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Block Wise Distribution Of Underground Water In Gurugram District (2000-2020): A Geographical Analysis

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Abstract:

This study presents a comprehensive geographical analysis of underground water resources in Gurugram district, Haryana, India, spanning the years 2000 to 2020. Gurugram, a rapidly urbanizing region, has witnessed significant changes in land use, population, and economic activities during this period, which have put substantial pressure on its groundwater reserves. The research employs a combination of remote sensing, geographic information systems (GIS), and statistical techniques to evaluate the spatiotemporal trends in groundwater levels, assess the impact of urbanization and climate change, and suggest potential mitigation strategies. The study reveals a consistent decline in groundwater levels over the two decades, with the most significant depletion occurring in the urbanized areas. Land use changes, particularly rapid urban expansion. The analysis also highlights variations in groundwater levels across different seasons, with the monsoon season playing a crucial role in recharging aquifers. The research underscores the need for a holistic approach that integrates geographical data, remote sensing technology, and community involvement to safeguard Gurugram's underground water resources for future generations.This research aims to scrutinize the extent and pace of groundwater depletion in Gurugram district while also shedding light on the contributing factors and their impact on the local populace. The research conducted uncovered significant disparities in the magnitude of groundwater depletion among different blocks within the district.

Keywords; Underground Water, Substantial, Remote Sensing, Monsoon Season and Land Use

Introduction

Groundwater is distributed unevenly across the world, with some regions having abundant reserves while others have very little. Groundwater flows underground at different rates. Notice the blue lines which indicate an approximate level that the groundwater would take to be recharged. For example, take a look at the "Centuries" line on the right side of the graphic. Groundwater at that depth might take centuries to recharge. Note: this graphic is a model. The lines in the diagram are not a precise or accurate depiction of groundwater recharge in all areas; groundwater recharge varies (USGS, 2023). The movement of groundwater is influenced by a combination of factors, including the topography and geology of the land. The slope and orientation of the land's surface affect the direction and speed of groundwater flow, while the composition and structure of the subsurface materials determine the permeability and storage capacity of the aquifer (Sophocleous, 2002). Groundwater, the water stored beneath the Earth's surface within aquifers-geological formations composed of permeable rocks or sediments capable of holding and transmitting water (Domenico & Schwartz, 1998) varies in depth, size, and thickness. Replenished primarily through precipitation and infiltration (Sophocleous, 2002), this unseen but vital component of the water cycle remains largely overlooked by the general public.

Water, essential for all life forms and ecosystems, exists in various depths underground and is constantly in motion. Understanding the water cycle, including the relationship between rainfall, runoff, infiltration, evapotranspiration, and underground water, is crucial for rational water resource management (National water policy, 2002). Various factors, such as precipitation, wind, air temperature, terrain features, vegetation cover, and soil types, affect stream flow on the land surface. Additionally, diurnal phenomena caused by uneven heating of the Earth's surface, like land and sea breezes, redistribute heat and moisture.

In India, groundwater serves as a major source of water for agriculture, industries, and domestic use, contributing to nearly 60% of the country's total irrigation potential (NRSA, 2008). Alongside groundwater, surface water, including streams, rivers, lakes, and reservoirs, plays a significant role in a nation's economy and the functioning of ecosystems. Lakes, based on topographic and morphological peculiarities and hydrological regimes, can be classified as lowland, foothill, or mountainous. They can also be categorized according to their water sources; snow-fed, rain-fed, glacier-fed, or underground water-fed (Khublaryan, 2003).

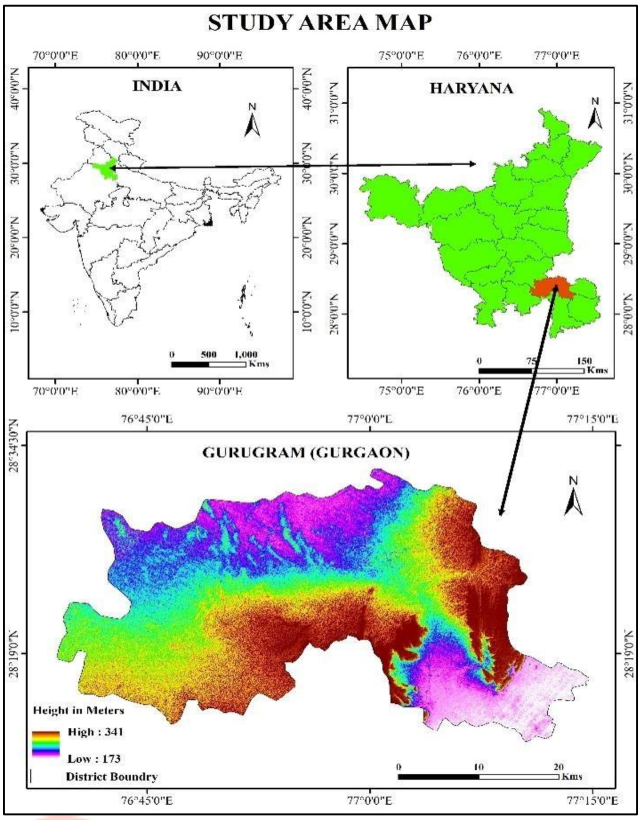
Balancing the increasing demands for water due to population growth, urbanization, industrialization, and agricultural needs presents a complex challenge for sustainable development and efficient water management in India (CGWB, 2017). Acknowledging the significance of groundwater and surface water resources, and understanding their characteristics and dynamics, is essential for protecting and utilizing these precious natural gifts effectively.

Groundwater possesses some inherent valuable properties compared with surface water, and compromising these properties has implications for human health (Lee et al. 2002; Clark et.

al. 2003; Aiuppa et al. 2003). Approximately 97% of the earth's usable fresh water is stored as groundwater (Delleur, 1999). However, it has a much higher resident time within the water cycle compared to the more readily available surface waters. Despite this, groundwater plays a crucial role in maintaining soil moisture, stream flow, wetlands, and serves as a vital source of drinking water, agricultural, and industrial supplies in many parts of the world. Its reliability during drought is relatively higher due to its large storage capacity, widespread occurrence, and protection from evapotranspiration, making its development relatively inexpensive.

Study Area

Gurugram district is situated in the northern part of Haryana, bordering the National Capital Territory of Delhi to the north and west. Its geographical coordinates lie between 28°25'N latitude and 77°02'E longitude. The district covers an area of approximately 1,250 square kilometers and is divided into three tehsils: Gurugram, Sohna, and Pataudi.The district shares its borders with several other administrative divisions within Haryana and the neighboring state of Rajasthan.Gurugram, situated in the northern Indian state of Haryana, is experiencing rapid urbanization, which, coupled with unsustainable groundwater extraction practices, has resulted in a considerable drop in groundwater levels. Understanding the blockwise variations in groundwater storage and depletion rates is imperative for the sustainable management of water resources in this region. Notably, the Pataudi block exhibited the highest magnitude of depletion, closely followed by the Sohna and Gurugram blocks, whereas the Farrukh Nagar blocks displayed the least depletion.Covering an area of approximately 732 square kilometers, Gurugram District has witnessed rapid development primarily driven by industrialization and urban expansion. This growth has spurred an escalating demand for water resources, including groundwater, leading to the persistent decline in groundwater levels. To comprehensively evaluate changes in groundwater storage and depletion within Gurugram district, the Central Ground Water Board (CGWB) conducted a study in 2017 (Central Ground Water Board, 2017). The district was meticulously divided into its respective blocks, and each block underwent a comprehensive assessment of its groundwater storage variations and depletion rates (Central Ground Water Board, 2017). The study involved a thorough analysis of historical groundwater level data to ascertain the trends in water table fluctuations for each block. Areas experiencing swift urbanization were identified, and their contributions to groundwater depletion were examined. Additionally, hydrogeological studies were conducted to evaluate the susceptibility of aquifers to excessive extraction and contamination (Central Ground Water Board, 2017). The findings illuminated varying degrees of groundwater depletion across the blocks of Gurugram District (Central Ground Water Board, 2017). Blocks characterized by high rates of urbanization and industrialization exhibited more substantial groundwater depletion compared to their rural counterparts (Central Ground Water Board, 2017). This database now serves as a valuable tool for the ongoing monitoring and assessment of these trends, facilitating the formulation of sustainable groundwater management strategies (Central Ground Water Board, 2017).The blockwise assessment of changes in groundwater storage and depletion magnitudes within Gurugram District underscores the pressing necessity for sustainable water resource management in the region (Central Ground Water Board, 2017). Equipped with this invaluable database, policymakers and stakeholders can make informed decisions aimed at mitigating the adverse effects of groundwater depletion and ensuring a sustainable water future for Gurugram District (Central Ground Water Board, 2017). However, it is imperative to acknowledge that Gurugram is also grappling with various environmental challenges. One of the most pressing issues is the depletion of its natural resources, notably a severe water shortage and rapid decline in groundwater levels. Furthermore, Gurugram is contending with air pollution concerns, and its forests are facing rapid deforestation. Efforts to combat groundwater depletion should include the implementation of responsible water management practices, the promotion of water conservation measures, and the regulation of groundwater extraction. Additionally, the development of alternative water sources, such as rainwater harvesting and recycling, can help alleviate the strain on groundwater resources. To tackle the issue of air pollution, Gurugram can invest in cleaner transportation options, promote green technologies, and enforce emissions control measures. The preservation and restoration of forests are essential to maintain ecological balance, prevent soil erosion, and mitigate the impacts of climate change. Reforestation initiatives and stricter regulations on deforestation can contribute to a healthier environment.



Map 1: ***Study Area***

Objective

- To examine the change of the groundwater level depth for the period 2000-2020 in the study area.

Database and Research Methodology

A review of earlier studies has provided a good practical and theoretical knowledge for designing the present study as well as facilitating in the selection of accurate methodologies. Adoption of accurate methodologies in any scientific investigation acts as a foundation stone for deriving the precise results and subsequently the interpretations. Therefore, in order to meet and achieve the proposed set of the objectives of the present work, following sections present a brief overview of the database and adopted methodologies.

The secondary data sourced from various departments, agencies, and both published and unpublished literature. To evaluate the availability of groundwater, the researchers collected rainfall data from the District Revenue Offices. Additionally, data on the depth to water table for both pre and post monsoon periods was obtained from the Ground Water Cell, Directorate of Agriculture, Haryana, Panchkula. The study focuses on analyzing groundwater levels in Gurugram District. The researchers collected groundwater level data from the Central Groundwater Board for a period of nine years (2000-2020) from 65 observation wells. The purpose of collecting this data was to investigate the spatial variation of groundwater levels in the Gurugram district. To understand the seasonal effect on groundwater levels, the monthly data was divided into three distinct seasons: Monsoon (June-September), Post-Monsoon (October-January), and Pre-Monsoon (February-May), along with annual data covering January to December. Various graphical representations were employed to interpret the temporal variation in groundwater levels throughout the district.

A comprehensive examination of previous research has bestowed invaluable practical and theoretical insights, which have proven instrumental in shaping the current study's design. By drawing from the wisdom of earlier works, the selection of precise and appropriate methodologies has been facilitated. In scientific investigations, the adoption of accurate methodologies serves as the bedrock upon which precise results and subsequent interpretations are built. To accomplish the intended objectives of this study, a concise overview of the database and the methodologies employed will be presented in the subsequent sections. In this study, the spatial data pertaining to the road network, boundary maps, and census data for the year 2011 were obtained from the Society for Geoinformatics and Sustainable Development (SGSD).

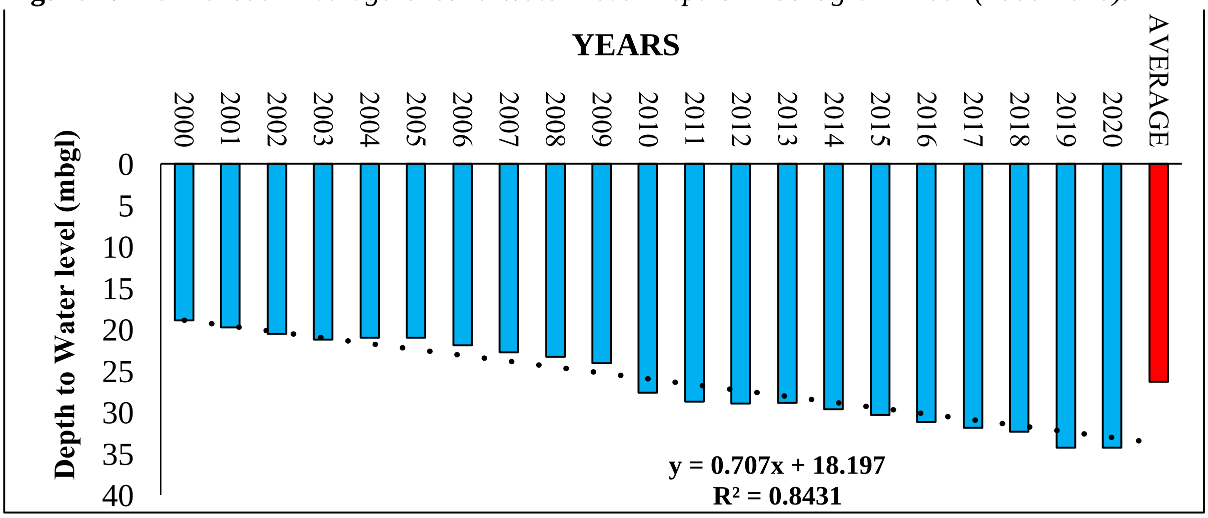
Spatial analysis was employed to detect trends and patterns, supported by spatial statistics. Microsoft Excel was utilized to generate graphs, charts, and tables to visually represent these trends. Interpreting the results involved comparing statistical findings with GIS and remote sensing data to identify the key factors influencing changes in groundwater level depths. Visual representations, such as maps, graphs, and tables, were crafted to effectively communicate the findings. The study culminated in the compilation of a comprehensive scientific report, which included sections covering the introduction, data sources, methods, results, discussion, and conclusions. Peer review was considered to validate the scientific rigor of the study.

Result and Discussion

Spatial-Temporal Distribution of The Pre-Monsoon Groundwater Level Depths in Gurugram Block from 2000-2020.

The figure 2 presents a comprehensive overview of the average groundwater level depths in the Gurugram block over a 21-year period, from 2000 to 2020. The data indicates a notable trend in groundwater levels during this time frame. In 2000, the average groundwater level depth was recorded at 18.88 meters, gradually increasing over the years. By 2009, it had risen to 24.10 meters, reflecting a consistent downward trend. However, a significant shift occurred from 2010 onwards, with the groundwater level depths experiencing a sharp increase. In 2010, there was a substantial jump to 27.65 meters, followed by a continuous ascent in the subsequent years. By 2019, the average groundwater level reached 34.25 meters, showcasing a substantial increase over the decade. Interestingly, 2020 recorded a slight decrease compared to the previous year, with a depth of 34.28 meters. Nevertheless, the overall trend suggests that groundwater levels have been on the rise, with an average depth of 26.33 meters over the entire period.

Figure 2: *Pre-Monsoon Average Ground Water Level Depths in Gurugram Block (2000-2020).*



Source: Department of ground water board Gurugram and prepared by Research Scholar

This data is essential for understanding the dynamics of groundwater availability in the Gurugram block. The consistent downward trend from 2000 to 2019 implies an increasing reliance on groundwater resources. It is crucial for local authorities and environmental agencies to monitor and manage groundwater resources effectively to ensure their sustainable use in the face of potential challenges like depletion and contamination. The data also highlights the need for water conservation efforts and sustainable practices to maintain adequate groundwater levels for the future.

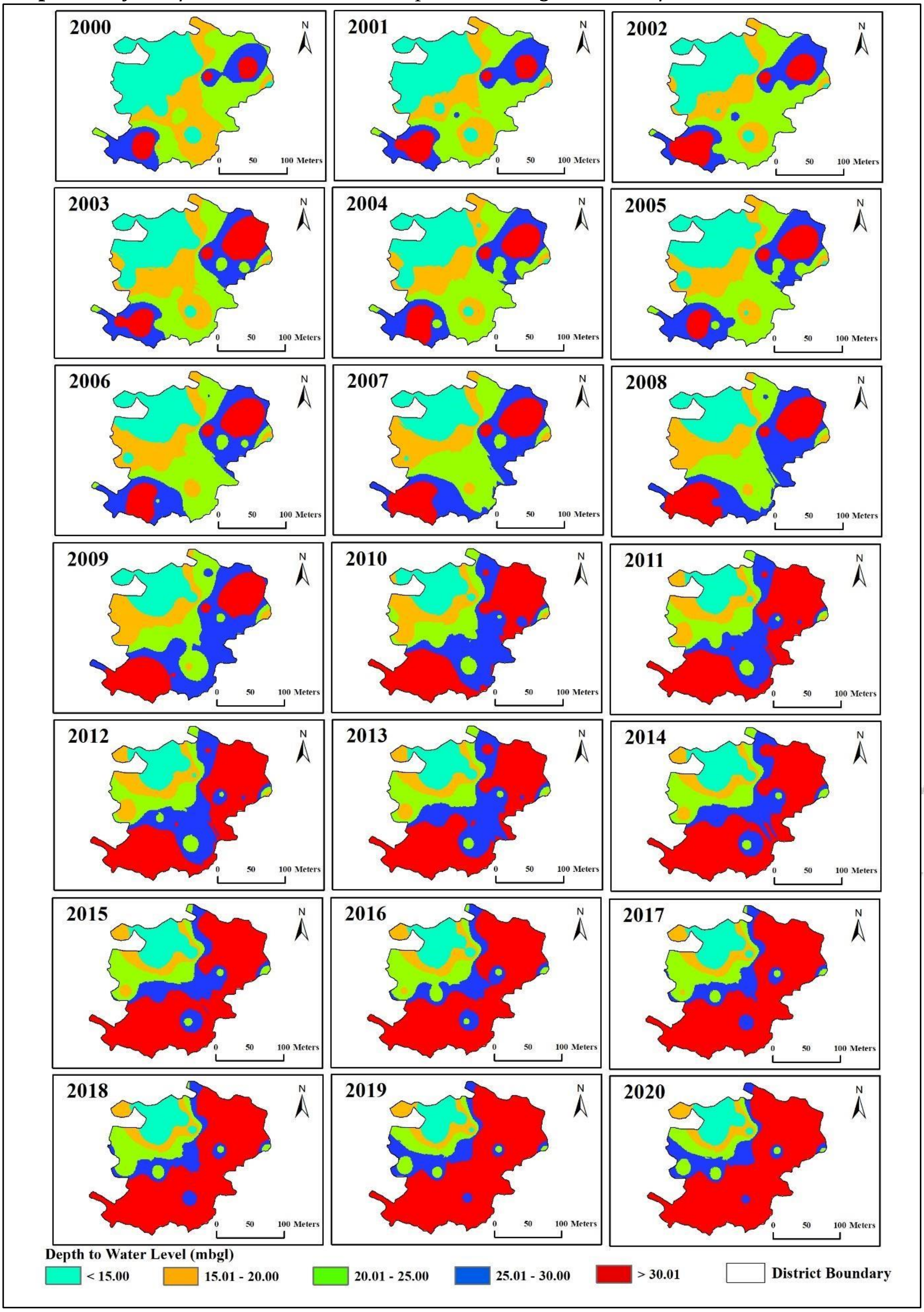
Analysis of the Pre-Monsoon Groundwater Level Depths in Gurugram Block of Gurugram district from 2000-2020.

The map 2 shows a series of maps of the Gurugram block in India, with each map showing the depth of underground water levels in meters below ground level (mbgl) in a different year from 2000 to 2020. The maps are color-coded to show the depth of the water table, with darker colors indicating deeper water levels. The analysis of the figure shows that the depth of underground water levels in Gurugram block has increased significantly from 2000 to 2020. In 2000, the majority of the block had water tables at depths of less than 15 mbgl. However, by 2020, the majority of the block had water tables at depths of greater than 30 mbgl.

The maps show that the decline in groundwater levels has been particularly severe in the southern part of Gurugram block. This is likely due to the fact that this area is more urbanized and industrialized, and it has less groundwater recharge than other parts of the block.The maps also show that the decline in groundwater levels has not been uniform across Gurugram block. The maps show a clear trend of increasing depth of underground water levels in Gurugram block. This is evident from the fact that the areas with the shallow water tables in 2000 are now the areas with the deep water tables. For example, in 2000, the areas with water tables less than 15 meters deep were concentrated in the southern and western parts of the block. By 2020, these areas had largely disappeared, and the shallowest water tables were now found in the northern and eastern parts of the block. Some areas, such as the northern part of the block, have experienced less decline than others. This is likely due to the fact that these areas have more groundwater recharge and less groundwater demand. The decline in groundwater levels in Gurugram block is a serious problem that needs to be addressed. The government and water users need to work together to reduce groundwater demand, increase groundwater recharge, and manage groundwater resources more sustainably. The increasing depth of underground water levels is a serious concern, as it could lead to water scarcity in the future. This is because it becomes more difficult and expensive to extract water from deeper aquifers.

Various kinds of factors that have contributed to the decline in underground water levels in Gurugram block. This has led to increased pumping of groundwater, which has depleted the water tables. In Gurugram block, the recharge rate has been declining due to factors such as land use changes, such as the construction of impervious surfaces, and climate change. By taking these steps, it is possible to reverse the trend of declining groundwater levels in Gurugram block and ensure a sustainable water supply for the future.

Map 2:*Analysis of Groundwater Level Depths in Gurugram Block from 2000-2020.*



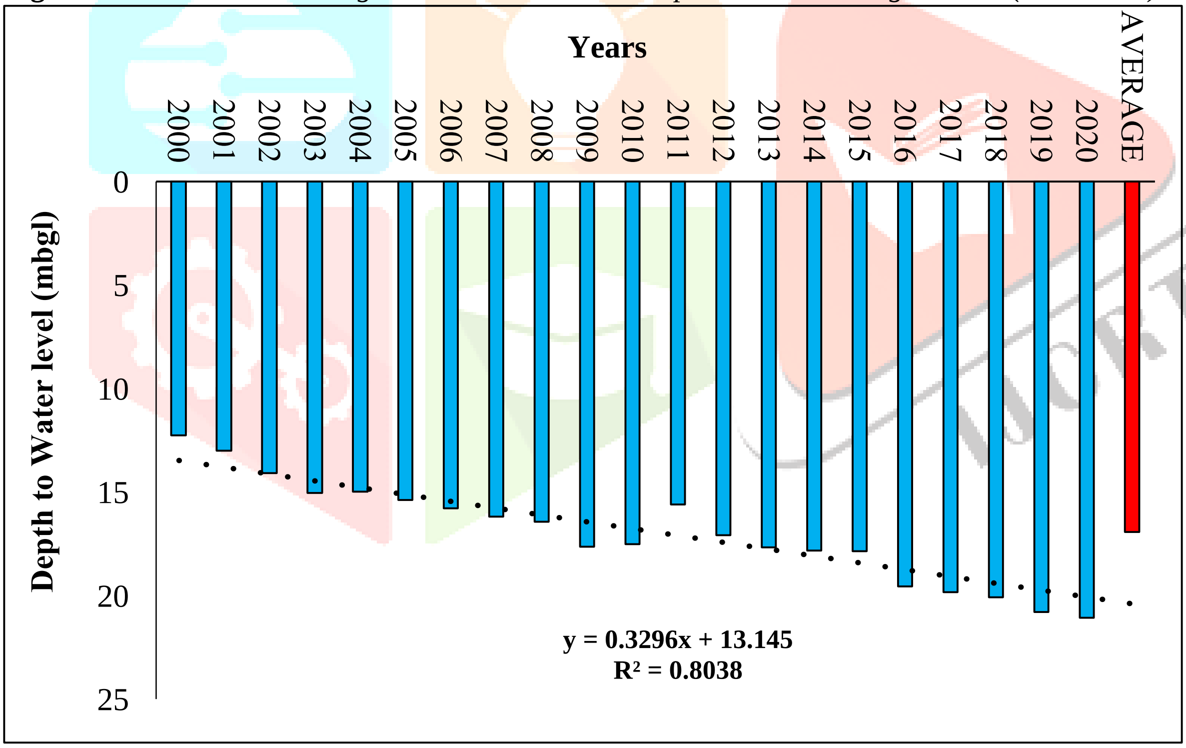
Source: Department of ground water board Gurugram and prepared by Research Scholar **Spatial-Temporal Distribution of The Pre-Monsoon Groundwater Level Depths in Farukh Nagar Block of Gurugram District from 2000-2020.**

The figure 3 presents a detailed record of groundwater level depths in Farrukh Nagar Block in Gurugram District over a span of 21 years, from 2000 to 2020, along with an average calculated for the entire period. The groundwater level depths are measured in meters. The data reveals a fluctuating trend in groundwater levels over the years. In the initial years from 2000 to 2003, the groundwater levels were relatively high, starting at 12.24 meters in 2000 and gradually decreased to 15.03 meters in 2003. From 2004 onwards, there was a period of stability with minor fluctuations, hovering around 15 meters.

However, a notable decrease in groundwater levels is observed from 2009 to 2020. Starting at 17.63 meters in 2009, there is a steady decline each year, reaching upto 21.06 meters in 2020. This significant increase suggests a possible improvement in groundwater availability over the past decade. The average groundwater level depth for the entire period, from 2000 to 2020, stands at 16.94 meters. This average serves as a useful reference point to understand the overall groundwater situation in Farrukh Nagar Block during this time frame.

It's important to note that this data can have implications for water resource management, agriculture, and environmental sustainability in the region. Further analysis and consideration of local factors are necessary to fully interpret and address the changes in groundwater levels observed in this table.

Figure 3:_Pre-Monsoon Average Ground Water Level Depths in Farukh Nagar Block (2000-2020)._



Source: Department of ground water board Gurugram and prepared by Research Scholar **Analysis of the Pre-Monsoon Groundwater Level Depths in Farukh Nagar Block of Gurugram District From 2000-2020.**

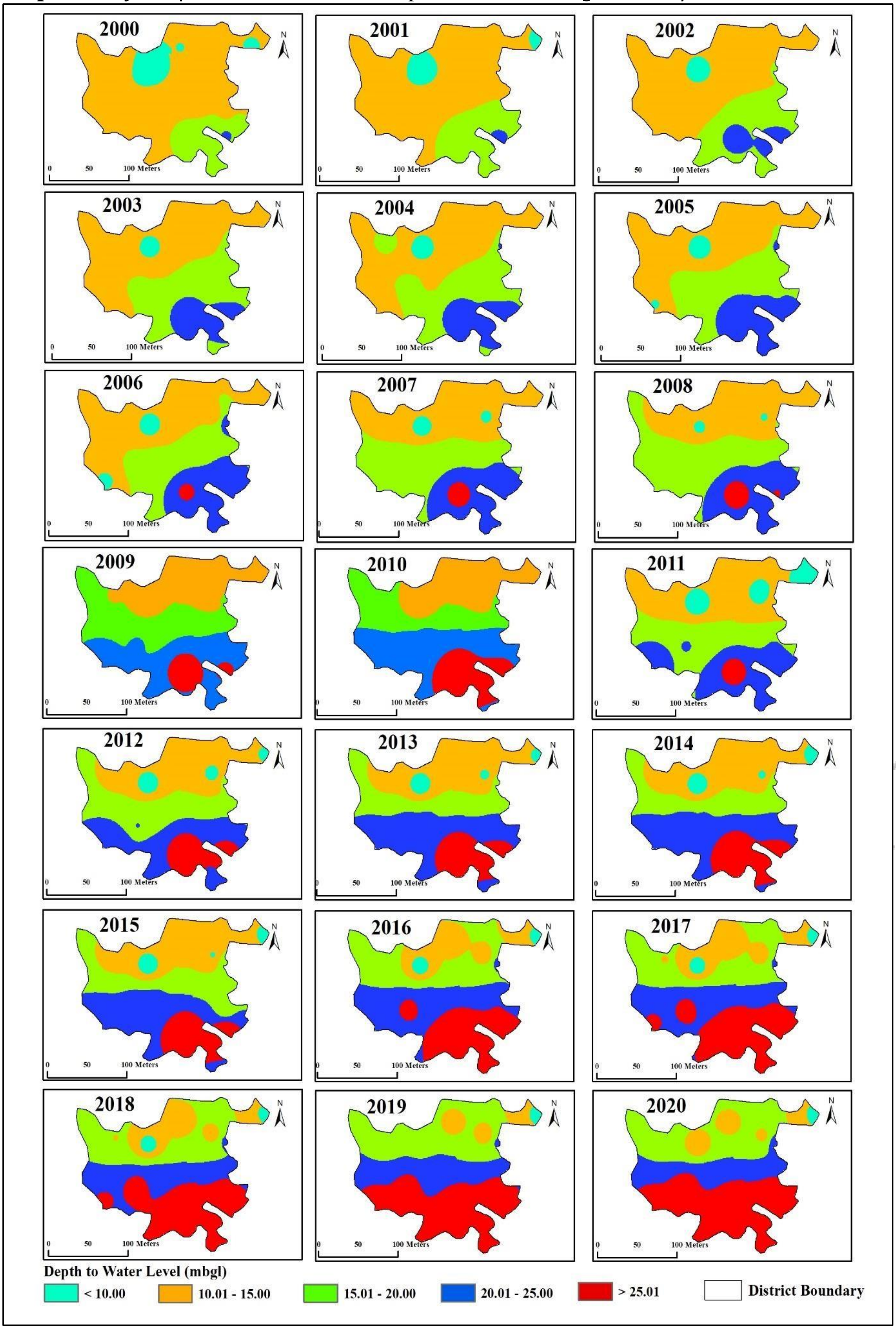
The maps 3 in the image show the depth of groundwater levels in Farukh Nagar Block from 2000 to 2020. The maps are color-coded to indicate the depth of the water table, with darker colors indicating deeper water tables. The maps show that there has been a general trend of increasing depth of groundwater levels in Farukh Nagar Block over the past 20 years. This is evident from the fact that the areas with the shallow water tables in 2000 are now the areas with the deep water tables.

The maps show the average depth of groundwater levels for each year. This means that there may be areas within the block where the water table is deeper or shallower than the average. The maps do not show the distribution of groundwater resources across the block. This means that it is possible for there to be areas with high groundwater resources even if the average depth of the water table is deep.

Overall, the maps show a clear trend of increasing depth of groundwater levels in Farukh Nagar Block over the past 20 years. This is a serious concern, as it could lead to water scarcity in the future. There are a number of things that can be done to help mitigate the problem, such as reducing groundwater pumping, increasing recharge rates, and developing alternative water sources. The increasing depth of groundwater levels is a serious concern, as it could lead to water scarcity in the future. This is because it becomes more difficult and expensive to extract water from deeper aquifers. Additionally, deeper aquifers are often less productive than shallower aquifers.

There are a number of factors that have contributed to the decline in groundwater levels in Farukh Nagar Block. As the population of Farukh Nagar has grown, so has the demand for water. This has led to increased pumping of groundwater, which has depleted the water tables. The recharge rate of groundwater is the rate at which rainwater and other surface water infiltrates into the ground. In Farukh Nagar Block, the recharge rate has been declining due to factors such as land use changes, such as the construction of impervious surfaces, and climate change. It is important to note that the decline in groundwater levels in Farukh Nagar Block is a complex problem with no easy solutions. However, by taking action now, we can help to protect this valuable resource for future generations.

Map 3: *Analysis of Groundwater Level Depths in Farukh Nagar Block from 2000-2020.*



Source: Department of ground water board Gurugram and prepared by Research Scholar **Spatial-Temporal Distribution of The Pre-Monsoon Groundwater Level Depths in Pataudi Block in Gurugram District from 2000-2020.**

The figure presents a valuable record of groundwater level depths in the Pataudi Block, highlighting a consistent and positive trend of increasing groundwater levels depth over the 21-year period, with the average depth rising from 20.81 meters in 2000 to 37.41 meters in 2020, ultimately averaging at 29.25 meters. Over the 21-year period, the average groundwater level depths exhibit a notable trend. At the beginning of the observation period in 2000, the average depth was 20.81 meters, and it gradually increased over the years. There were fluctuations in the early 2000s, but from 2006 onwards, there was a consistent downward trend in groundwater levels. The average depth reached its highest point in 2020 at 37.41 meters, signifying a substantial increase over the two-decade period. This increase in groundwater level depths is indicative of various factors, such as precipitation patterns, groundwater recharge rates, and potentially changes in water usage and management practices within the Pataudi Block. It is important to note that the year-to-year variations in groundwater levels may be influenced by climatic conditions, seasonal fluctuations, and human activities.

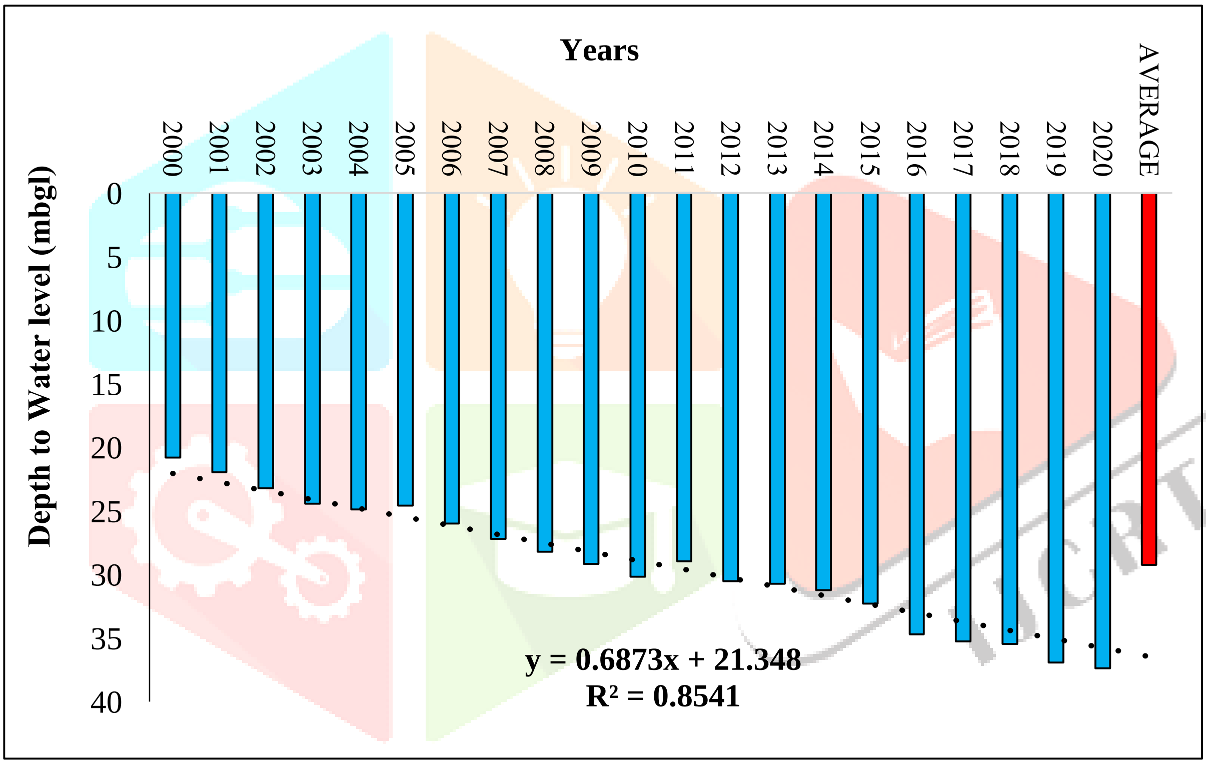


Figure 4:*Pre-Monsoon Average Ground Water Level Depths in Pataudi Block*

Source: Department of ground water board Gurugram and prepared by Research Scholar **Analysis of the Pre-Monsoon Groundwater Level Depths in Pataudi Block of Gurugram District From 2000-2020.**

The map 4 in the image shows the depth of groundwater levels in Pataudi Block from 2000 to 2020. The maps are color-coded to indicate the depth of the water table, with red colors indicating deeper water tables and light colors indicates shallow water table.

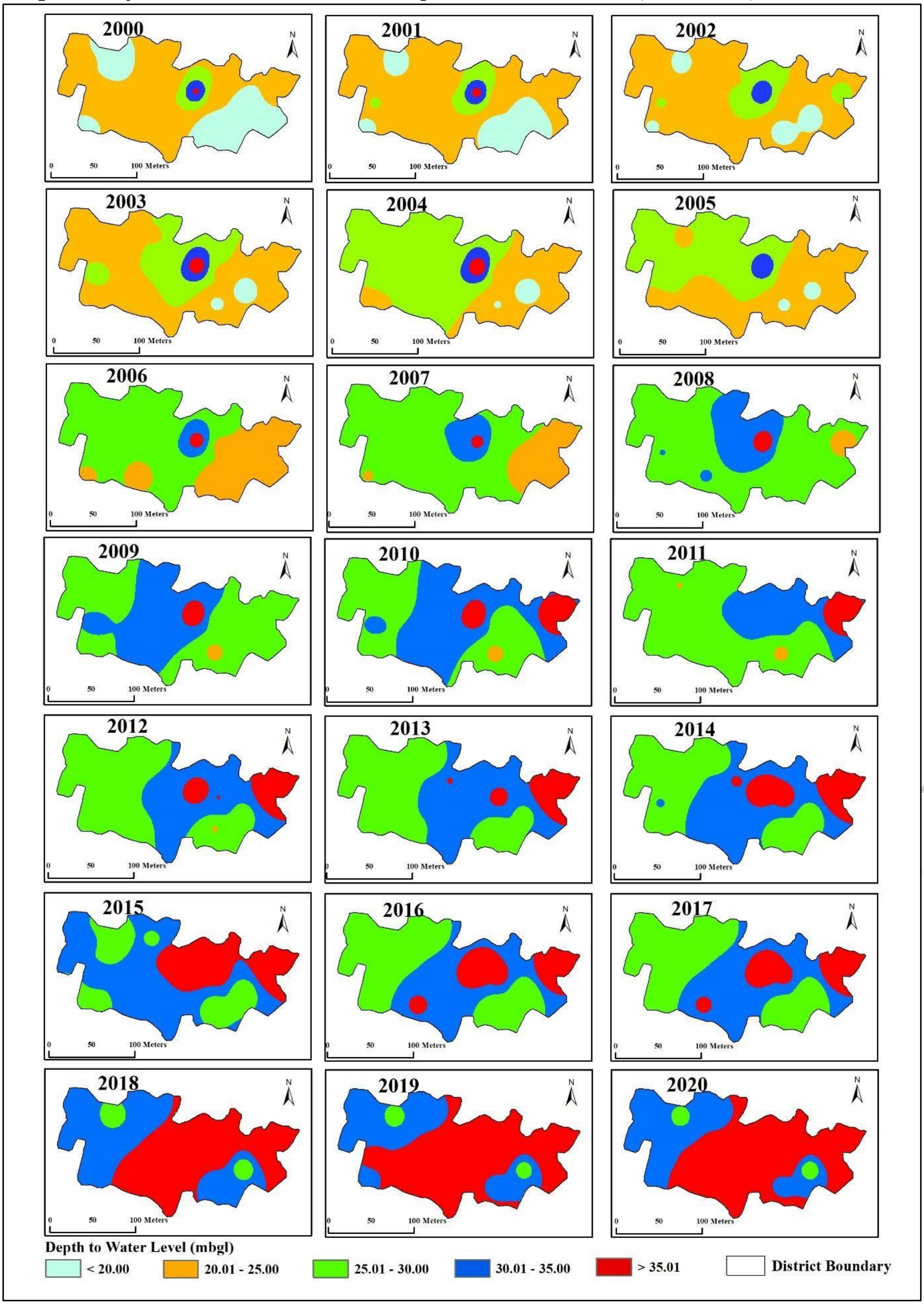
The maps show that there has been a general trend of increasing depth of groundwater levels in Pataudi Block over the past 21 years. In 2000, the almost all block was having water table upto 25mbgl but till 2020 the scenario changed completely, water level declined in almost all regions. In 2020 all regions of the blocks were having water table below 30mbgl. Major area of the block had water table below 35mbgl. The increasing depth of groundwater levels is a serious concern, as it could lead to water scarcity in the future. This is because it becomes more difficult and expensive to extract water from deeper aquifers. Additionally, deeper aquifers are often less productive than shallower aquifers.

The maps show the average depth of groundwater levels for each year. This means that there may be areas within the block where the water table is deeper or shallower than the average. The maps do not show the distribution of groundwater resources across the block. This means that it is possible for there to be areas with high groundwater resources even if the average depth of the water table is deep.

Overall, the maps show a clear trend of increasing depth of groundwater levels in Pataudi Block over the past 20 years. This is a serious concern, as it could lead to water scarcity in the future. There are a number of things that can be done to help mitigate the problem, such as reducing groundwater pumping, increasing recharge rates, and developing alternative water sources. It is important to note that the decline in groundwater levels in Pataudi Block is a complex problem with no easy solutions. However, by taking action now, we can help to protect this valuable resource for future generations.

The increasing depth of groundwater levels is a serious concern for all three blocks. This is because it becomes more difficult and expensive to extract water from deeper aquifers. Additionally, deeper aquifers are often less productive than shallower aquifers. The factors that have contributed to the decline in groundwater levels in all three blocks are similar. These include increased urbanization and population growth, reduced recharge rates, and climate change.

Map4: Analysis of Groundwater Level Depths in Pataudi Block (2000-2020).



Source: Department of ground water board Gurugram and prepared by Research Scholar **Spatial-Temporal Distribution of the Pre-Monsoon Groundwater Level Depths in Sohna Block in Gurugram District from 2000-2020.**

The figure 5 provides a comprehensive overview of the average groundwater level depths in the Sohna Block area over a 21-year period, spanning from 2000 to 2020. From 2000 to 2020, there is a clear trend of increasing groundwater levels in the Sohna Block. In the year 2000, the average groundwater level depth was recorded at 13.84 meters, and it steadily fasll over the years, reaching its lowest point in 2020 at 26.18 meters. This downward trend suggests an overall decrease in the availability of groundwater in the region during this period. During the early years, from 2000 to 2007, there was a relatively gradual decrease in groundwater levels. However, from 2007 onwards, the rate of fall became more pronounced. Between 2007 and 2020, the average groundwater depth increased by approximately 5.76 meters, indicating a significant change in the groundwater dynamics in the Sohna Block. It's important to note that while there is a general downward trend in groundwater levels, there are some fluctuations from year to year. These fluctuations can be influenced by various factors such as seasonal variations, precipitation patterns, and changes in water usage practices. For instance, there are noticeable fluctuations in 2010 and 2017, where the groundwater levels temporarily increased before resuming their downward trajectory. The average groundwater level depth for the entire period from 2000 to 2020 is calculated to be

20.76 meters.

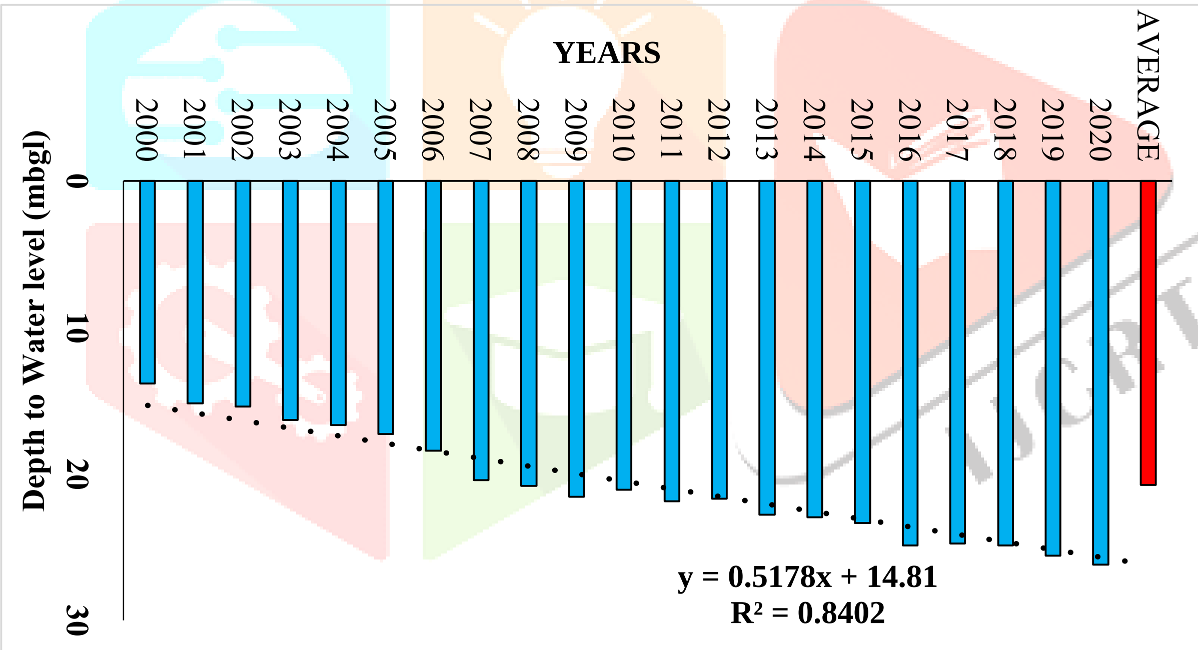


Figure 5: Pre-Monsoon Average Ground Water Level Depths in Sohna Block (2000-2020)

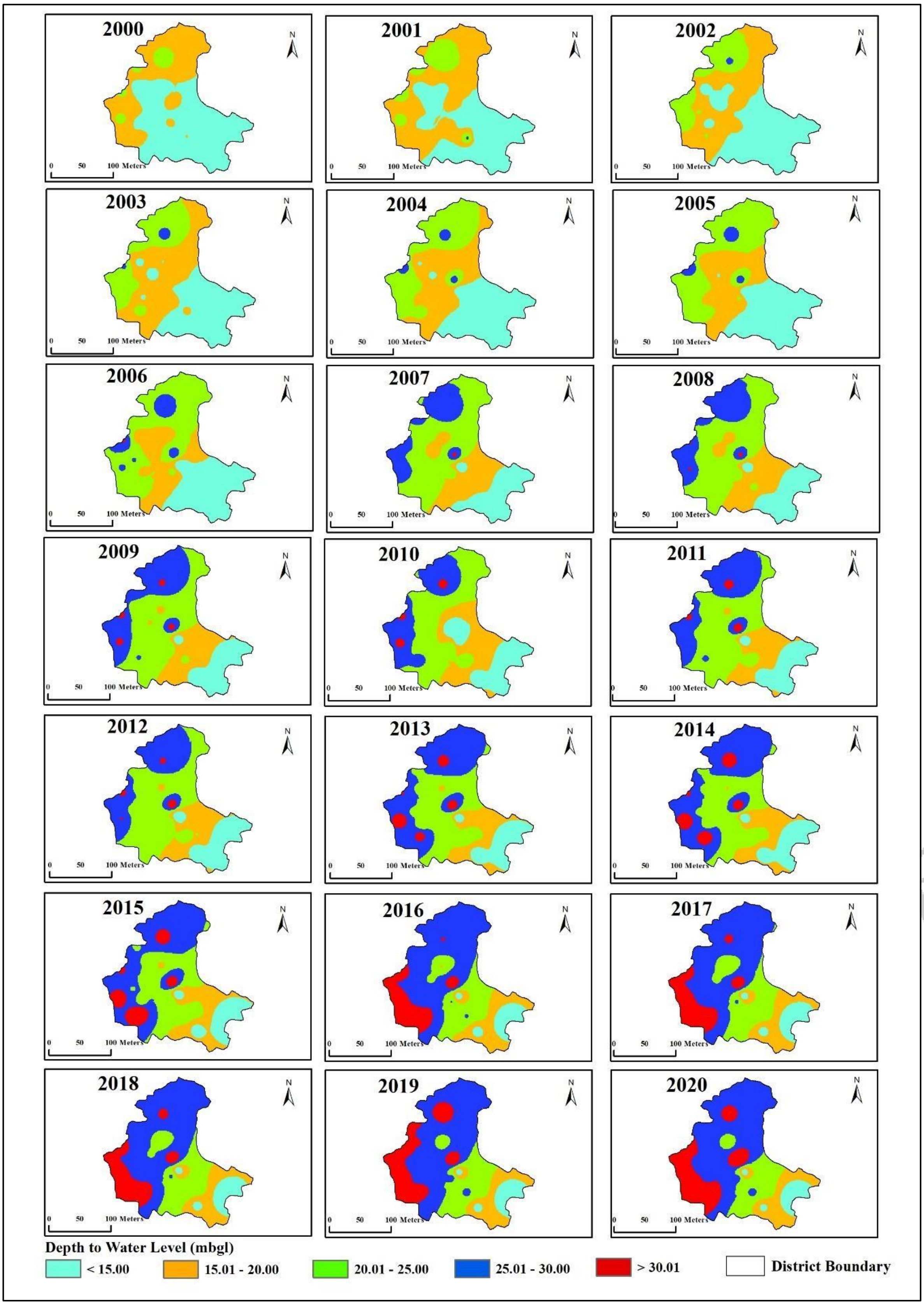
Source: Department of ground water board Gurugram and prepared by Research Scholar **Analysis of the Pre-Monsoon Groundwater Level Depths in Sohna Block of Gurugram District from 2000-2020.**

The map 5 shows the pre-monsoon groundwater level depth in Sohna Block (Gururam) from 2000 to 2020. The map is divided into different color-coded zones to represent different groundwater depths. The legend at the bottom of the map shows the groundwater depth ranges in meters below ground level (mbgl). The analysis of groundwater level depths in Sohna Block shows that there is a significant spatial variability in groundwater levels. Groundwater levels are generally shallower in the southern part of the block. In the northern part of the block, groundwater levels are deeper, often more than 20 meters below the ground surface.

The map 5 also shows that there is a significant variation in groundwater depth across Sohna block. The deepest groundwater levels are found in the northern and western parts of the block, where the groundwater depth is greater than 25 mbgl. The shallowest groundwater levels are found in the southern and eastern parts of the block, where the groundwater depth is less than 15 mbgl. The map shows that the average groundwater level depth in Sohna Block has been increasing over the past 20 years. In 2000, the average groundwater depth was between 15 and 20 mbgl. However, by 2020, the average groundwater depth had fallen to between 20 and 30 mbgl. This represents a decline of 5 to 10 meters over the past 20 years. The groundwater level depth has increased significantly over the years, indicating a decline in groundwater availability. The average groundwater level depth in the region was 3.8m in 2003, and it increased to 7.9m in 2019, which is more than double. The increase in groundwater level depth was more pronounced in the northern and western parts of the region, where the depth reached more than 9m in some areas by 2019. The southern parts of the region had relatively lower groundwater level depth, ranging from 1.5m to 6m, but they also showed a gradual increase in depth over the years.

The possible causes of the decline in groundwater level depth could be overexploitation of groundwater resources, low rainfall, high evaporation, poor recharge, and land use changes. Overexploitation of groundwater: Sohna Block is a rapidly developing area with a growing population and economy. This has led to an increase in water demand, which has put pressure on groundwater resources.

Climate change: Climate change is leading to more extreme weather events, such as droughts and floods. These events can have a significant impact on groundwater levels. Poor water management practices: Inefficient irrigation practices and lack of wastewater recycling can also lead to the depletion of groundwater resources.



Map5:*Analysis of Groundwater Level Depths in Sohna Block (2000-2020).*

Source: Department of ground water board Gurugram and prepared by Research Scholar

3.22 Conclusion

In conclusion, while Gurugram has experienced significant development and urbanization, it also faces formidable environmental challenges, including groundwater depletion, air pollution, and deforestation. Addressing these issues requires a multifaceted approach that involves sustainable resource management, pollution control, and community engagement. By taking proactive measures and working collaboratively, Gurugram can work towards a more sustainable and environmentally friendly future for its residents and the region as a whole. In the Pre-Monsoon Session, the provided content discusses a comprehensive overview of groundwater level depths in four different blocks within Gurugram District, India, spanning a 21-year period from 2000 to 2020. Each block exhibits varying trends in groundwater levels, with implications for water resource management, agriculture, and environmental sustainability. In the Gurugram block, there is a consistent downward trend in groundwater levels over the 21-year period, indicating decline in groundwater availability. This data underscores the importance of effective monitoring and management to ensure sustainable use, considering potential challenges like depletion and contamination. Farrukh Nagar Block, on the other hand, shows fluctuating groundwater levels, initially high but gradually falling, stabilizing for a period, and then consistently falling from 2009 to 2020. This shows declining groundwater availability over the decade and emphasizes the need for further analysis and consideration of local factors. Pataudi Block exhibits a steady decrease in groundwater levels, attributed to various factors, including precipitation patterns, recharge rates, and changes in water usage. Maps visually depict this trend, with increasing depths over the years, raising concerns about future water scarcity due to the cost of extracting water from deeper aquifers. Sohna Block experiences a clear and consistent downward trend in groundwater levels, indicating decreased availability. However, spatial variability exists within the block. The average depth has declined over 20 years, suggesting decreased availability due to factors like overexploitation, climate change, and poor water management practices. The analysis of Gurugram District as a whole reveal's significant variations in groundwater depth across regions and blocks. It highlights the importance of sustainable groundwater management and the need for proactive measures, such as reducing pumping, enhancing recharge rates, and exploring alternative water sources. The provided map and analysis offer valuable insights into the complex dynamics of groundwater levels in Gurugram District, emphasizing the urgency of addressing these challenges to safeguard this vital resource for future generations

The complexity of groundwater dynamics is evident, with variations across the block and an accelerating decline in recent years. Overall, these analyses highlight the need for ongoing monitoring and sustainable resource management to address groundwater challenges in Gurugram District. It's crucial to strike a balance between extraction and recharge to safeguard this vital resource for future generations.

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