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Distribution and Management of Water Resources in Haryana: A Geographical Study

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Abstract

Water is the most critical natural resource governing the agricultural economy, settlement pattern, and ecological balance of Haryana, a predominantly agrarian state located in the semi-arid to sub-humid climatic zone of north-western India. The state's water resources comprise surface water carried by the Yamuna and Ghaggar rivers and an extensive network of canals, together with groundwater accessed through tube wells and dug wells. This paper undertakes a geographical examination of the spatial distribution, availability, and utilisation pattern of water resources across the districts of Haryana, and critically evaluates the institutional and technical measures adopted for their management. The study highlights a pronounced regional imbalance: canal-irrigated north-eastern districts such as Karnal, Kurukshetra, and Yamunanagar face waterlogging and salinity, whereas groundwater-dependent south-western and Aravalli-fringe districts such as Mahendragarh, Bhiwani, Gurugram, and Charkhi Dadri are experiencing rapid aquifer depletion, with water tables falling below forty metres in several blocks. The paper further reviews management interventions, including canal lining, micro-irrigation promotion, the Atal Bhujal Yojana, and water-use regulation, and argues for an integrated, basin- and block-level approach to water governance that reconciles agricultural demand with long-term sustainability.

Keywords: *Haryana, water resources, groundwater depletion, canal irrigation, spatial distribution, water management*

1. Introduction

Haryana, carved out of the composite state of Punjab in 1966, occupies an area of about 44,212 square kilometres in the north-western part of the Indo-Gangetic plain. The state's economy and settlement geography are overwhelmingly shaped by the availability of water, since more than seventy per cent of its population continues to depend, directly or indirectly, on agriculture. Physiographically, Haryana can be divided into the Shivalik foothill zone in the north, the flat alluvial plain drained by the Yamuna and Ghaggar rivers in the centre and east, and the semi-arid sandy tract merging into the Aravalli hills in the south and south-west. This physiographic diversity, combined with a sharp east-to-west gradient in rainfall (from over 1,100 mm in the sub-mountainous north to less than 350 mm in the arid south-west), produces marked spatial variation in the natural endowment of water.

Unlike most other natural resources, water is renewable but finite in any given time and space, which makes its rational distribution and management a matter of geographical as well as developmental significance. In Haryana, the Green Revolution of the 1960s and 1970s, coupled with the expansion of canal networks and free or heavily subsidised electricity for tube wells, encouraged water-intensive cropping patterns dominated by paddy and wheat. Over time this has produced two contrasting but equally serious problems: waterlogging and soil salinity in

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canal-command areas of the north and east, and severe groundwater depletion in the tube-well-dependent tracts of the south and south-west. A geographical study of these patterns is therefore essential for identifying region-specific strategies of water conservation and equitable distribution.

This paper aims to (i) examine the major sources and spatial distribution of surface and groundwater resources in Haryana, (ii) analyse inter-district variations in water availability and stress, (iii) identify the key challenges confronting water management in the state, and (iv) evaluate the policy and institutional measures adopted to address these challenges. The study is based on secondary data drawn from government reports, including those of the Central Ground Water Board, the Haryana Water Resources Authority, and published research literature.

2. Sources and Distribution of Water Resources in Haryana

The water resources of Haryana can be broadly classified into surface water and groundwater resources. Surface water is drawn mainly from the Yamuna river along the state's eastern boundary and, to a much smaller extent, from the seasonal Ghaggar river in the north. These rivers feed a dense network of canals, of which the Western Yamuna Canal and the Bhakra canal system are the most important, supplemented by lift irrigation schemes such as the Jui, Siwani, Loharu, and Jawaharlal Nehru lift canal systems that serve the relatively elevated south-western districts of Bhiwani, Charkhi Dadri, Rewari, Jhajjar, and Mahendragarh.

Groundwater constitutes the second major source and has, over the past four decades, emerged as the dominant source of irrigation. The area irrigated by tube wells increased manifold between 1980-81 and 2017-18, even as the area under canal irrigation gradually declined, reflecting both the unreliability of canal water supply in tail-end areas and the ease of access to subsidised electric tube wells. However, the state's total water requirement for irrigation is estimated at close to twenty million acre-feet, while surface water availability meets only a small fraction of this demand, placing the remaining burden almost entirely upon groundwater aquifers.

Table 1: Region-wise Distribution of Water Resources in Haryana

Region	Representative Districts	Dominant Water Source	General Characteristic
North-Eastern Plain	Yamunanagar, Kurukshetra, Karnal, Panipat, Ambala	Canal irrigation (Yamuna & Bhakra system)	High rainfall, shallow water table; risk of waterlogging and salinity

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Central Plain	Rohtak, Sonipat, Jhajjar, Panipat	Canal supplemented by groundwater	Fertile alluvial soils; localised waterlogging
South-Eastern (Aravalli-fringe)	Gurugram, Faridabad, Palwal, Nuh	Groundwater (tube wells)	Rapid urbanisation pressure; falling water table
South-Western Semi-Arid	Mahendragarh, Bhiwani, Charkhi Dadri, Rewari	Groundwater and lift canal schemes	Low rainfall; deep and saline groundwater; high stress
Western Sandy Tract	Hisar, Sirsa, Fatehabad, Jind	Canal (Bhakra system) and groundwater	Sandy soils; moderate to high groundwater extraction

Source: Compiled by author from Haryana Water Resources Authority, Integrated Water Resources Plan Haryana 2023–2026, and Central Ground Water Board reports.

3. Regional Disparities and Groundwater Stress

One of the most striking geographical features of Haryana's water scenario is the sharp contrast between water-surplus and water-deficit regions occurring within a relatively small area. According to groundwater level assessments, a substantial number of villages in the state fall in the severely stressed category, with water levels deeper than thirty metres below ground level, while several hundred villages face moderate stress. At the same time, canal-irrigated districts of the north and east suffer from the opposite problem of waterlogging caused by seepage from unlined canals and over-irrigation, which in turn aggravates soil salinity and reduces agricultural productivity.

Central Ground Water Board data indicate that groundwater levels have declined in the majority of Haryana's districts over the last two decades, with the steepest fall recorded in Ambala, Kaithal, and Karnal, even though these are canal-served districts, underscoring that canal supply alone does not guarantee groundwater sustainability when extraction for water-intensive crops continues unabated. Out of the state's blocks assessed by the Central Ground Water Board, a large proportion have been categorised as over-exploited or critical, particularly in the southern and south-western parts of the state.

Table 2: Groundwater Stress Categories in Haryana (based on CGWB block assessment)

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Category	Approx. No. of Blocks/Villages Affected	Representative Districts	Depth Range
Severely Stressed / Over-exploited	≈1,948 villages	Mahendragarh, Bhiwani, Charkhi Dadri, Gurugram, Kaithal, Kurukshetra, Panipat	> 30 m bgl
Moderately Stressed / Critical	≈1,093 villages	Sirsa, Faridabad, Palwal, Mewat	20.01–30.00 m bgl
Potentially Waterlogged	Selected village clusters	Rohtak, Sonipat, Jhajjar	1.51–3.00 m bgl
Safe / Semi-Critical	Remaining blocks	Parts of Ambala, Panchkula, Yamunanagar	Variable, generally shallow

Source: Adapted from Central Ground Water Board reports and Integrated Water Resources Plan, Haryana (2023–2026); figures are indicative and based on assessment years cited in cited reports.

4. Key Issues in Water Resource Management

- Over-extraction of groundwater due to free or heavily subsidised agricultural electricity, encouraging cultivation of water-guzzling crops such as paddy in naturally water-scarce tracts.
- Seepage losses from unlined canal networks, leading to waterlogging and secondary salinisation in the command areas of Rohtak, Sonipat, and Jhajjar.
- Inequitable distribution of canal water between head-reach and tail-end areas, pushing tail-end farmers towards greater dependence on tube wells.
- Deteriorating groundwater quality, with high salinity and fluoride/nitrate contamination reported in districts such as Nuh, Jind, Hisar, and Rohtak.
- Rapid urban and industrial growth in the National Capital Region districts (Gurugram, Faridabad), intensifying competition between domestic, industrial, and agricultural water demand.
- Inadequate adoption of micro-irrigation (drip/sprinkler) technologies despite their proven water-saving potential in the semi-arid south-western districts.

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5. Water Management Measures and Policy Interventions

Recognising the gravity of the water crisis, the Government of Haryana and the Government of India have initiated several measures aimed at both augmenting supply and rationalising demand. These range from engineering interventions such as canal lining and check-dam construction to institutional reforms such as the creation of the Haryana Water Resources Authority for integrated basin-level planning, and demand-side interventions such as crop diversification incentives under the 'Mera Pani, Meri Virasat' scheme, which offers financial incentives to farmers who shift from paddy to less water-intensive crops.

Table 3: Major Water Management Initiatives in Haryana

Initiative / Scheme	Implementing Agency	Primary Objective
Atal Bhujal Yojana (Atal Jal)	Central Government with State Irrigation Department	Community-led sustainable management of groundwater in over-exploited blocks
Mera Pani, Meri Virasat	Haryana Agriculture Department	Incentivise crop diversification away from paddy to conserve groundwater
Integrated Water Resources Plan (2023–2026)	Haryana Water Resources Authority	Basin-level planning, demand-supply balancing, and stress-zone mapping
Canal Lining and Modernisation Programme	Irrigation and Water Resources Department	Reduce seepage losses and control waterlogging in canal-command areas
Micro-Irrigation Promotion (drip/sprinkler subsidy)	Department of Agriculture & Farmers' Welfare	Improve water-use efficiency in groundwater-stressed districts
Pond and Water Body Rejuvenation Mission	Rural Development & Panchayati Raj Department	Rainwater harvesting and recharge through revival of village ponds

Source: Compiled by author from Haryana Water Resources Authority and Government of Haryana departmental reports.

While these initiatives represent important steps, their impact remains geographically uneven. Canal lining and drainage works have progressed faster in politically and agriculturally prominent districts, whereas groundwater recharge and micro-irrigation adoption remain

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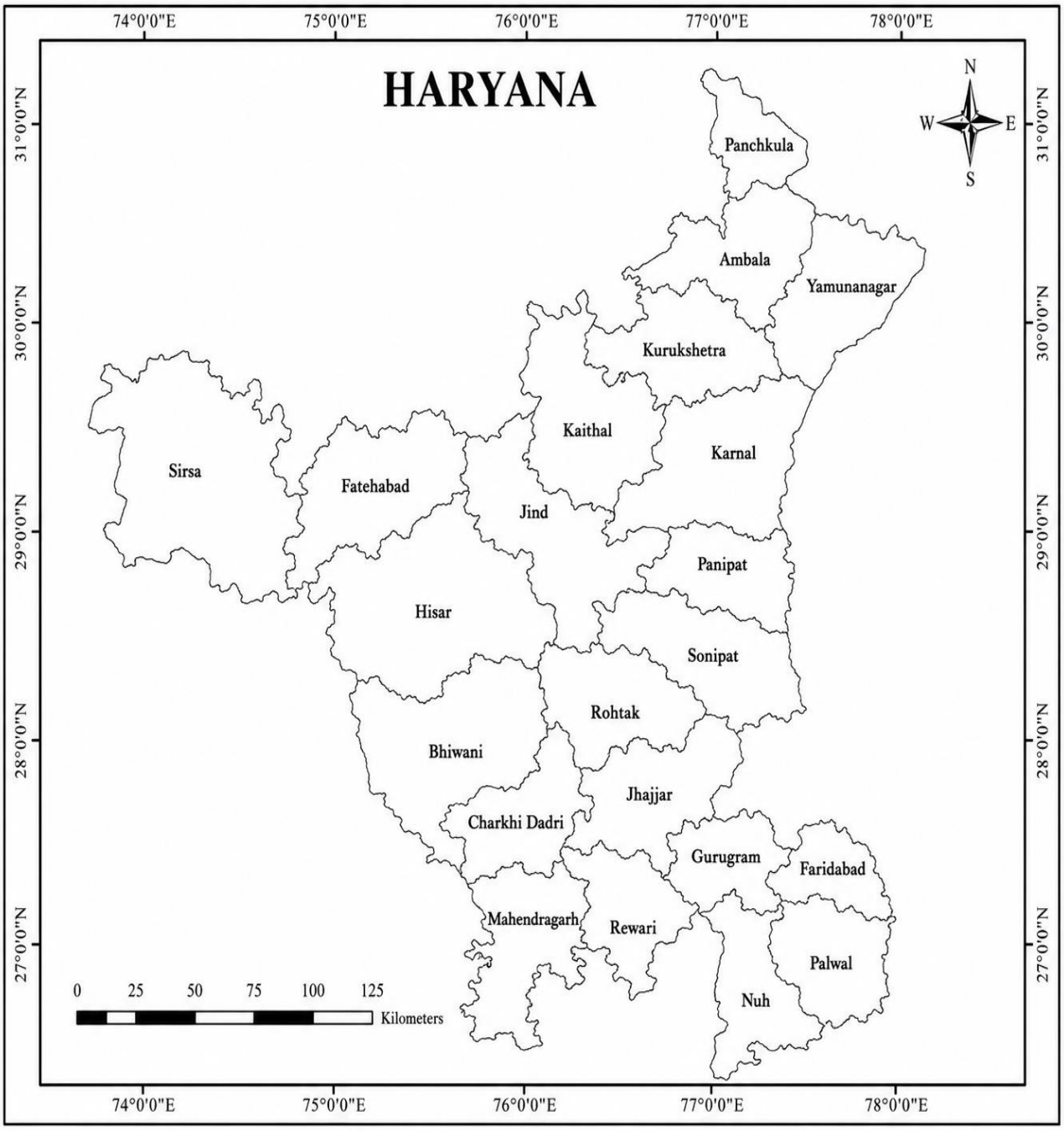
limited in the most stressed south-western blocks. This suggests that the success of water management policy in Haryana depends not merely on the design of schemes but on their spatially differentiated implementation, tailored to the specific hydro-geographical conditions of each region.

Map 1: Location of the Study Area



Study Area

The present study is based on Haryana, a north-western state of India situated in the Indo-Gangetic plain. Haryana was carved out of the composite state of Punjab in 1966 and covers

an area of about 44,212 square kilometres. The state has a predominantly agrarian economy, where water resources play a crucial role in shaping agricultural practices, settlement patterns, regional development and ecological balance. Due to its semi-arid to sub-humid climatic conditions, Haryana presents a significant case for the geographical study of water distribution and management. Physiographically, Haryana may be divided into three broad regions. The northern part consists of the Shivalik foothill zone, while the central and eastern parts form a flat alluvial plain drained mainly by the Yamuna and Ghaggar river systems. The southern and south-western parts gradually merge into the semi-arid sandy tract and the Aravalli-fringe region. This physiographic diversity creates considerable variation in the availability and use of water resources across the state. The rainfall pattern also shows a clear regional gradient, ranging from more than 1,100 mm in the sub-mountainous northern areas to less than 350 mm in the arid south-western districts. The major sources of water in Haryana are surface water and groundwater. Surface water is mainly supplied by the Yamuna River along the eastern boundary of the state and by the seasonal Ghaggar River in the north. These rivers support an extensive canal network, including the Western Yamuna Canal and the Bhakra canal system. In addition, lift irrigation schemes such as the Jui, Siwani, Loharu and Jawaharlal Nehru lift canal systems serve the relatively elevated and water-scarce districts of Bhiwani, Charkhi Dadri, Rewari, Jhajjar and Mahendragarh. Groundwater, accessed mainly through tube wells and dug wells, has become an important source of irrigation, especially in areas where canal supply is inadequate or unreliable.

On the basis of water availability and dominant source of irrigation, Haryana can be divided into distinct water-resource regions. The north-eastern plain, including Yamunanagar, Kurukshetra, Karnal, Panipat and Ambala, receives relatively higher rainfall and is largely supported by canal irrigation through the Yamuna and Bhakra systems. However, shallow water table conditions in this region have led to problems such as waterlogging and soil salinity. The central plain, including Rohtak, Sonipat, Jhajjar and parts of Panipat, depends on both canal irrigation and groundwater. This region has fertile alluvial soils, but selected areas also face localised waterlogging due to canal seepage and over-irrigation. The south-eastern Aravalli-fringe region, covering Gurugram, Faridabad, Palwal and Nuh, is mainly dependent on groundwater. Rapid urbanisation and industrial growth in this region have increased pressure on available water resources. The south-western semi-arid region, including Mahendragarh, Bhiwani, Charkhi Dadri and Rewari, experiences low rainfall, deep groundwater levels and high groundwater stress. In many areas, groundwater is saline and unsuitable for extensive agricultural use. The western sandy tract, including Hisar, Sirsa, Fatehabad and Jind, depends on the Bhakra canal system as well as groundwater, but sandy soils and rising extraction have created problems of water-resource sustainability. Thus, Haryana represents a region of sharp spatial contrasts in water availability and water-related problems. While the canal-irrigated north-eastern and central parts face issues of waterlogging and salinity, the south-western and Aravalli-fringe districts experience groundwater depletion and scarcity.

6. Conclusion

The geographical study of water resources in Haryana reveals a state characterised by acute spatial contrast: regions of surplus and waterlogging coexisting with regions of severe scarcity and aquifer depletion, often within a distance of a few hundred kilometres. This paradox is rooted in the interaction between the state's physiography and rainfall gradient on one hand, and its cropping pattern, irrigation infrastructure, and energy-pricing policies on the other. Canal-command districts in the north and east continue to struggle with seepage-induced waterlogging and salinity, while the semi-arid south and south-west face a rapidly deepening groundwater crisis that threatens the long-term sustainability of agriculture in the region.

Effective and equitable management of Haryana's water resources requires a shift from source-specific, sector-specific interventions towards an integrated, block- and basin-level approach that combines supply-side measures (canal lining, water-body rejuvenation, artificial recharge) with demand-side reforms (crop diversification, rationalised power pricing, and micro-irrigation). Geographical analysis, by mapping the precise spatial pattern of availability, stress, and use, has an important role to play in guiding such region-specific policy design, ensuring that scarce water resources are directed to where they are most needed and used most efficiently.

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