Geospatial Perspective for Groundwater Augmentation: A Case Study for Hunsur Taluk of India

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Abstract: Groundwater augmentation is increasingly recognized as a critical strategy for addressing the global water crisis, particularly in regions experiencing groundwater depletion. This study aims to determine site suitability for Artificial Recharge Structures (ARS) in Hunsur taluk to support long-term groundwater sustainability. The integration of PAN (Panchromatic) and IRS-1D LISS (Linear Imaging and Self Scanning) satellite data improved the identification of suitable recharge locations using Geographic Information Systems (GIS) and the Analytic Hierarchy Process (AHP). Key groundwater recharge controlling parameters, including slope, lithology, geomorphology, land use/land cover (LULC), lineament density, soil, drainage density, and stream order were integrated to delineate potential recharge zone. The analysis identified suitable locations for 44 check dams, 16 nalah bunds, and 10 percolation tanks as site-specific remedial measures to enhance groundwater recharge, reduce surface runoff, and improve aquifer storage. These interventions are particularly recommended along moderate drainage networks, fractured zones, and gentle slope regions to maximize infiltration and recharge efficiency. The findings demonstrate the effectiveness of integrating GIS and AHP for scientifically guiding groundwater augmentation planning and implementing location-specific remedial measures for sustainable groundwater management in Hunsur taluk.

Keywords: AHP, Geospatial, Groundwater augmentation, Hunsur

1. Introduction

Groundwater is one of the most critical freshwater resources supporting global water security. It contributes approximately 26% of global freshwater withdrawals and serves as a primary source for domestic supply, irrigation, and rural drinking water needs (NGWA, 2025). Agriculture alone accounts for nearly 70% of global groundwater withdrawals, reaching up to 90% in some arid and semi-arid countries where irrigation heavily depends on groundwater resources (Ingrao et al. 2023). Due to increasing water demand and unsustainable extraction, groundwater resources worldwide are under significant stress, particularly in dry and semi-arid regions. Recent assessments indicate that nearly 30% of the world's regional aquifers have experienced rapid depletion over the past four decades, highlighting the urgent need for effective groundwater management strategies (Jasechko et al. 2024).

Excessive groundwater abstraction not only threatens long-term water availability but also contributes to problems such as salinity intrusion and water contamination, particularly in densely populated and intensively cultivated regions such as South Asia and coastal urban areas (Shah et al. 2000; Pointet, 2022). Recognizing these challenges, global organizations have emphasized the importance of sustainable groundwater governance and recharge interventions. Several countries, including Thailand and Iran, have successfully implemented Managed Aquifer Recharge (MAR) practices to restore declining groundwater levels, demonstrating the effectiveness of scientifically planned recharge measures (Jasechko et al. 2024).

In India, the groundwater crisis has become increasingly severe due to factors such as over-extraction for irrigation, climate variability, rapid population growth, mining activities, and expanding urbanization (Tandon, 2018). Groundwater plays a dominant role in India's irrigation sector, which significantly increases pressure on aquifers. Nearly two-thirds (63%) of India's districts are facing declining groundwater levels, while many regions also experience groundwater contamination (Roome, 2022). Furthermore, about 17% of groundwater assessment blocks in the country are categorized as over-exploited, where groundwater extraction exceeds natural recharge rates (Shiferaw, 2025). In states such as Punjab, Haryana, and Rajasthan, more than 25% of assessment units are classified as critical or over-exploited, indicating severe groundwater stress (Ministry of Jal Shakti, 2023).

Multiple factors contribute to this increasing groundwater crisis. Rapid population growth and urban expansion have substantially increased water demand, particularly for agriculture (Boretti and Rosa, 2019). Intensive irrigation practices often prioritize short-term agricultural productivity over long-term aquifer sustainability (Ingrao et al. 2023). Additionally, limited awareness among farming communities regarding aquifer capacity and sustainable groundwater use has resulted in unregulated groundwater extraction. Climate change further complicates groundwater management, as variability in rainfall patterns influences recharge processes and hydrological balance (Hughes et al. 2021). Irregular monsoon conditions frequently lead to both flooding and drought events, which disrupt natural groundwater recharge cycles (Ward et al. 2020). Moreover, groundwater quality is increasingly threatened by agricultural runoff, industrial discharge, and inadequate sanitation infrastructure (Afshan et al. 2022).

Given these challenges, identifying suitable locations for artificial groundwater recharge has become a key strategy for sustainable water resource management. In recent years, geospatial technologies such as remote sensing and GIS have emerged as powerful tools for groundwater assessment and recharge planning. Several national studies have highlighted the effectiveness of these techniques in groundwater augmentation. A study of (Muthamilselvan et al. 2019) demonstrated that integrating remote sensing and GIS significantly improves the identification of groundwater potential and recharge zones by analyzing hydrogeomorphic parameters. Similarly, (Saraf and Choudhury, 1998) showed that the integration of remote sensing and GIS effectively delineates groundwater prospect zones and suitable sites for artificial recharge structures. Further (Prapanchan et al. 2024) applied GIS integrated with the AHP to delineate groundwater potential zones, demonstrating that multi-criteria geospatial evaluation enhances decision-making in groundwater recharge planning. Likewise, (Rajasekhar et al. 2021) utilized geospatial and decision-support techniques to identify priority zones for artificial groundwater recharge, enabling effective planning of recharge structures such as check dams and percolation tanks in semi-arid regions.

In this context, the present study aims to identify suitable locations for groundwater augmentation structures in Hunsur taluk using GIS and the AHP. The study seeks to provide a scientifically informed framework for groundwater recharge planning to support sustainable groundwater management in the region.

2. Methodology

2.1 Study Area

Hunsur taluk is in the Mysuru district of Karnataka, India and encompasses 981 km^2 (Figure 1) (Manjunatha and Basavarajappa, 2021a). The taluk has a varied elevation ranging from roughly 656 meters above mean sea level (msl) in the south to about 908 meters in the north. The topography consists of a mix of hilly areas in the central region and plains across the taluk (Manjunatha and Basavarajappa, 2021a). The terrain is influenced by geological features, which are predominantly formed by metamorphic rocks from the Precambrian era, such as gneissic and schistose formations (Manjunatha and Basavarajappa, 2021a). It experiences a semi-arid climate and is designated as part of Southern dry agro-climatic zone of Karnataka (CGWB, 2022a). The annual rainfall is roughly 816 mm, with the southwest monsoon season accounting for approximately 47.3% of total rainfall (CGWB, 2022a). The River Lakshmana Tirtha flows through Hunsur, which is important for local water supply (CGWB, 2022a). Paddy, maize, ragi and vegetables are the most common kharif crops, whereas maize, vegetable and oilseeds are grown during the rabi season. Tobacco was also observed to be grown in Hunsur taluk as a water intensive crop (CGWB, 2022a; CGWB, 2022b).

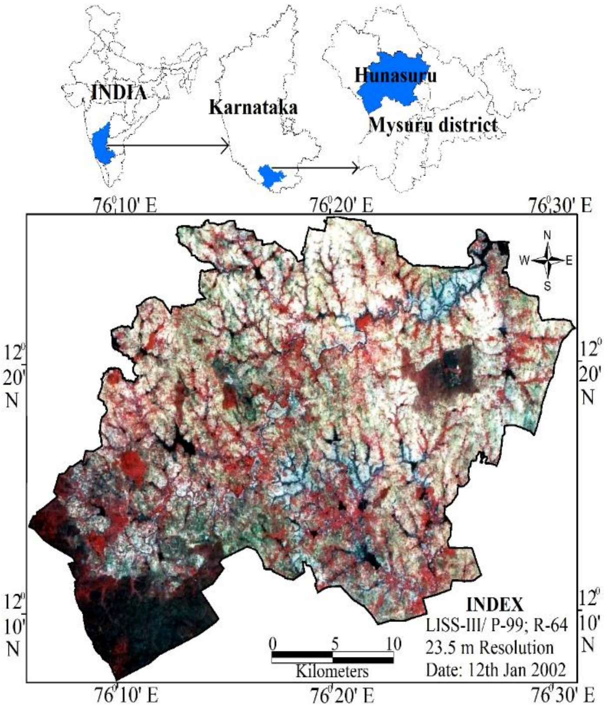

Figure 1: IRS-1D LISS-III image of Hunsur Taluk

2.2 Data Sources

The Bengaluru-Survey of India (SoI) office provided toposheets (57D/3, 4, 7, 8, 11) at a scale of 1:50,000, which were used to prepare base maps and taluk boundary extraction (Manjunatha, 2024). IRS-1D LISS-III (Nov-2001 and Jan-2002) images were acquired from ISRO-NRSC, Hyderabad. The LISS-III images have spatial resolutions of 23.5 mts and the PAN images have 5.8 mts, whereas the satellite-based DEM was downloaded from USGS-earthexplorer (Figure 2a) (Manjunatha, 2024). Both Digital Image Processing (DIP) and Visual Image Interpretation Technique (VIIT) are used on LISS-III images for extraction of thematic layers (Figure 3a to 3g) along with limited field survey using Garmin eTrex-10 GPS (Manjunatha, 2024).

2.3 Data Analysis

The lithology types of Hunsur are prepared using the GSI Quadrangle maps 57D and 58A, which have a scale of 1:250,000. The geomorphological features are digitized using the Karnataka geomorphological map of 1:250,000 scale (Manjunatha et al. 2019). Slope categories and drainage patterns are prepared using 30m resolution of DEM data superimposed on SoI topo map (Manjunatha, 2024). Land use/ land cover patterns and lineaments are extracted from PAN+LISS-III merged map of 5.8m resolution (Figure 1) (Manjunatha, 2024). The best ARS sites have been depicted by overlaying all seven layers of the Hunsur using a weighted pairwise comparison approach (Figure 4; Table 1 & 2).

2.4 Analytic Hierarchy Process (AHP)

The relative importance of influencing factors was determined using the Analytic Hierarchy Process (AHP) proposed by Thomas L. Saaty (Saaty, 1980). Seven thematic layers such as slope, lithology, geomorphology, lineament density, soil, drainage density, and land use/land cover were considered for groundwater prospect evaluation. Each factor was assigned a relative importance value using Saaty's Scale in fractional form (1, 1/2, 1/3…), representing decreasing influence on groundwater occurrence. Subsequently, the percentage influence of each factor was calculated using below formula:

$$\text{Percentage Influence} = \frac{\text{Saaty's scale value}}{\text{Total sum}} x100$$

These values were converted to decimal form and summed to obtain the total weight.

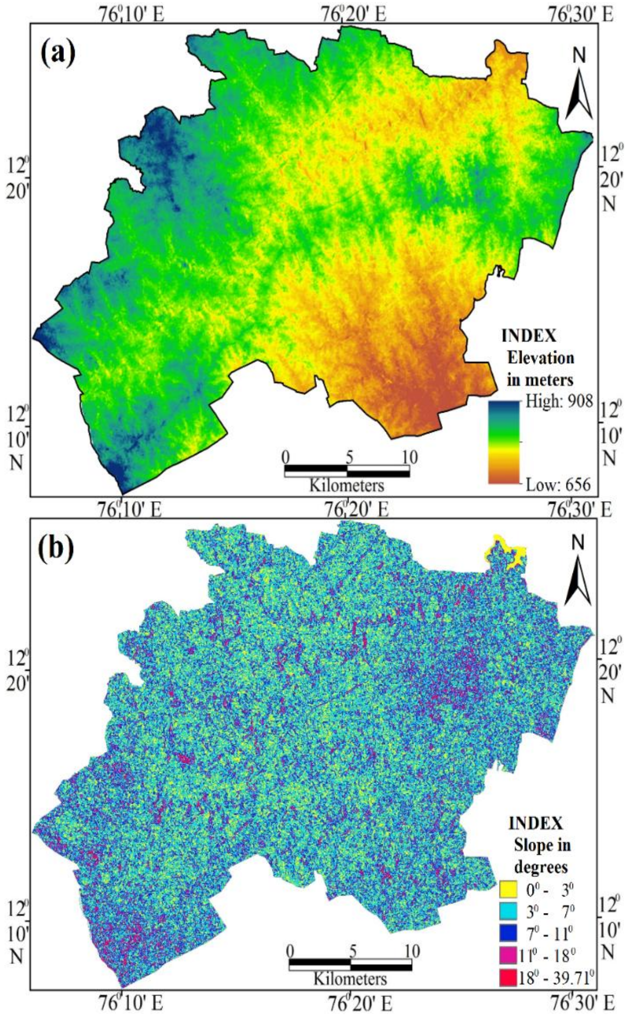

Figure 2: (a) DEM and (b) Slope Map of Hunsur Taluk

3. Results

Several earlier studies had adopted RS and GIS technologies to analyze the parameters of lithology, geomorphology, drainage density, lineament density, soil, slope, land use land cover (Rajasekhar et al. 2021), stream orders to identify potential sites for artificial recharge.

3.1 Slope

The elevation varies significantly from 908 meters in the north to 656 meters in the south, influencing the patterns of groundwater flow. The center region is distinguished by hilly terrain and the rest of the taluk is mostly made up of plains with mild slopes that are ideal for agriculture. Steeper slopes in hilly regions restrict groundwater infiltration, while gentler slopes in plains enhance water retention and support agriculture. Surface water infiltration and run-off rates are influenced by slope (Manjunatha, 2024).

Flat surface lands are ideal for ARS since they indicate lesser surface; while higher slopes increase run-off, making the site unsuitable for ARS (Manjunatha, 2024; Han et al. 2018). The 'very good' ARS category lies under the range of 0 to 3 degree, which is almost flat terrain with a high infiltration rate (Rajasekhar et al. 2021). 'Good' category lies between 3 to 7 degrees (Manjunatha & Basavarajappa, 2021b), which indicates considerable runoff and slight undulation. The 'moderate' category, which range between 7 to 11 degrees, indicates high runoff and low infiltration. The 'poor' category, which represents moderate to severe slopes, runs from 11 to 18 degrees, whereas 'Very Poor' ARS category, which represents higher slope and greater runoff varies from 18 to 39 degrees (Figure 2b) (Basavarajappa et al. 2014).

3.2 Lithology

The lithology is primarily composed of metamorphic rocks of Precambrian age including Schist and Banded Gneissic complexes, which are the main water-bearing formations in the taluk. The geological structures are characterized by weathered and fractured schist, granite and granitic Gneiss, which influence groundwater occurrence under both water table and semiconfined conditions. Groundwater recharge is controlled by the geological and hydrological features of the aquifer system (CGWB, 2012; Manjunatha et al. 2019). Amphibolitic metapelitic schist/ pelitic schist and calc-silicate rock are widely exposed in the central and eastern regions within the vast agricultural land, whereas charnockite is observed at numerous locations within the forest zones. Migmatite, granodiorite and tonalitic gneisses are noticed to be widespread within the taluk. Alluvial soils are derived from the weathering of local rock formations which is noticed in southeastern parts of Hunsur (Figure 3a).

3.3 Geomorphology

The geomorphological features are characterized by a mix of hilly in the central part and plain regions in the surrounding with varied topography. The vast plain lands are suitable for land usage, including agriculture. A piedmont zone denotes regions where plains and hills meet, frequently producing distinctive soil and water dynamics. The study area is classified as dissected pediment, dyke ridge, linear ridge, pediment, pediment inselberg complex, moderately weathered pediplain, shallow buried pediplain, reservoir, residual hills, river/stream and valley fill shallow (Figure 3b) (Manjunatha and Basavarajappa, 2015). The Lakshmana Tirtha River flows eastward through plain to undulating regions before joining the Cauvery River at the Krishna Raja Sagar reservoir (Manjunatha et al. 2019). The water tables are comparatively shallow near the tributaries of Lakshmana Tirtha River and topographically low elevations (Basavarajappa et al. 2014).

Pediplain shallow is the most prominent feature mapped and linked to very good to moderate recharge zones whereas residual hills showed poor occurrences (Rajasekhar et al. 2021). Residual hills are composed of gneiss and schistose rocks which serve as runoff zones with poor recharge conditions (Manjunatha and Basavarajappa, 2015). Shallow valley fills are highly prospective whereas moderately weathered pediplain are very good to good recharge zones and considered to be the most favorable zones for groundwater prospects while pediplain shallow zones are good to moderate, pediment inselberg complex and pediment zones are moderate to poor and residual hills and inselbergs are regarded as poor to very poor recharge zones (Manjunatha and Basavarajappa, 2021b). River, streams and hills are unsuitable for ARS among the specified landforms (Basavarajappa et al. 2012).

3.4 Land-Use Land-Cover

Hunsur LULC patterns show its predominance in agriculture, forested areas, and growing urbanization (Figure 3c). Nearly 30% of the total land area is used for intensive agricultural practices, while more than 52% is made up of net sown area. Urbanization has been rapidly rising, as transportation and communication facilities have grown over time. About 7.9% of the land is covered with forests, which maintains ecological balance. The region is home to many lakes and tanks, which are essential for water management and irrigation supply. LULC is also a crucial factor in the site suitability analysis of ARS which have higher impacts due (Manjunatha et al. 2019) to the increased demands of expanding irrigational activities, demographic growth and climate change. Agricultural practices are noticed to be significantly impacted by LULC over the hydrologic condition at the surface and below ground level (Saraf and Choudhary, 1998). These are more soil fissures, and the soil is less compacted in agricultural croplands, which speeds up the rate of infiltration.

3.5 Lineaments Density (Ld)

These are important geological features that affect aquifer properties and groundwater flow. The lineaments are essentially fractures or faults in the rock formations that may serve as channels for water circulation. Lineament density can ultimately reveal the groundwater potential, since the existence of lineaments typically indicates a permeable zone (Rajasekhar et al. 2021). Lineament density (Ld) is generated digitally using LISS-III image by Line Density tool of ArcGIS software which ranges from 0.016 to 0.739 km/km^2 (Figure 3d) (Manjunatha and Basavarajappa, 2021b). Limited infiltrations are observed along the weak planes, hard and compact rocks which serve as run-off zones (Singhal and Gupta, 1999). More suitability for ARS is indicated by low Ld, whereas less suitability is indicated by very high Ld (Manjunatha and Basavarajappa, 2015).

3.6 Soil

Hunsur soil types majorly covers clayey and clayey skeletal (Figure 3e) and certain regions have red sandy loam soils, which are especially good for crops like tobacco. These soils are useful for agriculture since they are typically rich and have good moisture retention qualities. Clay soil is relatively deep, well drained and has a small amount of saline in its particles (Manjunatha and Basavarajappa, 2021b). Clay-Skeletal soil is quite deep, well-drained, and has minor erosion (CGWB, 2012). It relates to shallow to excessively drained, gravelly clay soil that is moderately degraded (CGWB, 2012).

3.7 Drainage Density (Dd)

The drainage system is well-developed and belongs to the Cauvery River Basin. It is classified as dendritic to sub-dendritic, and it typically occurs in regions with homogenous geological formations. The Lakshmana Tirtha River, a tributary of the Cauvery, flows east, providing water for drinking and cultivation. Altitude affects groundwater flow patterns and surface runoff. Drainage density is one of the essential criteria for site suitability study of ARS (Manjunatha et al. 2019), ranging from 0.230 to 1.307 km/km^2 (Figure 3f). Drainage density (Dd) is an important component in determining the travel duration by water in a terrain (Rajasekhar et al. 2021). High drainage density suggests narrow channel spacing, whereas low drainage density occurs in very resistant or permissible sub soil materials, dense vegetation and low relief (Manjunatha et al. 2019). Higher Dd suggests increased surface runoff, which makes ARS harder due to low infiltration; on the other hand, low Dd implies less surface runoff and is very appropriate.

3.8 Stream Orders

The taluk is drained by 1st to 4th order streams, indicating a hierarchical drainage system in which lower-order streams progressively converge to form higher-order channels (Figure 3g). These streams flow towards the central to southeast and north to center of the taluk, reflecting the terrain and geological structure of the area. The 1st order streams are critical for localized recharge, as their low flow volume allows more water to infiltrate into the soil and underlying aquifers, whereas 2nd to 4th order streams, which have higher flow volumes, primarily contribute to focused recharge riverbeds and floodplains (CGWB, 2022a).

3.9 Stream Orders Overlaid on Google Earth Image

Google Earth image provide advantages for overlaying stream patterns and assessing groundwater recharge potential through their high spatial resolution of 3mts (Dated: April 16th, 2024). Overlaying stream orders on Google Earth imagery improves artificial recharge planning and verification via ground truth checks (Figure 3i). AHP can use spatially weighted decisions to find the exact sites that are best suited for ARS.

4. Need of Artificial Recharge Structures

4.1 Groundwater Conditions and Demand

Between 2000-01 and 2013-14, cultivable land use grew from 14.22% to 21.42%, demonstrating a trend towards more intensive agricultural practices in Hunsur (CGWB, 2022a). Urbanization is slowly encroaching on agricultural covers, as witnessed in nearby taluk such as Mysuru (CGWB, 2022a). The reliance on surface water for irrigation emphasizes the vulnerability to rainfall fluctuation and associated water resource management issues. Hunsur irrigation is predominantly based on groundwater, with bore wells and wells providing around 29% of the net irrigated area, while surface water meets the majority irrigated needs. Many small irrigation tanks have dried up or deteriorated due to low rainfall and poor management. The current groundwater extraction rate is 45.25%, classifying it as safe (CGWB, 2022a).

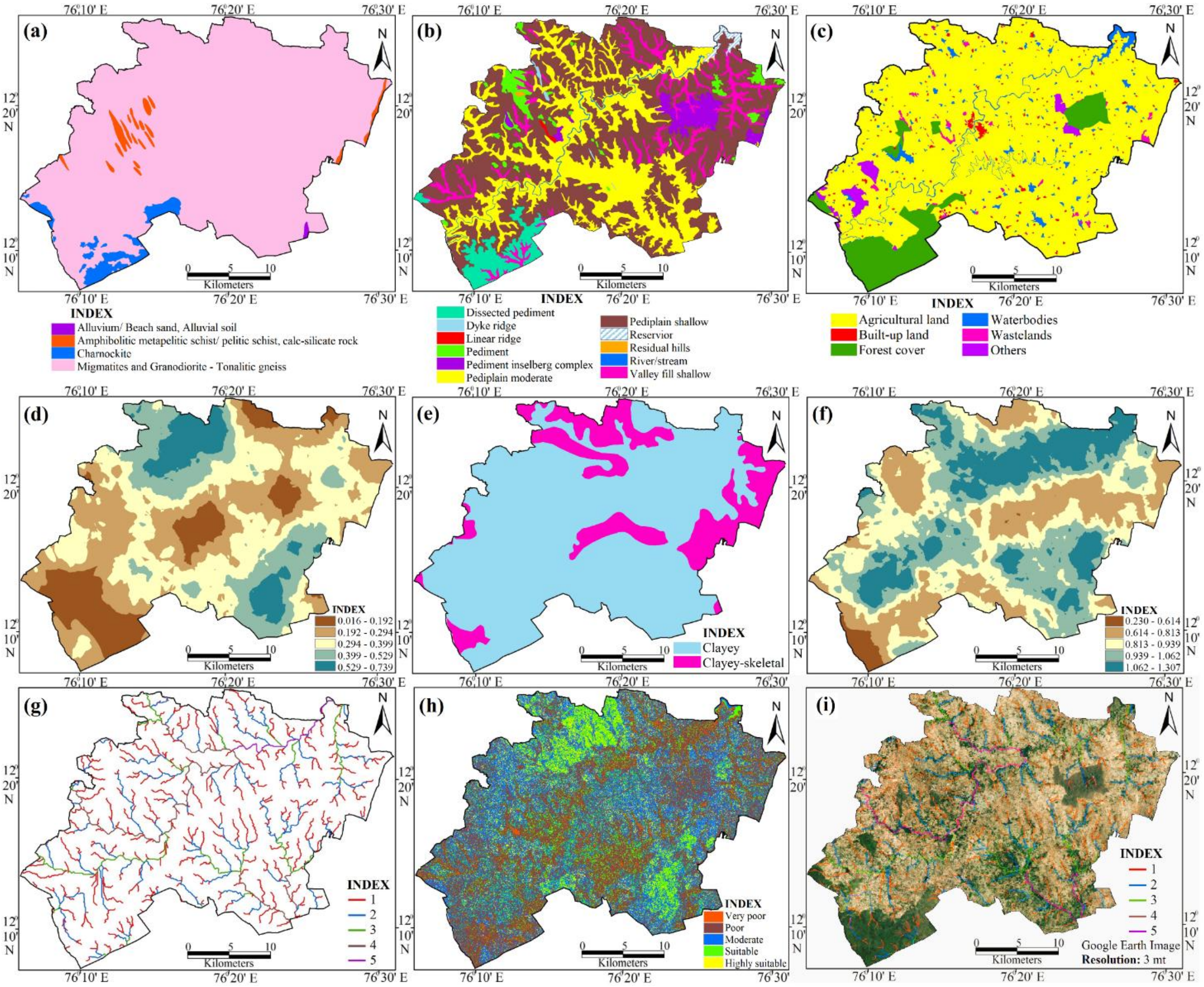

Figure 3: (a) Lithology, (b) Geomorphology, (c) Land Use Land Cover, (d) Lineament density, (e) Soil, (f) Drainage density, (g) Stream Orders, (h) Overlay Weightage, (i) Stream Orders overlaid on Google Earth Image of Hunsur Taluk

Table 1: Percentage of Influencing Factors Based on Saaty's Analytical Hierarchy Process (AHP)

Influencing factor	Saaty's scale (in fraction)	Saaty's scale (in decimal)	Percentage influence = (Saaty's scale/ sum * 100)	Relative influencing factor
Slope	1	1	38.71	39
Lithology	1/2	0.50	19.35	19
Geomorphology	1/3	0.33	12.77	13
Lineament density	1/4	0.25	9.67	10
Soil	1/5	0.20	7.74	8
Drainage density	1/6	0.16	6.19	6
Land use land cover	1/7	0.14	5.42	5
		Sum = 2.583		

Table 2: Assigned Weight According to Saaty's Analytical Hierarchy Process (AHP)

Influencing factor	Class intervals or features	Saaty's scale (in fraction)	Saaty's scale (in decimal)	Percentage influence = (Saaty's scale/sum * 100)	Relative influencing factor
Slope (in degrees)	0 – 3	1	1	43.85	44
	3 – 7	1/2	0.5	21.92	22
	7 – 11	1/3	0.33	14.47	14
	11 – 18	1/4	0.25	10.96	11
	18 – 39.71	1/5	0.20	8.77	9
			Sum = 2.28		
Lithology	Alluvial soil	1	1	42.91	43
	Amphibolitic metapelitic schist/ pelitic schist, calc-silicate rock	1/2	0.5	21.47	21
	Migmatites and granodiorite – tonalitic gneiss	1/2	0.5	21.47	21
	Charnockite	1/3	0.33	14.16	14
			Sum = 2.33		
Geomorphology	Pediment	1	1	19.76	20
	Pediment inselberg complex	1	1	19.76	20
	Dissected pediment	1/2	0.5	9.88	10
	Dyke ridge	1/2	0.5	9.88	10
	Linear ridge	1/2	0.5	9.88	10
	Pediplain moderate	1/3	0.33	6.52	7
	Pediplain shallow	1/3	0.33	6.52	7
	Residual hills	1/4	0.25	4.94	5
	Valley fill shallow	1/4	0.25	4.94	5
	Reservoir	1/5	0.20	3.95	4
	River/ stream	1/5	0.20	3.95	4
			Sum = 5.06		
Lineament density (Ld)	0.739 - 0.529	1	1	43.85	44
	0.529 - 0.399	1/2	0.5	21.92	22
	0.399 - 0.294	1/3	0.33	14.47	14
	0.294 - 0.192	1/4	0.25	10.96	11
	0.192 - 0.016	1/5	0.20	8.77	9
			Sum = 2.28		
Soil types	Clayey-skeletal	1	1	66.66	67
	Clayey	1/2	0.5	33.33	32

			Sum = 1.5		
Drainage density (Dd)	1.307 - 1.062	1	1	43.85	44
	1.062 - 0.939	1/2	0.5	21.92	22
	0.939 - 0.813	1/3	0.33	14.47	14
	0.813 - 0.614	1/4	0.25	10.96	11
	0.614 - 0.230	1/5	0.20	8.77	9
			Sum = 2.28		
Land Use Land Cover	Wastelands	1	1	43.85	44
	Agricultural lands	1/2	0.5	21.92	22
	Forest cover	1/3	0.33	14.47	14
	Water bodies	1/4	0.25	10.96	11
	Built-up land	1/5	0.20	8.77	9
			Sum = 2.28		

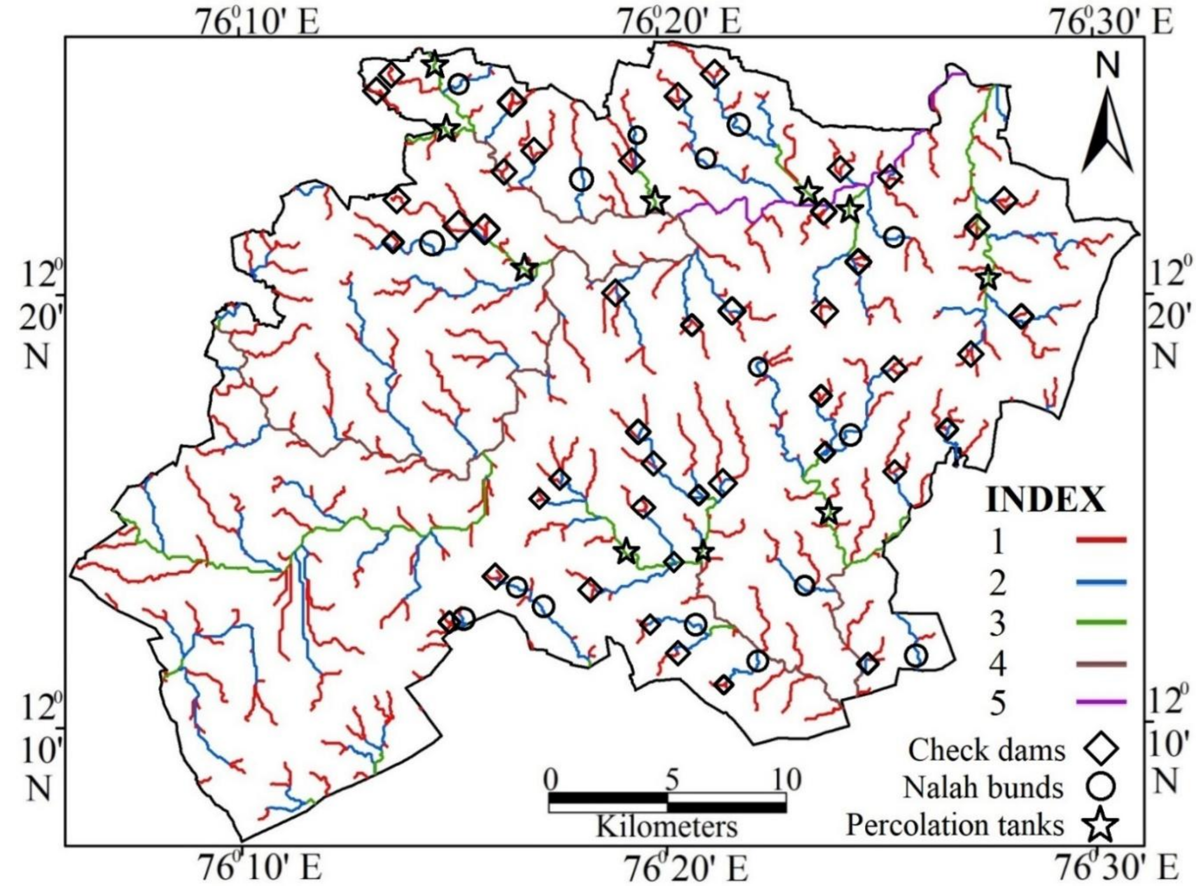

Figure 4: Final output map to implement ARS for Hunsur Taluk

However, this classification does not take into consider future demands owing to rapid industrialization, urbanization, global warming, increased demand of groundwater for agricultural and irrigational activities and other factors.

4.2 Overlay Weightage Analysis for ARS

The AHP is a multi-criteria decision-making technique (Prapanchan et al. 2024) utilized in the present study to select suitable ARS locations that includes pair-wise comparisons of factors. AHP entails selecting characteristics that influence groundwater recharge zones, such as slope, lithology, geomorphology, land use land cover, lineament density, soil, drainage density

(Prapanchan et al. 2024), stream orders in a hierarchy manner. The relative importance of each parameter for recharge was compared to other parameters using a pairwise comparison matrix, which reflected each factor's influence on groundwater recharge (Figure 3h). A variety of ARS types, including check dams, nalah bunds and percolation tanks could be used to replenish groundwater in Hunsur taluk. These structures were efficient rainwater storage techniques, particularly for agricultural practice such as Hunsur, which rely heavily on rainfall. This is a sustainable groundwater augmentation approach, especially during lean seasons.

Check dams are small, low-cost and effective ARS that contribute significantly to increased groundwater storage, improved water quality, and sustainable water resources management. This also lowers soil erosion by building a series of check dams to channel water over wider regions (Manjunatha, 2024). These small dams must be built near crop types with the most potential for improved harvest water allocation (Manjunatha, 2024). The gentler slopes of 1st and 2nd stream orders are ideal for these structures (Figure 4). They hold runoff water, most of which is limited to a stream channel less than 2m above ground level (Manjunatha, 2024).

Nalah bunds are small earthen dams that serve as mini percolation tanks (Manjunatha and Basavarajappa, 2021b). This should preferably be positioned on contours or graded bunding has occurred. These are best suited for larger 2nd order streams with gentler slopes (Figure 4). The catchment areas should get less than 1000mm of rainfall per year, and the soil in the bund downstream should be susceptible to waterlogging (Rajasekhar et al. 2021).

Percolation tanks are the finest conventional form of groundwater recharging, particularly in India's hard rock terrain such as Hunsur taluk (CGWB, 2000). These are intentionally managed surface water on permeable areas that are observed parallel to the streams (Manjunatha, 2024) to obtain maximum percolation while minimizing evaporation losses. Small streams with gentler slopes of 3 to 7 degrees are most suited for these tanks (Figure 4), which retain monsoon runoff from bigger areas of soil types with moderate to higher pores/ voids (Manjunatha, 2024). Nalah bunds are small earthen dams that are 2 to 3 m high, 1 to 3 m wide and 10 to 15 m long which are typically used as mini percolation tanks (Manjunatha, 2024). These are best suited to bigger streams with gentler slopes and contour/ graded bunding areas that get less than 1000mm of yearly rainfall and are susceptible to waterlogging (CGWB, 2007; 2012).

5. Discussions

With India's population expected to continue to grow, the demand for water will rise, compounding existing pressures on groundwater resources. Climate induced changes in rainfall patterns pose new challenges for groundwater recharge. Although monsoon rainfall contributes significantly to recharging, unpredictability can result in periods of surplus and deficit water availability. Water demand is expected to increase by about 1% annually over the next three decades, exacerbating existing constraints on groundwater supplies if not effectively managed. This demands immediate effort to establish sustainable management techniques. While appropriate practices exist, there is a need for enhanced rainwater harvesting infrastructure as well as better monitoring systems to accurately measure groundwater levels.

Hunsur taluk has about 71.11 million cubic meters (MCM) of non-committed monsoon runoff that can be efficiently harnessed using ARS such as check dams, nalah bunds and percolation tanks. The expected recharge from these actions is 53.33 MCM, which creates additional irrigation potential. Agriculture significantly relies on irrigation, with surface water accounting for roughly 71% and groundwater for approximately 29% of the irrigated land. Artificial recharge can boost agricultural productivity by providing a consistent water supply. Continuous extraction may cause a reduction in water table levels, increasing farmer's expenses as they drill deeper wells. Groundwater quality is also a concern, with reports of nitrate pollution in several parts in Hunsur taluk, which can be attributed to agricultural runoff and poor sanitation practices. The limited thickness of aquifers, as well as their compaction as a result of excessive removal, pose a threat to the long-term sustainability of groundwater resources. As aquifers deplete, their ability to recharge decreases, resulting in a cycle of declining availability.

The major gneissic complex (granitic gneiss, schist) and charnockite formations have low primary porosity but increase secondary porosity through weathering and fracturing. Lineaments running NNE-SSW along the Lakshmana Tirtha River are predicted to yield greater. Check dams (44) nalah bunds (16) and percolation tanks (10) were identified as effective ARS sites for Hunsur taluk utilizing the AHP in GIS platform. These structures also serve to mitigate future water crisis caused by global warming, industrial and agricultural water needs.

The government of India has initiated various efforts intended at enhancing groundwater recharge and management, including the Atal Bhujal Yojana (2020), Jal Shakti Abhiyan (2019), National Aquifer Mapping (NQUIM), and Master plans for Artificial Recharge for taluk-level studies. These stress a nationwide push for groundwater conservation, sustainability and successful strategies through rainwater harvesting and dry lake restoration. Improving ARS and promoting sustainable agriculture practices would assist recharge aquifers, maintain water levels, and reduce groundwater overexploitation.

5.1 Society Impact of Groundwater Augmentation in Hunsur Taluk

Hunsur taluk in Mysuru district, India is largely dependent on groundwater for irrigation, domestic supply, and livestock needs, making groundwater sustainability a critical socio-economic concern. Increasing groundwater levels and borewell failures, which directly affect farmer's livelihoods and rural water security (Rodell et al. 2009; CGWB, 2022b). Geospatial techniques play a vital role in identifying suitable zones for groundwater augmentation by integrating hydrogeological, geomorphological, and land-use parameters. Such spatially informed planning supports the construction of recharge structures including check dams, percolation tanks, and recharge pits, which enhance aquifer recharge and improve groundwater availability (Jha et al. 2007; Machiwal and Jha, 2015). Improved groundwater recharge contributes to agricultural stability, ensures reliable drinking water supply for rural communities, and reduces vulnerability to drought and climate variability (FAO, 2018). Furthermore, groundwater augmentation has broader societal benefits by strengthening rural livelihoods and reducing economic distress among farmers. Sustainable groundwater management also supports ecosystem balance and long-term environmental sustainability in groundwater-dependent landscapes (Gleeson et al. 2012). Therefore, geospatially guided groundwater augmentation in Hunsur taluk can significantly enhance water security, agricultural resilience, and socio-economic stability in the region.

6. Conclusions

Hunsur is known for its diversified topography, semi-arid climate, substantial hydrological features, and excellent fertile soils. Combining GIS and AHP offers a robust approach to identifying optimal locations for ARS in Hunsur taluk. This integrated strategy ensures that decisions are made using both spatial analysis and multi-criteria evaluation, increasing the effectiveness of groundwater management. Artificial recharge can improve aquifer sustainability by increasing storage, diluting impurities, lowering reliance on groundwater and meeting agricultural and domestic needs in Hunsur taluk. These strategies will provide sustainable water management and long-term resistance to climate unpredictability and over extraction concerns.

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