Is all your rain going down the drain?

Look to Bioretainment— trees are a solution.

Center for
Urban Forest Research

How much rain can a tree retain?

*One tree reduces stormwater runoff by over 4,000 gallons per year.**

More community **trees**
= *equals* =
lower costs
for stormwater control

"Trees retain more water during a 1-inch rainfall event that lasts two days than one that lasts only two hours."

Bioretainment—The New Technology

Trees are the new technology to retain water on site, some permanently, some temporarily, to slow the flow to waterways.

Trees protect water and soil resources. Healthy trees can reduce the amount of runoff and pollutants in creeks, ponds and other receiving waters in three primary ways;

- leaves, branch surfaces, and trunk bark intercept and store rainfall, thereby reducing runoff volumes and delaying the onset of peak flows;
- root growth and decomposition increase the capacity and rate of soil infiltration by rainfall and reduce overland flow;
- tree canopies reduce soil erosion by diminishing the impact of raindrops on barren surfaces.

Urban Hydrology — The Problem

As we build our communities, considerable natural landscape is converted to impervious surfaces such as roads, parking lots, driveways and buildings. Manmade drainage systems, such as sewers and storm drains, are used to accelerate water movement through communities and into drainages and natural waterways. However, water quality suffers when runoff carries contaminants such as oil, metals or pesticides into streams, wetlands, lakes, and marine waters.

Trees Retain Water On Site — Bioretainment

During a rainfall event, precipitation is either intercepted by leaves, branches, and the trunk, or it falls directly through the tree to the ground. Intercepted water is stored temporarily on leaf and bark surfaces. It eventually drips from leaf surfaces, flows down stem and trunk surfaces to the ground, or it evaporates.

What is Bioretainment?

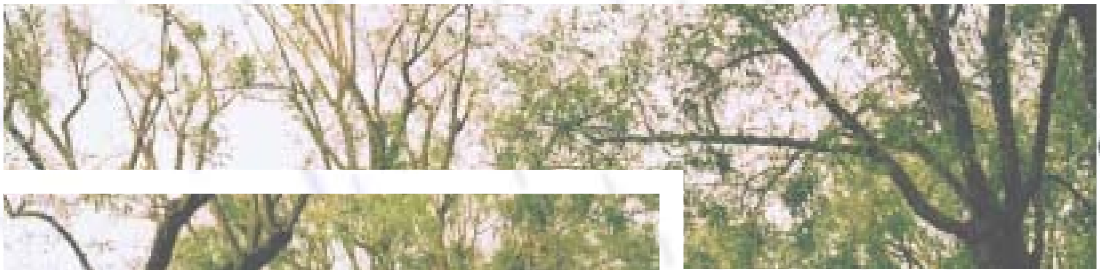
It is the storage of rainfall on leaves, branches and trunk bark. Following the rainfall event, the water is either evaporated directly to the atmosphere, absorbed by the canopy surfaces, or flows down to the ground surface.

Retainment of water is influenced by three factors: character and magnitude of the rainfall event, tree species and their structure, and weather. Not every event will produce the same results because 1) trees retain more water during a 1-inch rainfall event that lasts two days than one that lasts only two hours; 2) tree structure and leaf and bark surface area differ by species and each one controls the flow and storage of rainwater uniquely; and 3) temperature, relative humidity, net radiation and wind speed control the length of time rainfall is retained in storage.

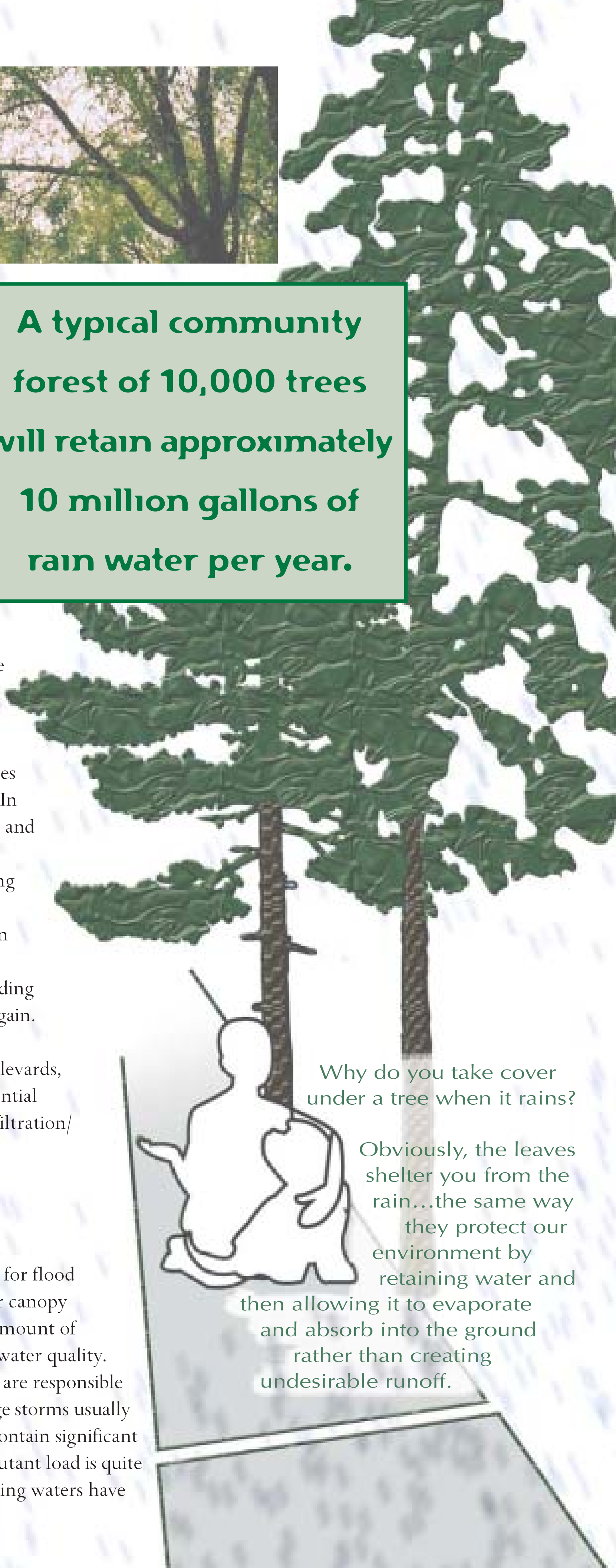
The Type of Tree is Important

The mix of tree species and their size influence interception. In regions where most precipitation occurs in winter, evergreen trees play the most important role in interception. Trees with evergreen foliage contribute to greater interception than deciduous trees. Some conifers intercept more rainfall than similar sized deciduous trees. In climates with summer precipitation, deciduous trees make a substantial contribution to rainfall interception. Planting more trees and improving health of existing trees is an important strategy that will help reduce the volume of stormwater runoff.

* One large deciduous tree in coastal southern California



A typical community forest of 10,000 trees will retain approximately 10 million gallons of rain water per year.



HOW TO

Incorporate Bioretainment into the Stormwater Management Process

- Select tree species with architectural features that maximize interception, such as large leaf surface area and rough surfaces that store water.
- Plant trees in small groves where possible.
- Plant low-water-use tree species where appropriate and natives that, once established, require little supplemental irrigation. In bioretention areas, be sure the species can adapt to standing and fluctuating water levels.
- Increase the tree canopy within your community by planting more large-crowning trees.
- Match trees to rainfall patterns so that they are in-leaf when precipitation is greatest.
- Plant broadleaf evergreens where appropriate, and avoid shading south-facing windows in the winter to maximize solar heat gain.
- Improve the maintenance of existing trees.
- Plant more trees in appropriate areas such as parkways, boulevards, parking lots, traffic islands, swales, median strips, and residential "rain gardens." This will aid the retention/detention and infiltration/filtration processes.

Urban Forests Produce More Benefits Through Water Quality Protection than Flood Control.

Although trees reduce runoff, they may not be very effective for flood control. Floods usually occur during major storms, well after canopy storage is exceeded. However, by substantially reducing the amount of runoff during less extreme events, urban forests can protect water quality. Small storms, for which urban forest interception is greatest, are responsible for most annual pollutant loading. Infrequently occurring large storms usually produce the greatest flood damage, and although they may contain significant pollutant loads, their contribution to the annual average pollutant load is quite small. Also, because of the infrequency of large storms, receiving waters have relatively long periods of recovery between events.

Why do you take cover under a tree when it rains?

Obviously, the leaves shelter you from the rain…the same way they protect our environment by retaining water and then allowing it to evaporate and absorb into the ground rather than creating undesirable runoff.

What is the Value of Bioretainment?

To estimate the value of bioretainment, we use stormwater management control costs based on minimum requirements for stormwater management in a particular region. For example:

- In Western Washington, for a 10-acre, single-family residential development on permeable soils it costs approximately $0.02779/gal to treat and control flows stemming from a 24-hour storm.
- In Fresno, the average cost for constructing and maintaining a typical detention/retention basin is $121,439/acre. With a 50 percent probability of filling 10 times in a 20-year period, the cost of detention/ retention is $0.0077/gallon.
- In Los Angeles, it costs approximately $0.0183/gal to treat sanitary waste, and we assume a similar cost for stormwater.

Trees manage stormwater runoff. They help reduce pollution and make waterways healthy for people and fish.

To calculate benefits, we multiply the management cost by gallons of rainfall intercepted after the first 0.1 inch has fallen for each storm (24-hours without rain) during the year, depending on the region. Based on surface detention calculations, the first 0.1 inch of rainfall seldom results in runoff. Thus, interception is not a benefit until precipitation exceeds this amount. Check out our website at *http://cufr.ucdavis.edu/* to see all the other benefits trees provide.

NOTE: In looking for solutions to stormwater runoff it is important to consider an integrated approach that uses other water conservation, water retention, flood management, and pollution control strategies. Community solutions include but are not limited to porous pavement, vegetated swales and filter strips, recharge areas under parking lots, holding tanks and cisterns under playfields, surface area holding ponds, turf grass filters, and riparian retention and treatment areas.

We conduct research that demonstrates new ways in which trees add value to your community, converting results into financial terms to assist you in stimulating more investment in trees.

This summary is based on Dr. Xiao's research published in the *Journal of Arboriculture* in 1998.

Xiao, Q. F.; et. al. 1998. *Rainfall interception by Sacramento's urban forest.* J. Arbor. 24(4): 235–244.

For more information, refer to the following publications:

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McPherson, E. G.; 1998. *Structure and sustainability of Sacramento's urban forest.* J. Arbor. 24(4): 174–190.

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