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District Level Information System Through Web GIS- A Tool for E-Governance and Local Self-Government in India

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Web (GIS) and the underlying spatial data infrastructures have potential to assist in planning, monitoring and exchange of information between various agencies in Rural Development Administration. The paper describes the importance of spatial and non-spatial data alongwith the thematic maps and linking these to develop a district information system database on a Web GIS platform for present decision making process and the rural informatics situation in Indian districts. A study was undertaken in a rural district in India to demonstrate the integration of village-level spatial and non-spatial data into a useful tool, called 'DIS' (District Information System), for decentralized planning. This simple and robust tool will assist the decision-makers to generate various ecological and socio-economic views for identifying candidate villages for rural watershed management schemes (prescriptive and executive level planning). The paper also stresses on the future development and usefulness of GIS tool for grass-root planning.

KEYWORD

Web GIS, DIS (District Information System), Spatial, Database, Thematic maps, Rural planning.

INTRODUCTION

India having an agrarian economy has 60% of its population in villages. With every 5 year plans regional imbalance and inter regional disparity is going on increasing. Developmental and infrastructural disparity is more pronounced in the rural areas than their compatriot the urban areas although rural India is the backbone of India's economy. One of the main reason of underdevelopment of rural India and lopsided planning is dearth of information system database for rural areas. An information system is a recent concept and a research methodology which covers information regarding the village or circle or tehsil or district. Now-a-days it is used in all the fields with a great scope. Information system focuses on the basic concept of databases, data requirements and the mechanism to store, organize, process and analyze it.

In the absence of updated and accurate information about all kind of resources at village level, the government and people of the nation are handicapped in planning and controlling their own destiny (Khan *et al.*, 2005). On the other hand, it is also very difficult to make full use of natural and social wealth that lies in these areas. Besides, planning is now widely accepted as a way to handle complex problems of resource allocation at regional level (Roy *et al.*, 2006). Proper planning has to implement micro level planning which requires a database of both spatial and non-spatial data of the region. Studies at village level is important to undertake grass root level down to top planning by understanding the socio-economic problems faced by the people linked with agrarian society and undertake necessary planning procedures.

Management of the physical and socio-economic information about the district in a web-based environment is called District Information System (DIS). The incorporation of RS and GIS in DIS/TIS/VIS, which has emerged as an important tool to assist

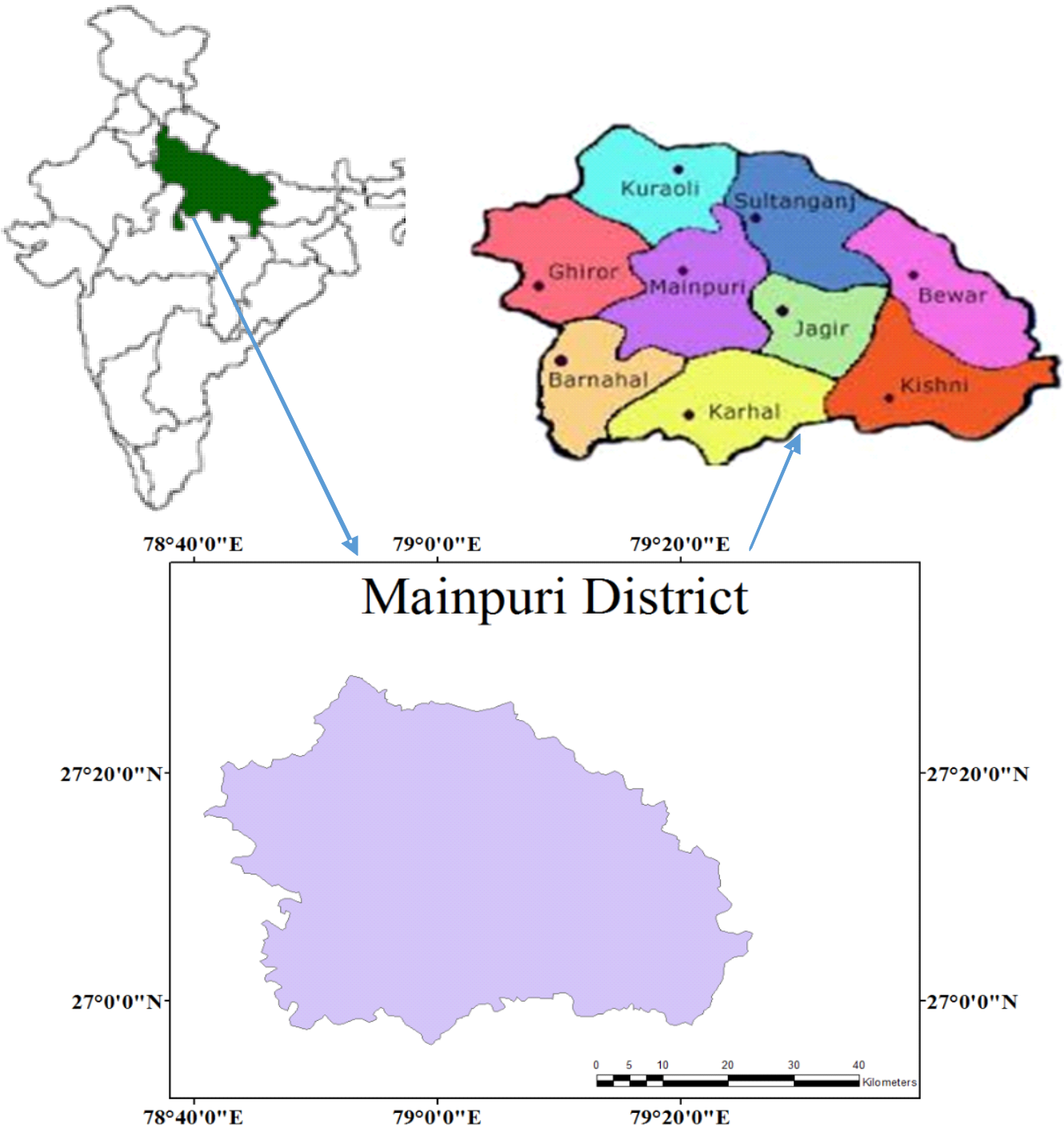

Figure 1. *Study area*

information system by developing, organizing, storing and analyzing the huge spatial and non-spatial database, has made the information system more effective and reliable. The emergence of RS and GIS as a powerful tool for spatial analysis and storage has in effect alleviated the problem by computerization of the spatial data (Ravindran and Jaishankar, 2006). This new technology can reduce the time and cost for the development of an information system and help the planners in organizing the data to arrive at precise conclusion and decisions (Sitender *et al.,* 2012).

Study area

The study area is Mainpuri district which is one of the districts in Agra division of Uttar Pradesh State of India (Figure 1). It is subdivided into 6 tehsils, namely Mainpuri, Bhongaon, Karhal, Kishni, Kurwawali and Ghiror. The tehsils have been further subdivided into 9 blocks-Mainpuri, Ghiror, Sultanganj, Jagir, Bewar, Barnahal, Karhal, Kishni and Kurawali. It lies between latitude 26^0 53' N to 27^0 31' N and longitude 78^0 27' E to 79^0 26' E. The total area is 2760 km^2. According to the 2011 census, Mainpuri district has a population of 18,68,529 with a population density of 677 inhabitants/km^2. The sex ratio is 881 females/ 1000 males and a literacy rate of 78.26%.Cultivation is the dominant occupation with 48.30% of the districts' population involved in it.

METHODOLOGY

The work has been divided into 5 main parts. In the first part satellite imagery (LANDSAT) and DEM (ASTER) of the study area has been downloaded from USGS, Earth Explorer and processed. Subsequently, the LULC of the study area, geomorphology, major drainage and transport network were extracted and analyzed from the base satellite map through QGIS and ERDAS Imagine 14 software. In the second part the various secondary data (socio-economic and demographic) of the study area were obtained from census of India and statistical handbooks. In the third part physical and socio-economic survey of the study area was done for ground truth verification and generation of information not yet obtained through step 1 and 2. In the fourth part various shape files related to village locations, drainage and road network, waterbodies, places of interest of the study area were digitized in the base map and the various spatial and non-spatial attribute data were interlinked in QGIS software. In the final step, the final database was published online through ARC GIS online to make the information accessible globally by making a Web GIS application- http://arcg.is/2glL4u0.

Objective

i. To prepare digital thematic maps, namely geomorphology, drainage, transportation, landuse/land cover, slope map and to develop a spatial digital database.

ii. To prepare physical, demographic and socio-economic database of the study area.

iii. To create web-based District Information System (DIS) database for the study area, involving the spatial and non-spatial data obtained, for macro level planning and assist in e-governance through single click 'query' based option on a web-GIS based platform.

DISCUSSION

The district information system has been done for Mainpuri district of Uttar Pradesh, which is the home district of the present Chief Minister of Uttar Pradesh. Being politically in the limelight zone, the study apart from its basic objectives also tries to find out the various amenities present and the demand supply gap with respect to basic amenities, if any, in the study area. The primary step for planning procedure is to procure spatial data, like different types of road network, landuse, drainage network, accessibility to safe drinking water, number of households in a village, sanitation facilities in each household, agricultural diversity, etc. Spatial information database infrastructure is a common problem for the nation. Presently various spatial data is procured manually which is not only time consuming but also restricts repeated ground truth verification and data management. Wherever spatial information is available they are outdated or in sketches. As a result Cadastral maps having sketchy information becomes the basis of planning procedure for the districts. Further being unscaled, these maps can neither be digitized nor the information be processed which hinders inter and intra departmental planning. Herein comes the necessity of digitized spatial information which is both empirical and can be used at any level of planning. At present in India due to the emphasis of e-governance and local

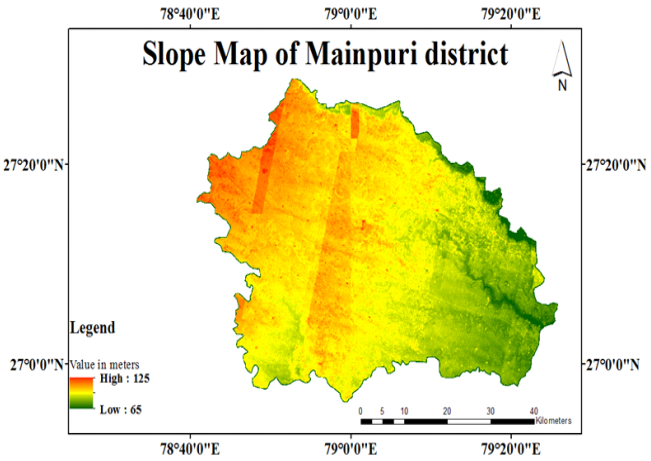

Figure 2. *Slope map of the study area*

self-governance the use of GIS in district/ block/village level planning is slowly gaining ground to prepare digitized village database to make the process more efficient and effective. Certain district in India have already started taking the necessary steps towards district spatial information digital database. Uttarakhand State of India has VIS for all its villages. Kolar district in south India is in the process of creating district spatial digital database with the assistance of Department of Science and Technology (DST). NIC Tamil Nadu has designed, developed and hosted Tamil Nadu maps website at http://tnmaps. tn.nic.in (Gayatri and Narayanan, 2006). The website envisages dissemination of land information of various administrative units of Tamil Nadu in spatial and non-spatial format.

Over the last decade, districts in developing countries enthusiastically embraced geographical information systems (GIS) (applications) and the supporting spatial data infrastructures (SDI) (the geodetic control and common base maps) (Bishop *et al*., 2000). It is foreseen that where geographical aspects are important for rural management, decision-making and planning, these GISs and SDIs would help to improve the efficiency of these rural management activities (Adinarayana *et al.,* 2004). For proper planning the development of digital thematic maps having detailed geographical attributes is important. For both 'long term plan and 'annual plan', the district officials require digital thematic maps with dynamic details of the district at reasonable scale to address the various problem areas which at present is lacking for the district. The present study provides a blue print for planning by preparing various database and thematic maps of the district.

Table 1. *Major soil type of Mainpuri district*

Major soil type	Area ('000 ha)	Cropping intensity, %
Deep, silty soils with moderately salinity and sodicity	74.6	32
Deep, silty soils, slightly saline	65.3	28
Deep, loamy soils, slight salinity	44.3	19

Source: District Census Handbook, 2011

Topography

The district generally bears the aspect of an extensive level plain intercepted by sand ridges and elevated terrain on the western border, Kali and the Isan rivers and the ravines along the Yamuna to the south west. The general slope of the land is from north-west to south east as is evident from figure 2. The highest point in the district is about 125 m. The average slope of the surface is 0.422 m/ km^2. The study area has a few structural fault zones. There are 3 well defined soil tracts in the district-The northern sandy tract between the Isan and the Kali river, the central loam tract between the Isan and the Kak river on the north and the Sirsa on the south and the southern mixed tract between the Yamuna and the Sirsa river. The soil in many places is salt affected and is known locally as 'usar' and 'reh' soils. Table 1 shows the major soil types of the study area.

Landuse pattern

The statistical dynamic information, like agricultural diversity, livestock census, secondary irrigation source, salt affected soil,

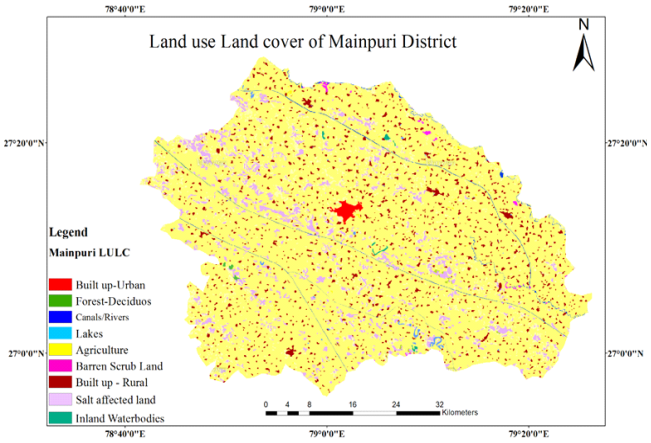

Figure 3. *Landuse land cover of the study area*

Table 2. *Landuse land cover of the study area*

Landuse	Area, ha
Agriculture	224000
Barren scrub land	877
Salt affected soil	16456
Builtup	
Rural	14253
Urban	1034
Forest	145
Inland wetlands	2271
Lakes	566
River/streams/canals	1943

Source: Calculated on the basis of LULC

Table 3. *Agricultural landuse of the study area*

Agricultural landuse	Area ('000 ha)
Gross area sown	347
Net area sown	186
Gross irrigated area	339
Net irrigated area	185
Percentage of irrigated	
Gross area to sown area	97
Net	99

Source: Statistical Diary, UP- 2015

general landuse, etc., of the study area have not been spatially linked or mapped which

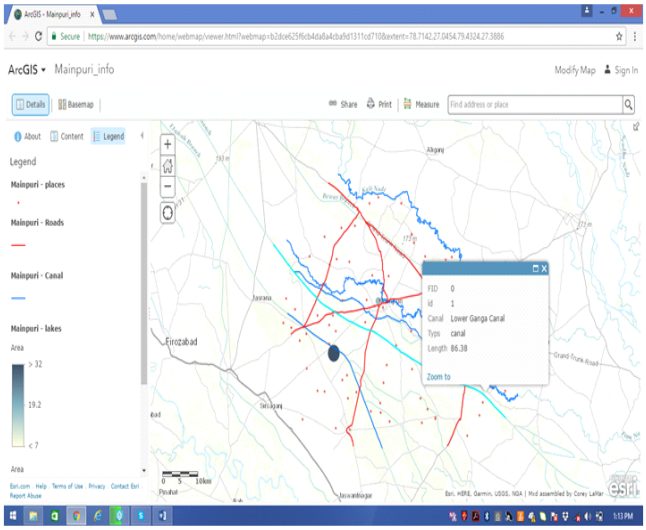

Figure 4. *Drainage and irrigation network of the study area portrayed through Web GIS*

hinders ready reference for planning in the district. The landuse land cover of the district has been divided into agriculture, barren scrubland, saline/salt affected, builtup (rural and urban), forest, inland wetlands, lakes and waterbodies. Agriculture is the dominant land-use type of the study area as19,057,888 people are involved in it (Census Handbook, 2011). The total area under agriculture is 2240.05 ha. The statistical detail of the land-use of the district is given in table 2 and represented in figure 3, while the details of agricultural landuse is represented in table 3.The barren land consist of mostly usar land in certain portion of loam tracts mainly in the blocks of Mainpuri, Ghiror, Bhogaon, Karhal, Kisni and north of Barnahal. A considerable area of barren land is covered with the Dhak jungle.

Irrigation and road network

Bore wells and canals are the most dominant irrigation types in the district. Table 4 gives the irrigation detail of the study area. The study area has 2 canals and a feeder canal running through it – Lower Ganga, upper Ganga and R1 with a total irrigation capacity of 98,100 ha of land. Apart from this, water from Isan and Kali rivers is also harnessed to nearby agricultural fields.The plain topography of the study area restricts tank irrigation and

Table 4. *Irrigation characteristics of the study area*

Irrigation			Area, ha	
Net irrigation area			185060	
Gross irrigated area			339000	
Rain fed area			1500	
Sources of irrigation	Name	Length, km	Area, ha	Percentage of total irrigated area
Canals	Lower Ganga	86.38	98100	30.3
	Upper Ganga	45.26		
	R1	67.03		
Tanks			200	0.1
Open wells			4400	1.4
Bore wells (tubewells)			136719	68.1
Lift irrigation schemes			NA	
Micro-irrigation			NA	
Other sources			20	0.1

Source : Statistical Diary, UP- 2015 and derived by authors from thematic maps

Table 5. *Road network of the study area*

Type of road	Length, km	
State Highway 84	47	107.07
State Highway 83	35.45	
State Highway 84 A	20.52	
State Highway 29	4.10	
National Highway 234/ SH 29	32.80	100.6
National Highway 91	67.80	

Source: Calculated by the authors based on digitized thematic map

encourages well irrigation. Figure 4 shows the thematic maps of irrigation and river network of the study area as portrayed in the dynamic web GIS view. The district has 2 national highways, 4 state highways, various metalled roads joining the tehsil HQs and towns apart from un-metalled roads joining the various villages. A spatial database of the road network was prepared and the derived information was linked to Web GIS application. Table 5 gives the spatial data of roads as obtained from the prepared thematic map of transport network.

Socio-cultural database of villages of the study area

Mainpuri district has a total of 851 villages according to 2011 census of which 31 are uninhabited. There are 3,13,690 households in the district (Census Report, 2011). The district is renowned for Tarkashi (a popular art form of brass wire inlay work on wood), its temples, forts and Sarus crane (Grus Antigone). For the present study a location map of 06 tehsil towns, 02 towns and 60 villages was done alongwith a database of each of the villages having details of their administrative subdivision, total number of households, total population, total area and their importance. While preparing database, preference was given to villages having geographical/historical/religious importance. The details of the socio-cultural database is presented in table 6. The database was prepared on a QGIS platform. The same was later linked to Web GIS through ARC GIS online dynamic interactive application as detailed in methodology section. The outcome is presented in figure 5.

Mainpuri district has numerous waterbodies

Table 6. *Database of village of the study area*

Place	Adminstrative unit	Importance	Population	Household	Tehsil	Area, ha
Mainpuri	H.Q/ Tahseel	Fort, religious importance, Tarkashiwork	1,36,557	24,498	Mainpuri	700
Bhongaon	Tahseel/ Town	Garlic market, Police station, cottage industries	30,874	5,040	Bhongaon	434
Karhal	Tahseel/ Town	Garlic market, Sarus crane	27,701	4,607	Karhal	958
Kishni	Tahseel / police sta	Garlic market	11,098	1,978	Kishni	1900
Kurawali	Tahseel /Town	Garlic market	24,969	4161	Kurawali	1260
Ghiror	Tahseel / Town	Garlic market	15,911	2687	Ghiror	1300
Bewar	Town	Karpiya Temple	23,729	4202	Bhogaon	900
Dehuli	Village	Relics of Fort, Sarus crane	3517	584	Karhal	278.1
Harwai	Village	Relics of old village, Sarus crane	1088	214	Karhal	269.6
Katholi	Village	Sarus crane	723	142	Karhal	131.0
Barnahal	Village	Garlic market, Sarus crane	10203	1732	Karhal	635.8
Bahsi	Village	Sarus crane	875	115	Karhal	167.4
Agrapur	Village	Sarus crane	880	146	Karhal	145.4
Sajhajipur	Village	Sarus crane	2417	405	Karhal	381.5
Urthan	Village	Relics of fort, Sarus crane	6696	1110	Karhal	1332.5
Bausak	Village	Relics of old village	2577	467	Karhal	735.5
Udhan	Village	Sarus crane	730	143	Karhal	853.3
Bhanti	Village	Sarus crane	3055	530	Karhal	1741.6
Sahan	Village	Sarus crane	6820	1109	Karhal	1741.6
Jaurai	Village	Sarus crane	5164	864	Mainpuri	1218.9
Palia	Village	Relics of old village	2233	427	Karhal	0.0
Paharpur	Village	Sarus crane	2689	418	Bhogaon	488.1
Saman	Village	Bird sanctuary	14522	2382	Bhogaon	3255.3
Sauj	Village	Relics of fort/ pond	7957	1318	Karhal	1991.6
Basait	Village	Relics of old village	8837	1472	Bhogaon	1020.6
Ratheh	Village	Relics of fort	5193	933	Bhogaon	13.5
Tariha	Village	Sarus crane	3593	625	Bhogaon	698.8
Kusmara	Town	Birth place of MahaKavi Dev	11,938	2042	Bhogaon	400
Kitah	Village	Sarus crane	1439	236	Bhogaon	175.7

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Jasmai	Village	Sarus crane	4261	679	Bhogaon	672.1
Bhadei	Village	Sarus crane	3259	513	Bhogaon	462.5
Adhar	Village	Relics of Fort	4944	866	Bhogaon	780.1
Noonari	Village	Sarus crane	2275	372	Bhogaon	311.7
Naviganj	Village	Garlic and vegetable wholesale market	4883	792	Bhogaon	304.9
Ghutara	Village	Sarus crane	2707	436	Bhogaon	308.3
Masoom-pur						
Tiigwan	Village	Religious	3177	524	Bhogaon	411.5
Mahadiya	Village	Religious	683	116	Bhogaon	106.1
Syona	Village	Religious	477	72	Bhogaon	167.5
Jilhi	Village	Religious	1866	305	Bhogaon	148.5
Chhachha	Village	Relics of old village	11223	1810	Bhogaon	1705.7
Mohabb-atpur	Village	Sarus crane	4211	635	Bhogaon	1048.0
Ahema-dpur	Village	Main market	934	152	Bhogaon	95.0
Aurandh	Village	Relics of old village	7237	1300	Bhogaon	1053.2
Hasra	Village	Sarus crane	254	37	Bhogaon	80.2
Rakra	Village	Sarus crane	1103	189	Bhogaon	112.9
Alipur Khera	Village	Relics of fort	7125	1138	Bhogaon	0.0
Shivpalpur	Village	Sarus crane	357	54	Sutanganj	0.0
Alupura	Village	Sarus crane	3869	614	Mainpuri	79.1
Pirpur	Village	Sarus crane	623	86	Mainpuri	99.4
Burra	Village	Sarus crane	1756	309	Mainpuri	325.2
Dangan	Village	Sarus crane	979	170	Mainpuri	244.5
Dharendra	Village	Sarus crane	1461	225	Mainpuri	202.2
Thorwa	Village	Relics of Fort	4030	646	Mainpuri	875.6
Akbarpur Aunchha	Village	Religious / Pond	8579	1410	Mainpuri	1654.5
Nouner	Village	Relics of Fort	15516	2701	Mainpuri	4094.3
Khija	Village	Sarus crane	490	81	Mainpuri	86.4
Dannahar	Village	Police station	941	150	Mainpuri	152.0
Darwah	Village	Tarkashi	4460	682	Mainpuri	624.1
Rathera	Village	Sarus crane	4856	749	Mainpuri	141.4
Godhna	Village	Sarus crane	2931	472	Mainpuri	580.2
Nahili	Village	Sarus crane	2014	366	Mainpuri	408.1
Koson	Village	Sarus crane	2409	419	Mainpuri	793.2
Shahjah-anpur	Village	Sarus crane	4674	763	Mainpuri	722.7

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Dhaurasi	Village	Sarus crane	1813	263	Mainpuri	220.3
Jawapur	Village	Religious	6290	996	Mainpuri	1275.3
Lalpur Sathini	Village	Rice and floor mills	2610	467	Mainpuri	543.5
Allau	Village	Handloom	5087	859	Bhogaon	647.9
Bhanwat	Village	Religious	7025	1088	Bhogaon	1105.4

Source: Field Survey and Statistical Diary-UP, 2015

Table 7. *List of major waterbodies and migratory birds found*

Name of lake	Area, ha	Migratory birds found
Markandyey	33.56	*Grus Antigone, N. Rufina*,*Laridae, A. Anser*, *Anser indicus*, *Ardeola grayii*
Saman	6.85	*Grus Antigone, Pelecanus onocrotalus, Egretta* spp, *Ardeola grayii*
Raju Ka Tal	17.40	*Grus Antigone, Ardeola grayii*

Source: Field survey and derived from prepared thematic maps

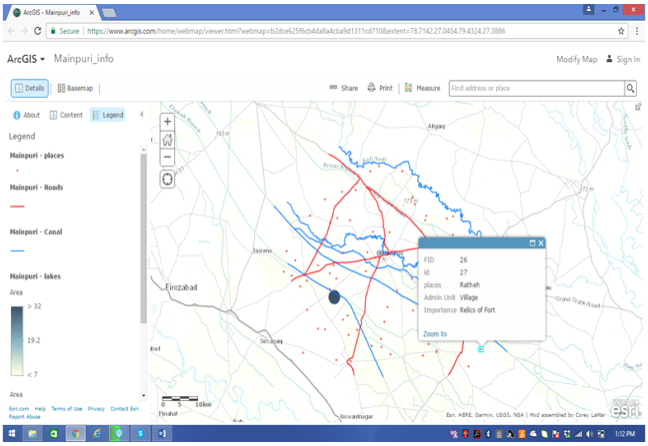

Figure 5. *Web GIS village information system (VIS)*

and wetlands. However, not all are big enough to be called lakes. 3 lakes of fair size have been mapped in the present study based on their geographical extent. These lakes and wetlands are frequented by numerous seasonal and migratory birds.Two third of the eight to ten thousand sarus crane (*Grus Antigone*), an endangered species, found in India dwells in this district. The spatial and attribute details of these lakes is given in table 7 and the same is interlinked in the Web GIS DIS.

CONCLUSION

A multilevel study has been undertaken for Mainpuri district of Uttar Pradesh to generate spatial and non-spatial database on a dynamic Web GIS platform through web application (http://arcg.is/2glL4u0) to assist the planners and decision makers for macro district level planning with special emphasis on rural development. It is very important that planners or decision makers have access to ready and accurate dynamic digital database which at present is absent for the district. The database for the study area includes various georeferenced thematic maps, like base map, slope map, drainage network map, transport network map, LULC map and geomorphology map. The spatial attributes linked to these thematic maps have also been linked to the database alongwith socio-economic-physical database of 60 villages, soil and agricultural characteristics of the study area. The development of digital thematic maps is the basic spatial infrastructure for a range of GIS based rural applications. GIS based district information system will be beneficial for the study area since the various socio-economic-physical attributes can be linked, upgraded and utilized for better planning procedure and e-

governance system which is being emphasized on presently in India. Web application based DIS helps in fast access to information globally. Since all the villages in a given district are now spatially correlated by a common georeferenced system and the database available in one click query system through web application, a number of management strategies can be performed easily and timely.

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