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Linkages Between Urban Growth and Groundwater Fluctuation Based on Remote Sensing and GIS: A Case Study of Kolkata City

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ABSTRACT

One of the most significant effects of expanding populations is the quickening expansion of metropolitan regions The surrounding rural hinterland is being consumed by the urban growth that is taking place because of enormous rural-urban migration and population increases. One of the major adverse effects that this unrestrained urban expansion has brought about is a vulnerability in the groundwater supply. The use of remote sensing and geographic information systems (GIS) in order to accurately show the interconnectedness of groundwater vulnerability with land use and land cover in the city of Kolkata is the main objective of the study. If this expansion is allowed to continue, the environment might be in grave danger. It is the responsibility of the urban entities that are responsible for urban planning to design methods that will reduce the impacts of this.

KEYWORDS: Urban Growth, Remote Sensing, GIS, Groundwater Vulnerability

INTRODUCTION

This unrestrained urban expansion has resulted in a number of negative implications, but one of the most critical and far-reaching of them is the vulnerability of the groundwater supply. The city of Kolkata is not an exception in this condition; being a heavily populated location, the city is experiencing a fall in the level of groundwater underneath it. This idea is given further weight by the groundwater data that were obtained between the years 1996 and 2016. Utilizing remote sensing and geographic information systems (GIS) to properly depict the interconnectivity of groundwater vulnerability with land use and land cover in the city of Kolkata is something that has the potential to be successful. The present work derived a groundwater vulnerability map for portraying the groundwater decline of the city.

STUDY AREA

Kolkata the largest metropolitan of eastern India served as the capital city of West Bengal. The city has a 4.49 million population (Census of India 2011a). The location map (Fig. 1) depicts the geographical coordinates of the city.

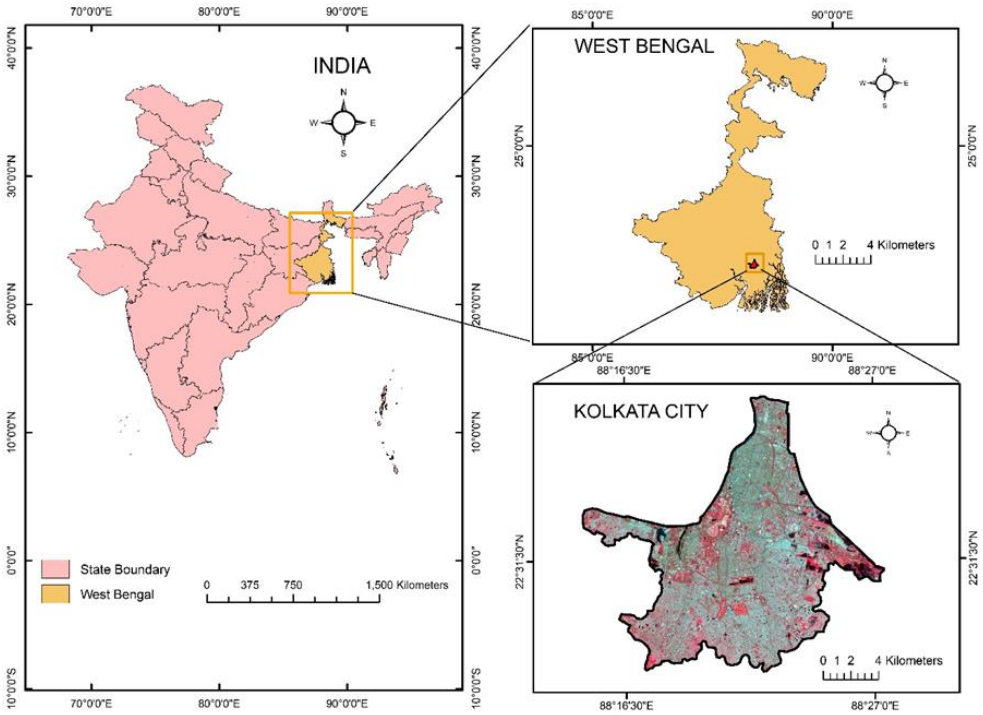

Fig 1. Map showing the location of the study area

OBJECTIVES

1. To demonstrate the Land Use and Land Cover pattern of Kolkata city from 1991-2016
2. To show the built-up growth from 1996-2016
3. To derive a groundwater map from 1996-2016
4. Derivation of a Groundwater vulnerability
5. Correlation Analysis of Built-up area and Groundwater Vulnerability

METHODS

1. Downloading of Landsat Satellite Imageries from USGS Earth Explorer.
2. Derivation of Land Use and Land Cover (LULC) map through Support Vector Machine (SVM) Classifier.
3. Derivation of Built-up expansion map from 1996-2016
4. Deriving Groundwater Vulnerability Index Map From 1996-2016

RESULTS AND ANALYSIS

LAND USE AND LAND COVER MAP OF KOLKATA CITY

For deriving the LULC map, the SVM classification algorithm was used. This is a reliable method that divides the classes based on a hyperplane and support vectors. The LULC classifications (Fig. 2) were broken down into nine distinct groups. The categorization of land use and land cover is required (Qi et al. 2012) for the purpose of exhibiting the land pattern of the earth and its land use. In addition, the generated map is evaluated by means of an error matrix, which is an important stage in the process of establishing how well the categorized map corresponds to the real world. Several research, like Alam et al. 2020 and Yuan et al. 2009, reported error matrices to evaluate the reliability of the categorization.

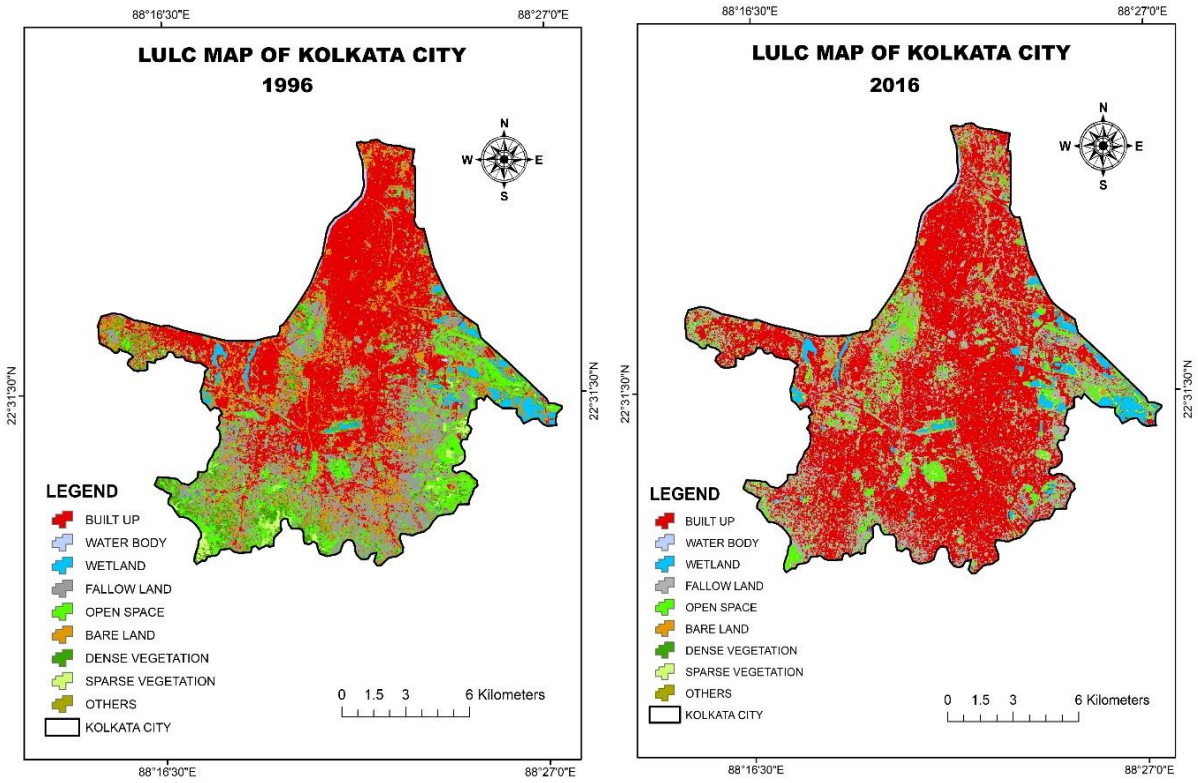

Fig 2. LULC map of Kolkata city of 1996 and 2016

BUILT UP SCENARIO

Land use and land cover map of 1996 and 2016 were reclassed where built-up classes were assigned 1 and others as 0 for deriving built-up growth maps of 1996 and 2016. Derived built-up growth maps of 1996 and 2016 were overlaid to depict the spatiotemporal growth map (Fig. 3)

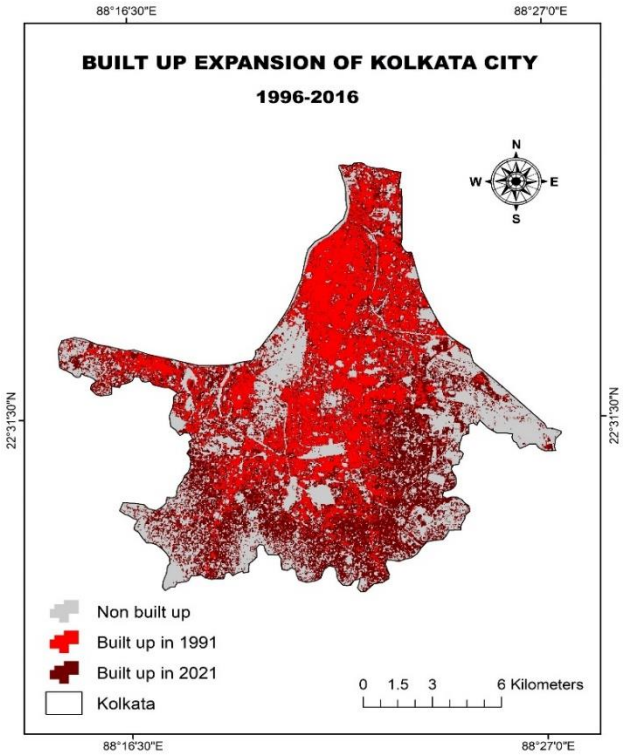

Fig 3. Built up maps of the city from 1996-2016

GROUNDWATER VULNERABILITY

The developed environment and the strain of a growing population both contribute to the vulnerability of groundwater (Islam 2022). The level of groundwater has decreased in the built-up development region, which may be identified by this trait. According to Machiwal et al. (2018), this issue is more prevalent in bigger cities because of the overuse of resources. Over-abstraction and pollution of groundwater are two effects that are eventually caused by population increase that occurs in places that are already built up.

The present vulnerability index depicts how the groundwater trend has been declining due to built-up areas (Fig. 4)

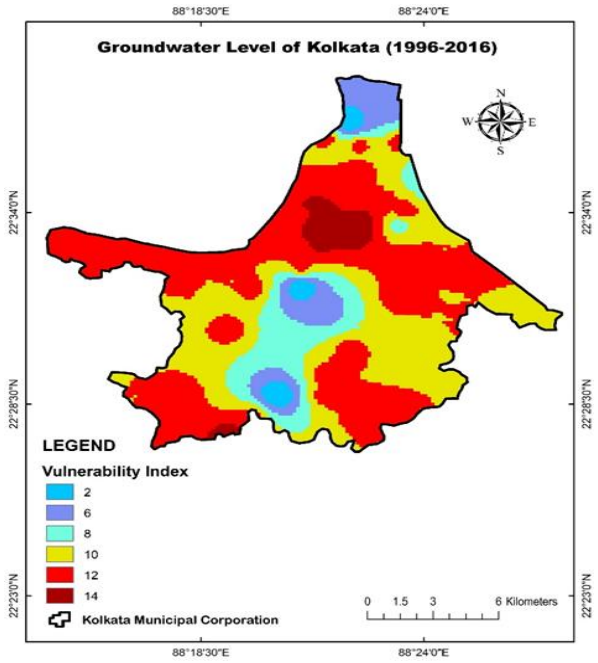

Fig 4. Groundwater Vulnerability Index map

CONCLUSION

The interconnectedness of groundwater vulnerability with land use and land cover in the city of Kolkata is something that may be successfully illustrated via the use of remote sensing and GIS. It is one of the worst repercussions of unregulated urban expansion, which may lead to catastrophic environmental problems if it is allowed to continue. The urban bodies responsible for urban planning should devise strategies to mitigate the effects of this.

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