RESEARCH ON ASSESSMENT OF GROUND WATER LEVEL VARIATION IN RELATION TO LULC IN AURANGABAD DISTRICT

Diksha Meghare[1], Amit Ingle[2], Abhinav Ramteke[3], Vaidip Barsagade[4], Suraj Raut[5] Shubham Parate[6]

[1]Diksha Meghare Professor, Civil Engineering Department, Nagpur Institute of Technology
[2]Amit Ingle Student, B.E Civil Engineering Department, Nagpur Institute of Technology
[3]Abhinav Ramteke Student, B.E Civil Engineering Department, Nagpur Institute of Technology
[4]Vaidip Barsagade Student, B.E Civil Engineering Department, Nagpur Institute of Technology
[5]Suraj Raut Student, B.E Civil Engineering Department, Nagpur Institute of Technology
[6]Shubham Parate Student, B.E Civil Engineering Department, Nagpur Institute of Technology

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Abstract - This study aims to develop an intertwined approach for mapping and covering land use/ land cover(LULC) changes and to probe the impacts of LULC changes and population growth on groundwater position and quality using Landsat images and hydrological information in a Geographic information system(Civilians) terrain. All Landsat images (1990, 2000, 2010, and 2018) were classified using a support vector machine(SVM) and spectral analysis mapped(SAM) classifiers. The result of confirmation criteria, including perfection, recall, and F1, indicated that the SVM classier has a better performance than SAM. The attained LULC charts have an overall delicacy of further than 90. Each brace of enhanced LULC charts (1990 – 2000, 2000 – 2010, 2010 – 2018, and 1990 – 2018) were used as input data for an image difference algorithm to cover LULC changes. Charts of change discovery were also imported into a Civilians terrain and spatially identified against the spatiotemporal charts of groundwater position and groundwater quality. The results also show that the approximate built up area increased from227.26 km^2 (1.39) to869.77 km^2 (7.41), while vegetated areas (spreads, premises and auditoriums) increased from about76.70 km2(0.65) to290.70 km2 (2.47). The observed changes in LULC are largely linked to the reduction in groundwater position and quality across the study area from the Oman Mountains to the littoral areas.

Key Words: Groundwater level, Land use /Land cover change, Satellite imagery, GIS, Aurangabad

1. INTRODUCTION

Groundwater is an extremely important resource across numerous corridor of the world; especially where face water is of limited force or is of poor- quality groundwater comes into the script. Groundwater provides drinking water entirely or in part for as important as 50 of the global population and accounts for 43 of all of water used for irrigation. Worldwide, 2.5 billion people depend solely on groundwater coffers to satisfy their introductory diurnal water requirements

. Groundwater extremity in the recent times has come a global concern as its vulnerability increased with lesser frequency and magnitude. Since the twentieth century, the groundwater birth strongly increased around the world. The emergence of the ultramodern pumping system and electrification in pastoral areas has led to the increase in groundwater birth from 312 boxy kilometers/ time in 1960s to about 743 boxy kilometers/ time in 2000. According to a database of 2010, the groundwater birth is about 1000 boxy kilometers/ time and the major consumers are from Asia including India, China, Pakistan, Bangladesh and birth rate has been tripled over the 50 times and still rising.

India is the largest stoner of groundwater in the world. It uses an estimated260 boxy kilometers of groundwater per time- over a quarter of the global aggregate. further than 60 of irrigated husbandry and 85 of drinking water inventories are dependent on groundwater. Groundwater in India is a critical resource; an adding number of aquifers are reaching unsustainable situations of exploitation. Major corridor of the Indian aquifer system is showing a declining trend due to revision in the pattern of precipitation. However, in 20 times about 60 of all India’s aquifers will be in a critical condition says a World Bank report, Deep Wells, If current trends continue. This will have serious counteraccusations for the sustainability of husbandry, long- term food security, livelihoods, and profitable growth.

One of the major causes of the change in water position is LULC changes together with expansive birth of groundwater from the shallow aquifer for husbandry, assiduity and other domestic purpose. Rapid urbanization and increase in erected-up areas increase the change of groundwater position due to environmental declination and concretion of soil face. Changes in spreads and irrigation increase evapotranspiration(ET) and groundwater recharge by irrigation return inflow tool to improve manuscript clarity for the reviewers. The final layout of the typeset paper will not match this template layout.

2. DATASETS AND METHODS:

Study Area:

Primarily two datasets were collected from different sources to find the impact of LULC changes on groundwater level. The first dataset included Landsat data which consists of Landsat images with a time span of about 10 years having spatial resolution of 30 m. These time spans and spatial resolutions were the most suitable remote sensing data to monitor LULC change overa regional scale in a timely and charge less.The Landsat imagery comprises of the Landsat Thematic Mapper (TM)which is Landsat 5imagery acquired between 15/11/1990 – 25/12/1990 for the year 1990, the Landsat Enhanced Thematic Mapper (ETM+) (Landsat 7) acquired on 25/11/2000 - 02/12/2000, again Landsat 5 imagery acquired between 25/03/2010 - 03/04/2010 for the year 2010 as the Landsat 7 failed in 2003 giving'SLC-off' outputs, and the Operational Landsat Imager (OLI) Landsat 8 acquired between01/12/2020 – 25/12/2020 for the year 2020 for the paths 146, 147 and rows 46 and 48 for all the years.The Landsat images were downloaded from the USGS earthe xplorer(www.earthexplorer.usgs.gov)portal with cloud cover less than 10%. temperature rise and downfall failure). The integration ofmulti-temporal remote seeing and hydrological information in a Civilians terrain has been set up to be a suitable approach to probe the LULC change impacts on groundwater position and quality over a indigenous scale at low cost and with lesser delicacy(7- 10). The study of the spatial association between LULC changes and groundwater position and quality permits a better understanding of how LULC changes affect groundwater and is important in erecting an adaption strategy(11- 12). With this background, present study is done to find the impact of LULC changes on the groundwater position in the Aurangabad quarter.

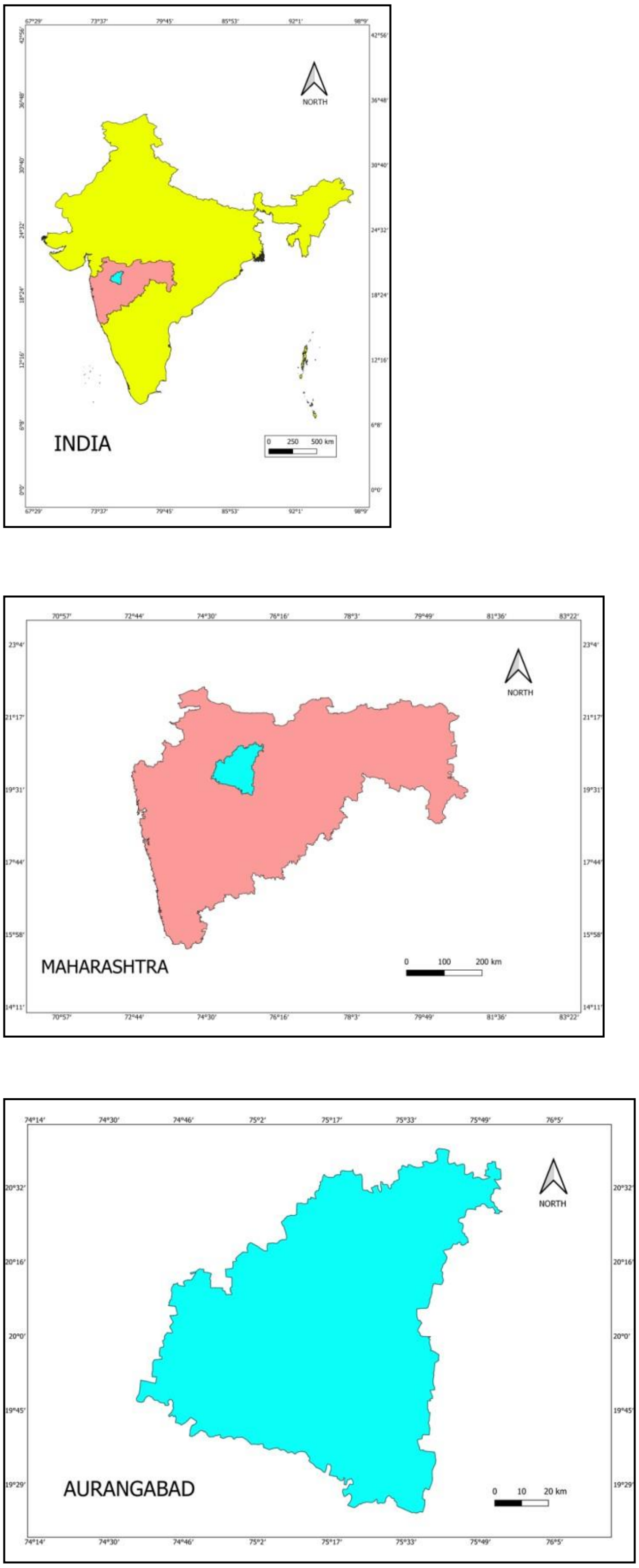

Image 1: Location of study area

DATASETS AND PRE-PROCESSING:

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Period of Acquisition	Satellite	Bands	Resolution (m)	Path and Row
15/11/1990-25/12/1990	Landsat -5 Thematic Mapper (TM)	Band 1 Band 2 Band 3 Band 4	30 30 30 30	Path-146, 147 Row- 46, 48
25/11/2000-02/12/2000	Landsat-7 Enhanced Thematic Mapper Plus (ETM+)	Band 1 Band 2 Band 3 Band 4	30 30 30 30	Path-146, 147 Row- 46, 48
25/03/2010-03/04/2010	Landsat -5 Thematic Mapper (TM)	Band 1 Band 2 Band 3 Band 4	30 30 30 30	Path-146, 147 Row- 46, 48
01/12/2020–25/12/2020	Landsat 8 Operational Land Imager (OLI)	Band 1 Coastal aerosol Band 2 Blue Band 3 Green Band 4 Red	30 30 30 30	Path-146, 147 Row- 46, 48

Table1: Characteristics of Landsat Images of study area

The second dataset was the hydrological information of all the observation wells in Aurangabad district during period from 1990 to 2020 which was collected from Groundwater Survey and Development Agency (GSDA). Hydrological information includes Tehsil and Village of all the monitoring wells with their latitude and longitude along with the groundwater level (GWL) for pre and post-monsoon season in the following format.

District	Tehsil	Village	Latitude	Longitude	GWL for Pre Monsoon	GWL for Post Monsoon
-	-	-	-	-	-	-

Table 2: Format of data collected from GSDA

The third dataset was the vector boundary file of Aurangabad district along with all the tehsil boundaries within district which was extracted from Geopackage file containing all the districts and tehsils in India; this Geopackage file was downloaded from GADM (Database of Global Administrative Areas) website.

DATA CLASSIFICATION AND PROCESSING:

Following five steps were involved in order to investigate the impact of LULC changes on groundwater level (i) collecting required datasets, (ii) preparing LULC maps, (iii) monitoring LULC changes, (iv) monitoring spatiotemporal variations of groundwater level, and (v) correlation analysis between LULC change and groundwater level.

1. COLLECTING REQUIRED DATASETS:

As discussed earlier, for this study primarily two datasets were collected which include Landsat imagery from four decades and the hydrological information containing groundwater level of pre and post-monsoon season.

2. PREPARING LULC MAPS:

Using the above downloaded data LULC maps were prepared in QGIS and were manually classified in five different LULC classes.

3. MONITORING LULC CHANGES:

The main objective of the study was to investigate the impact of LULC changes on groundwater level. In order to do that study has classified the district into five LULC classes and the change in areas of each LULC class was calculated.

4. MONITORING SPATIOTEMPORAL VARIATIONS OF GROUNDWATER LEVEL:

The raster maps of groundwater level variation were prepared from 1990 to 2020 using hydrological data to monitor the spatiotemporal variation of groundwater levels. The interpolation process was performed using the inverse distance weighted (IDW) algorithm implemented in QGIS software. The main advantage of IDW interpolation is that it is a simple procedure, easy to understand, intuitive, and efficient. The IDW algorithm determines the values of points based on a weighted combination of a group of selected points and assumes that closer values are more related than further values. For these maps study took the output raster size (resolution of each pixel in output raster in layer units) as 100 x 100m. The groundwater recharge maps were then prepared using the raster calculator by subtracting the pre-monsoon groundwater level with post-monsoon groundwater level.

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5. CORRELATION ANALYSIS:

To investigate whether there was an impact of LULC changes on groundwater level the correlation analysis was done by comparing the average groundwater level depth for pre & post-monsoon and recharge value of each decade of every single monitoring well in the district along with the land cover map of the respective decade.

3. RESULTS AND DISCUSSION

MONITORING THE LULC CHANGES

Monitoring the LULC changes Land use and land cover controls the groundwater recharge of a region. The application of soil face for anthropogenic conditioning similar as agreement and construction of road impedes the face water infiltration in a region. Conversion of forested land into bare land increases face run- off and hence decreases recharge. Then, land use and land cover practice around the observation wells has been analysed for the times 1990, 2000, 2010 and 2020. Five different classes of LULC have been classified which include husbandry, barren land, foliage, civic area and water bodies. From the analysis of the classified charts, it can be seen that the areas under different LULC classes have been changed over the times. One of the predominant LULCs in the quarter is husbandry – which has covered53.12 in 1990,67.26 in 2000,63.36 in 2010 and70.54 in 2020 among all the other classes. The second largest LULC class is barren land which has been reduced to half till the end of last decade. In 1990, it was43.94 of total area, which reduced to29.57 in time 2000 and again it has increased in 2010 covering33.67, which has again dropped to22.11 of total area in 2020. The presence of barren land indicates poor groundwater recharge, advanced peaks of face run- off which is relatively predominant Sillod, Phulambri and Aurangabad tehsil. Chance of thick timber cover over the region has also dropped from 1990, i.e. from0.19 of the total area to0.03 in 2020. This drop in natural foliage has far reaching effect on the groundwater eventuality of the study area. But the chance of water bodies(like ponds) have gradationally increased over the study area from2.21 in 1990 to in 2020 perhaps to wash the agrarian land as the downfall quantum dropped over the time. The civic area has increased mainly over the last decade. In the time of 1990 civic area covered only0.52 of total area which has increased to4.35 in the time of 2020. The maturity of the well locales has been converted into agrarian area in the alternate & third decade and into civic area in the final decade.

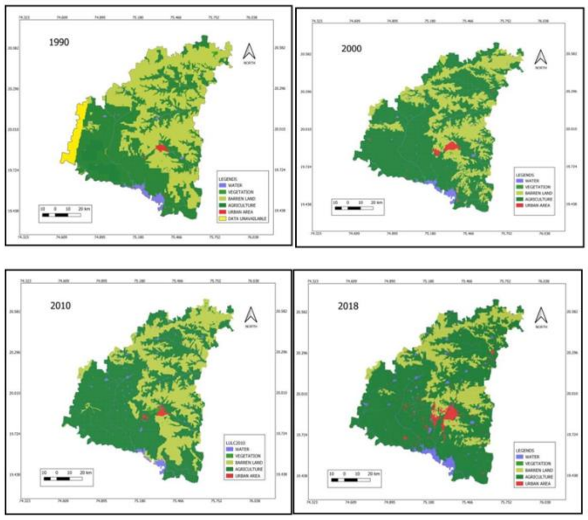

Image 2: LULC map for each decade

LULC Class	1990	2000	2010	2020
	Area in percentage	Area in percentage	Area in percentage	Area in percentage
Water	2.21	1.89	2.10	2.95
Vegetation	0.19	0.75	0.41	0.03
Barren Land	43.94	29.57	33.67	22.11
Agriculture	53.12	67.26	63.36	70.54
Urban	0.52	0.51	0.44	4.35

Table 3: Areal description of LULC class

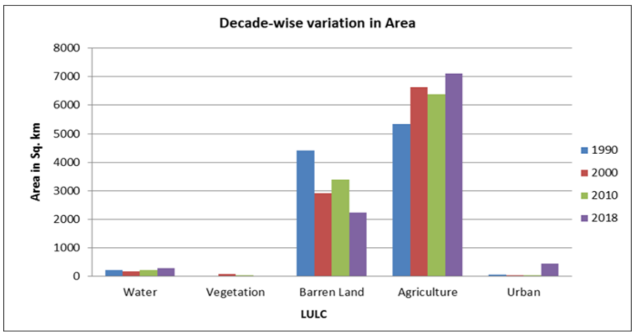

Image 3: Graphical representation of LULC changes from 1990-2020

Monitoring Spatiotemporal changes:

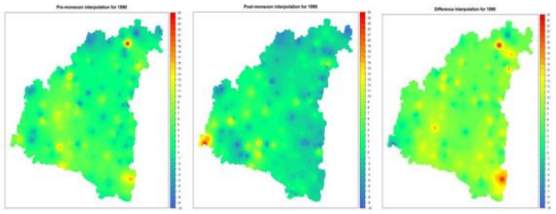

Image 4: Spatiotemporal Maps for pre & post monsoon and recharge for 1990

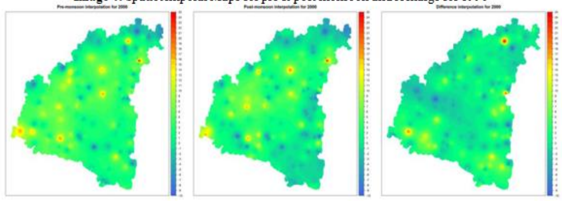

Image 5: Spatiotemporal Maps for pre & post monsoon and recharge for 2000

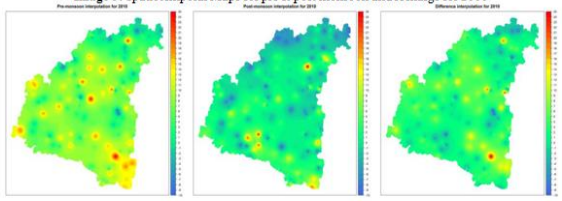

Image 6: Spatiotemporal Maps for pre & post monsoon and recharge for 2010

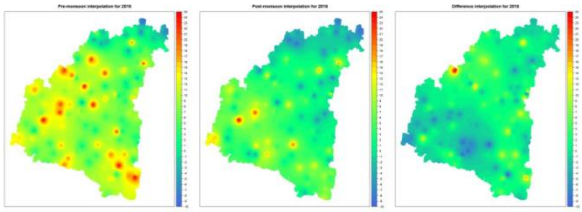

Image 7: Spatiotemporal Maps for pre & post monsoon and recharge for 2020

Image (4-7) shows the interpolated maps prepared from hydrological information of all the monitoring wells distributed across the Aurangabad district. The maps show the spatial variation of groundwater level which is represented using different colour codes within the study area. From the spatiotemporal variations it can be observed that the groundwater level has sharply dropped down over the last three decades. Also it can be observed that most of the values of pre and post-monsoon season are highly skewed and show asymmetrical distribution across the study area. For the pre-monsoon season the average value of groundwater level in 1990 was 9.94 mbgl which increased to 14.37 mbgl in the year 2020, which clearly reflects the decrease in groundwater level during the last during three decades. This downfall in groundwater level in pre-monsoon season can be observed from the year 2003 was may be due to less rainfall or excessive utilization of water for irrigation. Serious depletion can be especially seen in Paithan, Kannad, Vaijapur and Gangapur tehsils where most of the land is covered by agricultural area. During the post-monsoon season the average value of groundwater level in 1990 was 4.46 mbgl which has increased to 9.09 mbgl till the year 2020. This indicates replenishment of groundwater of aquifers through infiltration when compared with the pre-monsoon values. The above values also reflect the decrease in groundwater level in the last three decades for the post-monsoon season. Poor recharge can be seen in Kannad and Vaijapur tehsils as groundwater levels of monitoring wells are very low even in the post-monsoon season., whereas in Paithan and Gangapur due to better recharge groundwater level has increased in the post-monsoon season.

CORRELATION ANALYSIS

A locational description of the wells has been done based on the LULC of the four years (1990, 2000, 2010 and 2020) to identify the LULC class in and around each well which is shown in the table below along with groundwater level values for pre-monsoon, post- monsoon and recharge.

Year	1990	2000	2010	2020
LULC	Barren	Agriculture	Agriculture	Urban
Pre	6.6	9.01	9.08	10.21
Post	4.9	6.83	5.36	6.13
Recharge	1.7	2.18	3.72	4.08

Table 4: Locational description, Pre & Post monsoon groundwater level and recharge values for each decade ofa monitoring well in Daultabad

Note: *The depth of groundwater level value for pre &post monsoon is in mbgl (Meters below ground level) and recharge value is the difference between pre and post GWL.*

4. CONCLUSION:

The present study is an attempt to assess the impacts of LULC changes on groundwater level in Aurangabad district for the last three decades. With the aid of the remote sensing data, GIS, and hydrological data, it was possible to map and monitor changes in land use/land cover classes over a regional scale and investigate its impact on ground water quantity.

The analysis provides rapid and significance evidences of LULC change in the study area forthe period of 1990 to 2020 (decade wise). It was observed that large portion of land has shifted to agriculture where as the barren land has almost been reduced to half during last three decades. A major increase in urban area is observed during 2010 to 2020 and also there is a slight increase in the water bodies till the final decade. These conversions might have some serious impact one system and the overall water resources of the district.The spatio temporal variations indicate that the study area is experiencing a sharp depletion in groundwater levels throughout the district. There is a continuous depletion in ground water level since the 1990s which is expected to increase year after year. The results of correlation analysis showed a strong linear relationship between land use /land cover changes and depth to groundwater level. From the correlation analysis it can be observed that wherever theLULC class was barren the water levels for pre and post-monsoon were high and had poor recharge values.Whenever the LULC class shifted to agriculture the groundwater level for pre and post-monsoon was observed to increase for initial decades and also due good to infiltration the recharge values increased however due to excessive extraction the ground water level was again lowered in further decades. For urban LULC class surprisingly the recharge values were constant and had no impact of urban features.

As most of the Maharashtra including the study area being a semi arid region there is scarcity of water during the summer season in most the tehsils. The rapid LULC changes represent a serious threat to hydrological resources of the district. Thus, there is a need for authorities to control the rapid LULC changes and to manage the use of water. Results of the study provide great assistance in the delineation of areas that need detailed groundwater assessment and will guide land use planning authorities & water resources department. Future work should incorporate further investigation of the impact of various other factors such as annual rainfall, population growth, cropping pattern, hydro geomorphological situation, etc. on groundwater level depletion to more precise results. This investigation allows a better understanding of the impact of the spatio temporal variations in ground water level on environmental setting.On a global scale, this kind of spatiotemporal change analysis is fewer in number because of the lack of groundwater monitoring systems but is needed for sustainable management.

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