



# Groundwater Contamination And Health Risks In Rural Punjab: An Ecofeminist Lens

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**Abstract** - The contamination of groundwater has appeared as a consequential health and environmental crisis in the rural Punjab. The modern agricultural practices for maximisation of profit through overindulgence of chemicals and pesticides as well as industrial waste crucially deteriorate the quality of groundwater in many areas of rural Punjab. The poisonous substances such as uranium, nitrates and heavy metal cause critical threats to health of public. The gendered perspectives of this crisis remain little known. The present research paper focuses on exploring the health risks in rural Punjab due to groundwater contamination through an ecofeminist lens.

**Key words:** Groundwater Contamination, Rural Punjab, Women, Health Risks and Ecofeminism.

## Introduction

*"Water is the driving force of all nature."*

- Leonardo da Vinci, an Italian polymath and greatest painters (Wolf, 2023).

The above quote highlights the belief that water is the fundamental and indispensable element, powering natural processes and sustaining life on earth. As a universal solvent, it sustains life by facilitating metabolism, transporting nutrients and driving photosynthesis. It shapes landscapes through erosion and regulates global temperature. Water is essential for every form of life process on earth. Through the hydrological cycle like: evaporation, condensation, precipitation, it distributes energy around the globe. Its ability to dissolve substances allows for the chemical reactions which are necessary for life. Thus, it sustains ecosystems, supporting both aquatic life and terrestrial biodiversity. The groundwater is the primary source of drinking water for rural communities in Punjab. However, in recent decades the state has been experiencing a serious environmental crisis due to groundwater contamination caused by intensive agriculture, industrialization, and over-extraction of water resources. Environmental degradation in Punjab is

closely linked to the legacy of the Green Revolution, which promoted chemical fertilizers, pesticides and groundwater irrigation to increase agricultural productivity (Wolf, 2023).

### **Environmental Context of Punjab**

The recent reports indicate that Punjab faces one of the most severe groundwater contamination problems in India. According to the “Central Ground Water Board” under the Ministry of Jal Shakti, a large proportion of groundwater samples in Punjab contain toxic elements such as uranium, nitrate, arsenic and fluoride beyond safe limits. This report raises serious public health concerns. The struggle of Punjab with groundwater contamination, often linked to industrial discharge, agricultural run-off and poorly managed waste disposal systems. Such pollutants can cause severe health complications ranging from chronic illnesses to irreversible organ damage (Kumar, 2025).

The Ministry of Jal Shakti reported that 32.6% of groundwater samples tested in Punjab exceeded the permissible uranium limit of 0.03 mg/L, which was the highest contamination rate recorded among all tested parameters. Thus, out of 908 samples analysed in Punjab, 296 contained uranium beyond the permissible limit. In comparison, 10.7% of samples tested in Delhi crossed the same threshold. The elevated uranium levels in drinking water are known to cause kidney damage and other long-term health issues (GOI, 2025).

The report also clarifies that 13.8% of groundwater samples had fluoride levels above the safe limit of 1.5 mg/L, linked to ailments such as arthritis, infertility, hypertension, neurotoxicity and high risk of skeletal cancer. Its long-term exposure can also damage the liver, kidneys and lungs. Also, out of 922 samples, 12.6% exceeded the nitrate limit of 45 mg/L, 4.8% were contaminated with arsenic beyond the 0.01 mg/L, while 6.7% of samples showed electrical conductivity above 3000  $\mu\text{S}/\text{cm}$  at 25°C, indicating high salinity levels in groundwater. The Report highlights that: -

- 62.5% of groundwater samples exceed the safe uranium limit of 30 ppb.
- 14–15% of samples contain excessive nitrate, mainly from fertilizer run-off.
- Fluoride and arsenic contamination are also present in several districts. (GOI, 2025)

The environmental crisis of Punjab is closely related to its agricultural model. The Green Revolution transformed the state into one of leading food producers of India but also led to the excessive use of fertilizers, pesticides and groundwater irrigation. Punjab now extracts groundwater at extremely high level. A report of “Centre for Science and Environment” indicate that the rate of groundwater extraction of state has reached 156.87% of its annual recharge capacity which was highest in India. The number of districts with groundwater levels deeper than 40 metres rose from

three in 2014 to eleven in 2024. This over-exploitation has not only lowered water tables but also intensified the concentration of toxic elements in groundwater (Kamal, 2025).

The sixteen districts, including Bathinda, Mansa, Sangrur, Patiala, Ludhiana and Amritsar have been identified as contamination hotspots. The CGWB Annual Groundwater Quality Report 2025, not only records highest rate of uranium contamination in whole state but also highlights a public health emergency. The excessive amounts of nitrate in 14.6% and fluoride in 11% samples are making our children susceptible to blue baby syndrome and bone diseases (The Tribune, 2025).

These environmental conditions illustrate how agricultural intensification and industrial development have contributed to ecological degradation in Punjab. While the environmental and health impacts of contaminated water have received increasing attention, the gendered dimensions of this crisis remain underexplored. Rural women are primarily responsible for water collection, household sanitation and family healthcare which makes them particularly vulnerable to the effects of contaminated water. This paper examines groundwater contamination in rural Punjab from an ecofeminist lens, focusing on how environmental degradation intersects with gender inequalities to produce disproportionate burdens on women.

### **Theoretical Framework**

This study uses the ecofeminist framework to analyse the relationship between environmental degradation and gender inequality. Ecofeminism argues that the domination of nature and the oppression of women are interconnected processes rooted in patriarchal social structures. The scholars such as Vandana Shiva argue that modern development models prioritize economic growth and technological expansion while ignoring ecological sustainability and community knowledge. Ecofeminists emphasize that women often maintain a closer relationship with natural resources because of their roles in food production, water management and household care. As a result, environmental degradation disproportionately affects women's livelihoods and well-being.

### **Review of Literature**

The Tribune (2025) in their article "Uranium Exceeding Safe Limit in 62.5% of Punjab Groundwater Samples: Satnam Sandhu in Rajya Sabha" stated that sixteen districts, including Bathinda, Mansa, Sangrur, Patiala, Ludhiana and Amritsar have been identified as groundwater contamination hotspots resulting into public health emergency. The excessive amounts of nitrate fluoride are making our children susceptible to blue baby syndrome and bone diseases.

Kumar (2025) in his article "1 in 3 of Punjab's Groundwater Samples Contains Uranium Beyond Safe Limits, Rajya Sabha Told" explained that environmental studies have linked nitrate contamination to excessive fertilizer use and improper waste disposal systems in rural areas. The industrial discharge and untreated sewage are major sources of groundwater pollution. The high

levels of uranium in drinking water have been associated with kidney damage, bone disorders and cancer risks.

However, the studies neglect social and gender dimensions of environmental crises. This gap highlights the need for a sociological approach that integrates environmental health and gender analysis.

### **Research Objectives**

1. To examine the extent and causes of groundwater contamination in rural Punjab.
2. To analyse the public health implications of contaminated groundwater on rural communities in Punjab.
3. To explore the gendered dimensions of the water crisis, focusing on how groundwater contamination disproportionately affects women.
4. To suggest policy recommendations for gender-sensitive water management and environmental governance in Punjab.

### **Research Methodology**

This research adopts a qualitative approach based on secondary data. The data sources include the government reports from the Central Ground Water Board, Ministry of Jal Shakti and Centre for Science and Environment. It also includes environmental monitoring data, research articles, news reports and policy documents related to water quality in Punjab. The secondary data analysis allows the study to examine both environmental statistics and sociological interpretations of the water crisis. A few case studies also added in this research paper to provide a ground level reality of state of Punjab.

### **Gendered Dimensions of Groundwater Contamination in Rural Punjab**

*“Every step a girl takes to collect water is a step away from learning, play and safety.”*

- Cecilia Sharp, UNICEF Director of WASH and CEED  
(WHO, 2023).

According to the UNICEF-WHO report, 1.8 billion people live in households without water supplies on the premises at global levels. Women and girls aged 15 and older are primarily responsible for water collection in 7 out of 10 such households, compared with 3 in 10 households for their male peers. Girls under 15 (7 %) are also more likely than boys under 15 (4 %) to fetch water. In most cases, women and girls make longer journeys to collect water they lose their time in education, work and leisure. The latest data from WHO shows a stark reality as “1.4 million lives are lost each year due to inadequate water, sanitation and hygiene,” said Dr Maria Neira, WHO Director, Environment, Climate Change and Health Department (WHO, 2023).

In some drought-prone villages in Maharashtra and Rajasthan, men marry multiple women called 'water wives,' solely to ensure there are enough people to fetch water for the household. This depicts poor state of women and sick mentality of patriarchy in rural households (Koli, 2025).

Women and girls not only face WASH-related infectious diseases, like diarrhoea and acute respiratory infections, they face additional health risks because they are vulnerable to harassment, violence and injury when they go outside to haul water or just to use the toilet. But achieving the Sustainable Development Goals target for universal access to safely managed drinking water, sanitation and basic hygiene services by 2030 will require a six-fold increase in current rates of progress for safely managed drinking water, a five-fold increase for safely managed sanitation and a three-fold increase for basic hygiene services (WHO, 2023). The water crisis in Punjab has following significant gender implications: -

1. **Increased Domestic Labour:** - Women are responsible for collecting and managing water for drinking, cooking and cleaning in rural households. When water from hand pumps is unsafe, women travel to distant RO plants or community water stations or spend additional time finding safe water sources which increased their domestic labour.
2. **Gendered Health Risks:** - Women are more vulnerable to contaminated water due to reproductive health risks and nutritional inequalities. Pregnant women and children are particularly affected by nitrate and heavy metal contamination. Also, the new born children susceptible to blue baby syndrome and bone diseases due contaminated water by mothers during pregnancy (The Tribune, 2025).
3. **Care Burden:** - Women are usually responsible for caring for sick family members. In areas affected by water-related diseases, the illness of male breadwinners increases women's unpaid labour and emotional stress. Women may be forced to work as agricultural labourers or informal workers when family income declines.
4. **Limited Access to Healthcare:** - Rural women frequently face barriers in accessing healthcare services due to limited mobility, financial constraints, gender norms that prioritize health of men over women. As a result, many women delay medical treatment even when they experience symptoms related to contaminated water exposure.
5. **Impact on Education of girls:** - In households where water sources are distant or unsafe, girls may be required to assist their mothers in collecting water. This responsibility can reduce their time for schooling and homework, contributing to gendered educational inequality.
6. **Food Preparation and Nutritional Implications:** - Women are responsible for preparing food for the family. Using contaminated water in cooking may expose entire households to toxins, but women face direct and prolonged exposure during food preparation and cleaning activities.

7. Limited Decision-Making: - Despite being the primary managers of household water, rural women often have limited participation in village-level water governance and environmental decision-making.

8. Psychological Burdens on Women: - Environmental stress increases psychological and social burdens on women. Long journeys to remote water sources or shared latrines expose women to increased risks of sexual harassment, assault and rape.

9. Menstrual Hygiene: - A lack of clean water limits, or even prevents, proper washing, leading to the reuse of old cloths and increased risk of infections.

10. Marginalised Caste Groups: - Poor women, landless labourers and marginalized caste groups often face the most severe impacts because they lack access to alternative water sources such as private bore wells or water purification systems.

### **Case Studies on Groundwater Contamination and Gendered Vulnerabilities in Punjab**

- Bathinda district in the Malwa region has become one of the most studied areas for groundwater contamination in Punjab. The scientific studies have found high levels of uranium in groundwater samples used for drinking purposes. A research study found that uranium concentrations in Bathinda's groundwater ranged from 0.48 to 571.7 µg/L, far exceeding the safe limits of World Health Organization of 30 µg/L (Lakhwant Singh et al., 2012). There is another study that estimated 1089 cancer cases per million people, about 36% higher than India's national average in cancer belt of Punjab (Virk and Mahajan, 2024).
- Mansa district is another major hotspot of groundwater contamination. Studies have shown that a large percentage of groundwater samples in this region contain uranium above safe limits. In fact, earlier environmental surveys found that over 80% of drinking water samples from Bathinda and Mansa districts exceeded permissible uranium levels. Researchers attribute this contamination to multiple factors such as excessive use of phosphate, fertilizers, pesticides, intensive groundwater extraction for irrigation and natural geological deposits that release uranium into aquifers. In addition to uranium contamination, nitrate pollution from fertilizers is also a major concern in rural Punjab. (Hindustan Times, 2012)
- The broader Malwa region including Bathinda, Mansa, Muktsar and Faridkot districts has become a symbol of environmental crisis in Punjab. The region is widely known for the so-called "Cancer Train," a train that carries cancer patients from Bathinda to treatment centres. Experts attribute this environmental crisis to heavy pesticide use during the Green Revolution, industrial waste discharge and over-exploitation of groundwater resources (Prakash, 2025).

## Policy Implications and Recommendations

Addressing groundwater contamination in Punjab requires both environmental and social policy interventions. The key recommendations include: -

1. Reducing the use of chemical fertilizers and pesticides by promoting sustainable agricultural practices.
2. Strengthening water quality monitoring systems and its regular maintenance.
3. Expanding rural healthcare services in contaminated regions.
4. Ensuring actual participation of women in local water governance.
5. Providing safe drinking water infrastructure through government programs and their maintenance.

## Conclusion

The groundwater contamination in Punjab represents a complex environmental and public health crisis. The government data indicates widespread contamination by uranium, nitrate, and fluoride, posing serious risks to rural populations. However, women in rural Punjab experience disproportionate burdens due to their roles in water collection, household management and caregiving. By applying an ecofeminist perspective, this study highlights the importance of integrating gender analysis. Addressing groundwater contamination requires not only technological solutions but also socially inclusive approaches that recognize women's knowledge, experiences, and participation in environmental governance.

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