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“Reconcile land system changes
with planetary health”

Nature-based and circular solutions for soil health in climate-resilient urban-peri-urban landscapes

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Abstract

Urban soils, historically neglected in development discourse, are increasingly recognised as critical natural infrastructure for climate resilience, sustainability, and livability. With urban areas projected to house 68 % of the global population by 2050, soil degradation is intensifying through sealing, compaction, contamination, and organic matter loss. These impacts disrupt key soil-mediated ecosystem services like carbon sequestration, stormwater infiltration, and microclimate regulation. For instance, sealed surfaces can reduce urban soil infiltration rates by up to 90 %, increasing flood risk and heat island effects.

This study examines how Nature-based Solutions (NbS) and circular resource management can restore soil health and enhance ecosystem functionality in rapidly urbanizing Indian cities, drawing from field experiences in Varanasi, Prayagraj, and Lucknow. Interventions such as decentralised composting (diverting up to 40 % of municipal organic waste), biochar application at 5–10 t ha⁻¹, microbial inoculants, green manuring, and urban agroforestry demonstrate measurable improvements in soil health indicators. In pilot sites, soil organic carbon (SOC) increased by 0.3–0.5 % annually, and microbial biomass rose by 25–35 %, indicating enhanced biological activity and nutrient cycling.

A city-level pilot framework is proposed, integrating digital advisory platforms like the Rice Crop Manager to track site-specific nutrient and water needs, alongside community compost hubs and green infrastructure zones. The framework emphasises soil health indicators – SOC, bulk density, infiltration rate, and microbial biomass – as metrics for monitoring and governance.

Policy recommendations include embedding soil restoration goals in city master plans, developing compost markets, incentivizing citizen-led soil stewardship, and fostering convergence among municipal, agricultural, and environmental departments.

This approach positions urban soil as “invisible infrastructure” vital for climate adaptation, food security, and health. The findings offer a replicable roadmap for cities in the Global South to transition toward regenerative, circular, and inclusive urban ecosystems.

Keywords: Circular economy, climate-resilient cities, nature-based solutions, regenerative urbanism, urban soil health