Application of ArcGIS for e-Governance of Rural Water Management

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Abstract

Water is one of the most important commodities. More than two third of India's population, over a Billion, lives in rural and semi-rural areas. A large number of villages have over 50% deficit crop yield, jeopardizing the lives of millions of people. For the lack of water, it is feared that 50% of the livestock could be lost. Farmers are abandoning cattle and migrating to cities. So to stop this migration the need has arisen to make water available to them.

Thus, key issues in the governance of rural water services in the country are lack of rural water access, high levels of poverty and poor management of water supply schemes that are under decentralization processes. In order to prioritize the need of the development of efficient water supply schemes several factors like demographic profile eg., population, number of households, literacy level and socioeconomic profile e.g., occupation, village area, land pattern, educational institution, health facility, power supply, social organizations, road connectivity, agriculture, drinking water system, sanitation, etc. were considered. As a pilot study a rural block was considered in the Maharashtra region. The spatial and non-spatial data was collected and was input to ArcGIS tool. The layered information was extracted further using various Boolean operations for analyzing Enhanced Water Point Needs (EWPN). Once all data of the block were fed, the behavioral pattern of each block could be visualized thereby easing the process of analysis. For example, it could be visualized that villagers give first preference to electric connections followed by the water supply connection while toilets are given less priority. Pockets could be identified where ground water exploitation was most. This had a direct relation with the cropping pattern. The proposed approach is a feasible solution for solving the issue of governance of rural water management at national level.

About the Author

Dr. Rahul V Ralegaonkar is working as a Associate Professor in the Department of Civil Engineering at VNIT, Nagpur. He has over 12 years of teaching, research and administrative experience at both industrial and adacemic levels. He is working broadly in the area of sustainable resource management and has over 70 research publications to his credit at International and National Level.

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Introduction

Water is a vital component for the economic prosperity of any country. Overall water usage in low and middle income countries and their per capita domestic consumption is expected to increase over a period of time due to increasing population, like in India. Domestic food grain demand has also increased which in turn put excess pressure on water resource substantially. The key issues addressed in the governance of rural water services are lack of rural water access, high level of poverty and poor management of water supply schemes that are under decentralization processes. Research indicated that 50% of the water saving comes from water management practices (Shangguan et al., 2001). To support improved irrigation scheduling in the Syr Darya basin, Uzbekistan, the ISAREG model integrated with a Geographical Information System (GIS) was developed. This GIS based application was aimed at supporting the implementation of improved farm irrigation management, support irrigation scheduling advising and help in the identification of practices that may lead to water saving and provide for salinity control (Fortes et al., 2005). A resource database using remote sensing and GIS technique was generated to understand the resources situation which was then followed by critical analysis of the ground water scenario to arrive at identification of appropriate sites for construction of water conservation structure. Based on the study water conservation structures for Kantori watershed was suggested by Pradhan & Kale (2008). Water management projects essentially in rural India are governed by state nodal agencies. The decision makers and the engineers on-site needs proper communication as well as visualization of the project. For the watershed management project the concept of e-governance was briefed by Ralegaonkar & Gautam (2008). In order to resolve the challenge for demand and supply management of water resource in rural India an interactive graphical user interface (GUI) is proposed in the paper and the concept is elaborated with a case study.

Methodology

Spatial data of the study area (Village province data for Amravati district) were procured from authorized agency (Maharashtra Regional Remote Sensing Application Center, Nagpur). The desired non-spatial (attribute) data was procured by physical survey in association with Rural Water Supply Division, Zilla Parishad, Amravati. The georeferenced spatial data was fed to ArcGIS software and was associated with gathered attribute data. Suitable queries were framed using specific operators and resultant output were stored as a raster layer for display. The desired layers were further published for sharing amongst decision makers for better management of rural water supply challenge.

Case Study

To demonstrate the concept of e-governance, a pilot study of two rural blocks (Morshi (21.3392° N, 78.0131° E) and Warud (21.4667° N, 78.2667° E)) were considered from the Maharashtra region (Figure 1). Morshi & Warud covers an area of 52728.8 Ha and 64078.07 Ha respectively. Morshi comprising of 89 villages while warud has 100 villages.

Several factors like demographic profile and socioeconomic profile drinking water system, sanitation, etc. were considered. Demographic profile includes population, number of household, the literacy level of the village. A socioeconomic profile includes occupation, number of job cards, village area, landholding pattern, a number of educational institutions, health facility, power supply, active social organizations, road connectivity, the area under cultivation, area irrigated under the canal, water lifting sources, water level issues, principle crops, water saving devices, animal population. The layered information was extracted further using various Boolean operations for analyzing Enhanced Water Point Needs (EWPN). The behavioral pattern of each block was visualized once all data of the block were fed.

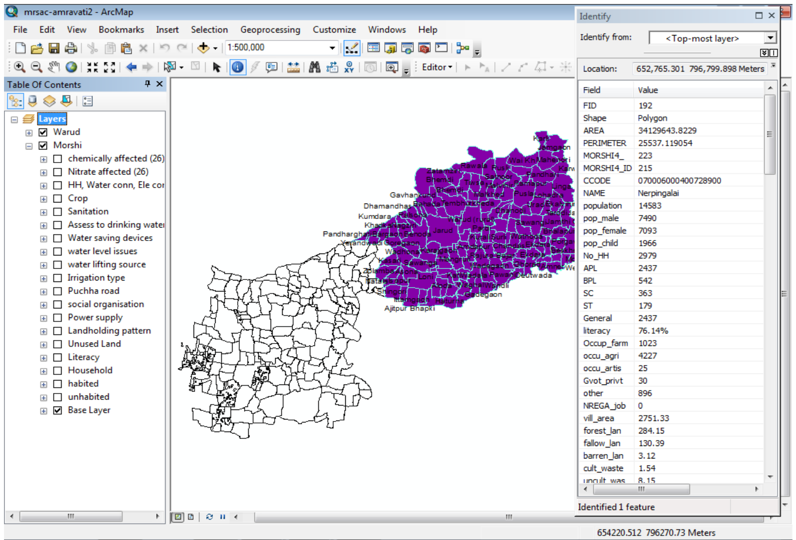

Figure 1 – Map showing Morshi and Warud blocks

Table 1

Study Parameters and Layered Analysis

Sr. No.	Parameters	Layered Analysis			
1	Chemically affected	Nitrate	Fluoride	TDS	
2	Crops	Summer-groundnut, Onion, Vegetable	Rabbi-Grain, Chana, Vegetable	Kharif- Cotton, Soyabean, Tur, Vegetable	
3	Households (HH) with basic services	Number of HH	HH with electricity connection	HH with water connection	HH with toilet
4	Sanitation	HH without toilet	HH with toilet		
5	Access to drinking water	Number of HH without source of drinking water	Number of HH with source of drinking water		
6	Water saving devices	Drip	Pat	Sprinkler	
7	Water level issues	% of well falling under water level	% of irrigation well	% of drinking well	% of defunct well
8	Water lifting sources	Submercible pump	Centrifugal pump		
9	Irrigation type	Bore well	Dug well		
10	Road connectivity	Kachha road	Pucca road		
11	Social organization	Co-operative societies	Youth club	SHG's	VWSC
12	Power supply	HH with electricity connection	HH without electricity connection		
13	Landholding pattern	Big farmer	Marginal farmer	Small farmer	Landless farmer
14	Unused land				
15	Literacy				
16	HH category	SC, ST, General	APL, BPL		
17	Habitat				
18	Unhabitat				

As per the decision makers understanding desired query analysis was carried out. Table 1 indicates broadly there were 18 classifications which were carried out on the data categorically specifying visual layers as mentioned in layered analysis columns for the specific parameter (Table 1).

Result and discussion

Figure 2 helps to visualize that villagers gave first preference to electric connections followed by the water supply connection while toilets are given less priority. Pockets could be identified where ground water exploitation was the most (Figure 2). This had a direct relation with the cropping pattern. The proposed approach is a feasible solution for solving the issue of governance of rural water management at national level.

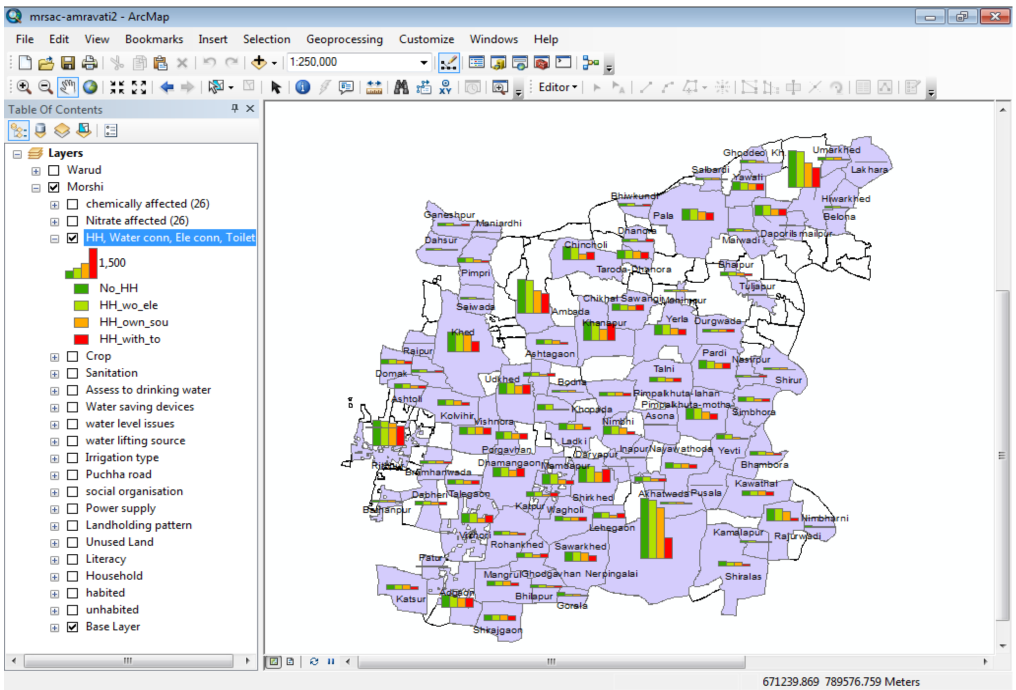

Figure 2: Villagers Preference for facilities

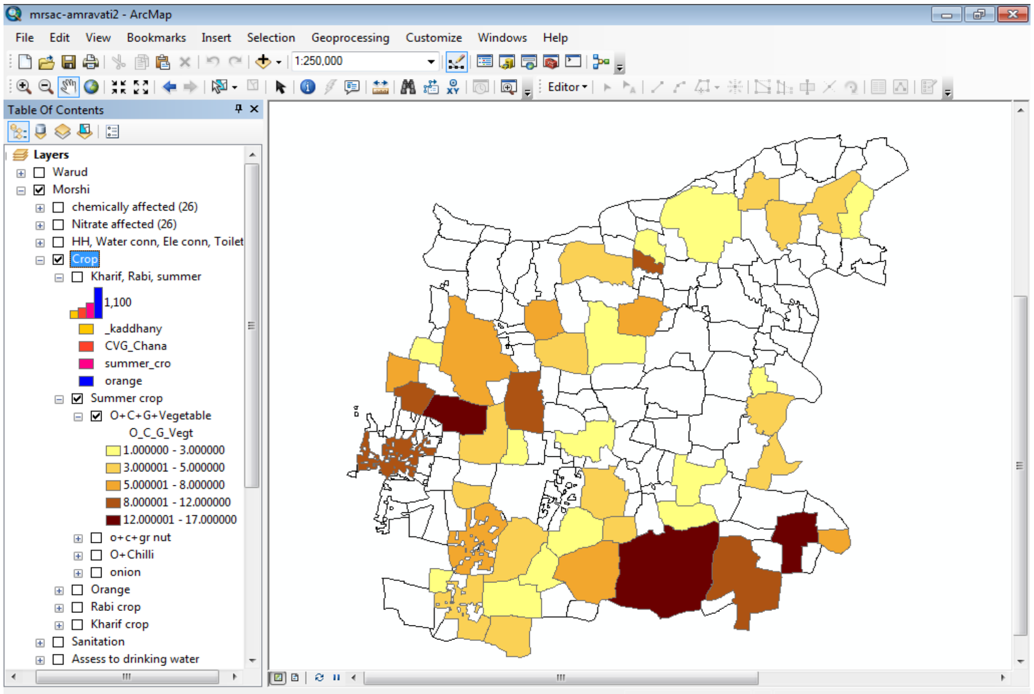

Figure 3: Areas indicating ground water exploitation

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