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Geospatial Technologies for Groundwater Management in Aurangabad City

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Abstract:
The Aurangabad City is located in the heart of Maharashtra State an urban center of the Deccan sub-region. The water provided by the Aurangabad Municipal Corporation (AMC) is not sufficient for the use of citizen. In this study, we have only considered the water resources available in the different area only in the Aurangabad city.All resources are mapped on the Google map/Google earth using KML platform. The Groundwater resources available in the Aurangabadare mapped in Google earth and detail availability of the water is provided. These ground water resources are divided into different Zones according to the availability of the water in that particular location. The spatial data of the available water resources according tothe area are mapped with all detail of the water available such as usage and different sources available along with their property so it's convenient for analysis the spatial data.
Keywords:*GIS(Geographic Information Systems), ICT (*Information And Communications Technology), *OGC (Open Geospatial Consortium)*

I. INTRODUCTION

According to the China Academy of Telecom. Research [1], a smart city is defined as follows: "A city may be called 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure, fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government are successfully implemented".

It can be seen from the figure1.1 that the following seven components are required for the Smart city:

(1) Smart Energy (2) Smart mobility

(3) Smart water (4) Smart Public services
(5) Smart building and homes (6) Smart Integration

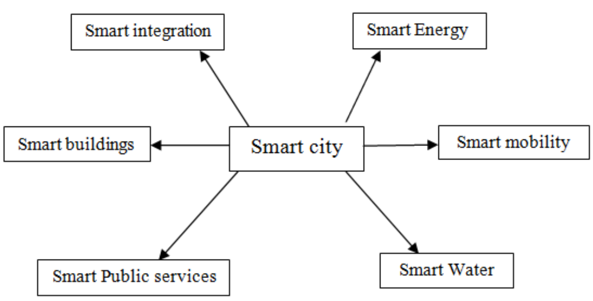

Figure1.1 SmartCity Sectors

a. Smart Water: A Key Building Block of the Smart City of the Future

The water system is the most important pieces of critical infrastructure. The term "smart water" points to water and wastewater infrastructure for the resource along with the energy used to transport it and managed effectively. To gather data about the flow, pressure and distribution of a city's water, a smart water system is designed. Water distribution and managedsystem,inthe long term to maintain its growth ,equipped along with the capacity to be monitored

b. Geospatial Technologies for Water Management

A ground-water system which is a mass water flowing below the Earth's surface in motion. The work is in the long-term, for the amount of water resources available in the region and providing a way to use it in an efficient manner. Modeling results are the design parameters for water management plans which are used by national and multinational decision-makers.

c. Water Supply and Groundwater Information of Aurangabad City

The Municipal Corporation of Aurangabad is incurring heavy losses. The corporation offers water to the citizens at subsidized rates. The actual annual cost of 200 liters of water per family once in two days is Rs 3,500 but the charge only Rs 2,000 per annum. The Groundwater use can change dry areas, huge quantities of water were available underground, but due to lack of political will, it remained untapped.[4]

d. Mapping bore well of the Aurangabad city through KML on Google API

The objective is to map the groundwater plans in Aurangabad city. Water supply, including volume extracted, use of the resource and benefits depending on the quantity and quality status of groundwater resources including constraints on existing use and the potential for further growth. The technologies within the language of open geospatial consortium (OGC) standards in-order to more fully understand urban systems .Working with the KML and Google API for locating the available ground water resources and analyzing their properties for water usage. [5]

II. RELATED WORK

The Cities is a complex systems, single data source are sufficient for the information needs required to map, monitor, model, and ultimately understand and manage our interaction within such urban systems. Remote sensing technology provides a key data source for mapping such environments.The integration of remote sensing and Geographic Information System (GIS) technologies has been widely applied and recognized as an effective tool in urban analysis and modeling. [6][7]

In Northwest China develop and utilize groundwater resources for the frangible ecological environment. The development of groundwater level information model basic fact that the surface soil water moisture is observably related to the shallow groundwater level.The generation of interactive 3D City Models based on free Geo-data available for the OpenStreetMap (OSM) project and public domain height information provided by the Shuttle Radar Topography Mission. In particular, the suitability and quality of the Open Street Map data for 3D visualizations of traffic infrastructure, buildings and points of interest (POIs) is reviewed. The diversity and quantity of the points of interest provide new opportunities and challenges in creating customized and detailed visualization of cities. Specialized web services were implemented to filter and display the data in an acceptable manner. All applied web services of the 3D spatial data infrastructure are based on standards and draft specifications of the open geospatial consortium (OGC). [8]

III. METHODOLOGY

Mathematical methods and numerical modeling are of great significance for groundwater management. Numerical models allow the analysis of the present conditions and the evolution of groundwater systems, as well as an estimation of the impact of factors such as temperature and salt dependent water density in the flow field. Furthermore, they can simulate and predict the spreading of solutes in groundwater as shown in Figure 3.1.

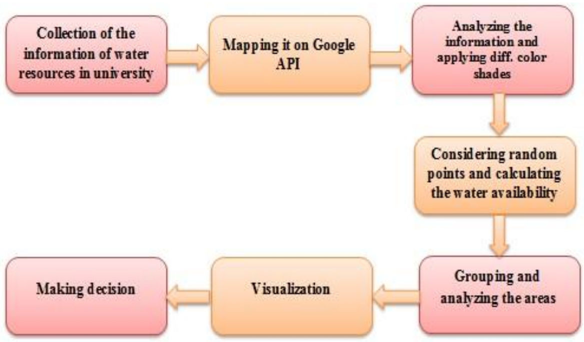

Figure 3.1 Process Flow diagram

The project work deals with the area of the focuses of ground water resources and they are represented through the KML file which is an OGC std an open sources. Thekml give a wayto mapped the spatial date of the ground water resources on Google API along with the detailed information of water resources along with the proper location of the resources is also highlighted .The proper detail are mention in different colors so it become easy to distinguished between the water resources are and no water resources area.

3.1 Water Modeling

A. Technique of Finding the Availability Water Management

A survey is done for finding the ground water resource in the university area and accordingly 70 such water resources found. The Groundwater resource such as bore well, well, dam available in university area are mapped on Google earth. The KML allows to map the spatial data on which the various water resources are located so to calculate the availability of water resource at a particular point certain assumption have been made.

The university area is best area which completely depends upon ground water usage, the model deal with plotting all available water resources in that area and analysis them according to the need for a near location where the water resources are not available or which are not sufficient for the usage. All the spatial data will be located on the Google earth and accordingly the water flow can be monitored which will give an exact usage and non water resources area in the university

Weight for a location are considered which is indicated by W, that consist of various levels that is weighted at 0 levels (W0), weight at 0.1 levels

(W0.1), weight at 0.2 levels (W0.2), weight at 0.3 levels (W0.3), weight at 0.4 levels (W0.4), weight at 0.5 levels (W0.5), weight at 0.6 levels (W0.6), weight at 0.7 levels (W0.7), weight at 0.8 levels (W0.8), weight at 0.9 levels (W0.9), weight at 0.1 levels (W0.1), weight at 1 level (W1). This weight at different levels indicates the availability of the water resource at a particular point.

The weight indicated the availability of water resources the weight W0 indicates no availability of water, W0.5 indicate Less water resources, W1 indicate High water resources listed on below table, along with the color shade are mensioned in the Table3.1 along with the weight at different level .

The gathering of information and mapping them on the Google earth, which will give a clear visual view of the spatial data on which analysis can be make and monitoring of the water resources can be carried out for making decisions

Table3.1: Assumption for Weight Water at a Given Location

Level	Weight	Water resource	Color
0	0	No water State	
0.1	0.1	Less Water State	
0.2	0.2	Less Water State	
0.3	0.3	Less Water State	
0.4	0.4	Less Water State	
0.5	0.5	Less Water State	
0.6	0.6	Intermediate Water State	
0.7	0.7	Intermediate Water State	
0.8	0.8	Intermediate Water State	
0.9	0.9	Intermediate Water State	
1	1	High water State	

Let d indicated the distance from the unknown point till the known point.
P=d(i) distance i=1 to n.
Wp= weight at the unknown point.

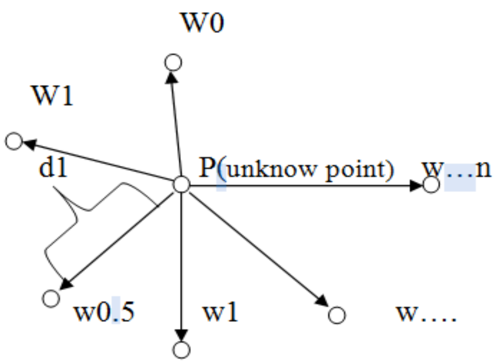

Figure 3.2Point with Ground Water Resources and Unknown Point

Therefore, to calculate the weight at that point up

$d_0 = (d_1+d_2+d_3+d_4+\ldots\ldots d_n)/N$ …(1)

$d_0 = \sum_{i=1}^{n} di/N$ …(2)

$wp = w_1\exp(-d_1/d_0)+w_2\exp(-d_2/d_0)+w_3\exp(-d_3/d_0)+\ldots\ldots w_n(-d_n/d_0)$ …(3)

$wp = \sum_{i=1}^{n} wi\ exp(-\frac{di}{d0})$ …(4)

where,

Wp = weight of the unknown point (how much water availability)

W_i=weight of known point (i= 0 to n).

d_i=distance between the unknown point and known point (i= 0 to n).

The "Haversine" formula to calculate the great-circle distance between two points – that is, the shortest distance over the earth's surface – giving an 'as-the-crow-flies' distance between the points (ignoring any hills, of course).

Haversine formula:

$a = \sin^2(\Delta\varphi/2) + \cos(\varphi_1).\cos(\varphi_2).\sin^2(\Delta\lambda/2)$

$c = 2.atan2(\sqrt{a}, \sqrt{(1-a)})$

$d = R.c$

Where φ is latitude, λ is longitude, R is earth's radius (mean radius = 6,371km)

note that angles need to be in radians to pass to trig functions

IV. EXPERIMENTAL WORK

a. Calculating Water Resource on A Particular Location

The availability of water resources in the university place is being mapped according on the Google earth. The spatial data are plotted on the map with the detailed features on it, which is represented by circular symbol as shown in the Figure 3.2.The circular symbol is represented in the color shade: green, light green, red, etc. Green colors indicate the availability of water resource in that location. Light green color indicates availability of less water resource in that location. Red color indicates availability of no water resource in that location. P is the unknown point which is mapped to which the availibty of the water need to find . W0,W1,W2,W…. are the nearest ploted point and d1,d2,d3,d… is the distance between the unknown point and weight, which is indicated by W.The distance is calculated by the "Haversine formula".

Consider the three random points(as shown in the Figure 4.1, Figure 4.2 and Figure 4.3) and try to find the availability of water resources.Consider the random location on the Google earth and try to find the availability of water resources at that point. Three random points have been considered as shown in the map. By applying theHaversine formula, we can calculate the distance between the known point and unknown point. To calculate the weight or unknown point.shown in the above formula in equation(4), accordingly from the given point we have the distance and according to data of ground water resource availability the water resources are located on the Google earth according to the area in the university campus shown in below image. The latitude and longitude of each point are given through which we can calculate the distance from the know to unknown point.

Figure4.1 Random Point 1

The above Figure4.1 shows the randompoint_1 and borewell, handpump,the availability of water at the randompoint_1 is calculated by using the formula as shown in equation (1), (2), (3), (4).

Table 4.1DistanceBetween Random Point and Known Well, Calculated Weight of Random Point1

Sr.no	Detail of a well, borewell, Handpump	Weight Assumed	Water availability	Distance miles	Km distance	D0
1	Borewell_1	1	Very high	0.024	0.038	
2	Hand_Pump_1	0.3	Very Low	0.01	0.017	
3	Hand_PumP_2	0.5	Medium	0.013	0.021	0.024
4	Hand_PumP_3	0.6	Low	0.01	0.017	
5	Borewell_2	0.8	Higher	0.018	0.03	
6	Random point1	**1.2**				

The Table4.1 shows the detailed information of the nearest water resources available from the random along with their assumed weight.The distance from the random is calculated and mention in the table by applying the formula as shown in the equation (1), (2), (3), (4).The D0 distance through which the water availability at random point can be calculated is1.2 which high from the Table3.1.

Figure4.2 Random Point2

Table 4.2 DistanceBetween Random Point and Known Well, Calculated Weight of Random Point2

Sr.no	Detail of a well, borewell, Handpump	Weight Assumed	Water availability	Distance miles	Km distance	D0
1	Borewell_15	0.1	No water	0.029	0.046	
2	Borewell_19	0	No water	0.053	0.085	
3	Borewell_20	0.5	Medium	0.038	0.062	0.0592
4	Borewell_21	0.7	High	0.029	0.047	
5	Borewell_22	0.9	High	0.035	0.056	
6	Randomponit2	**0.27**				

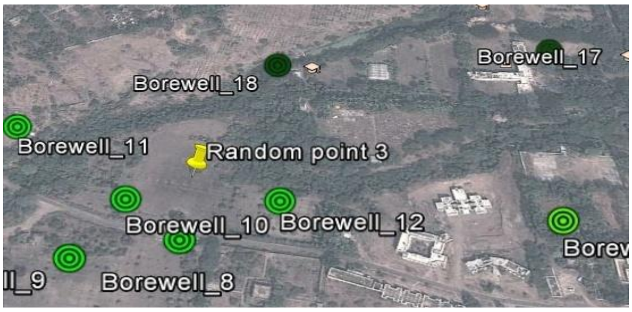

Figure 4.3 Random Point3

Table 4.3DistanceBetween Random Point and Known Well, Calculated Weight of Random Point 3

Sr.no	Detail of a well, borewell, Handpump	Weight Assumed	Water availability	Distance miles	Km distance	D0
1	Borewell_6	0.5	Medium	0.186	0.299	
2	Borewell_7	0.5	Medium	0.18	0.294	
3	Borewell_8	0.5	Medium	0.055	0.088	
4	Borewell_9	0.5	Medium	0.089	0.143	
5	Borewell_10	0.5	Medium	0.043	0.068	0.2461
6	Borewell_11	0.5	Medium	0.099	0.159	
7	Borewell_12	0.5	Medium	0.398	0.64	
8	Borewell_17	1	High	0.228	0.367	
9	Borewell_18	1	High	0.098	0.157	
10	Random Point3	**1.1256**				

The Figure4.2 andFigure 4.3 shows the random point 2 andrandom point 3respectivlyon which the availability of the water resources is need to be calculated.The calculated values are mentioned as shown in the Table4.2,Table4.3respectivly, that are the distance from the random and by considering the values in the equation (1), (2), (3), (4)the weight at the random point is calculated, which is 0.27 for Random point 2 less water and 1.1 for random point 3 which is high water mensioned in the Table3.1.

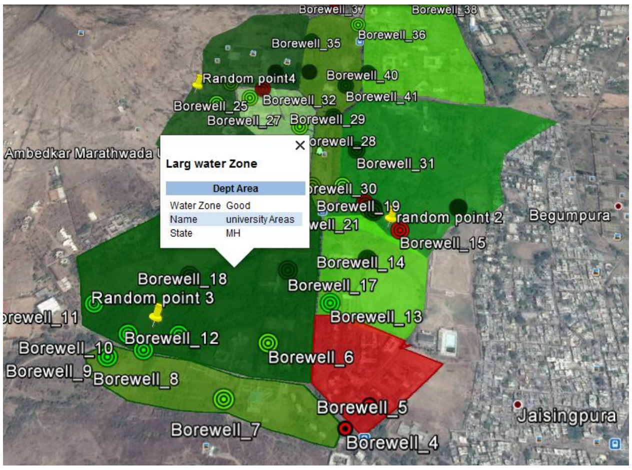

Figure 4.4 Zone of All Levels of Ground Water Resources

The above Figure4.4 givesan overview of all the available water resources in the university area along with the information of their location.Depending upon the water resources weight and consideration of the random point they are divided into different Zones which are indicated in different colors by referring the Table3.1 give their weight value along with the water availability.

V. RESULTS

The increasing citizens' quality of life, and improving the efficiency and quality of the ground- and surface-water modeling can provide a basis for predictive simulation of the effects of future water demand for ground- and surface-water resources. Some areas of the city facing ground-water issues have not been studied in sufficient detail to develop ground-water models, which could be used to provide insight into the effects of water-management. Long-term monitoring data can provide a basis to evaluate the effectiveness of water-management practices, and provide vital information for the development of new, and update of existing, ground-water models.The definitions and blueprints of Aurangabad city infrastructure of important places.

CONCLUSION AND FUTURE SCOPE

The information needs of a ground-water monitoring program is determined by the stated goals of the program. The KML recognized as the standard for geographic visualization it will continue to evolve and grow as more and more geographic browsers continue to be developed, and as the current geographic browsers grow it will be used for mapping bore and also important places of the city. KML is the international standard the. OGC and Google have agreed to harmonize KML and GML further. GML is Geography Markup Language an XML based encoding standard for geographic information. The language allows Internet browsers the ability to view web-based mapping without additional components or viewers. The entire bore well, according to the areas will be located on the map of the Aurangabad city which will give a preside view for the user (Municipal Corporation of Aurangabad) thought which we can make a decision and can provide water in the dry water area. The Google API is the specification used by software components to communicate with each other. An API may describe the ways in which a particular task is performed. Mapping the places of the city and also providing a better view for the users a smarter the information about the city.

The project identifies major topics of Smart Cities that will influence the ICT environment, as covered by NetWorks. All these domains raise new challenges in security and privacy, since users implicitly expect systems
to be secure and privacy-preserving. Smart Cities need to be able to integrate themselves into national, regional and international infrastructures. Requirements address a number of technologies, beyond the ones related to mobile and fixed networks. The needs for mobility in urban areas result into a number of problems.The information being managed in this area can be relevant to other domains, which increases its potential.

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