APPLICATION OF GEOINFORMATICS IN CREATION OF WEB BASED WATER & IRRIGATION RESOURCE INFORMATION SYSTEM

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ABSTRACT

Water Resource is natural resource potential which belongs to a region either by man-made or naturally formed. This paper proposes a new generation of Decision Support System (DSS) that leverages web services and web technologies to allow for new possibilities in the area of water resources and irrigation decision support system. . To help the efforts of management and maintenance of the water and irrigation resources, so this research is conducted. One of the approaches used in this research to support the efforts by developing a model of basic map by archetype concept using GIS. Analyzing large amount of data is necessity for management of irrigation projects. Data has been collected, stored and interrelated with each other in such a way that the data are readily accessible. The information and data related to each layer and infrastructure in GIS has a database connected to the object in the map. The developed tool is able to make different kinds of queries either on maps or on related tables. The cartographic and data overlaying capability of GIS coupled with its dynamic linking capability to models play a essential role in water management. A final geodatabase has prepared where spatial and attribute both the information are available, which is now beneficial for equally water resource as well as irrigation departments for resource inventory and for resource management. The Web GIS is an application of Geographic Information System than can be accessed online through the internet/web. The system is dynamic and has ability to bring up to date based on new information.

1.1. INTRODUCTION

Water is an integral part of the land resource and goes long way in determining the possibilities of socio-economic development of any region. Distribution of water resource is uneven, resulting in ample surplus water of one place and scarcity of it's on other. Due to the limited availability of surface water, there is an increasing demand on ground water sources, without considering recharge potential have dried up the traditional sources on a large scale. Since, irrigation is the only major economic use of water, its spatio-temporal trends are to be analysed for proper management. With the advent of GIS, the planning and management of water and irrigation resource can be achieved with more accuracy. Remote Sensing and GIS have power to derive and integrate up-to-date information with reference to the present practices and can asses various problems related to land and water. GIS also assist in specific planning and decision making process in irrigation through the input, spatial analysis and output of relevant information. Development of geospatial database and Web based Decision Support System for water and irrigation resources are important to achieve several objectives in planning the land and water resources.

1.2. STUDY AREA

Study area has been chosen as a newly formed district of Chhattisgarh that is Bemetara district. Bemetara district has been bifurcated from Durg District in the year 2012. The main purpose of bifurcation and formation of new district is for decentralized planning and for effective planning and proper implementation of different government scheme. The study area lies between 21°20'79" to 22°1'24" latitude and 81°10'22" to 81°56'8" longitude. It covers an total geographical area of 2886.94 sq.km. Bemetara district is also known as 'Unhari District". It mainly comes under Chhattisgarh plain and it is agriculturally sound district. Important river flowing in the district is Sheonath river. As per 2011 census, total population of the district is 599737 in which 298374 is male population and 302363 is female population. Density of population is 104 person/ sq.km. Literacy rate of the district is 71%. Sex-ratio has been found is 1015.

Bemetara district has been divided in two sub-division that is Bemetara and Saja. Total number of block is four namely, Bemetara, Berla, Nawagarh, Saja. Total number of Gram Panchayat in the district are 334 and total number of villages are 700. The district is divided into total 8 RI circles. Figure 1 shows the Location Map of Study Area.

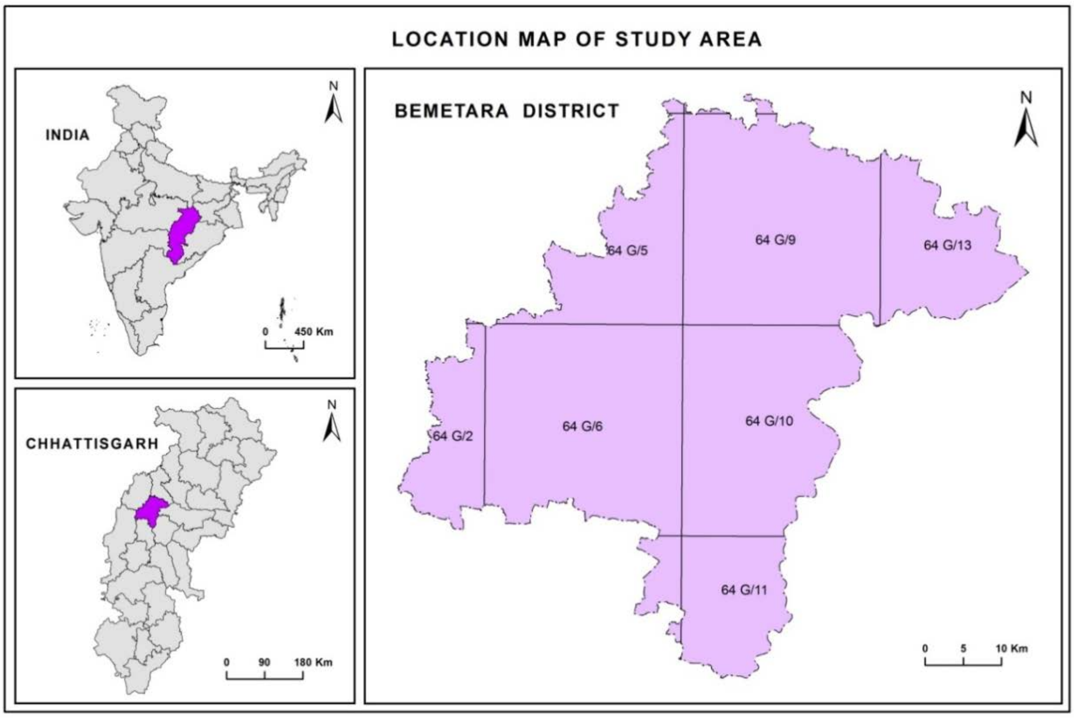

Figure 1 Location Map of Study Area

2. DATA AND METHODOLOGY

2.1. DATASETS

The data includes in the research work:

- Open Series SOI Toposheets in 1:50000 scale (64 G/2, G/5,6,8,9,10,11,13)
- High Resolution satellite image of Google Earth (0.6 m), Cartosat-I Pan (2.5m) and LISS IV MSS (5.8m)
- Hardcopy village and cadastral map from Revenue Department of concerned study area.
- Groundwater Quality data from Public Health Engineering Department (PHED)
- Other Collateral data on irrigation and water has collected from Irrigation Department of concerned study area.

2.2. METHODOLOGY

Surface water bodies like river, drainage, ponds and tanks and canal network with cross drainage structures has digitised and delineated from SOI Toposheets and high resolution satellite image. Village and cadastral boundary map has georefernced and digitised from scanned hardcopy maps from revenue departments. The methodology is represented in Figure 2.

The GIS data incorporates the following information on different layers which is illustrated in Table 1 and the list of software used for creation of water and irrigation resources database in Table 2.

Table 1 List of Layers generated in creation of Database

S.No	LAYERS	ATTRIBUTE DATA	ENTITY	SCALE	SOURCE
1	Ponds/Tanks	UID, X&Y, area, village, parcel no., owner, block, District, etc	Polygon	1:5000	Cartosat & Google Earth image
2	River & Streams	Length, UID, Name, etc.	Line	1:5000	SOI Toposheets, satellite image
3	Canal Network	Name, X&Y, UID, length, type, project, village, block, district	Line	1:5000	SOI Toposheets, satellite image

S.No	LAYERS	ATTRIBUTE DATA	ENTITY	SCALE	SOURCE
4	Cross Drainage Structure	Name, X&Y, UID, project, village, block, canal name	Point	1:5000	SOI Toposheets, satellite image
5	Hand Pump	X&Y, UID, project, village, block, GW element	Point	1:5000	PHE Data
6	Village Boundary	Name, UID, area, population,block, dist, etc.	Polygon	1:4000	Hardcopy map from Tevenue Department
7	Cadastral Boundary	Name, UID, area, parcel no,block, dist, etc	Polygon	1:4000	Hardcopy map from Tevenue Department

Table 2 List of Software used in creation of Database

S.No	Work	Software
1	Georeferencing, registration and mosaicing of maps and imagery	Eardas Imagine 11
2	Digitization and updation of base features	Arc GIS 10
3	Editing & transformation of digitised and ancilliary data, GIS database creation and linking	Arc GIS 10
4	Map composition and statistics generation	Arc GIS 10
5	Non Spatial database creation	MS Excel & Access
6	Generation of WEB-GIS platform	Geo Server, Xempp Server

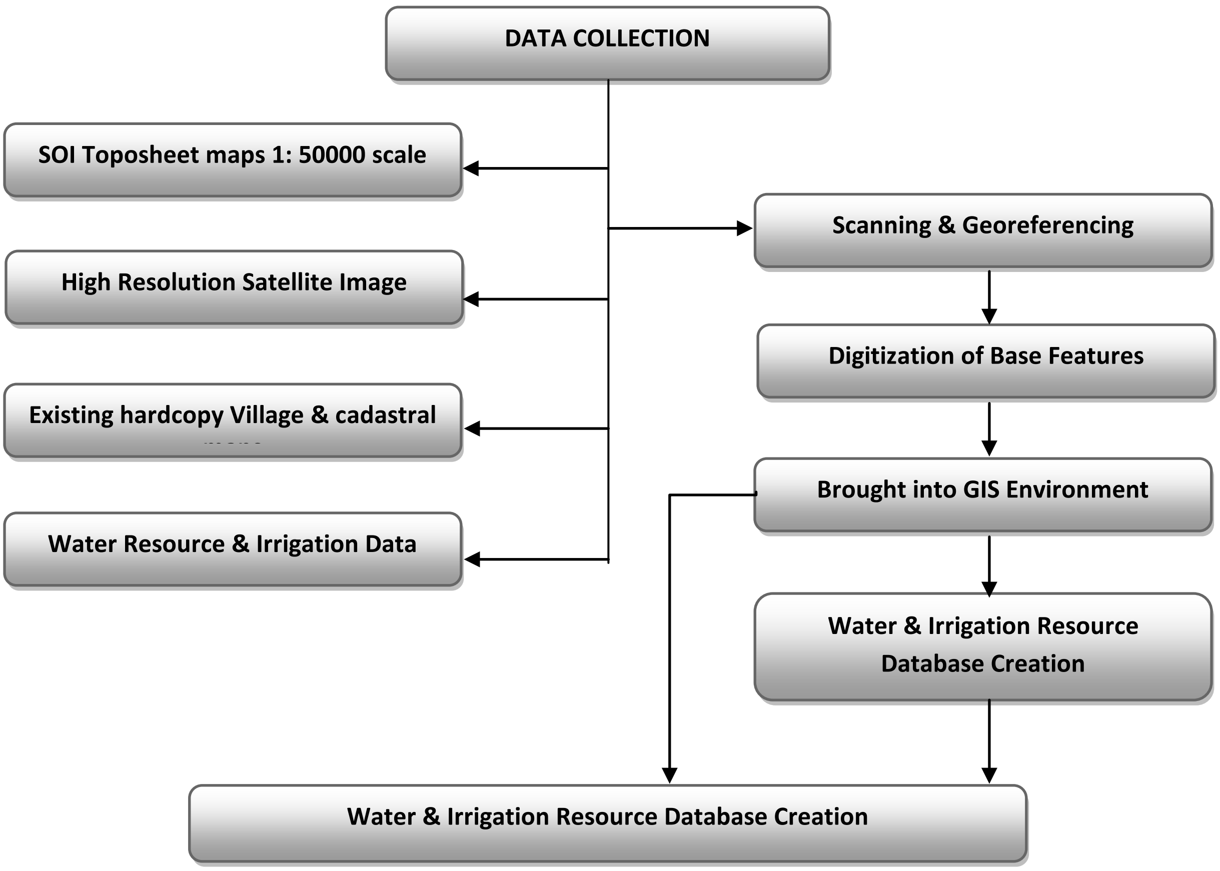

Figure 2 Methodology Adopted

3. RESULT & DISCUSSION

3.1.1. Surface Waterbodies Database Creation

Water resources are broadly put into two classes- surface water and ground water. The surface water bodies comprises of rivers, streams, tanks, reservoir and ponds. Since water has crucial role to play in the modern economy, survey of its potentials and possibilities of their utilization has been carried out by Government and other agencies. For this reason a proper database should be there for surface water bodies so that all line department can use those information according to their needs. In the creation of database regarding surface water bodies satellite remote sensing, GIS and GPS play important role. Through this technology all the existing water bodies has identified, mapped, analysed and finally create a database by which all the water bodies can be monitored , can generate statistics and can perform query according to specific need. High resolution Google Earth Image and Orthorectified Cartosat satellite image and Toposheets are used first to identify and mapped all available surface water resource of the concerned study area. Shown in Figure 3.

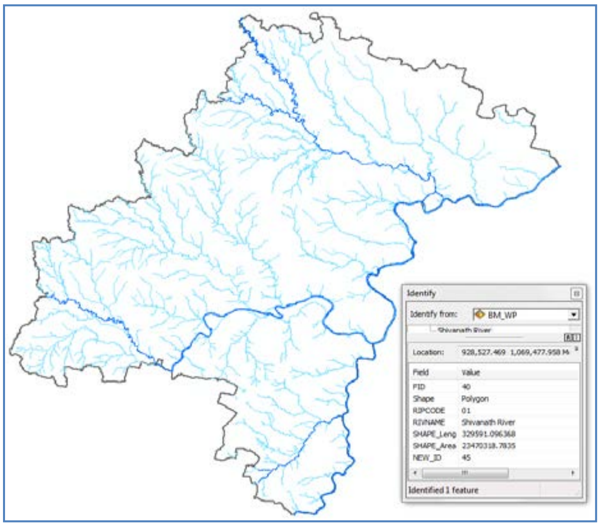

Figure 3 River& Stream Database

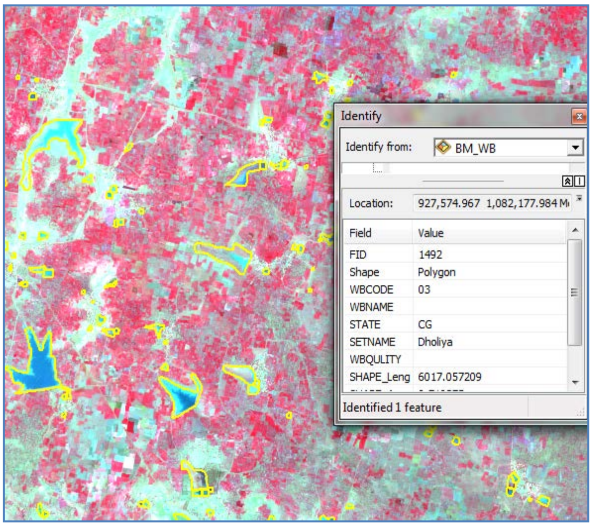

Figure 4 Reservoir, Tank & Pond Database

The entire major river has mapped in polygon because from high spatial resolution satellite image river can be mapped in poly features which is on of the major advantage for the decision maker and planner for further spatial analysis. All other streams has digitized in line features with attribute data like UID, shape, River/Stream name, length, block, district etc. One can perform query based on the attribute information.

Reservoir, Tanks, Ponds has been mapped from Google Earth image. This image has been downloaded, georeferenced and registration based on orthorectified Cartosat images and mosaic to form image for whole district. Very small ponds even less than one hectare has been mapped, no single water body has excluded. All other important attribute has linked with all those water bodies. From this type of database accurate area statistics can be generated by government and one can get timely, reliable and spatial information from a single platform. From the attribute information one can get UID, name of water body, cadastral no., area, X&Y, in which village it is situated, public or private, purpose etc. From this useful information one can query according to village wise. It is very important to have village and cadastral information for micro level study. GPS point has captured for all water bodies as well as geotagged photographed has taken from GPS-built camera. This photographed are called as Geo-tagged photographs as it contain lat, long information. Through the photographs one can assess the present condition of the water bodies. Shown in Figure 4

Figure 5 Geotagged Photographs

3.1.2. Groundwater Database Creation

The exploration, assessment and management of groundwater resources has become one of the key issues as ground water forms an important component of the total water supply for drinking and irrigation purposes. GIS is a tool which is used for storing, analyzing and displaying spatial data is used for investigating ground water quality information. It is also helpful for monitoring and managing ground water pollution. Shown in Figure 5

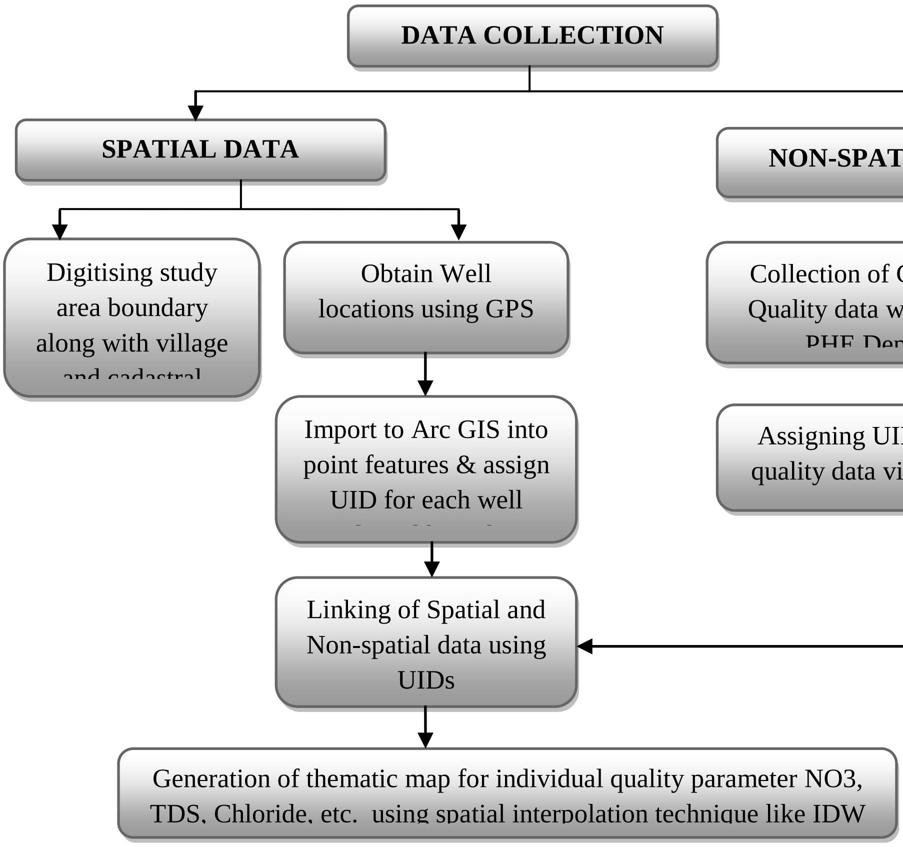

Figure 6 Flowchart for method adopted

Table

bemetara_alk_pre

Block	Village	Habitation	Source	Location	POINT_X	POINT_Y	Alkalinit	P_Class	M_CLASS
BERLA	SORLA	SORLA	Deep Tubewell	SC2236236	81.521701	21.532195	248	2	PRE
BERLA	KUMHI(B)	KUMHI	Deep Tubewell	SC2238073	81.571895	21.533116	242	2	PRE
BERLA	SONDH	SOND	Deep Tubewell	near jaithkham / S	81.443932	21.536741	0	1	PRE
BERLA	KHARRA	KHARRHA	Deep Tubewell	SC1567012	81.548753	21.546299	208	2	PRE
BERLA	BACHEDI	BACHEDI	Deep Tubewell	SC1318097	81.351228	21.546609	250	2	PRE
DHAMDHA	GADADIH	GADADIH	Deep Tubewell	SC1812997	81.238949	21.547449	200	1	PRE
BERLA	TARALIM	TARALIM	Deep Tubewell	SC1317769	81.508439	21.548087	308	2	PRE
SAJA	DEHRI	DEHARI	Deep Tubewell	SC1563510	81.338002	21.54993	320	2	PRE
BERLA	SINWAR	SIWAR	Deep Tubewell	SC1320555	81.409292	21.555445	218	2	PRE
BERLA	JAMGHAT	JAMGHAT	Deep Tubewell	SC1323631	81.645153	21.557964	236	2	PRE
BERLA	LENJWARA	LENJWARA	Deep Tubewell	SC2236181	81.532604	21.563306	230	2	PRE
BERLA	CHONGIKHAPRI	CHONGI KHAPARI	Deep Tubewell	SC1563666	81.353941	21.566709	262	2	PRE
DONDILOHAR	SAHGAON	SAHAGAON	Deep Tubewell	SC1568462	81.657237	21.567484	0	1	PRE
BERLA	CHATAWA	CHETUWA	Deep Tubewell	SC1319469	81.640692	21.567571	310	2	PRE
BERLA	SAHGAON	SANGOAN	Deep Tubewell	SC1324442	81.656645	21.56839	244	2	PRE
BERLA	BHARCHATTHI	BHARCHATTI	Deep Tubewell	SC1314894	81.43733	21.568632	242	2	PRE
BERLA	ACHHOLI	ACHHOLI	Deep Tubewell	SC1314854	81.631898	21.569155	262	2	PRE
BERLA	DEORI	DEORI	Deep Tubewell	SC2236066	81.587119	21.569909	224	2	PRE
PATAN	PATORA	PATORA	Deep Tubewell	Near Mahesh sen	81.457257	21.571194	208	2	PRE
BERLA	PATORA	PATORA	Deep Tubewell	SC1320791	81.457257	21.571194	262	2	PRE
BERLA	TABALGHOR	TABAL GHOR	Deep Tubewell	SC1563626	81.410734	21.572439	262	2	PRE
BERLA	TAKSIWA	TAKSIWA	Deep Tubewell	SC1313280	81.491475	21.572638	238	2	PRE
BERLA	JAMGAON	JAMGAON	Deep Tubewell	SC1566382	81.291806	21.572967	224	2	PRE

0 (0 out of 556 Selected)

Figure 7 Attribute Information of Groundwater Quality

Figure 7 showing all the attribute information regarding groundwater quality. The attribute table contains X, Y location, source, monsoon class (pre-monsoon and post-monsoon) habitation from where sample has taken, hand pump no., village block, quality class, etc. All these information has taken from PHE Department and convert into excel file and brought into GIS environment. From this database, one can access all types of quality data from a single platform. Figure 8 shows the spatial location of all hand pumps for which groundwater quality assessment has been done.

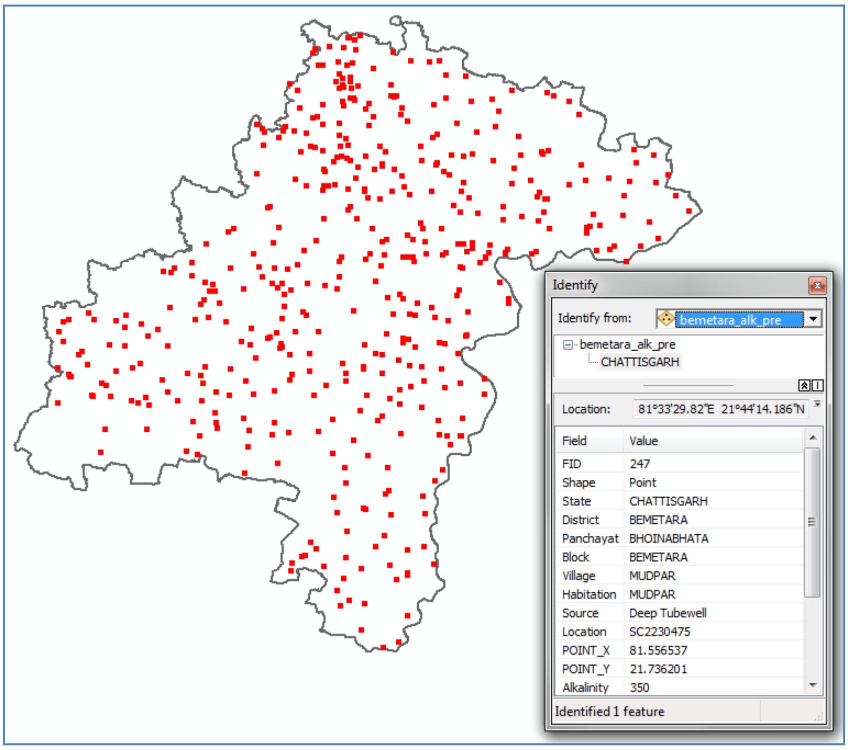

Figure 8 Spatial Location of Hand Pumps

3.1.3. Canal Network Database Creation

The canal network data structure is important to assess the spatial distribution of the water demand and supply for the irrigation planning and management. Google Earth image along with SOI toposheets has used to identify and mapped the canal network for the study region. The spatial database has prepared in a network module which constitutes nodes and lines. The node data refers to the cross drainage structures such as aqueduct, sluice, simphon, foot bridge, off-take points etc. The canal network with line and nodes are shown in Figure 8 and Figure 9.

The canal UID is created with unique multi-digit number constitute a combination of alphabets and numbers. There are 13 canals mapped in network module and including major and minor canals. The canal lengths in GIS are matching with the statistics given by the irrigation departments. The geospatial database found very useful in identification of canal and cross drainage structures. Due to the hierarchy and the unique identity of each canal the spatial queries and retrieval of the data and results are more convenient for decision making and planning of water releases for effective water management. Remote Sensing, GIS, GPS together play an important role in Irrigation management. It is necessary to develop a geospatial database that provides sufficient information for irrigation experts and water resource managers. This type of database will help to assess and plan water resources in efficient way.

Table

BEMETARA_CANAL_FINAL_WEB

FID	Shape	FID_BM_CNL	PRJNAME	CAN_LR	Shape_Leng	LENGTH_KM	NAME	FID_VIL_CA	VNAME_ENG	DNAME_NEW	TNAME_NEW	CANAL_TYPE
75	Polyline	24	Tandula Project	L	928.055639	0.928056	SOND DISTRIBUTARY	601	Rewe	Bemetra	Berla	DISTRIBUTARY CANAL
76	Polyline	24	Tandula Project	L	2826.54761	2.826548	SOND DISTRIBUTARY	611	Patora	Bemetra	Berla	DISTRIBUTARY CANAL
77	Polyline	24	Tandula Project	L	204.039777	0.20404	SOND DISTRIBUTARY	628	Bharchatthi	Bemetra	Berla	DISTRIBUTARY CANAL
78	Polyline	24	Tandula Project	L	3799.441028	3.799441	SOND DISTRIBUTARY	647	Sondh	Bemetra	Berla	DISTRIBUTARY CANAL
79	Polyline	25	Tandula Project	L	485.738568	0.485739	KOTA MINOR	691	Kota	Bemetra	Berla	MINOR CANAL
80	Polyline	25	Tandula Project	L	1772.313357	1.772313	KOTA MINOR	694	Pirda	Bemetra	Berla	MINOR CANAL

Figure 8 Attribute Information of Canal Network

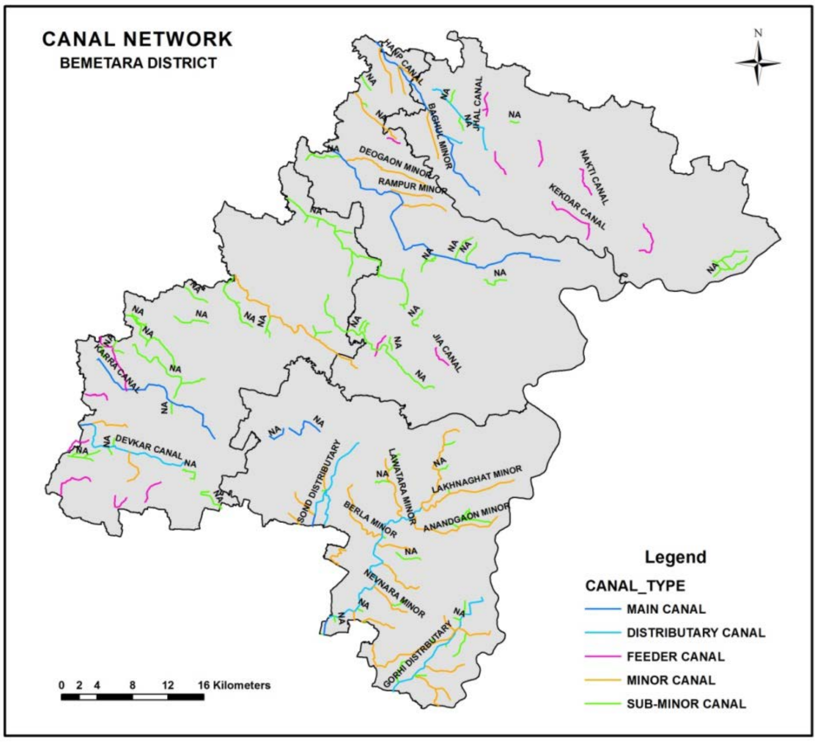

Figure 9 Canal Network Map

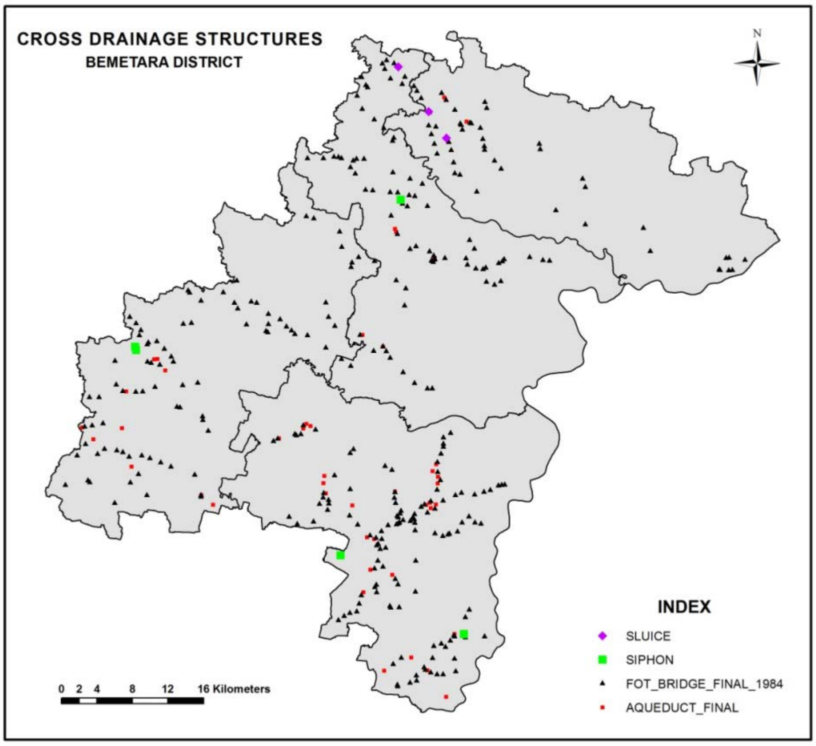

Figure 10 Cross Drainage Structure Map

3.1.4. Minor Irrigation Scheme Database Creation

In the study area various minor irrigation schemes are going on as it a plain area as well as agricultural dominated area. Information regarding minor irrigation are still available in hardcopy format. There is no spatial information provided the department. All other departments don't have access to those hardcopy data. So in order to reduce the inconvenience of getting data and spatial overview, a geospatial database has created which will provide all necessary information regarding minor irrigation up to cadastral level. In a single click one can get all attribute information along with spatial view. This whole database has created with the help of remote sensing and GIS. The attribute information includes all hardcopy information with additional village and cadastre information.

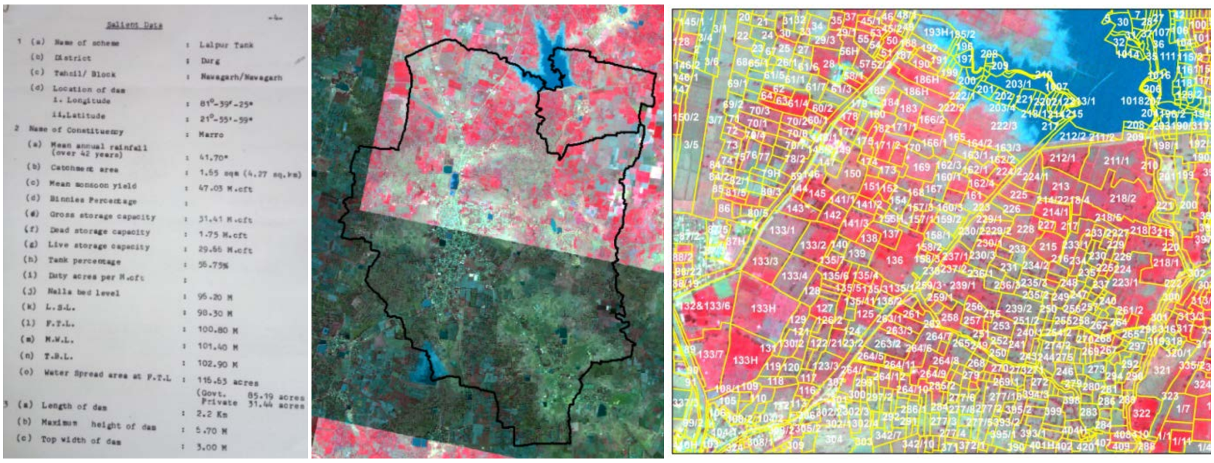

Figure 11 Transformation of Hard Copy Irrigation Scheme Data into GIS

3.2. Web-Based Creation of Geospatial Database

Geographic Information System has realized as monolithic and platform dependent applications. With the advent of Internet or World Wide Web, GIS have evolved and adopted to this new environment. The Web GIS or Web-Based GIS became a synonym for web information system that provides a functionality of geographic information system on the web through HTTP and HTML. Web Based GIS provide functions for displaying and navigation through maps, so as a functions for querying of geographic data using both spatial and non spatial criteria. ALL these water resource and irrigation resources maps have a definite rolle in Web GIS environment. In their interactive and dynamic appearance they will guide and assist the users, planners and decision makers in solving geospatial analysis problem.

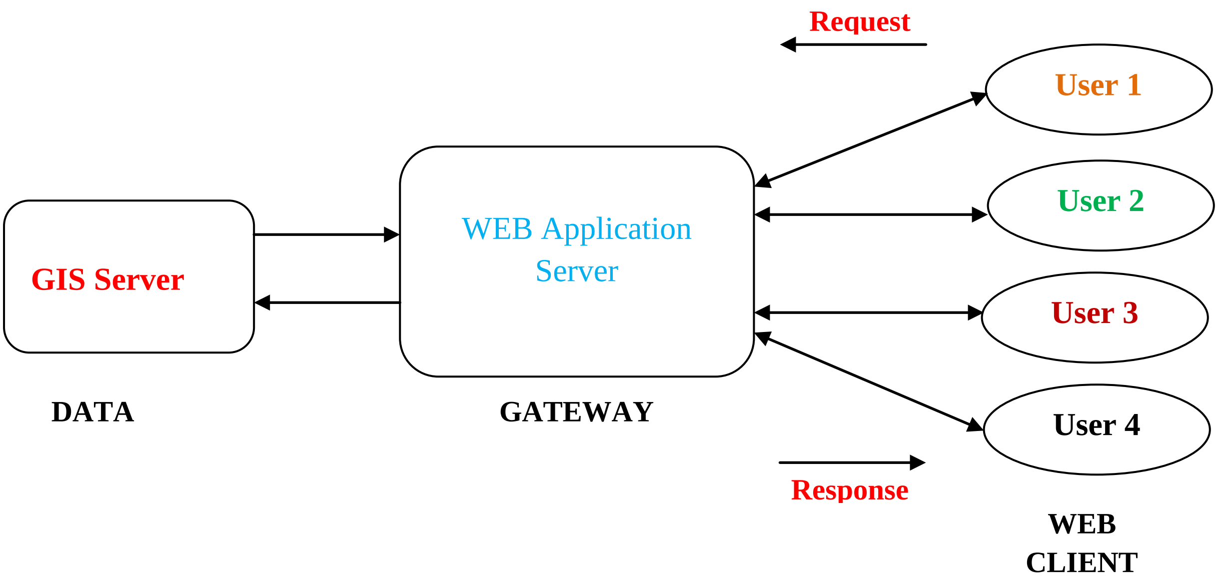

Figure 12 A Typical Client/ Server Communication

Figure 11 shows a typical client/ server communication which has adopted in creation of water and irrigation resource information system. This system has generated in local host **http://localhost/bemetaraGIS/home**. The advantage of the Web-Based Water & Irrigation Resource System is that all lined departments, public users, researchers, decision makers and planners can get all reliable and timely data with spatial location in a single click of mouse. It helps in reducing the data redundancy problem as well as help in getting all data in single platform. Same information will flow in all departments. The geoportal is providing various features like Zoom In, Zoom Out, Full Extent, Identify, measure, area calculator, buffer, query, add layer, legend, overview maps etc.

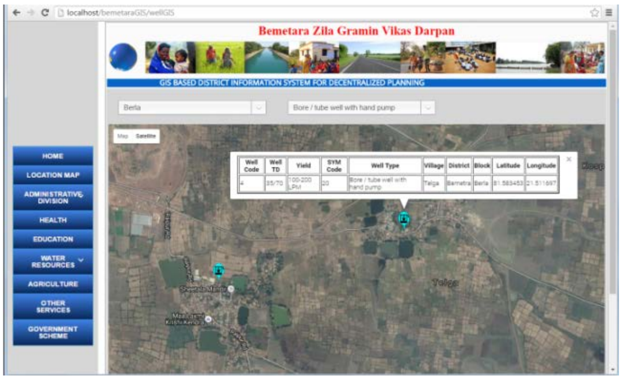

Figure 13

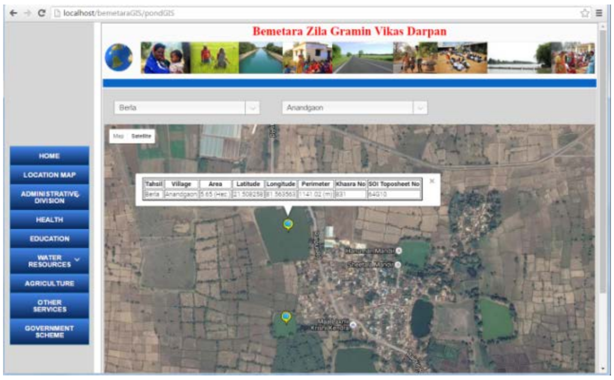

Figure 14

Figure 13 represents the web based pond information on Google earth platform. One can get information of all ponds available in the study area with their spatial location. This web GIS based information can help decision maker to get information in a single click sitting anywhere. Figure 14 shows the well information page in which all well are located with their nonspatial information. One can perform query based on their needs.

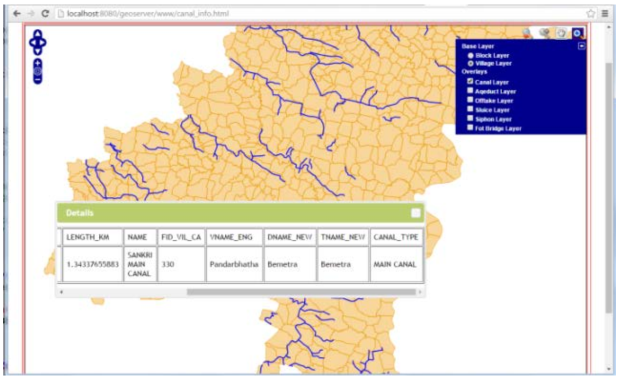

Figure 15

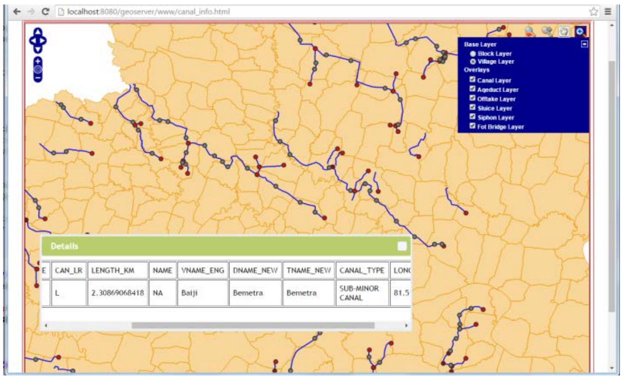

Figure 16

Figure 15 represents the irrigation information on the web platform, it is mainly showing canal network of the study are. As canal information is very much important as it is one the main source of irrigation. All spatial and non spatial information can be gathered by decision maker for proper planning. Figure 16 shows another major element of irrigation system that is all cross drainage structures. In a single click one can get exact location with village information also. The major advantage of this web portal is that one can get all necessary information with their spatial view without any hassle and without knowledge of GIS software. All information are available in GIS environment.

4. CONCLUSION

Integration of Geospatial Database with Water & Irrigation Resource is definitely an useful and applicable way of planning and management. Effective maintenance of all water bodies and irrigation projects through geospatial data integration. Through this modernization, maintenance and efficient operation of the irrigation system up to the parcel level is possible. Decision makers can plan new command areas, new distributary systems, irrigations structures, choosing the irrigation methods, calculation of irrigation water demands and water allocation etc. The aim of the study is to present a platform for Water & Irrigation Resource planners for effective decision making. The GIS and Web- Based GIS stores a considerable amount of spatial information in a compact and accessible form and it has ability to work with the spatial and non-spatial data and can create information by integrating different data layers. In this research work, various layers of information such as canal, cross drainage structures, drainage systems, cadastral level information, tank/ponds, ground water quality, minor irrigation projects are created in ArcGIS platform. Further all these information are transferred into Web-Based GIS platform for easy access for end users. The system is dynamic and has the ability to update based on new information. The only challenge now is the integration GIS and Remote Sensing into the everyday work of Government Departments and Water & Irrigation Resource Managers.

5. ACKNOWLEDGMENTS

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