

Why Living Soil Matters for Growing Cities?

Konga Bhuvana

Ph.D Scholar, Soil Science and
Agricultural Chemistry, College
of Agriculture, PJTAU,
Rajendranagar, Hyderabad,
Telangana. 500030.



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*Corresponding Author

Konga Bhuvana*

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INTRODUCTION

Beneath our feet, a silent revolution is underway rooted in the dark, unnoticed medium known as SOIL. Soil is not merely dirt; it is a living infrastructure that it carries memory, life, and history. Long before urban settlements emerged, soil nurtured life by supporting food, forests, and ecosystems. Even today, in an increasingly urban world, it is this living earth, not concrete and steel, that decides the future habitability and health of our cities. Cities often take pride in their infrastructure—flyovers, skylines, and expressways—but these structures do not truly lay the foundation for prosperity. The real strength of a city lies beneath the surface. Soil is alive with microorganisms that sustain ecosystems, regulate natural processes, and promote soil health. It reflects equality by supporting all forms of life. Scientifically, soil is a structured and dynamic medium whose formation and evolution are influenced by physical, chemical, biological, and human factors that determine its properties. It is composed of minerals, organic matter, air, water, and living organisms working together as an integrated system. Ultimately, a truly healthy city begins from the ground up—with healthy soil.

2. Functions of a Healthy Soil

A healthy soil acts as a dynamic living system that delivers multiple ecosystem services, such as sustaining water quality and plant productivity, controlling soil nutrient recycling decomposition, and removing greenhouse gases from the atmosphere. The numerous services rendered by the soil are classically divided into four categories namely (1) supporting services-for the development of vegetation, construction, (2) supply-food, fibres, (3) regulation-quality of the air, climate, and (4) cultural and social-educational, heritage and social values.

These services are derived from the functions ensured by the soil, each one being determined by complex interactions between the biotic and abiotic soil components (Guilland *et al.* 2018). Thus, the resilient and environmentally friendly ecosystems are built on healthy soils. Healthy soils perform functions like absorption and storage of rainwater which lessens flooding and increases urban resilience to climatic extremes; support agriculture; promote parks, trees, and

other green areas that cool cities; enhance biodiversity and improve air quality; support sustainability and enable cities adapt to environmental challenges by carbon sequestration, nutrients recycling, and filtering pollutants. Urban ecosystems thereby flourish, green infrastructure becomes efficient, and cities expand both externally and internally when soils are alive and well.

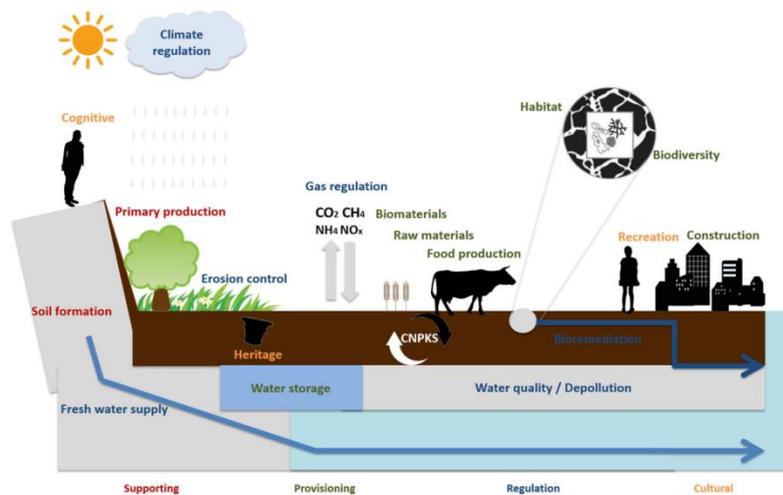


Fig. 1 Soil ecosystem services (Guilland *et al.* 2018) are distributed into four categories between supporting (red), provisioning (green), regulation (blue) and cultural (orange).

3. Urban Soils Today

Urban agriculture helps to increase urban sustainability with a special focus on food security. But due to their location, urban farms are highly influenced by past and present anthropogenic activities which can threaten both soil health and food safety. Their direct and indirect influence on soil properties include:

3.1 Direct Effects:

Direct effects include physical disturbance, mixing of human-made materials, and soil burial under fill or impervious surfaces.

3.1.1 Urbanization

The conversion of forest and agricultural lands to urban use caused changes in soil through land development and grading. Urban soils are intensively managed for stormwater control, landscaping, recreation, and waste disposal, often affecting urban agriculture. Initial grading commonly removes surface O and A horizons and compacts soils due to heavy machinery.

Even when topsoil is replaced, soil structure is degraded, soil carbon stocks decline (Chen *et al.*, 2013), and impairs hydraulic conductivity (Schwartz and Smith, 2016). Deeper soil layers may also experience severe compaction.

3.1.2 Waste Disposal

Urban areas produce large amounts of waste such as household and industrial waste, construction debris, ash, and dredged materials. Earlier, these wastes were used to fill wetlands or expand shorelines, while today most cities use landfills. These human-made materials containing black carbon, metals, and organic pollutants differ greatly from natural soils and can strongly alter soil formation and soil properties (Huot *et al.*, 2015).

3.1.3 Sealing and Paving

Urban areas are largely covered by impervious surfaces like asphalt and concrete, which seal soils. Soil sealing reduces ecosystem services by limiting root growth, soil organisms, and increasing anoxic conditions, placing more

pressure on remaining unsealed soils (Setälä et al., 2014). As cities expand, highly productive agricultural soils are often sealed and disturbed.

3.1.4 Soil Replacement and Recycling

In infill development, soils are often absent, degraded, or contaminated or recycled soils mixed with sand and compost are commonly imported. These replacement soils may be poorly structured, easily compacted, and have lower water-holding capacity than natural soils.

3.2 Indirect Effects

Indirect effects involve changes in abiotic and biotic conditions that can affect even undisturbed urban and peri-urban soils changing climate, chemical inputs (nutrients and pollutants), and species composition (Pouyat *et al.*, 2010). The urban heat island raises temperatures, alters plant growth, organic matter inputs, and often speeds up microbial activity, while changes in rainfall and atmospheric deposition modify soil chemistry and nutrient cycling. Urban areas are major entry points for invasive species, which

alter soil structure, organic matter decomposition, and nutrient cycles, ultimately reshaping urban soil function.

4. Measures to develop healthy soils

Creation of a healthy habitat below ground, with good soil structure, thriving and diverse soil organisms, and nutrients in sufficient supply results in healthy above ground habitat, field round its perimeter ensuring high crop yields with optimal conditions for their growth and protection against pests. Soil health can be improved through six main approaches: (a) reduced tillage, (b) avoiding soil compaction, (c) growing cover crops, (d) crop rotations, (e) application of organic amendments in appropriate quantities and (f) application of chemical inputs in appropriate quantities, timing and locations. Figure 2. (Magdoff *et al.*, 2021) describes the holistic approach to promote soil health over years.

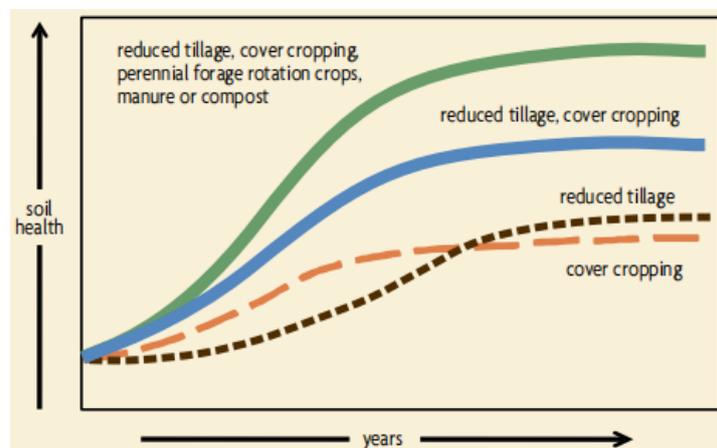


Figure 2. Combined effect of different management practices on soil health over years.

Other measures include creation of diverse plant communities by their roots at varying depths and shapes, which encourages biodiversity; minimize waste generation potentially by composting; educating individuals on their essential role in improving soil services; deep ripping combined with compost addition can also restore permeability in compacted urban soils (Schwartz & Smith, 2016).

CONCLUSION

In cities, living urban soils support trees, parks, and gardens, regulate water flow, reduce heat,

and filter pollutants. When soil life is protected, urban soils remain functional, green spaces thrive, and cities become healthier and more resilient. Particularly, soil biodiversity is the driving force that recycle nutrients, improve soil structure, and maintain soil functions. Their activity transforms ordinary soil into living soil, which inturn lead to the development of healthy cities.

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