FOR184

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# Urban Forests in Florida: Trees Control Stormwater Runoff and Improve Water Quality[1]

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Along with human actions, the trees, vegetation, pervious soils, and human structures that make up an urban forest influence several hydrological functions in ways that can affect the quality of life of people living in the urban forest. An area of particular concern is the loss of natural forests and tree cover in and around urban areas due to development. This loss can result in increased stormwater runoff and decreased water quality. Neighborhoods with fewer trees have the potential for increased stormwater, pollutants, and chemicals flowing into their water supply and systems, resulting in health risks, flood damage, and increased taxpayers' dollars to treat the water. Communities can lessen the effect of these damages by maintaining or increasing the numbers of trees in their communities and by minimizing roads and other impervious surfaces. In this fact sheet we will show how individual trees and urban forest cover assist in maintaining our watershed health, improve water and soil quality, and lower maintenance and construction costs of water storage and treatment systems.

## How do Trees Affect the Water Cycle?

Trees are part of the water cycle, as illustrated in Figure 1. A tree's leaves and branches create a tree crown. The crowns of many trees together make up an urban forest's canopy.  When it rains, most of the raindrops hit a leaf or branch surface and remain there a while in "temporary storage" before they are released by evaporation into the atmosphere or by drops falling to the ground.

The brief retention of rainwater by the tree canopy is called rainfall interception. Studies of rainfall interception indicate that interception rates are primarily dependent on the type and amount of leaves. Studies have shown that a mature deciduous tree (deciduous trees, such as sweetgums, lose leaves during the winter) can intercept 500–700 gallons of water per year. Mature evergreen trees (evergreens, such as magnolias or pines, retain their leaves year round) can intercept more than 4,000 gallons per year (Cappiella and others 2005). Rainfall interception also varies based on tree density, the types of plants growing under the tree canopy, and climate (the

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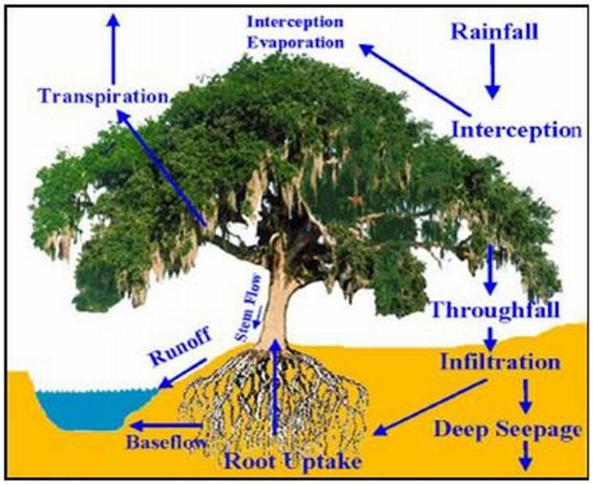


**Figure 1.** Urban trees are a key link in the cycle of water between the atmosphere and urban areas. From: Korhnak. 2000.

climate in an urban area is partly determined by the way the land in that area is used). For example, Table 1 <link to Table 1> shows that suburban and rural areas can intercept more rainfall than urban areas in central California. Although the vegetation and climates differ between Florida and California, Table 1 also shows the amount of rainfall that a Florida pine flatwood forest can intercept. The time of year that rain falls is also important (rainfall in winter, when deciduous trees lose their leaves results in less interception).

after a rain storm. It flows over the surface towards natural waterways and/or constructed stormwater systems. By intercepting some of the rain, tree cover can reduce the amount of money needed to construct stormwater management systems, thereby saving a community's funds. In Santa Monica, CA, rainfall interception was measured for 29,229 street and park trees. Researchers found that the trees intercepted 1.6% of total precipitation over a year, providing an estimated value of $110,890 ($3.80 per tree) saved on avoided stormwater treatment and flood control costs associated with runoff (Xiao and McPherson 2003).

Water that is stored on tree canopy surfaces may either be returned to the air by evaporation or transmitted to the ground via the leaves and bark for root absorption. The tree uses some of the absorbed rainfall and eventually releases the unused portion back into the atmosphere through a process called transpiration. Florida researchers found that substantial amounts of rainfall are transpired by a Florida pine forest (Riekerk and others 1995).

Water in the canopy that is not evaporated or absorbed will drip down to the ground as the canopy fills with water. Rainfall flowing from the trunk (stemflow) reduces the impact of the raindrops and

**Table 1.** Comparison of annual rainfall interception by tree cover in urban lands in Sacramento County, California and a natural forest in Alachua County, Florida.

| Type of land | Annual rainfall (mm) | Rainfall intercepted (%) |
|---|---|---|
| Urban Lands<br>Sacramento County, CA[1] | | |
| City | 393.2 | 6 |
| County | 414.1 | 11 |
| Suburban | 433.2 | 13 |
| Rural | 415.5 | 13 |
| Natural Forest<br>Alachua County, FL[2] | | |
| Pine Flatwoods | 1040-1238 | 18 |
| From: [1]Xiao, Q.F., E.G. McPherson, J.R. Simpson, and S.L. Ustin. 1998; [2]Riekerk, H., H. L. Gholz, D. G. Neary, L. V. Korhnak, and S. G. Liu. 1995. | | |

Individual trees intercept only a small percentage of the total rain, and, as a result, are not as effective at reducing and slowing the delivery of stormwater as is an urban forest cover. Stormwater is the rainfall that accumulates on the ground during and immediately

prevents some of the ground and soil displacement that causes erosion. The leaf litter underneath the tree serves as a sponge for the water. Trees can also absorb water in the soil by root uptake. Together, the roots and leaf litter stabilize soil and reduce erosion.

Without leaf litter, the tree canopy does not prevent soil erosion. Foot and vehicle traffic, roads, and removal of tree cover can result in soil becoming compacted, which reduces the infiltration or downward movement of water from the surface into the soil. Reduced infiltration causes more rainfall to run off, increasing stormwater volume and the potential for flooding.

## How Can Urban Forests Reduce Stormwater?

Since the amount of impervious surfaces (e.g., parking lots, roof tops, driveways, roads) is increasing in many communities, rainwater cannot infiltrate and runs off as stormwater. The community's urban forest cover, or the sum of all trees, vegetation and pervious soils and their ability to intercept, evapotranspire, infiltrate, and store rainfall, affects watershed hydrology, particularly storm flow and baseflow (e.g. dry-weather water flow). EDIS fact sheet FOR95 – Chapter 6: "Restoring the Hydrological Cycle in the Urban Forest Ecosystem," provides additional information on urban hydrology. Maintaining existing urban forests and planting trees and vegetation in strategic places will increase the opportunity for stormwater to be absorbed into the ground which will help clean the water of pollutants before it eventually flows into drainage systems and the water supply. The purpose of drainage systems in urban areas is to move stormwater quickly away from homes and businesses to reduce the risk of flooding. Urban forests can reduce the load on drainage systems. For example, urban forest cover in Dayton, Ohio reduced runoff from a storm by 7% (Sanders 1986) and heavily forested areas near Baltimore, Maryland reduced total runoff by as much as 26% (Neville 1996). Tree canopy over soil or vegetation is much more effective at reducing runoff than tree cover over impervious surfaces.

## How Can Trees Reduce Pollutants?

Research has found that water quality is strongly related to runoff (Xiao and others 1998). Stormwater flows into the community's stormwater system and ends up in a stormwater treatment/management system or flows directly into a water body. Before reaching a stormwater system or water way, stormwater picks up and transports heavy metals, fertilizers, bacteria, pesticides, trash, and other harmful substances from roadways, sidewalks, yards, and homes. Urban forests can reduce stormwater, as well as act as a sponge for rainfall and shelter to the soil. Tree roots, leaf litter, and vegetation can remove pollutants, sediment, and nutrients from the stormwater, lessening the amount of harmful substances reaching our ground or surface waters. Most pollutants absorbed by plants are transformed into non-harmful forms. Finally, tree canopy over streams and wetlands can reduce water temperatures, thereby increasing dissolved oxygen and reducing the formation of nuisance algae.

## Summary

Trees and vegetation are valuable parts of our urban ecosystem for the numerous benefits they provide to communities. Proper management of the urban forest will reduce stormwater runoff and improve water quality. The following practices can help achieve this:

- Maximize the amount of growing space and understory vegetation around a tree.
- Preserve established trees and minimize soil compaction, displacement, and erosion around a tree.
- Minimize clearing of trees and vegetation to preserve their benefits and minimize soil compaction.
- Do not over fertilize or over irrigate your trees or lawns.
- Route excess stormwater to bioretention areas made of a vegetated buffer and a soil bed to filter pollutants, store water, and prevent erosion.
- Include tree and vegetative strips in parking lots to collect, store, and treat the runoff.
- Maintain and increase the amount and width of urban forest buffers around urban streams, lakes, and wetlands.

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