



Contents lists available at ScienceDirect

Journal of Contaminant Hydrology

journal homepage: www.elsevier.com/locate/jconhyd

Unravelling groundwater contamination and health-related implications in semi-arid and cold regions of India

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ARTICLE INFO

Keywords:

Groundwater
Nitrate
Fluoride
Heavy metal
Geogenic
Anthropogenic
Water quality

ABSTRACT

Groundwater, a vital global resource, is essential for sustaining life and various human activities. However, its quality and availability face increasing threats from both natural and human-induced factors. Widespread contamination, arising from both natural origins and human activities such as agriculture, industry, mining, improper waste disposal, and wastewater release, poses significant risks to human health and water security. India, known for its dense population and pronounced groundwater challenges, serves as a prominent case study. Notably, in most of its regions, groundwater resources have been found to be severely contaminated by various chemical, biological, and radioactive contaminants. This review presents an examination of contamination disparities across various states of semi-arid and cold regions, encompassing diverse assessment methods. The studies conducted in semi-arid regions of North, South, West, and East India highlight the consistent presence of fluorides and nitrates majorly, as well as heavy metals in some areas, with values exceeding the permissible limits recommended by both the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). These contaminants pose skeletal and dental threats, methemoglobinemia, and even cancer. Similarly, in cold regions, nitrate exposure and pesticide residues, reportedly exceeding BIS and WHO parameters, pose gastrointestinal and other waterborne health concerns. The findings also indicated that the recommended limits of several quality parameters, including pH, electrical conductivity, total dissolved solids (TDS), total hardness, and total alkalinity majorly surpassed. Emphasising the reported values of the various contaminant levels simultaneously with