ANALYSIS OF SPATIAL VARIATION OF GROUNDWATER LEVELS USING GIS TOOL

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1. ABSTRACT

Understanding the spatial variation of groundwater levels is essential for effective water resource management. Accurate monitoring can help to predict water availability, manage supply during droughts, and prevent issues such as over-extraction and contamination. An attempt is made to analyse the spatial variation of ground water levels across three watersheds. The watersheds under consideration are Hebbal valley, KC valley and Vrishabhavathi valley in Bangalore, Karnataka. The ground water level spatial distribution maps of Hebbal, KC valley and Vrishabhavathi valley are prepared for 3 decades. GIS software and interpolation methods are used for the preparation of maps. From the maps it can be drawn that the ground water levels are depleting drastically. The drastic withdrawal is seen in each decade. Understanding the spatial variation of groundwater resources can help in developing targeted strategies for groundwater management, thereby safeguarding this vital resource for future generations.

2. INTRODUCTION

Groundwater, found in aquifers beneath the Earth's surface, is one of the most critical natural resources. It plays a vital role in sustaining ecosystems, supporting agriculture, and providing drinking water for millions of people worldwide. This invisible resource is often overlooked, yet its importance cannot be overstated. The depletion of groundwater is a growing concern globally. Over-extraction for agricultural, industrial, and domestic purposes, coupled with prolonged droughts and reduced recharge rates, has led to significant declines in groundwater levels. To mitigate the impacts of groundwater depletion, recharge is essential. Recharge involves replenishing groundwater by allowing water to percolate back into the aquifers. This can be achieved through natural processes or human interventions. Groundwater availability and quality vary significantly across different regions due to geological, climatic, and anthropogenic factors.

Groundwater is a critical resource for drinking water, agriculture, and industrial activities. The spatial variation of groundwater levels refers to the differences in the elevation of groundwater across different geographic areas. These variations can be influenced by a range of factors including geological formations, climate conditions, land use, and human activities.

The type of rock and soil in an area significantly influences groundwater levels. Permeable materials like sand and gravel allow water to move more freely, leading to higher groundwater levels, whereas impermeable materials like clay can restrict water flow, resulting in lower groundwater levels. Aquifers, which are underground layers of water-bearing permeable rock, play a crucial role in determining the availability and movement of groundwater. Precipitation and evaporation rates are critical in determining groundwater recharge. Regions with high rainfall generally experience higher groundwater levels due to increased recharge, while arid regions often have lower groundwater levels due to limited recharge and higher rates of evaporation. The physical features of the landscape, including elevation and slope, affect the distribution of groundwater. Water tends to accumulate in low-lying areas, leading to higher groundwater levels, whereas elevated areas may have lower levels due to drainage and runoff. Human activities such as agriculture, urban development, and deforestation can significantly alter the natural flow and recharge of groundwater. For instance, irrigation can raise groundwater levels locally, while over-extraction for agriculture or urban use can lead to a decline. Vegetation also impacts groundwater levels, as plants absorb water from the soil, reducing the amount available for groundwater recharge. Groundwater extraction for agricultural, industrial, and domestic use can create significant spatial variation in groundwater levels. In areas where groundwater is heavily exploited, levels can drop significantly, leading to problems such as land subsidence and reduced water quality. Conversely, areas with limited extraction may maintain higher groundwater levels.

Understanding the spatial variation of groundwater levels is essential for effective water resource management. Accurate monitoring can help predict water availability, manage supply during droughts, and prevent issues such as over-extraction and contamination. In regions where groundwater is the primary source of water, managing these variations is critical to ensuring sustainable water supplies. Modern techniques such as remote sensing, Geographic Information Systems (GIS), and advanced modelling tools have improved the ability to map and analyse groundwater levels. These tools enable better prediction and management of groundwater resources by providing detailed spatial data that can be used to identify trends, plan water usage, and mitigate potential risks.

An attempt is made to analyse the spatial variation of ground water levels across three watersheds. The watersheds under consideration are Hebbal valley, KC valley and Vrishabhavathi valley situated between latitude 12°58'33"N and 13°11'44"N, 12°50'06"N and 13°00'53"N and 12°44'40"N and 13°02'23"N and longitude 77°31'42"E and 77°46'12"E, 77°33'53"E and 77°46'54"E and 77°23'38"E and 77°35'40"E respectively. These watersheds having a tropical savanna climate with distinct wet and dry seasons. In general, all the three watersheds having a flat geological and geomorphological setting, built on large igneous rocks.

3. METHODOLOGY

The spatial distribution maps are prepared using CGWB water depth data for the years 1991, 2001, 2011 and 2021. GIS software is used for the preparation of maps. Interpolation method is used for the preparation of maps. IDW (Inverse Distance Weighting) interpolation is a spatial interpolation technique used in geographical information systems (GIS) to estimate unknown values at specific locations based on known values from surrounding points. This method assumes that the influence of known points diminishes with distance, meaning closer points have a more significant impact on the estimated value than those farther away.

The spatial distribution maps of Hebbal, KC valley and Vrishabhavathi valley for the year 1991, 2001, 2011 and 2021 are prepared. The prepared maps are shown below. From the maps it can be drawn that the ground water levels are depleting drastically. The drastic withdrawal is seen in each decade.

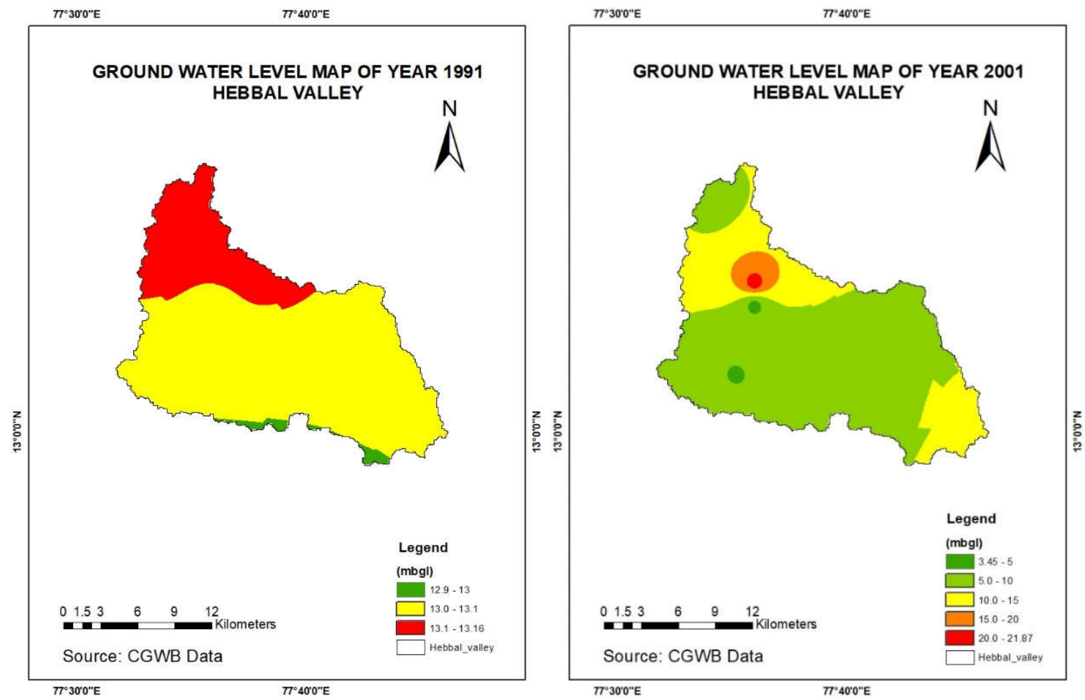


Fig 1 & 2: Ground water level map of Hebbal Valley of the year 1991and 2001

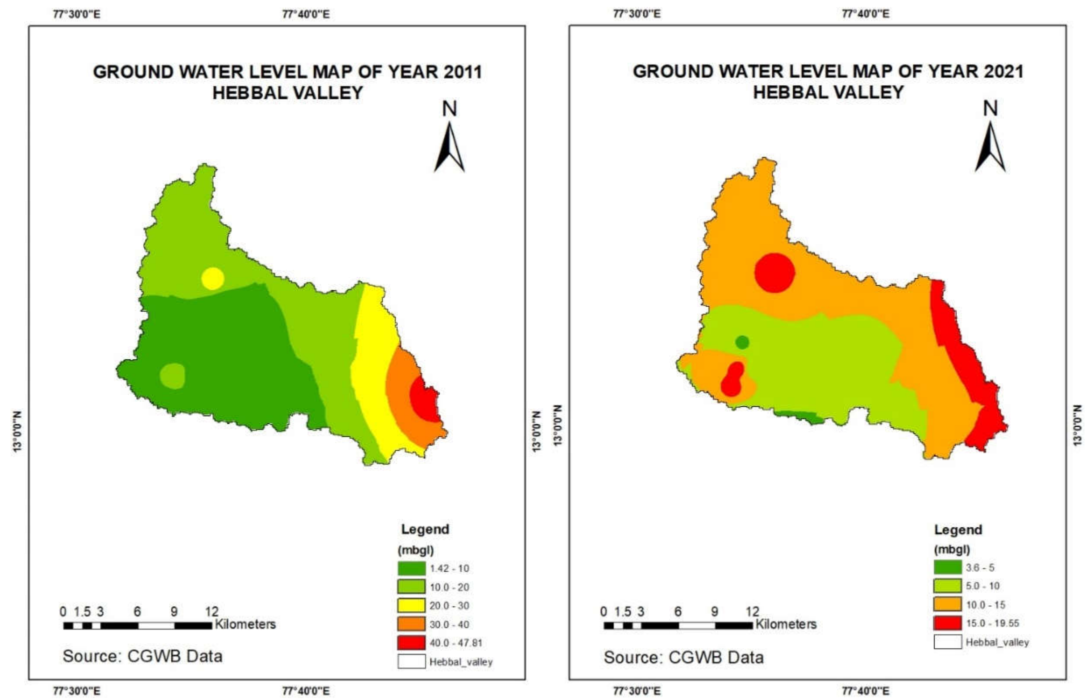
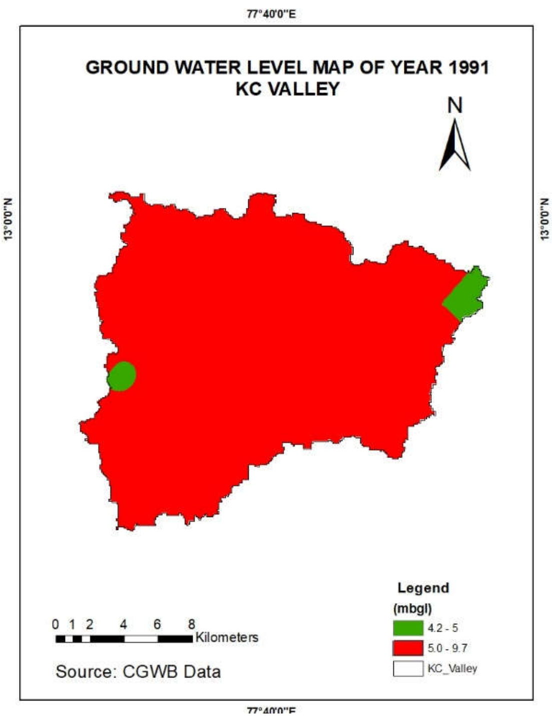


Fig 3 & 4: Ground water level map of Hebbal Valley of the year 2011 and 2021



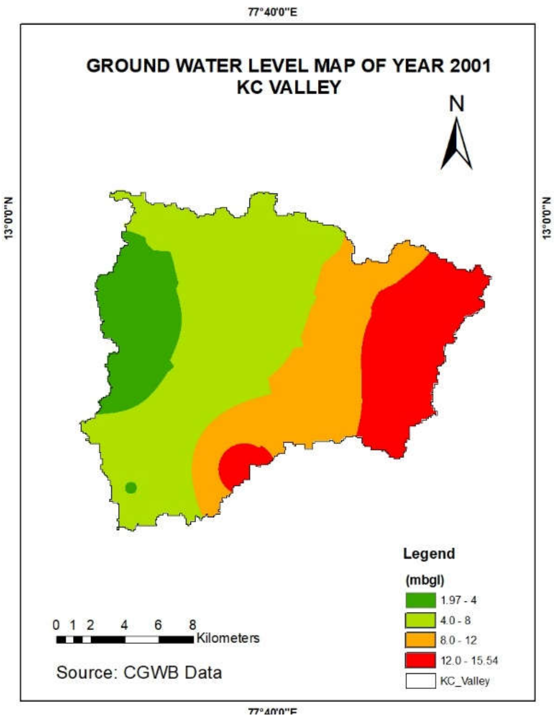
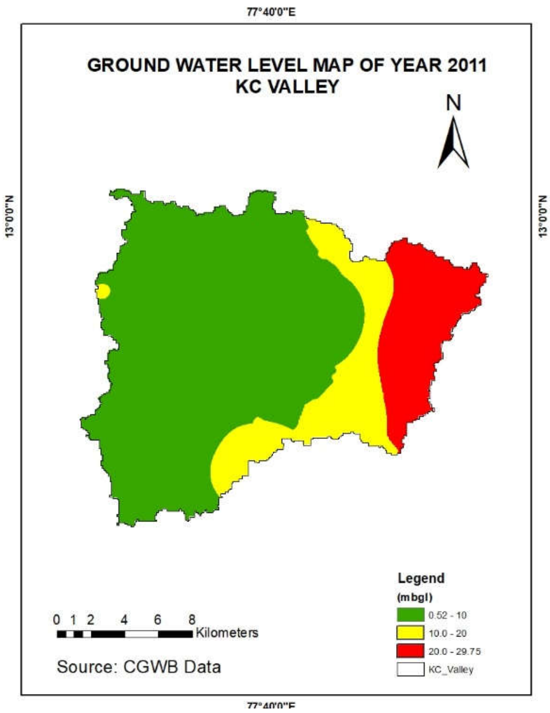


Figure 5 & 6: Ground water level map of KC Valley of the year 1991 and 2001



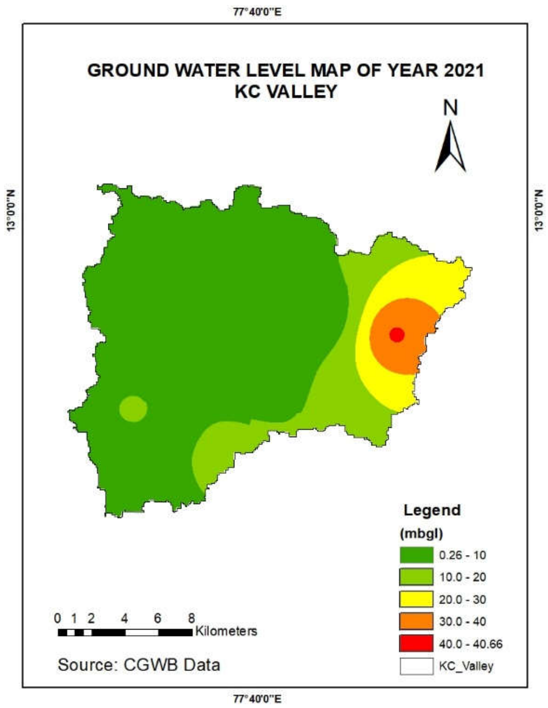


Figure 7 & 8: Ground water level map of KC Valley of the year 2011 and 2021

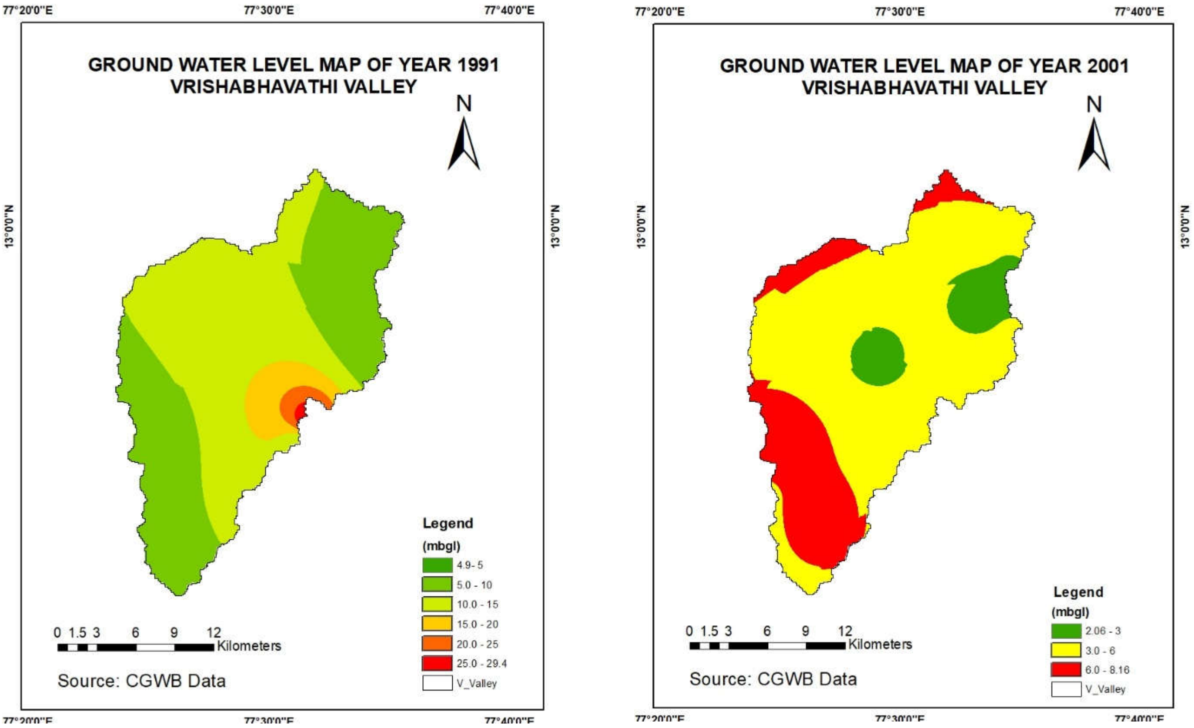


Figure 9 & 10: Ground water level map of Vrishabhavathi Valley of the year 1991 and 2001

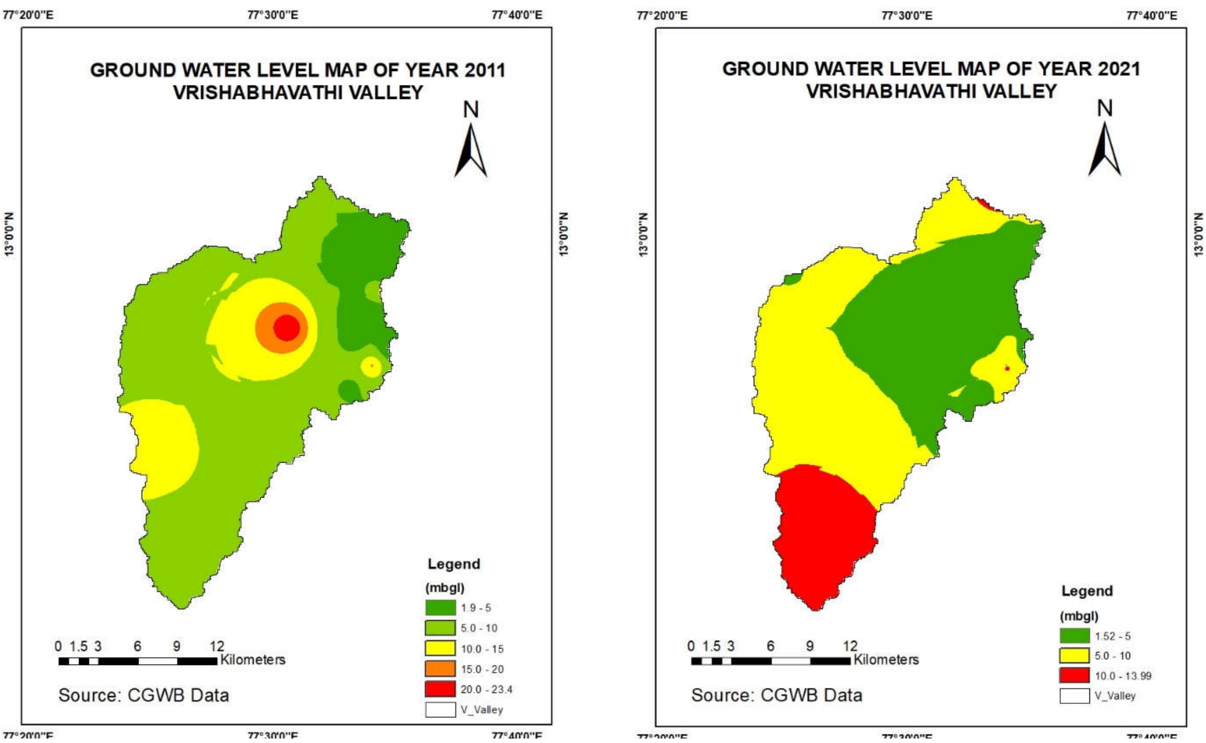


Figure 11 & 12: Ground water level map of Vrishabhavathi Valley of the year 2011 and 2021

4. RESULTS & CONCLUSIONS

The maps of Hebbal valley showing that about 10 m depletion is happening in 1st decade and the depth became double in the next decade both showing withdrawal. In the 3rd decade the depth is deceased indicating the ground water level has come up meaning recharge. The water level map of KC valley showing that the 1st decade having 5m depletion and by 2nd decade it got doubled and also in 3rd decade the levels are reducing further indicating always in withdrawal of groundwater. The maps of Vrishabhavathi Valley showing a different pattern of Spatial distribution of ground water over the 3 decades. In the 1st decade water levels are decreasing indicating recharge and in the next decade it is increasing indicating withdrawal followed by a decrease in the next decade indicating again recharge.

Groundwater is an indispensable resource that requires careful management and conservation. Addressing its depletion through recharge initiatives and sustainable practices is crucial for ensuring long-term water security. Understanding the spatial variation of groundwater resources can help in developing targeted strategies for groundwater management, thereby safeguarding this vital resource for future generations.

In conclusion, the spatial variation of groundwater levels is a complex and dynamic phenomenon influenced by natural and human factors. Effective management requires continuous monitoring, understanding the underlying causes of variation, and implementing strategies to balance use and recharge to sustain this vital resource.

5. ACKNOWLEDGEMENT

The author is grateful to CSIR (Counsil of Science and Industrial Research) for funding the fellowship for the research.

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