The Tree Project
Integrated Urban Environmental Improvement Through Tree Selection and Management
Trees and Water Quality

Trees and Water Quality - Background

Deforestation for commercial and residential development has led to polluted waterways and increasing flood damages, averaging over $3.1 billion annually (Hopkins, 1997). Stormwater, by definition is the water from rain or melting snow that fails to percolate through the soil or get soaked up by vegetation, instead moving across streets, sidewalks, parking lots, and pouring into storm sewers (Hopkins, 1997) Urban stormwater runoff is the second most common source of water pollution for lakes and estuaries, and the third most common source for rivers nationwide (Boulder report). Therefore, perhaps the greatest ecological benefit, as well as economic benefit that urban forests provide is stormwater management. Undeveloped, natural lands absorb falling rainwater to a greater extent than urban areas covered by impervious surfaces (e.g. pavement, buildings). Rainfall running over city streets and parking lots washes pollutants deposited by automobiles and other sources off these surfaces and into waterways, affecting both the quanity and quality of water (Boulder report). Trees help improve water quality by 1) intercepting and storing rainfall on leaves and branch surfaces, preventing the water from hitting the ground, reduc

Trees affect water quantity by intercepting rainfall and reducing flows, thereby reducing, or slowing the amount of stormwater flowing back into streams.

Technical Issue	Benefit/Potential Effect	Cost/Potential Issues	Notes
Above Ground Effects			
Rainfall Interception (Bioretainment)	Trees reduce stormwater runoff by intercepting and storing rainfall (referred to as bioretainment) in leaves, branch surfaces, and trunk bark, thereby reducing runoff volumes and delaying the onset of peak flows (I.e. the highest flow encountered in a waterway, during high rainfall or long periods of wet weather)	In urban areas, considerable natural landscape is converted to impervious surfaces (I.e. roads, parking lots, driveways, buildings). Manmade drainage systems (I.e. sewers, storm drains) are used to accelerate water through communities, into drainages and natural waterways. Water quality suffers when this runoff is not filtered, and carries contaminants such as oil, metals or pesticides in streams, wetlands, marine waters.	Rainfall interception is measured by: 1) intensity and duration of rainfall event 2) tree species (broadleaf evergreens intercept more rainfall than deciduous where winter rainfall patterns prevail 3) tree architecture (size, number and arrangement of leaves/branches 4) temperature (humidity, net solar radiation, wind speed) (fact sheet)
	During a rainfall event, precipitation is either intercepted by leaves, branches, or trunk, storing rainfall temporarily, or falls directly to the ground.		Trees store more water during a 1-inch rainfall event that lasts 2 days vs. one that lasts only 2 hrs. Therefore, small storms are responsible for most annual pollutant loading of waters, trees are most effective at intercepting during small events, and "urban forest are likely to produce more benefits through water quality protection than flood control".
Evaporation	Some of the intercepted precipitation by the tree surfaces is evaporated back into the hydrologic cycle, cooling air temperatures, and preventing some excess runoff (powerpoint).		Study found that typical medium-sized tree can intercept 2380 gallons of rainfall per year.
Below Ground Effects			

Pollution filtration	Trees provide a filtration system that removes significant amounts of pollution from the water itself. The tree canopies, trunks, roots, and associated soil and other natural elements of the landscape filter polluted particulate matter out of the flow toward the storm sewers. By reducing the flow of stormwater, trees reduce the amount of pollution that is washed into a drainage area. Trees use nutrients like nitrogen, phosphorus, and potassium--byproducts of urban living--which can pollute streams (colorodotrees.org).		CITYgreen computer modeling software, in conjunction with ArcView GIS program will quantify vegetation's effects on stormwater.
Permeation & Infiltration	Organic matter from leaf litter and other tree detritus tend to increase infiltration rates by increasing pore spaces in soil. Deep roots improve the rates of perclation of water from the upper soil horizon into the lower soil levels. (ppslide)	Soil compaction is an issue.	
Groundwater Replenishment (coloradotrees.org)	Trees keep the soil porous so that rainwater soaks in and downward into the soil to recharge underground aquifers.	Soil type, and rainfall are factors.	Trees provide their greatest benefit during light rains by increasing soil permeability, which faciliatates the groundwater recharge. Reducing impervious surfaces and increasing tree cover promotes movement of water into the water table (American Forests)
Trees and Phytoremediation	Phytoremediation - alternative clean-up technology that exploits the action of plants and their associated microbes to alleviate hazardous soil contamination. Plants can transform organic compounds that are assimilated through their roots and the rhizosphere (root system) provides an excellent environment for the adsorption and microbial transformation of organic compounds (Erickson, et al, n.d)	Certain species are more adapted to grow in soils containing heavy metals (e.g. nickel, lead, zinc, copper) and organic contaminants (trinitrotoluene, TNT) (Punshon, n.d.) than others, proper selection is required.	Poplars (and Willows, due to their fast growth) are the plant species of choice for the Phytoremediation studies due to recent findings suggesting they can take up and degrade organic contaminants and certain heavy metals (Punshon, et al, n.d).
	Phytoremediation needs only solar energy-inexpensive and widely available. "Evapotranspiration may be viewed as a solar driven pump-and-treat system that helps to bring contaminants to the rhizosphere (plant root system) and contain them on the site."		
Trees and Water Quality: Soil Erosion	The urban forest reduces soil erosion by reducing the rate and flow of stormwater runoff. It provides a physical barrier (roots and fallen branches) that spreads out water flow. Exposed soils located near impervious surfaces are especially vulnerable to eroding. The maximum soil retention benefit can be obtained when vegetation is covering exposed soil. When soil is supporting a tree, much of the available potential root space is occupied by a fine fibrous root system, especially in the upper 6 to 8 inches, the area most vulnerable to erosion.		"The sedimentation associated with soil erosion causes up to $7 billion in damage annually, destroying fish habitat and falling in channels and reservoirs." (Hopkins, 1997)

	Because trees and their root system hold soil in place, they prevent physical disruption of aquatic flora and fauna by preventing sediment and pollution flows into waterways.		Researchers have found a 1,000 fold increase in the erosion of soil in areas undergoing development compared to forested land (Lull and Sopper, 1969).
			For solutions to stormwater runoff, use an integrated approach that uses trees along with many water conservation, retention, pollution control strategies: porous pavement, vegetated swales/filter strips, recharge areas under parking lots, holding tanks under playfields, surface area holding ponds, turf grass filters, riparian retention/treatment areas (for more info: treepeople.org) (fact sheet)
			For every 5% tree cover added to a community, stormwater runoff is reduced by 2% (coloradotrees.org)
*American Forests Studies-Many on stormwater, all computer models8/2/2005 http://www.americanforests.org/downloads/graytogreen/stormwater.pdf			

APPENDIX G

Background Research-5

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