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# THE ROLE OF TREE ROOT ARCHITECTURE IN SOIL CONSERVATION

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Ultimately, increased knowledge on root form and function may help to develop new tools focused on root functions to monitor and assess root structure changes in the field and to improve or develop integrated practices that are able to mitigate gain, erosion, and off-site impacts of agronomic and silvicultural systems. Understanding root system architecture will also improve our definition of root development, regulation, and modeling, the mechanisms of these interactions, and the way that architecture affects the beneficial or potentially detrimental functions of the root system of the root (e.g. studies on water and nutrient management, soil erosion prevention & rehabilitation, global change in agricultural systems). Root morphological architectural traits are genetic traits that are controlled by environmental traits. At present, research on these traits has been extensive; some of the traits have become the focus of related research and section breeding, but most of the root morphology traits lack attention. Root visual genetic traits and their environment and trait values have been neglected. They determine the overall potential capacity and function of the root system of the root trait control system. Root architecture gene mapping and cloning and integration of multi-gene exploration of the control of root morphology and biological fertilizers, the formation mechanism of the rhizosphere system ecological environment and developing new technologies for functional markers of root phenotype profiles will be essential in the future. Tree root architecture is an integrated trait that is vital for intensive tree growth and development, and is also an important factor in typhoon resistance, soil retention, and the ecological environment (Freschet et al., 2021). In recent years, with people's increasing demands on the quality of the ecological environment, combined with concern over the ecological problems present in pure plantation forests, a greater understanding of root development and tree root architecture has grown in research and has become an important aspect of silvicultural studies.

## Types of Root Systems

Near the soil surface where the main portion of the fine root system is developed, a tree may be classified as (1) taprooted, (2) heart-rooted, or (3) lateral-rooted. The lateral-rooted type includes all cases in which there is no well-defined, single, elongate, persistent taproot. It includes two subtypes: heart-rooted and lateral-spreading types. In the heart-rooted type, which is best typified by coniferous trees, the central system consists of a short, stout, vertical root and some number of lesser vertical and semi-vertical roots; the rest of the root mass consists of a complex of large lateral roots with a prominent heart form. In the lateral-spreading type, which is characteristic of many hardwoods, the central system, where it is not a taproot, consists of a tangle of large vertical and semi-vertical roots, and the remainder of the root mass consists of a regular, descending tangle of large lateral roots, below the region of greatest taper of the trunk. Each of these types is related to a carpet system by botanical and structural characteristics associated with mechanical requirements arising from body form.

## Impact of Tree Root Architecture on Soil Conservation

When massive, deep-rooting trees are present in a catchment, storms or human activities can expose 'large areas of closely spaced, water-saturated, friable root intensive', organic carbon-rich, humic infill at considerable depths. The rapid formation of this infill layer and the 'binding capacity' of such root systems are thought to contribute to a substantial decline in cation leaching from the ecosystem over a short period of time. Furthermore, and importantly in the present context, well-developed root systems can 'reach a far larger volume of soil below the potential slide plane (Germon et al., 2020). Density of tree roots takes place in close proximity to the slide. In the long-term, following slope stabilization, it is anticipated that low root tensile strength roots undergo decay, become highly aggregated organic matter, indirectly enhancing soil aggregation. Soils overridden by slide initiation points are therefore likely to have good drainage and should resist further instability, and transport of clay and silt materials within these soils to the stream channel should largely stabilize the slope and wider catchment.

## Water Infiltration Enhancement

Trees produce many root channels of high hydraulic conductivity through the soil matrix. Various studies of land application of treated municipal wastewater demonstrated that wastewater disposal fields planted with trees infiltrate water at a higher rate and volume than do fields without the trees. Standing trees may be the only choice when right-of-way space is at a premium or a steep slope precludes other right-of-way uses. High-value sustainable crops, particularly fruit and landscape trees and turfgrass, do not rehabilitate landslides and are better maintained and enriched by the greater soil moisture that tree-aided infiltration can provide. Thus, tree root channels formed during the growing season provide the most desirable infiltration conduit for stormwater management throughout the entire year.

## Agroforestry Systems

Agroforestry systems, characterized by the spatial arrangement of trees and crops, have been a traditional land use in several regions in the world. The development of a root-dividing tool has allowed root system architecture measurements for plants in this land use. Since its application in doubled-row plantations, root system architecture traits have remained unchanged, showing vertical segregation of root orders. There is a large variety of arrangements, depending on specific agroforestry implementation. All these systems generally include fruit trees. Generally, the purpose of using them has been to protect and maintain soil, although diverse economic benefit derived from spontaneous or managed understories could also be secured.

## Urban Tree Plantings

In urban areas, tree roots and therefore soil are often heavily compromised by infrastructure. These areas can feature a combination of non-compacted, uncompacted, and heavily compacted soils, yet they are crucial locations where the utility of trees to provide soil/water/dissolved chemical retention during storm events is greatest. Even in compacted soils, trees can perform this service if their root systems are extensive and effective enough. This reduction of soil infiltration and biodiversity in urban areas reduces the functioning of the urban forest but also has serious downstream water quality impacts and legal implications.

## Conclusion

Tree root architectural research is a rapidly evolving field. Because root architectural traits can be linked to many other plant traits, there is enormous potential for developing new methods for selection of both genotypes and phenotypes in breeding programs for genetic root architectural components that contribute to soil conservation and serve a number of ecosystem services, beyond those we have documented here for soil conservation such as support for the above ground forest components, water conservation and protection of both soil and water from the effects of storm events. Use of GPS to map the root system should provide a new arsenal of data for examining the particulars such as substrate modification, distance to steep sections, overspill or drain off of underground sources.

## References

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