

# Water Resource Management in Haryana

Challenges and Prospects

Himanshu Grover  
Priyanka Rani

# Water Resource Management in Haryana: Challenges and Prospects

**Himanshu Grover**

GDC Memorial College, BRCM Vidyagram Campus, Bahal,  
Haryana, India

**Priyanka Rani**

GDC Memorial College, BRCM Vidyagram Campus, Bahal,  
Haryana, India



**DeepScience**

*Published, marketed, and distributed by:*

Deep Science Publishing, 2025  
USA | UK | India | Turkey  
Reg. No. MH-33-0523625  
www.deepscienceresearch.com  
editor@deepscienceresearch.com  
WhatsApp: +91 7977171947

ISBN: 978-93-7185-875-5

E-ISBN: 978-93-7185-134-3

<https://doi.org/10.70593/978-93-7185-134-3>

Copyright © Himanshu Grover, Priyanka Rani, 2025.

**Citation:** Grover, H., & Rani, P. (2025). *Water Resource Management in Haryana: Challenges and Prospects*. Deep Science Publishing. <https://doi.org/10.70593/978-93-7185-134-3>

This book is published online under a fully open access program and is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International License (CC BY-NC 4.0). This open access license allows third parties to copy and redistribute the material in any medium or format, provided that proper attribution is given to the author(s) and the published source. The publishers, authors, and editors are not responsible for errors or omissions, or for any consequences arising from the application of the information presented in this book, and make no warranty, express or implied, regarding the content of this publication. Although the publisher, authors, and editors have made every effort to ensure that the content is not misleading or false, they do not represent or warrant that the information-particularly regarding verification by third parties-has been verified. The publisher is neutral with regard to jurisdictional claims in published maps and institutional affiliations. The authors and publishers have made every effort to contact all copyright holders of the material reproduced in this publication and apologize to anyone we may have been unable to reach. If any copyright material has not been acknowledged, please write to us so we can correct it in a future reprint.



**Dr. Himanshu Grover** is a Hydro-Geographer and Assistant Professor at GDC Memorial College, BRCM Vidyagram Campus, Bahal, Haryana, specializing in Groundwater Resource Assessment and Modelling. He earned his Ph.D. and Master's Degree from Punjabi University, Patiala. With 8 years of teaching and research experience, his academic work spans groundwater quality assessment, trend analysis, groundwater potential zonation, agricultural sustainability, policy planning, and geospatial technologies. He has participated in over 130 academic events, published 18 research papers, authored 4 edited books, and holds 5 design patents, reflecting his strong academic and innovative contributions. Dr. Grover has also received a Best Research Paper Presentation Award at an international conference and has successfully organized seven academic events at institutional and national levels. As the coordinator of the IIRS Outreach Programme, he has completed several certifications from IIRS, Dehradun. Alongside academic pursuits, he actively contributes to social welfare and community engagement through his roles in the National Service Scheme (NSS) and the Eco Club.



**Ms. Priyanka Rani** is an Assistant Professor of Geography at GDC Memorial College, BRCM Vidyagram Campus, Bahal, Haryana, with six years of enriching teaching experience. She is the author of two books and has actively participated in more than 15 national and international conferences, contributing to academic dialogues at various platforms. She also serves as an IGNOU Academic Counsellor and holds an International UK Design Patent, reflecting her innovative and multidisciplinary approach to research. With four research papers published in reputed journals, she continues to strengthen her academic profile through quality scholarship. Her areas of specialization include Sustainable Agriculture, Water Resource Management, and Urban Geography. She is deeply committed to promoting environmental sustainability and integrating geographical knowledge with real-world applications. Through her teaching, research, and academic engagements, she strives to inspire students and contribute to the advancement of geographic studies.

# Preface

---

Human life is non-existent without water. In a state like Haryana, where agriculture plays a vital role in the economy, groundwater serves as a vital lifeline. The state faces increasingly serious challenges such as water scarcity, excessive water extraction, water quality degradation, and inequitable distribution. Recognizing the need to address these issues, we were inspired to write "Water Resource Management in Haryana: Challenges and Prospects."

This book attempts to present a comprehensive and analytical overview of Haryana's current water situation, emerging challenges, and potential strategies for sustainable water management. This book will provide readers with a holistic view of groundwater and surface water dynamics in the region.

We hope this book will inspire further research on sustainable water governance in Haryana..

# Acknowledgements

---

We, **Dr. Himanshu Grover** and **Ms. Priyanka Rani**, authors of the book *Water Resource Management in Haryana: Challenges and Prospects*, express our deepest gratitude to all those who have contributed to the successful completion of this work.

First and foremost, we extend our sincere thanks to **Dr. S. K. Sinha**, Principal, **GDC Memorial College, Bahal**, for his continuous support, encouragement, and academic guidance. His visionary leadership and motivation provided us with a nurturing environment to conceptualize and complete this book.

We are also grateful to the **Department of Geography, GDC Memorial College**, for providing the necessary academic resources, research facilities, and an inspiring atmosphere for scholarly work. Our heartfelt appreciation goes to our colleagues for their cooperation and constructive suggestions throughout the writing process.

We acknowledge the valuable inputs of researchers, academicians, and students whose insights strengthened the content and direction of this book. We also thank the various governmental and non-governmental agencies whose data and reports have enriched our understanding of water resource issues in Haryana.

Lastly, we extend our gratitude to our families for their unwavering support, patience, and encouragement during the preparation of this book.

This book is a result of collective efforts, and we are sincerely thankful to everyone who contributed, directly or indirectly.

**Dr. Himanshu Grover & Ms. Priyanka Rani**

*GDC Memorial College, Bahal (Haryana)*

# Table of Content

---

## **Chapter 1: Introduction to Water Resources in Haryana -----1**

### **1.1. Geographical and Climatic Profile of Haryana**

1.1.1. Topography, Agro-Ecological Zones, and Soil Profile

1.1.2. Rainfall Patterns and Distribution (Historical Trends)

### **1.2. Water Resource Endowment: Surface Water**

1.2.1. Major River Systems (Yamuna and Ghaggar-Hakra)

1.2.2. The Role and Extent of Canal Networks (Bhakra and Western Yamuna Canal Systems)

1.2.3. Inter-State Water Sharing Issues (Focus on the SYL Canal Dispute)

### **1.3. Water Resource Endowment: Groundwater**

1.3.1. Hydrogeological Characteristics of the State

1.3.2. History of Groundwater Exploitation (Post-Green Revolution Scenario)

### **1.4. Water Demand Across Sectors**

1.4.1. Agricultural Water Demand (Irrigation)

1.4.2. Domestic and Urban Water Demand

1.4.3. Industrial Water Demand and Future Projections

## **Chapter 2: The Alarming State of Groundwater Depletion-----23**

### **2.1. Quantitative Assessment of Groundwater Stress**

2.1.1. Annual Recharge vs. Annual Extraction Data

2.1.2. Stage of Groundwater Extraction (SoE) Analysis (135%+ Extraction Rate)

2.1.3. Categorization of Blocks: Overexploited, Critical, and Semi-critical Zones (Red Zone Analysis)

### **2.2. Drivers of Groundwater Overexploitation**

2.2.1. The Paddy-Wheat Cropping Cycle (Water-intensive Agriculture)

2.2.2. Subsidized Electricity and Unregulated Borewell Proliferation

2.2.3. Market Price Support (MSP) and its Impact on Crop Choices

### **2.3. District-wise Case Studies of Depletion**

2.3.1. High-Stress Districts (Kurukshetra, Kaithal, Karnal, Ambala)

2.3.2. Urban-Industrial Stress Zones (Gurgaon, Faridabad, Panipat)

## **Chapter 3: The Dual Water Challenge: Waterlogging and Pollution---53**

### **3.1. Groundwater Quality Concerns**

3.1.1. Nitrate and Fluoride Contamination in Aquifers

3.1.2. Saline Water Intrusion and Secondary Salinization

### **3.2. The Problem of Waterlogging (The Rising Water Table)**

3.2.1. Causes of Waterlogging in Southern and Western Districts (Rohtak,

Jhajjar)

3.2.2. Impact on Soil Fertility and Agricultural Productivity

### **3.3. Management of Wastewater and Industrial Effluents**

3.3.1. Sewage Generation and Treatment Capacity Gaps

3.3.2. Non-Compliance and Discharge of Untreated Water into Water Bodies

## **Chapter 4: Policy Frameworks and Institutional Structures-----77**

### **4.1. Key Policy Interventions in Haryana**

4.1.1. The Haryana Water Resources (Conservation, Regulation and Management) Authority (HWRA) Act, 2020

4.1.2. Integrated Water Resources Action Plan (IWRAP) 2025–2027

### **4.2. Government Schemes for Conservation and Recharge**

4.2.1. Mera Pani Meri Virasat Scheme (Incentivizing Crop Diversification)

4.2.2. Atal Bhujal Yojana and the Role of Community Participation

4.2.3. Jal Shakti Abhiyan Initiatives for Rainwater Harvesting

### **4.3. Role of Infrastructure Modernization**

4.3.1. Canal Lining and Modernization Projects (e.g., JLN Feeder Canal)

4.3.2. Development of the Treated Wastewater (TWW) Reuse Policy

4.3.3. Water Budgeting and Real-Time Monitoring (Piezometers and Telemeters)

## **Chapter 5: Technological and Sustainable Solutions-----88**

### **5.1. Water Use Efficiency in Agriculture**

5.1.1. Adoption and Economic Viability of Drip and Sprinkler Irrigation

5.1.2. Promotion of Direct Seeded Rice (DSR) and other Water-Saving Methods

5.1.3. Shift to Low-Water Consuming Crops (Pulses, Millets, Oilseeds)

### **5.2. Artificial Groundwater Recharge Techniques**

5.2.1. Construction of Check Dams, Percolation Ponds, and Recharge Wells

5.2.2. Utilizing Floodplains and River Beds for Natural Recharge

### **5.3. Urban and Industrial Water Management**

5.3.1. Mandatory Rooftop Rainwater Harvesting in Urban Settlements

5.3.2. Strategies for Zero Liquid Discharge (ZLD) in Water-Intensive Industries

5.3.3. Recycling and Reuse of Treated Wastewater for Non-Potable Uses



## References

- Agarwal, A., & Narain, S. (1997). *Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems*. Centre for Science and Environment.
- Aggarwal, P. K., Joshi, P. K., Ingram, J. S. I., & Gupta, R. K. (2004). Adapting food systems of the Indo-Gangetic plains to global environmental change: Key information needs to improve policy formulation. *Environmental Science & Policy*, 7(6), 487-498.
- Ahmed, S., & Rao, K. V. (2016). Groundwater dynamics and management in India: Challenges and opportunities. *Journal of Water Resource and Protection*, 8(3), 351-362.
- Amarasinghe, U. A., Sharma, B. R., Aloysius, N., Scott, C., Smakhtin, V., & de Fraiture, C. (2005). *Spatial variation in water supply and demand across river basins of India*. International Water Management Institute.
- Asoka, A., Gleeson, T., Wada, Y., & Mishra, V. (2017). Relative contribution of monsoon precipitation and pumping to changes in groundwater storage in India. *Nature Geoscience*, 10(2), 109-117.
- Bhattacharya, A. K., & Michael, A. M. (2003). *Land and water management engineering*. Konark Publishers.
- Bharadwaj, V., & Singh, R. (2019). Impact of Green Revolution on groundwater resources in Punjab and Haryana. *International Journal of Environmental Sciences*, 10(2), 145-159.
- Bhattacharyya, R., Ghosh, B. N., Mishra, P. K., Mandal, B., Rao, C. S., Sarkar, D., & Franzluebbers, A. J. (2015). Soil degradation in India: Challenges and potential solutions. *Sustainability*, 7(4), 3528-3570.
- Briscoe, J., & Malik, R. P. S. (2006). *India's water economy: Bracing for a turbulent future*. World Bank Publications.
- Central Ground Water Board. (2017). *Dynamic ground water resources of India (as on 31st March 2013)*. Ministry of Jal Shakti, Government of India.
- Central Ground Water Board. (2020). *Ground water year book – India 2018-19*. Ministry of Jal Shakti, Government of India.
- Central Ground Water Board. (2022). *National compilation on dynamic ground water resources of India, 2020*. Ministry of Jal Shakti, Government of India.
- Central Pollution Control Board. (2019). *Status of sewage treatment in India*. Ministry of Environment, Forest and Climate Change, Government of India.

- Chaudhary, S., & Sharma, V. (2018). Groundwater depletion and contamination in Haryana: A critical analysis. *Journal of Environmental Science and Engineering*, 60(1), 88-102.
- Chaudhuri, S., & Roy, M. (2017). Rural-urban spatial inequality in water and sanitation facilities in India. *Journal of Comparative Asian Development*, 16(1), 26-48.
- Dhawan, B. D. (1995). Groundwater depletion, land degradation and irrigated agriculture in India. *Commonwealth Publishers, New Delhi*.
- Directorate of Economics and Statistics. (2020). *Statistical abstract of Haryana 2019-20*. Government of Haryana.
- Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. M. (2022). Global maize production, consumption and trade: Trends and R&D implications. *Food Security*, 14(5), 1295-1319.
- Food and Agriculture Organization. (2017). *Water for sustainable food and agriculture: A report produced for the G20 Presidency of Germany*. FAO.
- Gadgil, S., & Gadgil, S. (2006). The Indian monsoon, GDP and agriculture. *Economic and Political Weekly*, 41(47), 4887-4895.
- Geological Survey of India. (2018). *Aquifer mapping and management plan: Haryana*. Ministry of Mines, Government of India.
- Gleick, P. H. (2003). Global freshwater resources: Soft-path solutions for the 21st century. *Science*, 302(5650), 1524-1528.
- Government of Haryana. (2020). *The Haryana Water Resources (Conservation, Regulation and Management) Authority Act, 2020*. Haryana Gazette Notification.
- Government of Haryana. (2021). *Mera Pani Meri Virasat scheme: Guidelines and implementation framework*. Department of Agriculture and Farmers' Welfare.
- Gupta, S. K., & Deshpande, R. D. (2004). Water for India in 2050: First-order assessment of available options. *Current Science*, 86(9), 1216-1224.
- Gupta, R., Seth, A., & Singh, G. (2015). Canal irrigation management in Haryana: Issues and challenges. *Agricultural Water Management*, 152, 43-52.
- Haryana State Pollution Control Board. (2021). *Annual report 2020-21*. Government of Haryana.
- Hira, G. S. (2009). Water management in northern states and the food security of India. *Journal of Crop Improvement*, 23(2), 136-157.
- Hira, G. S., Jalota, S. K., & Arora, V. K. (2004). Efficient management of water resources for sustainable cropping in Punjab. *Research*

*Bulletin, Department of Soils, Punjab Agricultural University, Ludhiana.*

- Indian Meteorological Department. (2020). *Rainfall statistics of India – 2019*. Ministry of Earth Sciences, Government of India.
- International Water Management Institute. (2007). *The agricultural groundwater revolution: Opportunities and threats to development*. CABI Publishing.
- Jain, M., Mondal, P., DeFries, R. S., Small, C., & Galford, G. L. (2013). Mapping cropping intensity of smallholder farms: A comparison of methods using multiple sensors. *Remote Sensing of Environment*, 134, 210-223.
- Jain, S. K., & Singh, V. P. (2003). *Water resources systems planning and management*. Elsevier.
- Jat, M. L., Gathala, M. K., Ladha, J. K., Saharawat, Y. S., Jat, A. S., Kumar, V., ... & Gupta, R. (2009). Evaluation of precision land leveling and double zero-till systems in the rice–wheat rotation: Water use, productivity, profitability and soil physical properties. *Soil and Tillage Research*, 105(1), 112-121.
- Jat, M. L., Saharawat, Y. S., & Gupta, R. (2011). Conservation agriculture in cereal systems of South Asia: Nutrient management perspectives. *Karnataka Journal of Agricultural Sciences*, 24(1), 100-105.
- Jogdand, S. V., Agarwal, M. C., & Vanani, H. R. (1990). Water management. In *A decade of dryland agricultural research in India 1971-80* (pp. 159-182). Indian Council of Agricultural Research.
- Kahlown, M. A., & Azam, M. (2002). Individual and combined effect of waterlogging and salinity on crop yields in the Indus basin. *Irrigation and Drainage*, 51(4), 329-338.
- Kaur, B., Sidhu, R. S., & Vatta, K. (2010). Optimal crop plans for sustainable water use in Punjab. *Agricultural Economics Research Review*, 23(2), 273-284.
- Kumar, M. D. (2007). *Groundwater management in India: Physical, institutional and policy alternatives*. SAGE Publications India.
- Kumar, M. D., Ghosh, S., Patel, A., Singh, O. P., & Ravindranath, R. (2006). Rainwater harvesting in India: Some critical issues for basin planning and research. *Land Use and Water Resources Research*, 6(1), 1-17.
- Kumar, M. D., & Singh, O. P. (2005). Virtual water in global food and water policy making: Is there a need for rethinking? *Water Resources Management*, 19(6), 759-789.

- Kumar, R., Singh, R. D., & Sharma, K. D. (2005). Water resources of India. *Current Science*, 89(5), 794-811.
- Ladha, J. K., Kumar, V., Alam, M. M., Sharma, S., Gathala, M., Chandna, P., ... & Balasubramanian, V. (2009). Integrating crop and resource management technologies for enhanced productivity, profitability, and sustainability of the rice-wheat system in South Asia. In *Integrated crop and resource management in the rice-wheat system of South Asia* (pp. 69-108). International Rice Research Institute.
- MacDonald, A. M., Bonsor, H. C., Ahmed, K. M., Burgess, W. G., Basharat, M., Calow, R. C., ... & Yadav, S. K. (2016). Groundwater quality and depletion in the Indo-Gangetic Basin mapped from in situ observations. *Nature Geoscience*, 9(10), 762-766.
- Maheshwari, B., Singh, V. P., & Thoradeniya, B. (2016). *Balanced urban development: Options and strategies for liveable cities*. Springer.
- Mall, R. K., Gupta, A., Singh, R., Singh, R. S., & Rathore, L. S. (2006). Water resources and climate change: An Indian perspective. *Current Science*, 90(12), 1610-1626.
- Ministry of Agriculture and Farmers Welfare. (2019). *Agricultural statistics at a glance 2018*. Directorate of Economics and Statistics, Government of India.
- Ministry of Jal Shakti. (2019). *Report of the committee on restructuring the Central Water Commission and the Central Ground Water Board*. Government of India.
- Ministry of Water Resources. (2012). *National Water Policy 2012*. Government of India.
- Mishra, V., Aadhar, S., & Mahto, S. S. (2021). Anthropogenic warming and intraseasonal summer monsoon variability amplify the risk of future flash droughts in India. *npj Climate and Atmospheric Science*, 4(1), 1-10.
- Molden, D. (Ed.). (2007). *Water for food, water for life: A comprehensive assessment of water management in agriculture*. Earthscan.
- Murthy, C. S., Yadav, M., Sai, M. V. R. S., & Roy, P. S. (2015). Spatio-temporal analysis of agricultural drought in Haryana using vegetation condition index. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 40(8), 605-610.
- Narayanamoorthy, A. (2007). Deceleration in agricultural growth: Technology fatigue or policy fatigue? *Economic and Political Weekly*, 42(25), 2375-2379.

- National Bank for Agriculture and Rural Development. (2018). *Potential linked credit plans: Haryana state focus paper 2018-19*. NABARD.
- National Institute of Hydrology. (2016). *Assessment of environmental flow requirements of rivers in India*. Ministry of Water Resources, Government of India.
- Niu, G., Li, Y., Huang, G., Liu, J., & Fan, J. (2013). Crop water use efficiency in response to climate change. In *Advanced Topics in Science and Technology in China* (pp. 209-230). Springer.
- Pandey, V. P., Babel, M. S., Shrestha, S., & Kazama, F. (2011). A framework to assess adaptive capacity of the water resources system in Nepalese river basins. *Ecological Indicators*, 11(2), 480-488.
- Panigrahi, P., & Panda, S. N. (2003). Optimal sizing of on-farm reservoirs for supplemental irrigation. *Journal of Irrigation and Drainage Engineering*, 129(2), 117-128.
- Patel, A., & Kumar, M. D. (2016). Feasibility of integrating groundwater recharge with canal irrigation system: A case study from Gujarat, India. *Water Policy*, 18(5), 1130-1147.
- Planning Commission. (2007). *Report of the Expert Group on groundwater management and ownership*. Government of India.
- Postel, S. (1999). *Pillar of sand: Can the irrigation miracle last?* W. W. Norton & Company.
- Postel, S., Daily, G. C., & Ehrlich, P. R. (1996). Human appropriation of renewable fresh water. *Science*, 271(5250), 785-788.
- Rao, C. S., Gopinath, K. A., Prasad, J. V. N. S., & Singh, A. K. (2016). Climate resilient villages for sustainable food security in tropical India: Concept, process, technologies, institutions, and impacts. *Advances in Agronomy*, 140, 101-214.
- Reddy, V. R., & Behera, B. (2006). Impact of water pollution on rural communities: An economic analysis. *Ecological Economics*, 58(3), 520-537.
- Rijsberman, F. R. (2006). Water scarcity: Fact or fiction? *Agricultural Water Management*, 80(1-3), 5-22.
- Rodell, M., Velicogna, I., & Famiglietti, J. S. (2009). Satellite-based estimates of groundwater depletion in India. *Nature*, 460(7258), 999-1002.
- Roy, A. D., & Shah, T. (2002). *Socio-ecology of groundwater irrigation in India*. International Water Management Institute.
- Sarkar, A. (2011). Socio-economic implications of depleting groundwater resource in Punjab: A comparative analysis of different irrigation systems. *Economic and Political Weekly*, 46(7), 59-66.

- Scott, C. A., & Sharma, B. (2009). Energy supply and the expansion of groundwater irrigation in the Indus-Ganges Basin. *International Journal of River Basin Management*, 7(2), 119-124.
- Shah, T. (1993). *Groundwater markets and irrigation development: Political economy and practical policy*. Oxford University Press.
- Shah, T. (2007). The groundwater economy of South Asia: An assessment of size, significance and socio-ecological impacts. In *The agricultural groundwater revolution: Opportunities and threats to development* (pp. 7-36). CABI Publishing.
- Shah, T. (2009). *Taming the anarchy: Groundwater governance in South Asia*. Resources for the Future Press.
- Shah, T., Molden, D., Sakthivadivel, R., & Seckler, D. (2000). *The global groundwater situation: Overview of opportunities and challenges*. International Water Management Institute.
- Sharma, B. R., Amarasinghe, U., Xueliang, C., de Condappa, D., Shah, T., Mukherji, A., ... & Sikka, A. (2010). *The Indus and the Ganges: River basins under extreme pressure*. *Water International*, 35(5), 493-521.
- Sharma, R., Singh, R., & Kaur, J. (2018). Groundwater contamination and health risks in Punjab, India. *Environmental Science and Pollution Research*, 25(14), 13254-13266.
- Shiao, T., Maddocks, A., Carson, C., & Loizeaux, E. (2015). *3 maps explain India's growing water risks*. World Resources Institute.
- Shiklomanov, I. A. (2000). Appraisal and assessment of world water resources. *Water International*, 25(1), 11-32.
- Simons, G. W. H., Bastiaanssen, W. G. M., & Immerzeel, W. W. (2015). Water reuse in river basins with multiple users: A literature review. *Journal of Hydrology*, 522, 558-571.
- Singh, A. (2014). Soil salinization and waterlogging: A threat to environment and agricultural sustainability. *Ecological Indicators*, 57, 128-130.
- Singh, O. P., & Kumar, M. D. (2005). Groundwater exploitation and electricity subsidies in Indian agriculture. *Water Policy*, 7(4), 371-384.
- Singh, R. B. (2000). *Environmental consequences of agricultural development: A case study from the Green Revolution state of Haryana, India*. *Agriculture, Ecosystems & Environment*, 82(1-3), 97-103.
- Sivanappan, R. K. (1994). Prospects of micro-irrigation in India. *Irrigation and Drainage Systems*, 8(1), 49-58.