Groundwater Modeling using GIS Techniques

Vimal shukla, Jyoti Sarup

***Abstract**: Geographical information systems (GIS) have become the most significant tool for mapping and modeling of groundwater level resources. An effort has been made to describe the groundwater level of district Bhopal, Huzur Tehsil, Madhya Pradesh, India. Bhopal district, Huzur Tehsil, Madhya Pradesh, India, is faces the problem of groundwater attainable in a few years. For assessing the groundwater Level suitability through GIS interpolation model techniques is used. Geospatial techniques employed for Geographical information systems (GIS) is more being used in the water resources managed and field of hydrology , and monitoring the groundwater level. This is the greatest advantage of using GIS interpolation methods techniques for Groundwater level (bore well) monitoring is its ability to generate information in water level potential position conditions in the area study, which is afford very critical for successful analysis, prediction, and validation. In the study, Kriging interpolation model method technique is used to interpolate the groundwater level and provided a suitable area of groundwater level positions. These are applying in the Interpolation techniques of groundwater levels fluctuation that were carried out for the year 1996-2015, and finally, we generated the fluctuation maps that show the fluctuation in period between the years 1996-2000, 2001-2005,2006-2010 and 2011-2015, and show the Ground water level Potential Zone (GWLPZ) maps ..*

Keywords: Groundwater Level Potential Zone; Interpolation Model; GIS, Mapping, Groundwater Fluctuation.

I. INTRODUCTION

The groundwater model is a representative scale model of a groundwater situation which can be used to predict the effects of hydrological changes like groundwater abstraction in urban and rural area. The increasing the demand of water for domestic, agriculture and industrial use demands the management of water in urban and rural area . Groundwater is subsurface water that occurs beneath the earth's surface. In a hydrologic water cycle, groundwater comes from surface waters (precipitation, lake, reservoir, river, sea, etc.) and percolates into the ground beneath the water table. Groundwater is a significant part of the hydrologic cycle, containing 21% of earth water. The Population of India almost about the 17 % of the total population world, it has only 2.4% of the land worlds and 4% of total available water resources (Biswas2004). In India, improvement in urbanization, population, and standards of lifestyle has resulted in more and more demand for water. A large number of states in India used the water right process to manage groundwater resource and to ensure that over drafting does not occur. The Groundwater is the important source of drinking water in rural and urban area in India. While, it is evaluation that approximately one-third of the world's population use groundwater for drinking purpose (Nickson et al. 2005). Mostly rural and urban households, public water supplies in various parts of the world depend on wells and groundwater. But due to increasing , the number of urbanization growth and increase population that means demand for water are is required more and more in an urban or rural area, and which increasing number is of bore well every house holding in an urban area, which is the reason to decline the Groundwater Level. As we know groundwater is an important source of water supply throughout the world, its uses in irrigation, industry, municipality and domestic areas continue to increase. Therefore, greater emphasis is being laid for a planned and optimal utilization of water resources. Owing to the uneven distribution of rainfall both in time and space, the water surface resources are unevenly distributed. That has resulted in an emphasis increased on the development of groundwater resources. The simultaneous growth of groundwater especially through bore wells a will decline water level. In such condition, a severe problem is generated resulting in the drought of bore wells. The Indian census data represent that in 1901 at most one in every 10 Indian lived in a city, while in 2011 almost 3 in 10 people live in a city (Chandramouliand General 2011). According to the Bhopal Municipal corporation (BMC 2018) Population of district Bhopal, Huzur tehsil, Madhya Pradesh as per Census 2001 (1429132) & 2011 (1834493). Out of a total population, 89.5% people live in urban areas while 10.5% lives in the rural areas and according to the CGWB (CGWB 2017), the sustainable annual groundwater resource for the whole country's 433 billion cubic meters (BCM); out of these, 231 BCM are drafted for irrigation, domestic and industrial uses, 34BCM is kept in account of natural discharge and only 168 BCM of groundwater are left for other purposes (Tiwari Anju et al.2019). Since the 1960, remote sensing (RS) Satellite imagery have been successfully used for mapping of structures surface and terrain characteristics (contour, slope, elevation), land use land cover (LULC) properties,

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infrastructure facilities, recharge and discharge areas salinity, geomorphology, soil type, geological fractures etc. (Srivastava 1997; Ray and Dadhwal 2001; Shaban and Dikshit 2002; Mogaji 2016). Modern techniques like GIS (Geographical information technology) are increasingly becoming important day by day in whole real world difficulty of geospatial nature. The field of water resource and hydrology development is also the area having an extensive scope of deriving benefits from these tools of geoinformatics (Krishna A.Pet al. 2005).

The purpose of modeling can vary widely, and the approach used may depend on site-specific needs, current understanding of the groundwater level (bore well) condition in hole of area. That means which area bore well water level is Low, Medium and High. This is one of the greatest dominance of using GIS for monitoring and investigations is its capability to generate information in groundwater fluctuation and condition of groundwater, which is very crucial for successful analysis, prediction, and validation (Kumar MG et al. 2008). Geographical information systems **(**GIS) technology is nowadays becoming most significant tool as a platform to efficiently manage large and complex details organized around that it core. That is also provides best alternatives for efficient management of extensive and complex databases. For the analysis of Resulted ground water modeling too easy to extract the ground water Level potential zone (GWLPZ) and analyst have successfully used Geographical information systems **(**GIS) techniques to aspect for modeling the groundwater level potential zones.

II. PROBLEM IDENTIFICATION

In few years the Groundwater Level (bore well) decline in Bhopal district, Huzur Tehsil, Madhya Pradesh, India. Due to increases in the high population and more urban sprawl that means increasing the number of bores well, which are affected by the groundwater level and few bore well dry in the pre-monsoon period. This condition produces a continuous decline groundwater level in Bhopal district, Huzur Tehsil, Madhya Pradesh, India.

III. OBJECTIVE

The assessment of the groundwater levels decline and the different factors responsible for it require the instantly need of assess the overall scenario concerning groundwater. The study includes the groundwater Level Potential Zone (GWLPZ), and depth of Ground water level (1996-2015). And analysis of each Five year fluctuation of water Level in Huzur Tehsil District Bhopal.

IV. STUDY AREA

The study was conducted in district Bhopal, Huzur tehsil, Madhya Pradesh (India).it is lies between the North latitude 23°04'18" and 23°25'46" and East longitude 77°10'07" and 77°37'32 covering an over area of 1361.77 km^{2} (Figure 1). Total area of Huzur is 1,361.77 km² including 1,025.71 km² rural area and 336.06 km² urban area (Adopted June 2017). The average annual precipitation study in Bhopal district Huzur Tehsil, Madhya Pradesh (India) is about 1121 mm. District Bhopal Average elevation 500 meters and located in central part of India, and which is cover the upper limit of the Vindhya mountain ranges and located on the Malwa plateau. District Bhopal has a well connected with all parts of the country by Air, Rail, and roads. District Bhopal, Huzur Tehsil has a consisted of the subtropical humid climate, with cool, hot summer, dry winters and a humid monsoon season. The summer begin in late April and go on till mid-June, the average temperature start around 30 °C, with the peak of summer in May, when the highs regularly exceed 40 °C Extreme high in May, and monsoon begin in late June and ends in late September. The groundwater data collected from Central Ground Water Board (CGWB), which is acquire from ground- water well information records intimate decline in groundwater level in various parts of District Bhopal Huzur Tehsil, Madhya Pradesh, India.

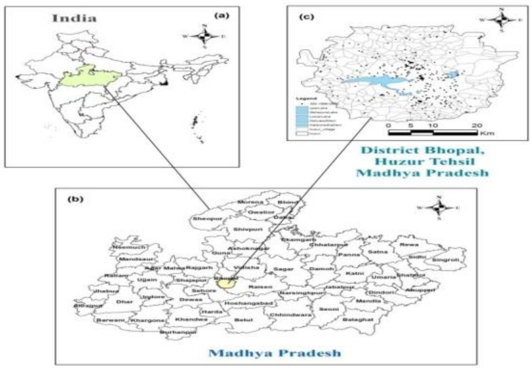

Figure1. Location of the study area (a) India, (b)Madhya Pradesh, and (c) Bhopal district.

V. MATERIALS AND METHODS

A. Data Collection

Multi-spectral satellite imagery from Landsat-8 and digital elevation model Shuttle Radar Topography Mission (SRTM) DEM data is obtained (Table 1). The both data sets are downloaded from Geological Survey (USGS) United States web portal Earth Explorer (http://earthexplorer.usgs.gov). Central Ground Water Board (CGWB) maintains 350 (bore wells) Records Huzur Tehsil, Bhopal district for monitoring groundwater resources. They are the identification of well point Ground truths location using the handholds Global Positioning System (GPS). The collected urban and rural Groundwater Level depth (bore well) in meter below groundwater level (mbgl) data (1996-2015) Huzur Tehsil, District Bhopal, Madhya Pradesh (Source: Central Ground Water Board, Ministry of Water Resources, Government of India, India, adopted 2015),and five-year annual average depth of groundwater level (Pre-post Monsoon) lies between the 1996-2000, 2001-2005 2006-2010,2011-2015, and find out the Fluctuation of district Bhopal, Huzur Tehsil, as shown in table 2,3,4,5 .

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Table 1: The describe of Imagery Landsat-8 and DEM Shuttle Radar Topography Mission (SRTM) data set

Satellite	Sensor	Row	Path	Date Acquisition	Resolution (m)
Landsat-8	OLI/TIRS	44	145	16August2018	30/100
SRTM DEM	NA	NA	NA	17October2016	30

Table 2: Sample data of five-year groundwater level annual average district Bhopal (1996-2000)

WID	YEAR Observation	Longitude	Latitude	Annual Average Depth (Pre-monsoon) (mbgl))	Annual Average Depth Post-monsoon (mbgl)	Fluctuation (mbgl)
U101	1996-2000	77.4321	23.2556	8.15	4.13	4.02
U102	1996-2000	77.4324	23.2559	22.80	14.27	8.53
U103	1996-2000	77.4321	23.2557	8.09	6.21	1.88
U104	1996-2000	77.4323	23.2548	9.35	4.66	4.70
U105	1996-2000	77.4723	23.2697	10.66	6.58	4.08
U106	1996-2000	77.4071	23.3161	14.36	10.67	3.69
U107	1996-2000	77.4635	23.2537	13.66	8.95	4.71
U108	1996-2000	77.4671	23.2209	10.63	8.13	2.50
U109	1996-2000	77.4876	23.2261	12.15	8.31	3.84
U110	1996-2000	77.4945	23.2280	13.21	8.74	4.47
R201	1996-2000	77.5114	23.2761	8.09	6.21	1.88
R202	1996-2000	77.5021	23.2759	15.72	10.21	5.52
R203	1996-2000	77.5026	23.2702	8.71	3.95	4.75
R204	1996-2000	77.5031	23.2691	8.94	3.96	4.98
R205	1996-2000	77.5007	23.2670	9.35	4.66	4.70
R206	1996-2000	77.3951	23.3241	14.32	9.26	5.06
R207	1996-2000	77.3883	23.3274	14.08	9.24	4.84
R208	1996-2000	77.4051	23.3145	16.61	10.17	6.44
R209	1996-2000	77.4793	23.1625	10.76	6.58	4.18
R210	1996-2000	77.4791	23.2055	14.49	11.75	2.74

Table 3: Sample data of five-year groundwater level annual average district Bhopal (2001-2005).

WID	YEAR Observation	Longitude	Latitude	Annual Average Depth (Pre-monsoon) (mbgl))	Annual Average Depth Post-monsoon (mbgl)	Fluctuation (mbgl)
U101	2001-2005	77.4321	23.2556	14.48	6.63	7.85
U102	2001-2005	77.4324	23.2559	34.12	21.09	13.03
U103	2001-2005	77.4321	23.2557	14.30	12.31	1.99
U104	2001-2005	77.4323	23.2548	10.96	7.10	3.86
U105	2001-2005	77.4723	23.2697	11.78	8.52	3.26
U106	2001-2005	77.4071	23.3161	23.11	13.82	9.30
U107	2001-2005	77.4635	23.2537	20.87	13.55	7.32
U108	2001-2005	77.4671	23.2209	16.60	13.82	2.79
U109	2001-2005	77.4876	23.2261	16.62	13.53	3.09
U110	2001-2005	77.4945	23.2280	20.87	13.68	7.19
R201	2001-2005	77.5114	23.2761	14.30	12.24	2.06
R202	2001-2005	77.5021	23.2759	17.92	13.48	4.44
R203	2001-2005	77.5026	23.2702	10.92	6.61	4.32
R204	2001-2005	77.5031	23.2691	10.93	6.61	4.32
R205	2001-2005	77.5007	23.2670	10.96	7.10	3.86
R206	2001-2005	77.3951	23.3241	22.57	13.95	8.62
R207	2001-2005	77.3883	23.3274	22.42	13.95	8.47
R208	2001-2005	77.4051	23.3145	28.74	16.66	12.08
R209	2001-2005	77.4793	23.1625	11.68	7.84	3.84
R210	2001-2005	77.4791	23.2055	20.12	15.55	4.57

B. Population data

The Population of district Bhopal, Huzur Tehsil, Madhya Pradesh as per Census 2001 (1429132) & 2011 (1834493) out of a total population, 89.5% people live in urban areas while 10.5% lives in the rural areas (Adopted in April 2018).As per

Table 4: Sample data of five-year groundwater level annual average district Bhopal (2006-2010)

WID	YEAR Observation	Longitude	Latitude	Annual Average Depth (Pre-monsoon) (mbgl))	Annual Average Depth Post-monsoon (mbgl)	Fluctuation (mbgl)
U101	2006-2010	77.4321	23.2556	16.65	7.92	8.73
U102	2006-2010	77.4324	23.2559	45.18	31.71	13.47
U103	2006-2010	77.4321	23.2557	21.29	15.17	6.13
U104	2006-2010	77.4323	23.2548	11.86	7.89	3.98
U105	2006-2010	77.4723	23.2697	15.28	12.03	3.25
U106	2006-2010	77.4071	23.3161	28.08	15.52	12.56
U107	2006-2010	77.4635	23.2537	27.00	15.56	11.44
U108	2006-2010	77.4671	23.2209	20.96	15.52	5.44
U109	2006-2010	77.4876	23.2261	20.98	15.81	5.17
U110	2006-2010	77.4945	23.2280	26.70	15.62	11.07
R201	2006-2010	77.5114	23.2761	21.29	15.17	6.13
R202	2006-2010	77.5021	23.2759	18.62	13.39	5.23
R203	2006-2010	77.5026	23.2702	12.13	7.84	4.29
R204	2006-2010	77.5031	23.2691	12.14	7.85	4.29
R205	2006-2010	77.5007	23.2670	11.86	7.89	3.98
R206	2006-2010	77.3951	23.3241	31.13	17.31	13.82
R207	2006-2010	77.3883	23.3274	31.15	17.27	13.88
R208	2006-2010	77.4051	23.3145	33.99	19.69	14.30
R209	2006-2010	77.4793	23.1625	12.63	8.13	4.51
R210	2006-2010	77.4791	23.2055	24.61	17.72	6.89

Table 5: Sample data of five-year groundwater level annual average district Bhopal (2011-2015)

WID	YEAR Observation	Longitude	Latitude	Annual Average Depth (Pre-monsoon) (mbgl))	Annual Average Depth Post-monsoon (mbgl)	Fluctuation (mbgl)
U101	2011-2015	77.4321	23.2556	17.99	9.99	8.00
U102	2011-2015	77.4324	23.2559	61.03	48.19	12.84
U103	2011-2015	77.4321	23.2557	31.91	20.51	11.40
U104	2011-2015	77.4323	23.2548	15.63	8.92	6.71
U105	2011-2015	77.4723	23.2697	22.92	19.30	3.62
U106	2011-2015	77.4071	23.3161	58.88	21.50	37.38
U107	2011-2015	77.4635	23.2537	45.93	20.89	25.04
U108	2011-2015	77.4671	23.2209	50.92	21.03	29.89
U109	2011-2015	77.4876	23.2261	46.07	21.03	25.04
U110	2011-2015	77.4945	23.2280	52.58	20.89	31.69
R201	2011-2015	77.5114	23.2761	28.02	17.20	10.82
R202	2011-2015	77.5021	23.2759	21.71	16.60	5.10
R203	2011-2015	77.5026	23.2702	13.47	8.32	5.15
R204	2011-2015	77.5031	23.2691	13.86	8.54	5.32
R205	2011-2015	77.5007	23.2670	15.63	8.92	6.71
R206	2011-2015	77.3951	23.3241	43.93	24.17	19.76
R207	2011-2015	77.3883	23.3274	42.49	24.14	18.35
R208	2011-2015	77.4051	23.3145	44.27	22.91	21.35
R209	2011-2015	77.4793	23.1625	22.55	15.27	7.28
R210	2011-2015	77.4791	23.2055	27.03	23.27	3.76

Census 2011, the total 211 Villages in district Bhopal, Huzur Tehsil, Madhya Pradesh, India. As per Census 2001 and 2011, the water demanded is increasing in 2011, and demand of water increases today and that also increase the number of bores well. These cause the groundwater level decline.

VI.METHODOLOGY

Above the data are collected first a fall to generate the base map of the study area was produce using India topographical survey of maps. The map slope was developing from DEM data. Spatial Analyst ArcGIS module was used for the developing of slope map (Xiao Yong et al. 2016).

As the study area has nearly flat terrain, resultant slope was classified into different five classes of 18 degree each using the equal-interval option. The satellite data (Landsat-8) product was stacked, cropped and the classified into different five classes. The obtained Geology maps were from the Geological Survey of India (GOI). Soil map are Generated to collect the information of soil in Indian Institute of soil science, Bhopal and generate the Agriculture land suitability of urban and rural area in Huzur Tehsil, District Bhopal, Madhya Pradesh, India. The rainfall distribution data over 20 years (1996–2015) were procured from Indian Meteorological Department (IMD). In total 350 observations, wells were selected for further processing of the data for Groundwater Level analysis. Based on above collection these are prepared the GIS map with the help of the Kriging interpolation model technique in Arc GIS Software. In this study, the Kriging technique was used for the spatial distribution of Groundwater level fluctuation (mbgl) for five-year interval (1996-2000, 2001-2005, 2006-2010, 2011-2015), and one seven-year interval (2011-2015). And long-term trend fluctuation (1996-2015), Show the flow chart of the methodology in figure 2. Using Geo-statistical tools for analyses of spatial interpolation model for suitability groundwater level potential zone. The Kriging is a strong type of spatial interpolation model that uses critical formulas mathematical to evaluation values at unknown points based on the values at known points. There are many different types of Kriging, consisting Ordinary, Universal, and CoKriging. This main thing will be focusing on the most common Ordinary Kriging.

The D.G. Krige scientist recommended by Kriging named, a South African engineer mining and pioneer in the application of Geo-statistical techniques. The kriging technique is insistent from the theory of variables regionalized (Krige, 1966; Matheron, 1963). Kriging be an interpolation point that needs a point map as input and returns a map raster with estimations Groundwater level Potential Zone (GWLPZ) map. The predicted values (Z) or estimated is thus a linear composite combination known input point values (zi) and consist have a minimum estimation error. Thus,

$$Z = \sum (wi * zi) \quad \text{.....(1)}$$

Where (wi) is represent weight factors. And assume that value of an output pixel hopeful depend on three input points, this would be understand:

$$Z = w1 * z1 + w2 * z2 + w3 * z3 \quad \text{.......(2)}$$

consequently, to calculate one pixel output value Z, first, three factors weight w1, w2, w3 must be found (one for each input point value z1, z2, z3), after then, the factors weight can be multiplied with the corresponding input values point and summed. In this Kriging, the factors weight are calculated by finding the semi-variance values for all distances between input points and by finding semi-variance values for all distances between an output pixel and all input points; after then a set of concurrently equations must be solved. The factors weight is estimated in such a way that the estimation error in every output pixel is minimized. The all values of semi-variance are calculated by using a user-generated semi-variogram model. The decline in groundwater levels in the using interpolation functions and whole zoning in the GIS was conducted, that due to very high population density, limited water resources in groundwater and increasing the crops of surface, decline in groundwater levels, and above the analysis using the ARC GIS software, version 10.5. The 5 models including ordinary -kriging (OK), simple- kriging (SK), universal- kriging (UK), Inverse distance weighting (IDW), Global polynomial interpolation (GPI), local polynomial interpolation (LPI), were studied. The carrying out of model in geographic information system (GIS) software; the major Geostatistics model was used. The groundwater level declination depends upon the rate of RMSE that means the RMSE to goes to lowest, that means groundwater level good condition, but RMSE lays grater that means water level increase.

VII. RESULTS AND DISCUSSION

In order to firstly obtained the distribution of groundwater level, the selection of model parameters the based on the root-mean- square errors. The parameters occur in the spatial interpolation model tools of ArcGIS 10.5, which are used to find out the approach and suitable model of the best interpolation effect for each method. The measurement of validation analysis a result be seen that the kriging ordinary (OK) method with the lowest root-mean- square errors (RMSE) is the accurate most one, and finally selected as the best method for producing the map difference in groundwater level decline of the region in Huzur Tehsil, Bhopal District. Generate the annual depth of the Ground water level map in Huzur Tehsil district Bhopal (mbgl). The zone map of changes in groundwater level fluctuation annual five year (1996-2000,2001-2005,2006-2010,2011-201) drop in the entire plain was developed using ArcGIS10.5 software .

The cross validation Results of the groundwater observation data in pre-monsoon and post-monsoon in the last 20 year (1996-2015).Take the 5 year five interval (1996-2000) as an example, the root-mean-square error sorting is OK<UK<SK<IDW<GPI; the RMSE error is lowest –Highest, and Pre and post monsoon time much more difference in RMSE Error. Above the cross validation are apply the groundwater data to be continues 2001-2005, 2006-2010, 2011-2015. In (2001-2005), (2006-2010) and (2011-2015) root-mean-square error sorting is OK<UK<SK<IDW<GPI lowest –Highest observed, and difference of groundwater level is much more compared to other observation year. In post-monsoon period groundwater level (1996-2000) ordinary Kriging (OK) is 1.684 Lowest and pre-monsoon period groundwater level (1996-2000) ordinary Kriging (OK) 2.531 Highest. In post-monsoon period groundwater level (2001-2005) ordinary Kriging (OK) is 1.940 Lowest and pre-monsoon period groundwater level (2001-2005) ordinary Kriging (OK) 3.070 Highest.

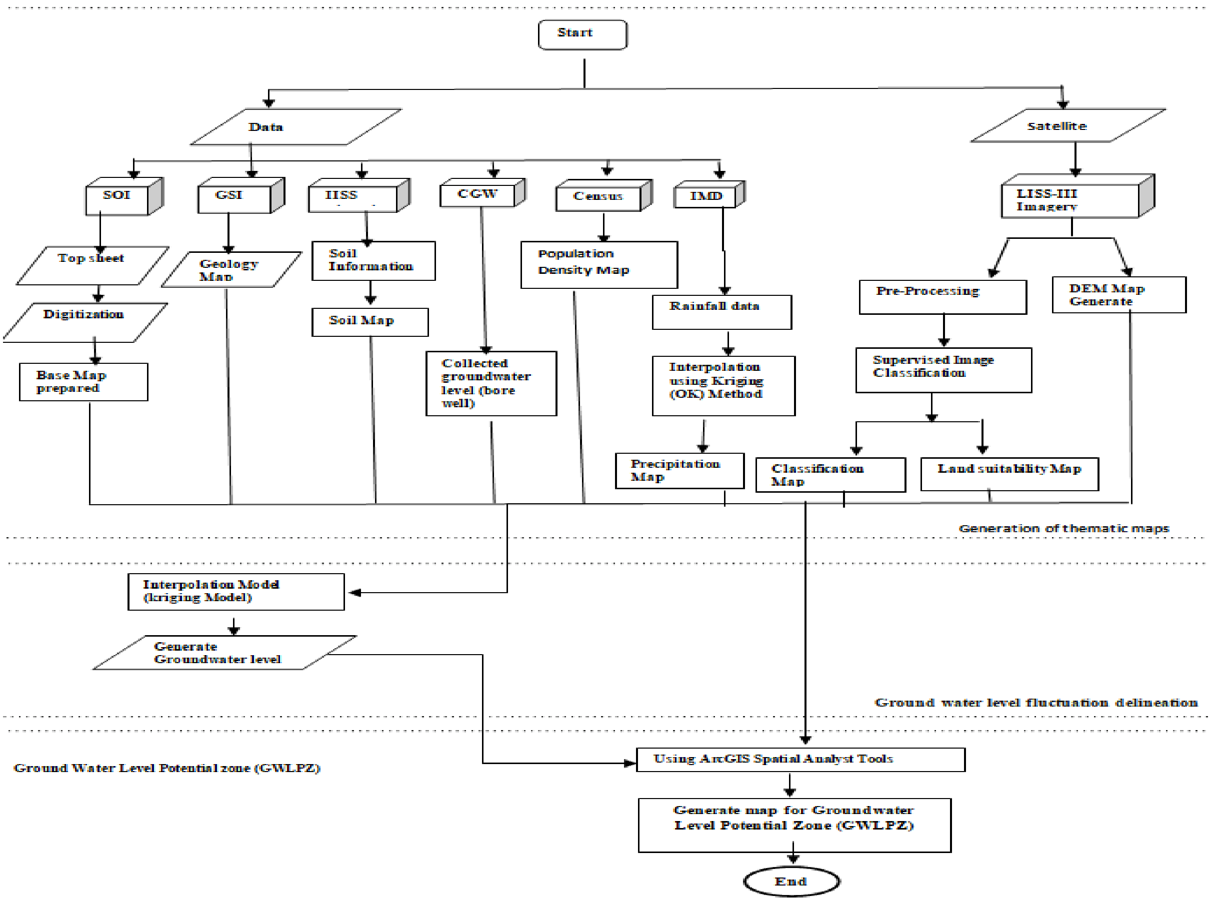

Figure 2: Flow chart of methodology

In post-monsoon period groundwater level (2006-2010) ordinary Kriging (OK) is 2.300 Lowest and pre-monsoon period groundwater level (2006-2010) ordinary Kriging (OK) 3.765Highest. In post-monsoon period groundwater level (2011-2015) ordinary Kriging (OK) is 3.015 Lowest and pre-monsoon period groundwater level (2011-2015) ordinary Kriging (OK) 7.456 Highest, and Figure 10, 11, the interpolation methods, including the ordinary Kriging (OK) methods, can be given the good results. Find out the Ground water Level Potential Zone (GWLPZ), these are made different eight factors are integrated to delineate GWPZ in the study area (geology, land suitability, soil, precipitation, population density, slope, groundwater level fluctuation). All these classes layers and individual potential class used to compute the GWLPZ (Ground water level potential Zone).It has taken all annual rainfall (1996-2015), and each well point groundwater level. And analysis of population 2001 and 2011 based on that analysis to project the population in 2051 year, and generate the density map of population (2001&2011). That means the population are increase yearly to yearly, the water demand are increases in Huzur tehsil, district Bhopal, which effected the declination of water level. Classification of Image Huzur Tehsil, District Bhopal, Madhya Pradesh, India, as shown in Figure 3.

A. Dem

The digital elevation model (DEM) is a 3D representation of a terrain's surface. As shown in Figure 4, the DEM is categorized into two classes High and Low elevation, the city has almost flat terrain and low elevation.

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B. Slope

Slope is an area of land that makes a definite angle to horizontal landscape. That means it is inclination of the surface to the horizontal of a topographical landscape is called slope. The map slope for the selected study area has been find out in degrees and is based on the DEM model. The map slope of the study area divided into five classes as shown in Figure 5, that are: [1]0–18 %, [2]19–36%, [3]37–54%, [4] 55–72% and [5] 73–90%.

Analysis, Comparative Investigation, Investigation'.

C. Geology

Geology is the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them. It is important role in groundwater recharge as it controls the percolation of flow water. In the study area, five types of geology are available, namely are describe basalt, laterite, alluvium, upper Bhander sandstone and lower Bhander sandstone are shown in Figure 6. The Basalt is highly volcanic igneous rock, which strongly fine-grained and dark in color and is present in the region abundantly. It is present in almost 65% of the region in the study area.

D. Contour

The contour representation a line (as on a map) connecting the points on a land surface that have the same elevation. As shown in Figure 7 contour map in district Bhopal, Huzur Tehsil, Madhya Pradesh, India.

E. Soil

It is consisting have two major soils in study area: clay and clay loam. Figure 8 as shown that clay soil is covered in major portions. The soil classes have been determined on the basis of their rate infiltration, which depends on the porosity and permeability of soil. Clay loam soil has least in the study area.

F. Precipitation

The Precipitation is the most important source, which recharge of groundwater. This is done in ArcGIS 10.5 using Ordinary kriging (OK) interpolation model technique. Ordinary kriging functions are observe as a good method for interpolation model of monthly and yearly climate impact parameter like annual pre- capitation (Peel et al. 2009). the map is divided into whole one average annual precipitation area: Average precipitation in Huzur tehsil, district Bhopal, is nearly 1121 mm perineum (Figure 9).

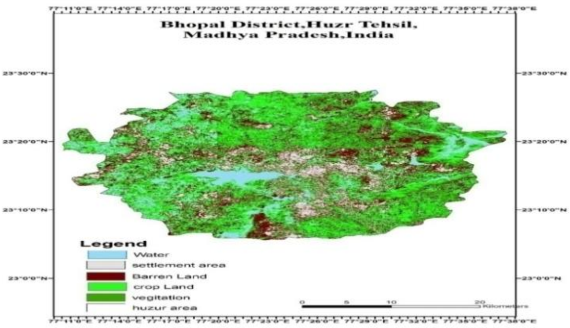


Figure 3: Image Classification of District Bhopal, Huzur Tehsil, Madhya Pradesh, India

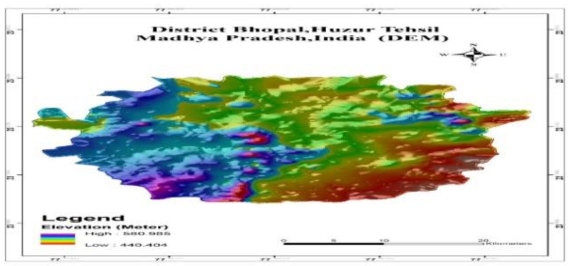


Figure 4: DEM map of Bhopal District Huzur Tehsil (datum: WGS84)

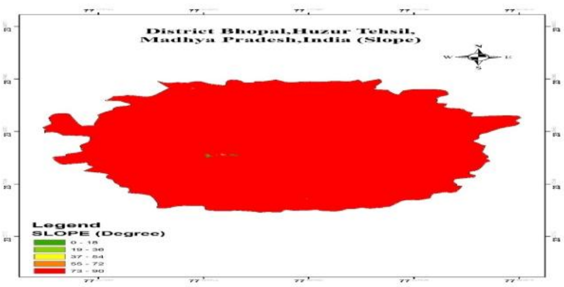


Figure 5 Slope map of Bhopal District Huzur Tehsil (datum: WGS84)

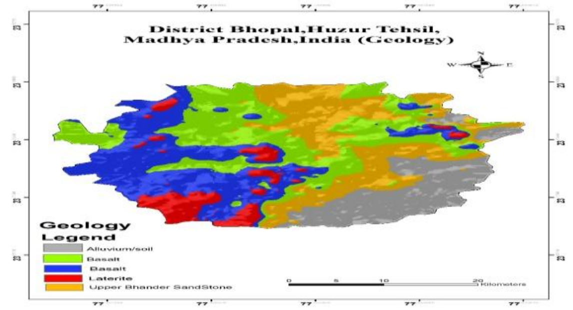


Figure 6 Geology map of Bhopal District, Huzur Tehsil

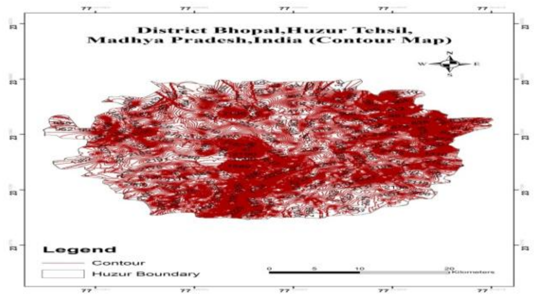


Figure 7 Contour map of Bhopal District, Huzur Tehsil

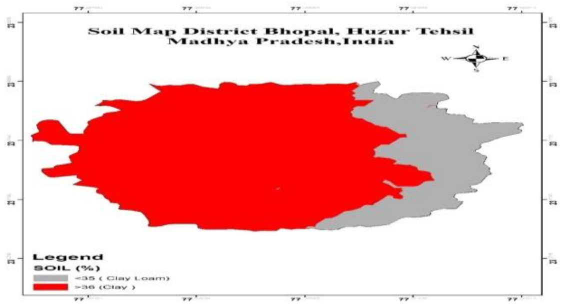


Figure 8 Soil map of Bhopal District, Huzur Tehsil

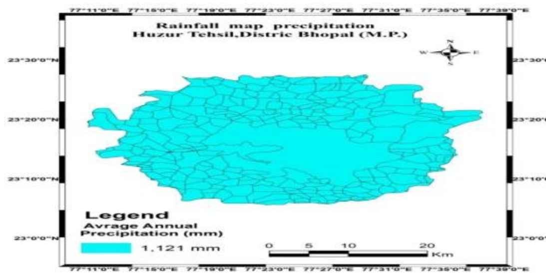
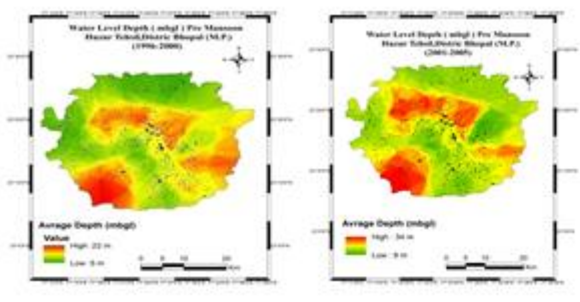


Figure 9 Precipitation map of District Bhopal, Huzur Tehsil



(a) (b)

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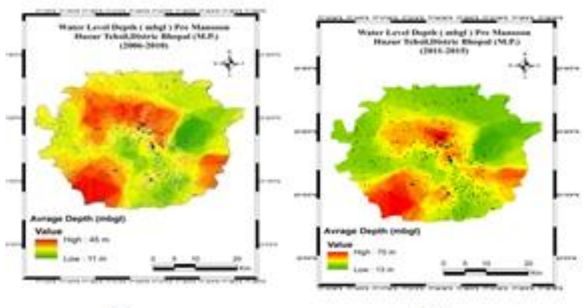
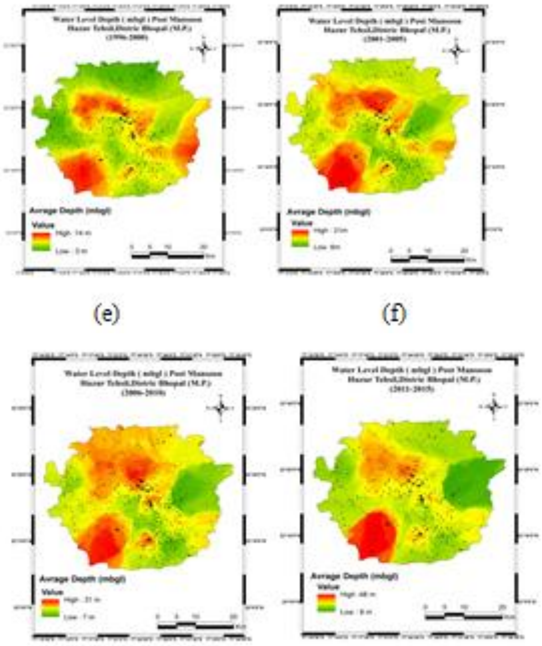


(c) (d)

Figure 10: Groundwater level well distribution of average depth (mbgl) since 1996-2000, 2001-2005, 2006-2010 and 2011-2015 (pre-monsoon).



(e) (f)

(g) (h)

Figure 11: Groundwater level well distribution of average depth (mbgl) since 1996-2000, 2001-2005, 2006-2010 and 2011-2015 (post-monsoon).

Water Level Fluctuation

The water level fluctuation of five year annual intervals represented by the change in pre-monsoon and post- monsoon groundwater levels (1996-2015). as shown in table 6 representations the Ground water level fluctuation (1996-2000, 2001-2005, 2006-2010 and 2011-2015) divided into four units ranging, and apply the interpolation ordinary kirging (OK) methods. As shown in the graph of each five year Groundwater level fluctuation Period 1996-2000, 2001-2005, 2006-2010 and 2011-2015 (Figure 12). During 1996 to 2000, the Groundwater level very good condition, the water level gets to 4-6 mbgl, and after the 2001 to 2005, the Groundwater level good condition, the water level gets to 6-8 mbgl, and 2006-2010, the Groundwater level Medium condition, the water level gets to 6-10 mbgl, and after 2011-2015 the very poor condition, the water level gets to 6-18 mbgl, and that means the overall the compared to three five year annual interval of groundwater level (1996-2000,2001-2005,2006-2010) are satisfactory condition but last five year annual interval of groundwater level (2011-2015) are going to decline(Figure 13).

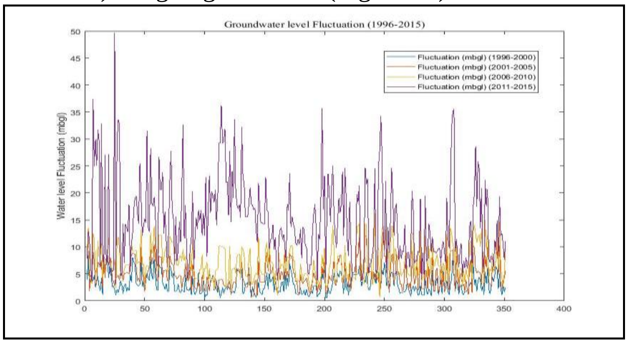


Figure 12: Groundwater Level fluctuation in District Bhopal, Huzur Tehsil (1996-2000, 2001-2005, 2006-2010 and 2011-2015)

Table 6: Groundwater Level Fluctuation each five year interval Layers

S. no.	Theme	Observation year	Class	Fluctuation condition for whole zone
1	Water-level fluctuation (mbgl)	1996-2000	<4	Very good
			4-6	Good
			>6	Medium
2	Water-level fluctuation (mbgl)	2001-2005	<6	Good
			6-8	Medium
			>8	High
3	Water-level fluctuation (mbgl)	2005-2010	<6	Good
			6-10	Medium
			>10	High
4	Water-level fluctuation (mbgl)	2010-2015	<6	Good
			6-18	Medium
			>18	High

Groundwater level Potential Zone (GWLPZ)

The Groundwater level potential zone (GWLPZ) map of the study area was produced with overlay all ten thematic maps using the ArcGIS 10.5., and the evaluate of pre-monsoon and post-monsoon groundwater level potential zone, that indicates general, post-monsoon time groundwater level potential zone are good condition but the most of the groundwater water levels potential zone are very poor conation in pre-monsoon time in district Bhopal, Huzur Tehsil. The groundwater potential values index (Table 7 & 8) are classified four classes as low, medium, medium–high, high and very high. Major portions of Huzur Tehsil have low ground water potential zone in pre-monsoon time. As shown in Figure 14 the output Post-monsoon Groundwater Level potential zone (GWLPZ) map values are classified into five intervals Low (<6), Medium(6-10) , Medium High(10-14), High(14-18)and Very High(>18). As shown in Figure 15 the output Pre-monsoon Groundwater Level potential zone (GWLPZ) map values are classified into five intervals Low (<8), Medium (8-14), Medium High (14-20), High (20-24) and Very High (>24).

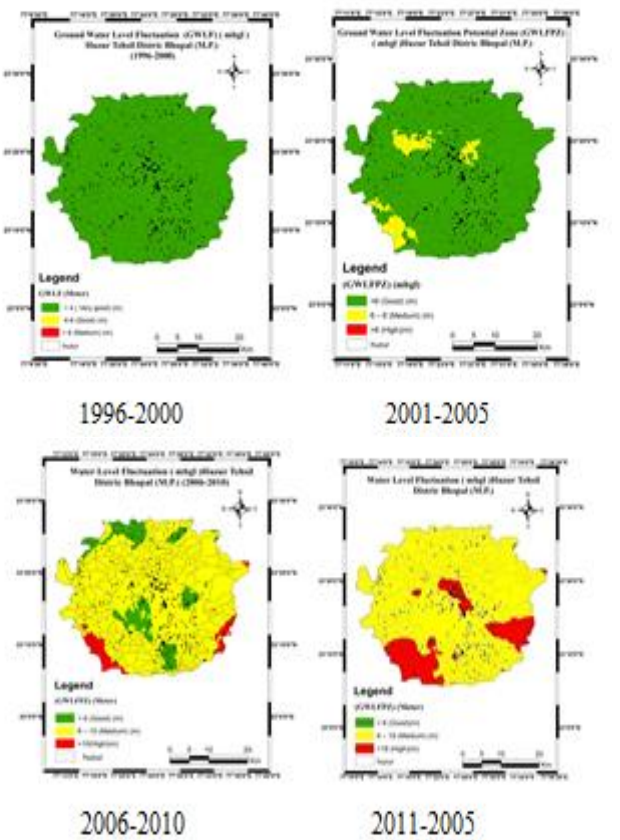


Figure 13: Groundwater Level fluctuation maps for the five years interval 1996-2000, 2001-2005, 2006-2010 and 2011-2015

Table 7 Classification of GWLPZ Post-monsoon

S.NO.	GWLP Zone	Post-Percentage of area (%)	Area (sq.km)
1	Low (<6)	1%	15.25
2	Medium(6-10)	4%	80.25
3	Medium High(10-14)	57%	850.25
4	High(14-18)	36%	385.55
5	Very High(>18)	2%	30.47
6	Total	100	1361.77

Table 8 Classification of GWLPZ pre- monsoon

S.NO.	GWLP Zone	Pre-Percentage of area (%)	Area (sq.km)
1	Low (<8)	2%	30.25
2	Medium (8-14)	5%	101.24
3	Medium High (14-20)	17%	150.25
4	High (20-24)	25%	285.25
5	Very High (>24)	51%	794.78
6	Total	100	1361.77

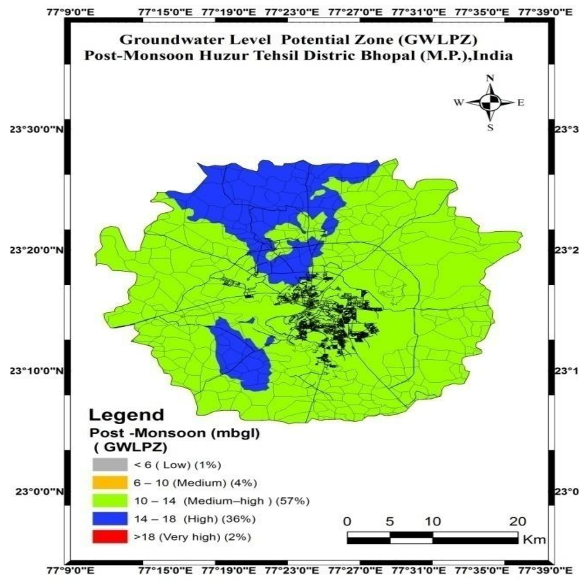


Figure 14: GWLPZ pre-monsoon map

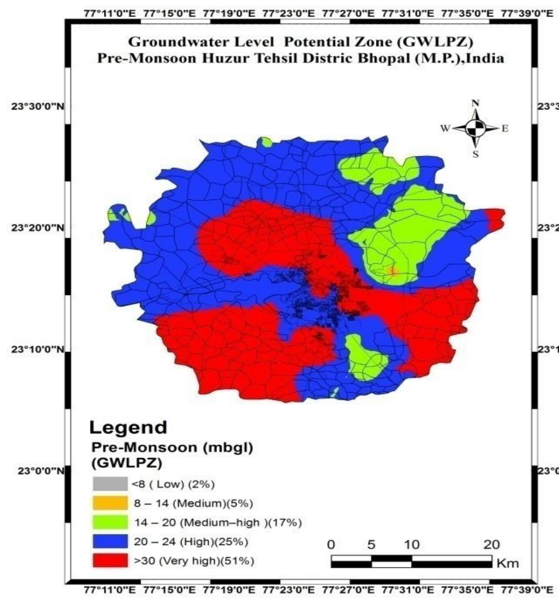


Figure 15: GWLPZ pre-monsoon map

VIII. CONCLUSION

The study determines the capability GIS techniques for detecting groundwater Level potential zones (GWLPZ) in District Bhopal, Huzur Tehsil, Madhya Pradesh (India). Based on this study, we achieve the following points.

- Delineation has been done through interpolation model and find out the Resultant analysis the order from model OK<UK<SK<IDW<GPI, that means Ordinary Kriging (OK) is Best Model for analysis of groundwater Level.
- Delineation groundwater Level potential zones (GWLPZ) can help us strategy the city so that the groundwater resources are not found deficient due to more demands of growing urban population of district Bhopal, Huzur Tehsil. The study revealed that only Pre-Monsoon times Ground Water Level more decline compared to post- monsoon time.

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The study revealed that only 2 % (30.25 km^2) of the area has Low groundwater level potential, 5 % (101.24 km^2) area has Medium groundwater level potential, 17 % (150.25 km^2) area showed Medium- High groundwater level potential, 25% (285.25 km^2) are within High groundwater level potential and 51 % (794.78km^2) are within Very High ground water level potential.

That means increasing the population, in urban sprawl, the effect of the increasing decline of groundwater. The study demonstrates the subtle use of GIS in spatial distribution mapping and monitoring for groundwater Level in the area. The status of overall fluctuations groundwater level has received very little attention of the study area. The behavior of groundwater level fluctuations is, however, is in the initial stages for the management and development of groundwater resources as an alternative resource for domestic and drinking purposes for future demand. In summary, the GIS tools take on the current research provided an agreeable outcome and can be considerably implemented else- where for groundwater level potential zone (GWLPZ) and residential urban land- use developed planning with the similar surrounding hydrologic, exclusively for central of India having terrain regions plateau and mostly suffering from water insufficiency and population explosion.

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