The Silent Crisis Below Our Feet Tracing How Pollution Travels from River to Root in the Gomti Basin

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Abstract- Soil pollution caused from wastewater discharge, urbanisation, industrial activities, and improper waste disposal creates a growing threat to agricultural sustainability. This study investigated the effects of pollution on soil quality and crop productivity in the Gomti River Basin, Lucknow, India. Six soil types representing different environmental conditions were tested.

Soil quality was assessed using pH, Total Dissolved Solids (TDS), and water-holding capacity. Crop productivity was analysed through a controlled plant growth experiment. Soil pH ranged from 6.5 to 8.5, TDS values ranged from 177–280 ppm, and water-holding capacity ranged from 10–70%. Farmyard manure-treated soil displayed the highest water-holding capacity (70%) and supported the greatest plant growth (11.5 cm), while roadside soil showed the lowest water-holding capacity (10%) and no measurable plant growth.

The results show a clear relationship between soil quality and crop productivity. Soils with greater moisture retention and balanced chemical properties supported improved plant growth, while polluted soils generally showed poorer performance. The findings show the importance of maintaining soil organic matter and adopting sustainable soil management practices to improve agricultural productivity.

Anomalously, garbage area soil (CS-02) outpaced clean garden soil (CS-01) by supporting 41.6% greater plant height, serving as a unique standout finding within the contaminated cohorts

Index-Terms: Soil health, wastewater contamination, crop productivity, organic matter, soil pollution, Gomti River Basin

I. INTRODUCTION

Healthy soil is fundamental to agricultural productivity, ecosystem stability, and food security. Soil supports plant growth, stores water, recycles nutrients, and sustains biodiversity [1]. However, increasing urbanization, industrial development, and improper waste disposal have accelerated soil degradation in many regions of the world [2].

The Gomti River Basin in Lucknow is characterized by fertile alluvial soils that support agricultural activities. However, wastewater discharge, roadside pollution, industrial activities, and garbage accumulation may alter soil properties such as pH, dissolved solids, and organic matter content, thereby affecting crop productivity [3].

Although several studies have focused on water pollution in the Gomti River, limited attention has been given to the impact of pollution on surrounding soils. This study evaluates the relationship between soil quality indicators and crop productivity across six contrasting soil environments in Lucknow.

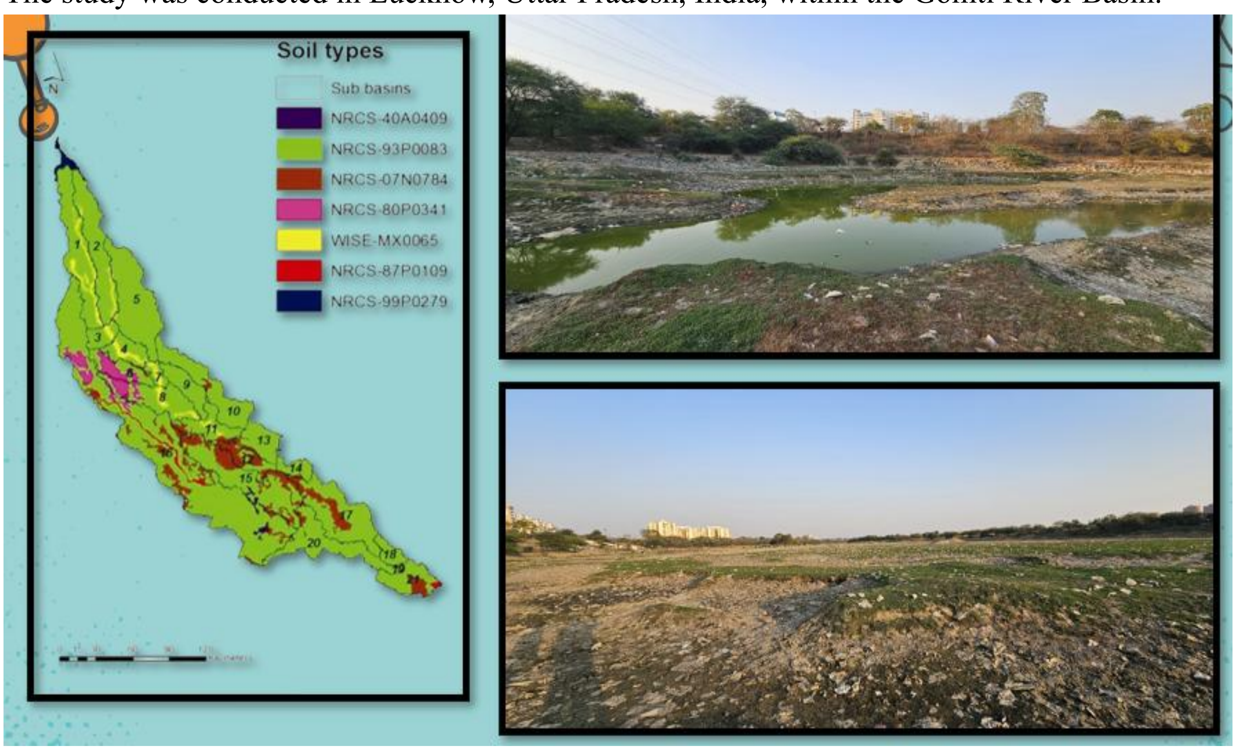
Research Question: How do wastewater contamination and pollution affect soil pH, Total Dissolved Solids (TDS), organic matter content, and crop productivity in soils of the Gomti River Basin?

Hypothesis: Polluted soils will exhibit altered pH, increased TDS, reduced organic matter content, and lower crop productivity compared with less polluted soils.

II. MATERIALS AND METHODS

A. Study Area

The study was conducted in Lucknow, Uttar Pradesh, India, within the Gomti River Basin.



[Figure 1: Sampling Location Map]

B. Soil Sampling

Six soil categories were investigated:

Sample	Soil Type
CS-01	Garden Soil
CS-02	Garbage Area Soil
CS-03	Farmyard Manure-Treated Soil
CS-04	Industrial Soil
CS-05	Roadside Soil
CS-06	Wastewater-Contaminated Soil

Approximately 1 kg of soil was collected from each site from the top 0–20 cm soil layer.

C. Soil Analysis

Soil pH was measured with a digital pH meter and with pH liquid, Methyl Orange. TDS was checked using a digital TDS meter. Water-holding capacity was measured as an indirect indicator of organic matter due to soils with higher organic matter retaining more water [1].

D. Crop Productivity Assessment

A pot experiment was conducted and the average plant height was recorded after seven days.

E. Crop Productivity Assessment

To ensure experimental rigorousness, critical variables were kept uniform across all groups:

- Seed Selection: Identical *[Insert Seed Species name, e.g., Vigna radiata]* seeds of equal size and batch were used.
- Hydration: Every pot received exactly 50 mL of distilled water daily at 08:00 AM.
- Environment: All pots were kept on the same south-facing windowsill, securing identical sunlight exposure and ambient temperature.

III. RESULTS

A. Soil Quality Indicators

Sample	pH	TDS (ppm)	Water-Holding Capacity (%)	Plant Height (cm)
CS-01	6.5	177	40	6.0
CS-02	8.0	225	50	8.5
CS-03	7.5	280	70	11.5
CS-04	8.5	246	30	6.5
CS-05	8.0	261	10	No Growth
CS-06	7.5	264	20	2.5

Farmyard manure-treated soil (CS-03) exhibited the highest water-holding capacity and greatest crop growth. Roadside soil (CS-05) demonstrated the poorest performance and failed to support measurable plant growth.

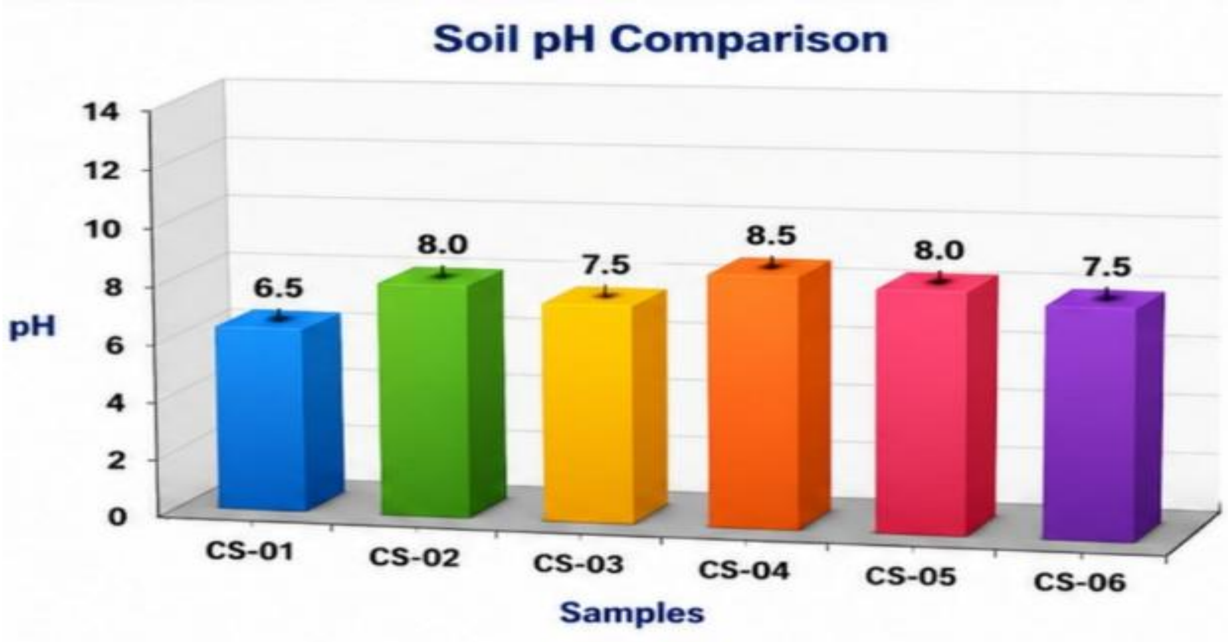


Figure 2: Soil pH Comparison Graph

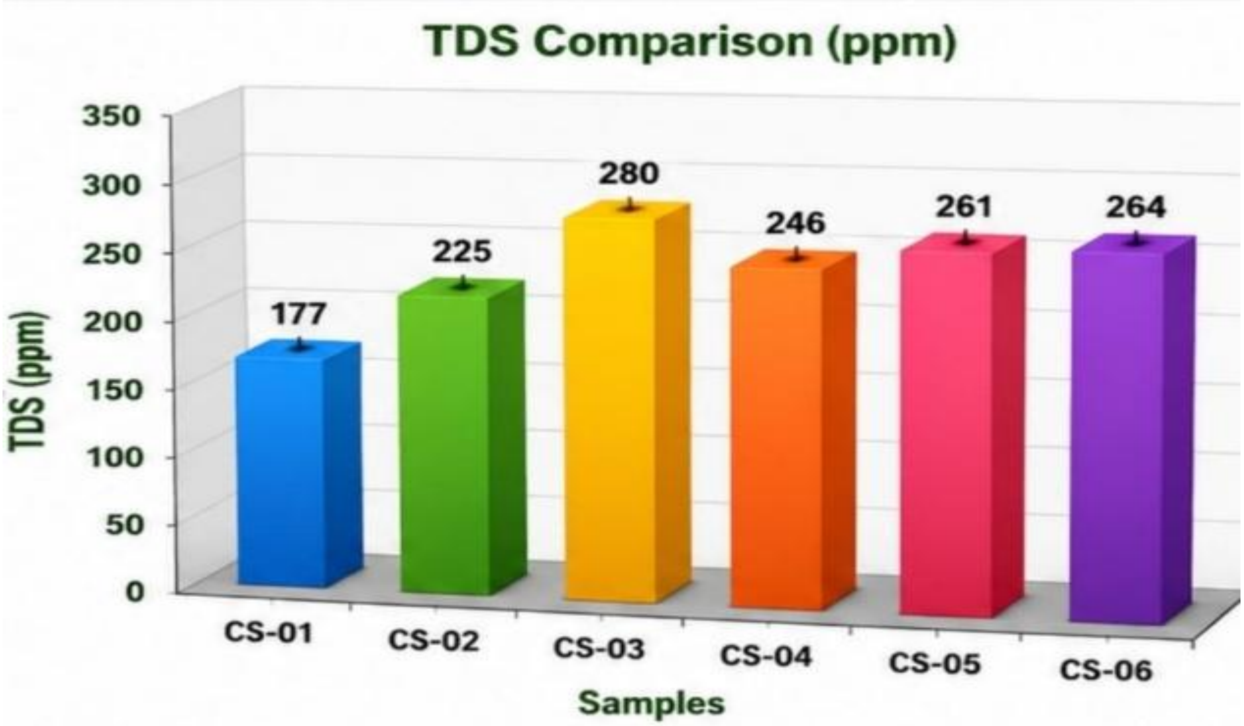


Figure 3: TDS Comparison Graph

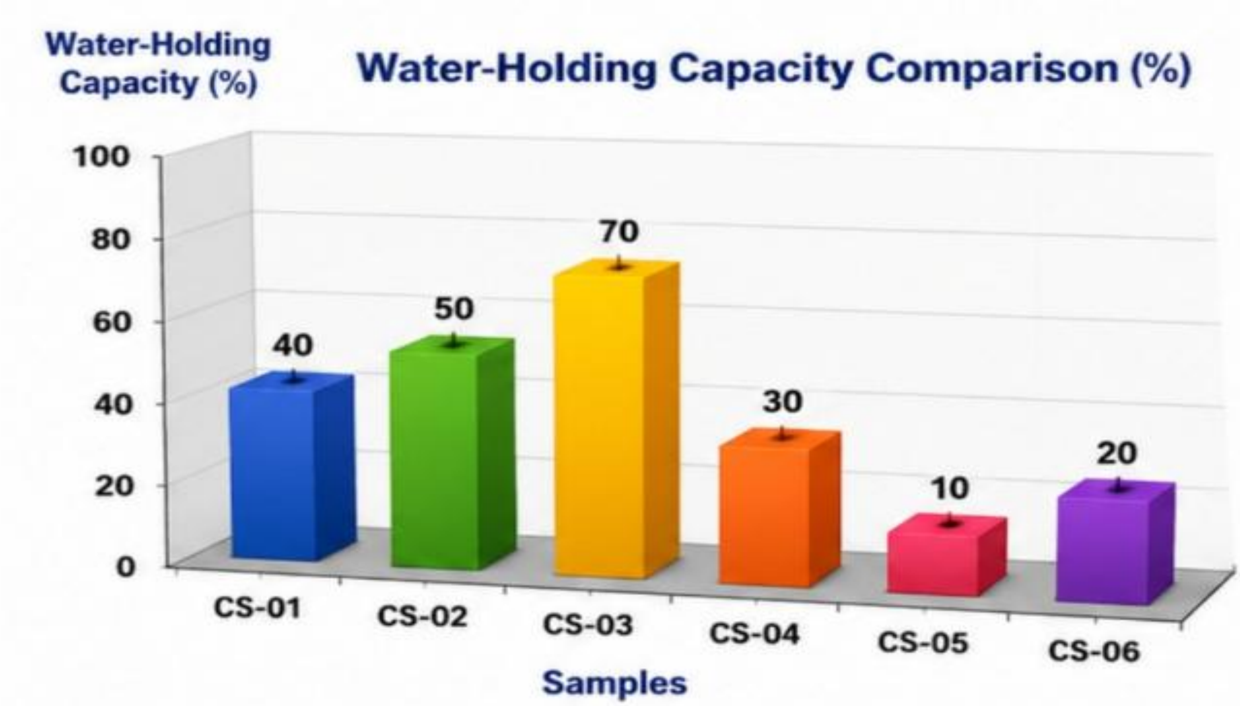


Figure 4: Water-Holding Capacity Comparison Graph

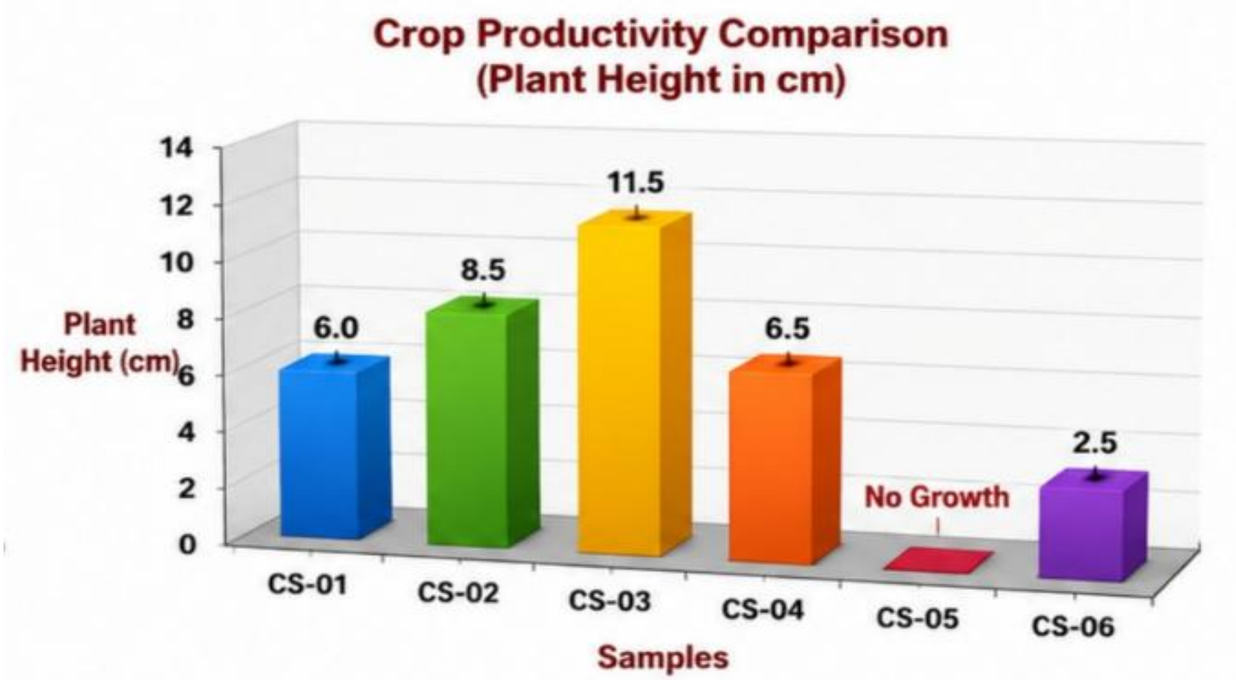


Figure 5: Crop Productivity Comparison Graph

IV. DISCUSSION

The results indicate that soil quality strongly influences crop productivity. Quantifiably, a 50% drop in water-holding capacity between garden soil (CS-01) and wastewater soil (CS-06) triggered a 58.3% reduction in plant height. This establishes a direct, non-linear correlation between moisture retention capacity and vegetative growth metrics. Farmyard manure-treated soil (CS-03) consistently performed best across all indicators, suggesting that increased organic matter improved moisture retention and supported plant growth. In contrast, roadside soil (CS-05) exhibited the lowest water-holding capacity and failed to support crop growth.

Although some polluted soils exhibited moderate pH values, reduced water-holding capacity was associated with lower productivity. This finding suggests that moisture retention and organic matter content may be more important determinants of crop growth than pH alone.

The outperformance of garbage area soil (CS-02) over pristine garden soil presents a distinct trade-off: while macro-growth was temporarily accelerated over seven days, underlying heavy metal toxicity or pathogen loads remain unaccounted for, presenting long-term phytotoxicity risks.

Certain limitations apply to the scope of this study. The investigation relied on a seven-day observation window, which captures early seedling germination rather than the complete crop lifecycle. Additionally, while the analysis focused on primary soil quality indicators, heavy metal profiling and microbial assays were not conducted. Acknowledging these parameters helps clarify the boundary of the current data and highlights valuable pathways for more comprehensive testing in future studies.

Overall, the results support the hypothesis that pollution negatively affects soil quality and agricultural productivity. Water-holding capacity emerged as the strongest indicator of crop performance within this investigation.

V. CONCLUSION

This study demonstrated that wastewater contamination and pollution influence soil quality and crop productivity in the Gomti River Basin.

Farmyard manure-treated soil exhibited superior soil quality and supported the greatest plant growth, whereas roadside soil showed the poorest performance. The findings highlight the importance of maintaining soil organic matter and adopting sustainable practices such as farmyard manure application to improve soil health and agricultural productivity.

This study highlights the need to shift from simple pollution monitoring to active soil restoration in developing urban areas. The Author believes that promoting natural soil treatments can help local communities protect agricultural land from city waste.

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