

- Mobile based complaints and redressal system is being provided.
- Web based feedback utility is provided for issues and suggestions.
- User manual is being provided online for ready reference.

To maintain the pace of technological upgradation and for ease of doing business in the Government sector for the welfare of the masses, this application has made the best use of communication and dissemination of the services.

5. MODALITIES OF THE NEW SYSTEM (SOLUTION)

5.1. Technology Platform used:

5.1.1 Description

a. Android Studio - Android Studio is the official Integrated Development Environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. Asset mapping and geofencing mobile applications are developed on min SDK version 15 and Target SDK version 23, the app is compatible on 4.2 and support higher OS version of Android.

b. Java - Java with its advantage of system independent and Screen size independent functionality is used in the variety of computing platforms from embedded devices and mobile phones to enterprise servers and supercomputers and hence is selected for this particular application.

c. REST Services (**R**epresentational State Transfer) - REST is a web standard based architecture and uses HTTP Protocol for data communication. Each resource is identified by URLs/ Global IDs. REST uses various representations to represent a resource like Text, JSON and XML.

d. SQLite - SQLite is an open-source relational database that is used to perform database operations on android devices such as storing, manipulating or retrieving persistent data from the database.
e. ArcGIS API for JavaScript - ArcGIS API for Javascript provides a rich set of geospatial, mapping and administrative functionality through REST web services. The Application Programme Interface **(**API**)** combines modern web technology and powerful geospatial capabilities enabling to create high performing apps and smarter visualizations of geospatial data.
f. Database Management - The database is ported in GIS environment with Oracle 11g as a backend and imported using ArcGIS Spatial Database Engine **(**SDE**)**.
g. Other technologies used - The other technologies used are ARCGIS DESKTOP, ARCGIS SERVER, IMAGINE for image processing, etc.

5.1.2 Interoperability

At present the mobile app is developed for Android users, considering the lower cost of the gadgets which are more in number as compared to iOS. Secondly the penetration of the android is more as compared to the iOS. The survey officials/ground level staff are well versed and friendly with android technology. This saved the extra effort of capacity building for the applications and the acceptability of the mobile app was very high.

The web application/ geo-portal developed for the project can be viewed both on Linux as well as windows desktop environment. Since the data is available on a single server location and viewable at client location, the interoperability is high. The ArcGIS server platform is open to export/exchange all type**s** of geospatial database to other GIS systems, when required. Also the MIS database attached at the backend can be ported with various Relational Database Management System **(**RDBMS**)** suites like ORACLE, MS SQL, etc.

5.1.3 Security concerns

To use the app, every user needs to register with basic info like Full Name, Mobile Number and **e-**mail ID. User has to verify the mobile device by providing the valid OTP Send by SMS gateway to the registered mobile number.

The geotagged photographs captured using mobile applications are watermarked with **D**epartment tag, this avoided the piracy and unauthorized tampering of the deliverables**,** thus making the system very secure.

5.1.4 Any issue with the technology used

Delay in data transfer happens when there is no/poor internet connectivity. Many mobiles use the A-GPS technology, which requires the data plans for the GPS signals. Sometimes the data loss happens while sending Text and Image File, due to connectivity issues. To overcome this challenge**,** the offline Global Satellite Navigation System **(**GLONASS**)** GPS enabled smart phones were recommended. This removed the issue of data card requirement. In the mobile app, facility of **'**send

later option**'** was used to transfer the data after coming in the range of mobile connectivity. FTP connectivity gateway**s** were developed and used to overcome the data losses.

5.1.5 Service level Agreements (SLAs)

Maharashtra Remote Sensing Application Centre has signed Memorandum of Understanding (MoU) with Water Supply and Sanitation Department for providing mobile application and web application development and support along with capacity building at various stages of the project. Various actionable items were listed and the role & responsibility of various officials and Department were clearly spelt out. This helped to execute the mammoth task in a limited period of 18 months.

5.2. **Citizen Centricity**

5.2.1 Impact on effort, time and cost incurred by user

The project, besides harnessing the benefit of citizen centric service objectives, showcases the effective use of Government infrastructure and collaboration with line Department. It has impacted in saving on effort, time and cost by deployment of solution using modern technology.

The locations of the scheme sources and its related asset can be viewed by line Department online in a uniform pattern. This adds to the responsibility of the field officers which reduces their efforts and increases the competency.

5.2.2 Feedback/grievance redressal mechanism

To identify location of the schemes and its related assets, basic layers were made available on WSSD site which is helpful for proper field planning and reporting. For situations where network is an issue and the field officer is unable to upload data, the data is being received through emails.

The Water Supply Redressal System **(**WSRS**)** mobile application for complaints and redressal system is available on WSSD geoportal. This mobile App is especially designed in simple Graphical User Interface **(**GUI**)** and user friendly, which can be used by any citizen and officials. Whenever any problem is noted by the citizen or any stakeholder of the Department, they are able to launch a complaint using mobile interface. The concerned official will address the problem and resolve the complaint. The status of the complaint will be updated in web interface.

5.2.3 Audit Trails

Audit trail of the data uploaded by the field officer and its validation done is maintained in the RDBMS. The geodatabase generated is also certified by the scheme controlling officer.

5.2.4 Interactive platform for service delivery

The web application developed for WSSD is available on internet for viewing purpose to the line Department. The web page also has a link for downloading user manual and for communicating latest updates related to the project.

5.2.5 Stakeholder consultation

The stakeholder consultation and knowledge sharing is carried out in following ways in the project:

a. Multiple field visits to WSS locations.
b. Interactions with field level staff of WSS Department.
c. Meetings with the block level officials of WSS Department.
d. Decision maker inputs incorporation from Secretary level to ground staff.
e. Workshops and deliberations
f. Feedback forms.
g. Government process re-engineering using the modern technology of RS & GIS.

5.3. **User convenience**

5.3.1 Service delivery channels

The user is informed periodically by SMS alerts regarding updation of data. Besides this, notifications regarding the project are highlighted on the website.

5.3.2 Completeness of information provided to the users

Following information is readily available to the user on the web site:

a. District wise/ Taluka wise and scheme wise statistics available on daily basis
b. Detail list of mapped schemes
c. Detail list of mapped schemes and their location along with photographs
d. Cumulative date wise analysis of data received
e. Tabular and graphical representation of report generated

5.3.3 Accessibility

All the information is available online and hence accessibility is there 24 × 7.

5.3.4 Distance travelled to Access Points

All the information is available online in public domain.

5.3.5 Facility for online/offline download and online submission of forms

The user can work offline and capture the data and send later.

5.3.6 Status tracking

Online report generation on web application allows the user to track the status.

5.4. Efficiency Enhancement

(i) Volume of transactions processed

The mammoth task of GIS asset mapping has been completed in record time using *Jalsurksha* mobile App. The details are as follows :

a. Total GIS Assets mapped (Point & Line): 6,43,144 including 3,35,907 drinking water sources
b. Total Scheme mapped: pertaining to 34 districts of Maharashtra State
c. Total Number of schemes mapped: 592 Regional Rural, 64,647 Pipe Water Supply and 2,83,901 Spot Schemes.

Transactions for the above mentioned volume of data is carried out.

(ii) Coping with transaction volume growth

Storage Area Network (SAN) space has been allotted to store voluminous data received through mobile app. This is scalable architecture and can be augmented based on the need.

(iii) Time taken to process transactions

The field staff can capture the GIS asset and field geotagged photos for 15 to 20 villages per day. Nearly 1 min is required in mobile to process a single transaction received from the field at the server end.

Post processing to generate the final database is based on the geo-processing speed of the server and also the internet speed available at the different blocks. With the augmentation of the Optic Fiber connectivity to be provided very shortly by the GoM, the transaction speed will rapidly rise.

(iv) Accuracy of output

The assets mapped are based on the GPS coordinate (latitude and longitude) of the user's mobile. Hence, the latitude and longitude accuracy depends on the user's handset and its process. However the application is designed in such a manner that the module will allow the user to capture GPS locations only when the accuracy is below 8 m. The discrepancies in mapping are to be corrected through validation activity which is provided online based on the reference of the VHR satellite image. This reduces the errors to very minimal and near to a meter level accurate database.

(v) Number of delays in service delivery

The delay in services is observed in 15 % of the cases where there is network connectivity issue. The raw data is further processed in 2 days for integration in GIS format.

6. IMPACT ON THE STAKEHOLDERS/BENEFICIARIES

6.1 To Organization

The voluminous water supply scheme data of the Department was organized in a standardized manner during the course of the project. All assets and drinking water sources, especially the spot source, in the habitation was mapped. Many unrecorded assets were mapped with their location information for the GIS distribution and analysis for water quality assessment. Presently, all schemes with their Digital Key Plan and their operation location are readily available centrally on GIS portal.

With regards to the drinking water quality management, near real time water quality sample collection, lab analysis and quality assessment and its spatial distribution has been incorporated into the GIS system for ease of doing business.

6.2 To citizen

The most vital component, i.e. water is to be provided efficiently and without any contamination to the citizens. The system allows the citizen to know the schemes that supply water to their households along with the quality of the water. The citizen can also act as a watchdog by using the redressal system developed for effective monitoring and management of drinking water supply scheme assets.

6.3 Other stakeholders

Ease of decision making and effective monitoring of the drinking water supply schemes and their related assets can be shared to other Departments in the geospatial domain. The surface and ground water monitoring Department can understand the actual usability and requirement of the water in the habitation. In case of adverse water quality and quantity of the source, new alternative source can be planned out using this data. Further, the billing of the schemes can be taken up by the authority.

7. Future Roadmap/ Sustainability

The latest technology has been adopted to develop the mobile applications and the web applications. The mapping of asset helps the authorities from higher decision making to field level to monitor the activities in an unbiased and transparent manner. The WSSD and MRSAC are Government of Maharashtra organizations and have a strong sustainability basis for such ventures. No outside staff is hired as all the technical expertise in the area of mobile application and GIS is available with MRSAC.

Keeping in mind the type of users, the application has been developed in very simple and easy to use GUI and multiple trainings are provided to the entire selected staff of the WSS Department in phased manner. In case of any difficulty, the users are given support in all the possible ways like email, SMS, WhatsApp and personal interactions. Department users are able to view the database district/block wise and scheme wise also.

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8. Teaching Notes

Remote Sensing and GIS Based Mapping for Water Supply and Sanitation (WSS) using High Resolution Satellite Data

Use of Geospatial technology for effective planning, construction, execution & monitoring of the drinking Water Supply schemes in the State of Maharashtra

1. OVERVIEW

The objective of this project is mapping of all water supply schemes from the source to the stand post using Remote Sensing (RS), Geographic information system (GIS), Global Positioning System (GPS) & Mobile technologies and to evaluate and standardize the Water Supply Schemes, Geo-spatial database. It is aimed to design, develop and implement GIS based Mobile application for field level water source locations and its allied asset data collection, in a standardized and integrable format and to store and maintain Geo-spatial database on a central server of State Data Centre (SDC), Mumbai, Government of Maharashtra. It will develop a web browser based GIS application in Geo-portal, for seamless accessibility in G2G and G2C domain and to integrate existing Management Information System (MIS) database of WSSD and the geospatial technology based Geodatabase with Natural Resources and Administrative Database available with Maharashtra Remote Sensing Application Centre through Web Services. It aims to design and develop an online mechanism of water quality data collection, laboratory analysis and map preparation using mobile and web technologies and to design and develop an online redressal system for monitoring and management of the water supply schemes using mobile and web technologies.

The unique and maiden approach of using RS & GIS in association with the GPS & mobile mapping technology has yielded tremendous success in the area of introduction of modern geospatial technology in the day to day working of the conventional Government Department. Entire scope of this project is being concentrated on the rural and village setups, the same effort can be replicated for the urban enclaves in the country also.

2. TEACHING OBJECTIVES

- **Learning Objectives**

- As-is situation analysis and identification of main points in the existing process.
- Importance of innovation and technology to bring transparency and proper accountability.
- Expected outcomes and ease in accessing information due to the project.

- **Challenges/Issues Faced**

a. Database not stored in centralized and standardized manner which gave problems in data accessibility and reproduction for multiple usage needs.

b. The representation of the database in hardcopy maps and different for each district. This caused problems of unification and universal usage of the data.
c. The database lacking spatial domain which affected the decision making capabilities of the officials of the Department.
d. Reporting of the data and their usage and status was not possible and easy.

➢ **Ways to Improve the Situation**

- The pipelines network from source to sink for utilization of the limited water resource was a challenge. The aging systems of earlier laid down pipeline network, its orientation below the subsurface, encroachments of the pipeline corridors by the unauthorized structures were the key points to be monitored for rollout and implementation of the ambitious task.

- No other method but RS, GIS & GPS technologies were the solution in conjunction with the mobile communication technology. However the utilization of the technology in independent formats was also getting difficult.

- MRSAC with its strong hold of base geospatial database and the expertise in usage of RS & GIS technology for various domain areas came to the rescue of this challenge. The expertise of MRSAC helped in development of a unified approach of use of mobile mapping tools and integrating it with RS & GIS database. The roll out method which utilized the modern technology.

- The highlight of the effort was the method of mapping the WSS schemes using traverse method of GPS with the air valve as reference. Mapping of pipelines is very difficult and tedious job as pipeline survey is to be carried out by traversing on the pipeline.

- The entire activity provided a comprehensive Dashboard to manage the WSSD operations from a single server location as a unified system. The entire hierarchy from Secretary to ground level staff is now aligned in a single decision support channel.

SUGGESTED QUESTIONS & ANALYSIS

a) What changes were brought in the system using this project?

- Generation of "Digital Key plan" for drinking water supply schemes for the multiple and abundantly available but not standardized schemes.
- Conversion and standardization of the available regional rural drinking water schemes key plans from AutoCAD drawings to GIS intelligent maps.
- Integration of the Regional Rural (RR) drinking water supply and Pipe Water supply Schemes (PWS) key plans with the other natural resources maps, not available till the execution of project.
- Maiden effort for generation of standardized water supply digital database.
- Accurate and precise mapping for decision makers.

- Both point assets as well as line assets are mapped using the most advance technology of Remote Sensing (RS), Geographic Information System (GIS), Global Positioning System (GPS) and Mobile technology

b) How this project has helped in increasing efficiency and effectiveness in the system?

(i) Volume of transactions processed

The mammoth task of GIS asset mapping has been completed in record time using *Jalsurksha* mobile App. The details are as follows:

a. Total GIS Assets mapped (Point & Line): 6,43,144 including 3,35,907 drinking water sources
b. Total Scheme mapped: pertaining to 34 districts of Maharashtra State
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Transactions for the above mentioned volume of data is carried out.

(ii) Coping with transaction volume growth

Storage Area Network (SAN) space has been allotted to store voluminous data received through mobile app. This is scalable architecture and can be augmented based on the need.

(iii) Time taken to process transactions

The field staff can capture the GIS asset and field geotagged photos for 15 to 20 villages per day. Nearly 1 min is required in mobile to process a single transaction received from the field at the server end.

Post processing to generate the final database is based on the geo-processing speed of the server and also the internet speed available at the different blocks. With the augmentation of the Optic Fiber connectivity to be provided very shortly by the GoM, the transaction speed will rapidly rise.

(iv) Accuracy of output

The assets mapped are based on the GPS coordinate (latitude and longitude) of the user's mobile. Hence the latitude and longitude accuracy depends on the user's handset and its process. However the application is designed in such a manner that the module will allow the user to capture GPS locations only when the accuracy is below 8 m. The discrepancies in mapping are to be corrected through validation activity which is provided online based on the reference of the VHR satellite image. This reduces the errors to very minimal and near to a meter level accurate database.

(v) Number of delays in service delivery

The delay in service is observed in 15 % of the cases where there is network connectivity issue. The raw data is further processed in 2 days for integration in GIS format.

3. CLASSROOM MANAGEMENT

➢ Group Discussion

Divide the participants in groups of 4-5 and discuss the case on following aspects. Each group should take one aspect:

1. Discuss Change management and Communication as some of the key factors to project success.
2. Challenges and issues if the project is to be rolled across other States.
3. What is next for the project?

Please have an open brainstorming session regarding how this project can be evolved and replicated in other states. Each group should present their findings in a short 5-10 minutes presentation afterwards.

➢ Summary- Key lessons learnt (15 minutes)

Each participant shall write down a summary in not more than 500 words highlighting key learning from the case.

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Abbreviations and Acronyms

Abbreviation	Explanation
GIS	Geographic Information System
MRSAC	Maharashtra Remote Sensing Application Centre
WSSD	Water Supply and Sanitation Department
RS	Remote Sensing
GPS	Global Positioning System
SDC	State Data Centre
MIS	Management Information System
BIS	Bureau of Indian Standards
IDE	Integrated Development Environment
REST	Representational State Transfer
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
XML	Extensible Markup Language
ArcGIS	It is a geographic information system for working with maps and geographic information
SDE	Spatial Database Engine
OTP	One Time Password
GLONASS	Global Satellite Navigation System
FTP	File Transfer Protocol
WSRS	Global Satellite Navigation System
GUI	Global Satellite Navigation System
RDBMS	Relational Database Management System
SAN	Storage Area Network
VHR	Very High Resolution
RR	Regional Rural
PWS	Pipe Water supply Schemes

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