'ASSESSING THE IMPACT OF URBANIZATION AND CONSTRUCTION ACTIVITIES ON GROUNDWATER DEPLETION IN EMERGING URBAN AREAS: A CASE STUDY OF HADAPSAR, PUNE, INDIA'

Goal 11- Sustainable Cities and Communities

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Abstract:

The rapid urbanization of emerging urban areas like Hadapsar in Pune, India, has led to a surge in construction activities, particularly the construction of tall buildings with deep foundations. This urban development trend has raised significant concerns regarding its potential impact on the groundwater level and the rate of recharge in tube wells and water wells within the region. This research project seeks to comprehensively assess the groundwater dynamics in the Hadapsar urban area and investigate the direct consequences of construction activities on groundwater resources.

Through an extensive and multidisciplinary approach involving hydrogeological surveys, real-time monitoring of groundwater levels, and a thorough examination of construction-related factors, this study aims to uncover critical insights. The findings are expected to reveal a notable decrease in the groundwater level in Hadapsar, attributed primarily to the proliferation of construction projects, particularly that involving deep foundation work for tall buildings.

This research project underscores the urgent need for adopting sustainable urban development practices and formulating effective water resource management strategies specifically tailored to the unique challenges faced by rapidly urbanizing regions like Hadapsar. The study's outcomes are anticipated to provide actionable insights for urban planners, policymakers, and stakeholders, guiding them in the implementation of measures aimed at mitigating the adverse effects of construction on groundwater resources. Additionally, the research highlights the crucial role of incorporating groundwater conservation and recharge mechanisms as integral components of future urban development plans to ensure the sustainable growth and resilience of Hadapsar and similar emerging urban areas grappling with analogous challenges.

Keywords: Urbanization, Construction Activities, Tall Buildings, Groundwater Dynamics, Groundwater Depletion

Introduction

The rapid urbanization of emerging urban areas, exemplified by Hadapsar in Pune, India, has become a hallmark of the 21st century. The remarkable expansion of cities and the surge in construction activities have transformed the landscape and lifestyle of these regions. In this wave of urban development, towering buildings with deep foundations have become iconic symbols of progress, attracting both residents and businesses to these areas. However, this urban transformation is not without its challenges, and one of the most pressing concerns is the potential impact on the region's groundwater resources. The city of Pune, with its vibrant mix of tradition and modernity, has been no exception to this global trend. Hadapsar, once a relatively tranquil suburb on the outskirts of Pune, has witnessed a metamorphosis into a bustling urban hub. The construction of tall buildings and infrastructure projects has been instrumental in this transformation, promising a better quality of life for its inhabitants. However, as the concrete jungles rise higher and spread wider, they cast a shadow on a resource that is often taken for granted but is indispensable to the sustenance of life: groundwater.

Groundwater, a critical component of the hydrological cycle, plays a pivotal role in maintaining ecological balance, providing drinking water, and supporting agriculture and industry. The concerns regarding the potential depletion and contamination of groundwater are not unique to Hadapsar; they resonate across many rapidly urbanizing areas worldwide. Yet, the specific challenges faced by Hadapsar, influenced by its unique geography, demography, and urban development dynamics, warrant careful consideration. This research project embarks on a journey to comprehensively assess the groundwater dynamics in the Hadapsar urban area, with a particular focus on the consequences of construction activities. Our objective is to investigate the multifaceted relationship between rapid urbanization and the sustainability of groundwater resources. By examining the various factors affecting the groundwater level and rate of recharge in tube wells and water wells, we aim to shed light on the intricate web of interactions that define the urban hydrology of Hadapsar.

In the pages that follow, we will delve into the specifics of our research methodology, findings, and implications. We will explore how construction activities impact the local hydrogeology, and we will endeavour to provide insights that can guide policy and development decisions in Hadapsar and other emerging urban areas facing similar challenges. This research project serves as a testament to the critical importance of sustainable urban development and the careful stewardship of our invaluable groundwater resources.

Study Area

Hadapsar is situated in the eastern part of Pune, Maharashtra, India. The approximate coordinates of Hadapsar are 18.5062° N latitude and 73.9279° E longitude. It is located around 8 KM southeast of the Pune city centre, making it an integral part of the expanding metropolitan area. Hadapsar's geography is characterized by its location within the Deccan Plateau, known for its undulating terrain, rocky landscapes, and fertile plains. Over the years, the region has witnessed significant changes in its land use patterns, with the transformation of agricultural fields into urban and industrial areas. The climate in Hadapsar falls under the tropical wet and dry classification. It experiences three distinct seasons: summer, monsoon, and winter. Summers are hot and dry, with temperatures reaching up to 40°C. The monsoon season, typically from June to September, brings heavy rainfall, while winters are relatively mild. The population density in Hadapsar has witnessed a

steady increase as people migrate in search of better opportunities. The density varies across the area, with higher concentrations in developed urban zones and lower densities in the outskirts. Hadapsar's topography is characterized by a mix of flatlands, slopes, and rocky outcrops. The terrain has been significantly modified due to construction activities, leading to changes in land cover and water runoff patterns. The groundwater levels in Hadapsar are of particular interest in this study. Urbanization and construction activities have the potential to influence these levels significantly, affecting the availability of groundwater resources in the area.

Methodology

Hadasar, Pune, India, has been selected as the study area due to its status as an emerging urban zone with rapid urbanization and significant construction activities. The primary data collection methods involve utilizing Google Earth for spatial analysis and conducting actual field visits to wells for on-site measurements. Utilize high-resolution satellite imagery from Google Earth to identify and map existing wells in Hadapsar before and after construction activities. Analyze Google Earth images to track changes in land use patterns, identifying areas undergoing urbanization and construction. Conduct on-site visits to wells identified in the Google Earth analysis. Each well will be assigned a unique identifier, and relevant details, including depth and water quality, will be recorded. Used a water level measuring instrument during field visits to quantify the depth of the water table in selected wells, both pre and post-construction. Engage with local residents during field visits to gather qualitative insights into changes in water availability, quality, and community perceptions. Use GIS software to map the location of wells and overlay this information with construction zones, identifying areas where well presence has changed. Compare successive Google Earth images to assess changes in well density, land use, and construction activities over time.Interpret qualitative data from field interviews to understand the socio-economic impacts of changes in well availability and water quality.

Result

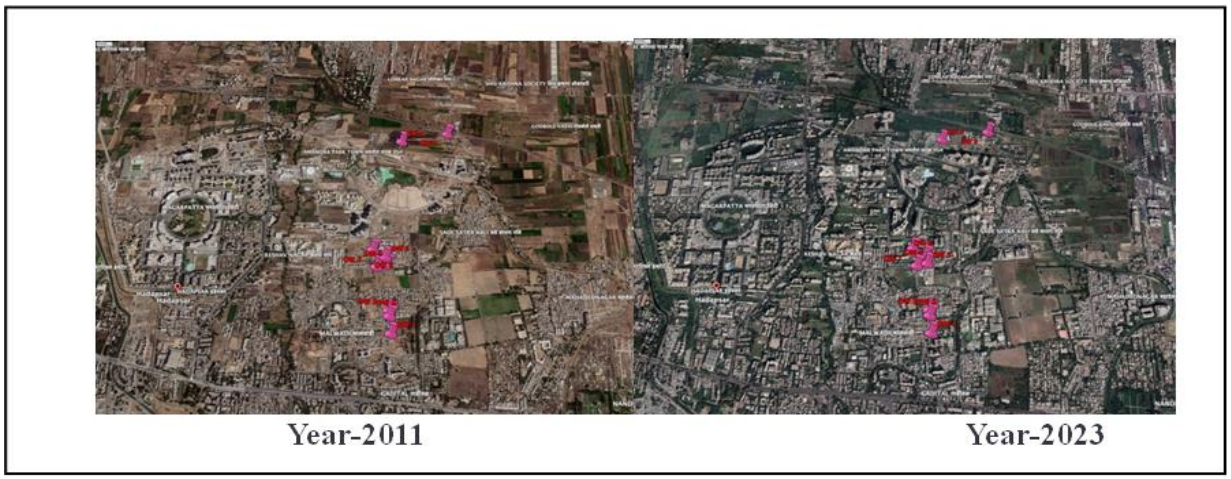

Fig 1: Showing locations of Observation wells and difference between 2011 & 2023

Year-2011 **Year-2023**

Fig 2 : Showing visibility of observation well 9 from 2011 & 2023

The results of the study reveal significant changes in the landscape of Hadapsar, Pune, over the 12-year period from 2011 to 2023, as observed through Google Earth imagery. The focus of the investigation was on the impact of urbanization and construction activities on groundwater depletion, with a specific emphasis on changes in well density and visibility.

1. Increase in Urbanization and Building Density:

Google Earth images indicate a substantial increase in urbanization and building density in Hadapsar between 2011 and 2023. The expanding urban landscape is evident through the proliferation of built structures, reflecting the ongoing urban development and construction activities in the area.

2. Changes in Well Visibility:

Observation wells (1, 4, 5, 7, 8, and 9), which were clearly visible in the Google Earth images of 2011, are not discernible in the images from 2023. This suggests a notable alteration in the local hydrogeological landscape, potentially indicating changes in well usage or, in more severe cases, abandonment. Conversely, Observation wells (2, 3, and 6) remain visibly present in both the 2011 and 2023 Google Earth images. This persistence may indicate that these wells have either been consistently in use or have not experienced a significant decline in groundwater levels over the studied period.

3. Groundwater Depletion in 6 out of 9 Observation Wells:

Out of the nine observation wells assessed in this study, six appear to be either abandoned or non-functional due to a notable depletion in groundwater levels. This finding aligns with the observed changes in well visibility and suggests a potential correlation between construction activities and groundwater depletion.

4. Potential Causes of Groundwater Depletion:

The study identifies several potential causes contributing to the depletion of groundwater levels in Hadapsar: 1. Deep Construction Foundations: The excavation and establishment of deep construction foundations can disturb the natural aquifer structure, leading to a decline in groundwater levels. 2.

Blasts Used in Construction: Explosive methods utilized in construction activities may contribute to the disruption of aquifer integrity, affecting groundwater recharge.

3. Construction Machines: The use of heavy construction machinery can exert pressure on the ground, potentially compacting aquifers and impeding natural groundwater flow. 4. Dumping Construction Wastes in Wells: Improper disposal of construction waste into wells can obstruct the natural flow of groundwater, leading to stagnation and depletion. These potential causes underscore the intricate relationship between construction activities and groundwater dynamics in emerging urban areas like Hadapsar.

In conclusion, the findings of this research underscore the urgency of sustainable urban development practices and water resource management in the face of rapid urbanization. The insights provided by the study serve as a clarion call for policymakers, urban planners, and stakeholders to prioritize measures that balance the demands of construction activities with the preservation of the invaluable groundwater resources essential for the sustainability of emerging urban areas like Hadapsar. As we move forward, a judicious and holistic approach is imperative to ensure the resilience and longevity of urban ecosystems and the preservation of this finite natural resource.

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