Making the Connection Between Woodlands and Water

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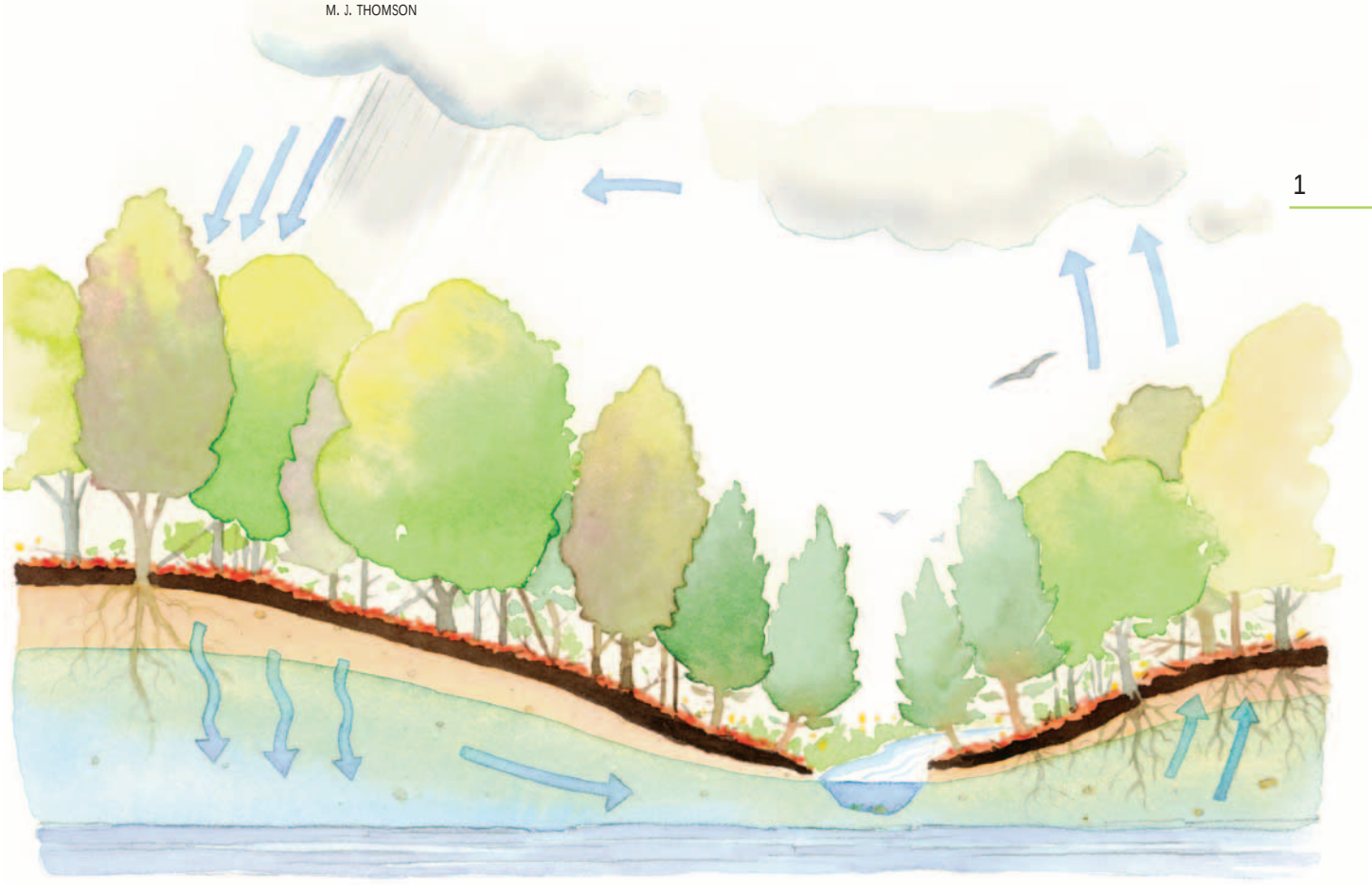

The Hydrologic Cycle

Precipitation falls from the atmosphere to the ground. Water can be intercepted by vegetation and evaporate directly into the atmosphere. It is also absorbed by trees and other vegetation and transpired through their leaves back into the atmosphere. Most of the water either flows from the surface and collects in watercourses, or infiltrates into groundwater flow. In vegetated areas, water infiltrates slowly and consistently, and is filtered as it flows through the aquifer.

All living things on our planet depend on water for their existence. In the vast sweep of evolution, all life is descended from species living in water. And, despite extreme variations in size, shape and character (not to mention habitat preference), no species has developed the ability to survive without water.

Roughly six billion people inhabit the earth today. As human populations increase, the pressures on our environment increase too. Greenhouse gases pollute the air and cause long-term climate change. Natural resources are being depleted. While renewable energy sources may one day replace fossil fuels, nothing can replace water. We must, then, be ever more active in safeguarding and improving its quality. Of all the tools available to assist us in doing this, forests are among the most important.

Like wetlands, forests store great volumes of water in themselves. They help replenish underground stores of water and protect watersheds by limiting erosion and flooding. Many life forms are dependent on forest habitats. Also, forests modify climate by being key players in the hydrologic cycle — the global process that keeps water perpetually in motion. The trend of ever-hastening loss of forest cover is contributing to a dangerous disruption of natural systems.

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Forest hydrology

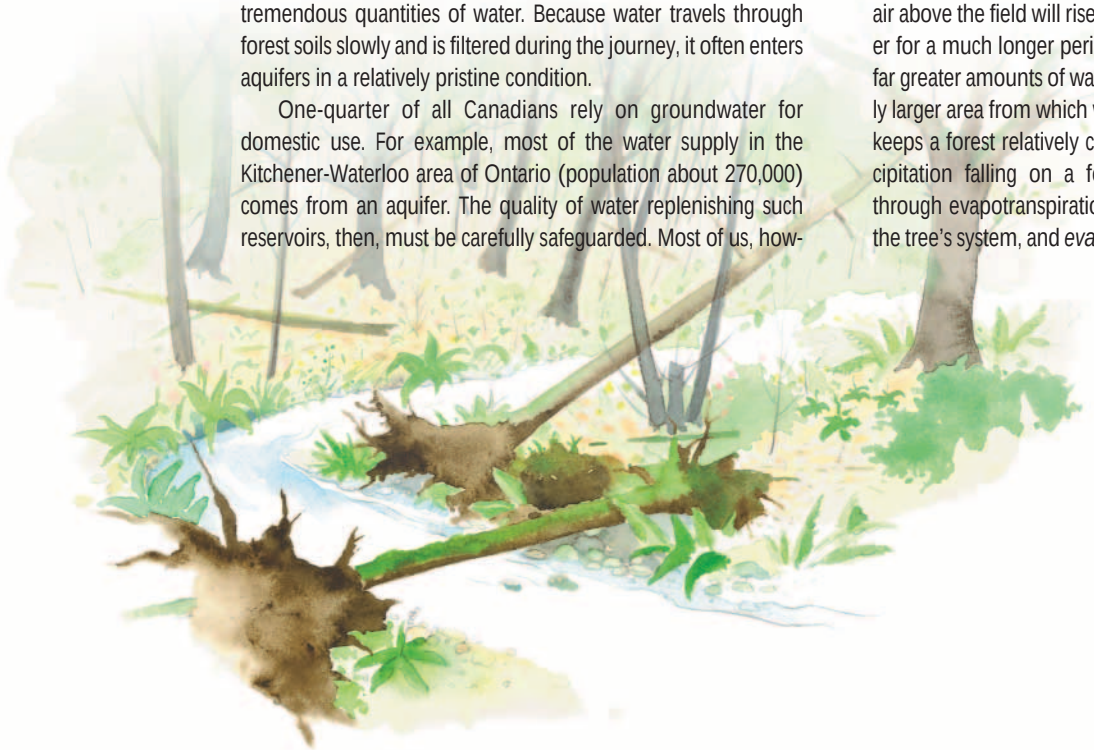
Forests store and recycle vast quantities of water. They are an indispensable component in the hydrologic cycle. Simply put, the sun's heat makes water evaporate from oceans, lakes and rivers. When the temperature of the air is cool enough, this moisture condenses and falls in forms like rain and snow. Most of this water re-evaporates into the atmosphere relatively quickly. The balance makes its way into surface water in lakes and rivers – or is absorbed into the ground and finds its way into aquifers (underground water storage).

When it rains or snows, the forest canopy "catches" the moisture. This aspect of the hydrologic cycle is known as "interception." Between 20 and 30 percent of the precipitation that falls on a forest evaporates. If rain or snowfall is heavy, the canopy will be unable to hold it for long, and the excess will either trickle down the branches and trunks (called "stemflow") or fall directly from the canopy to the ground ("throughfall").

Water reaching the forest floor will be readily absorbed. Its transit into the ground is called "infiltration." Particularly in older-growth forests, a substantial layer of organic matter – decaying leaves and tree limbs, incorporated by worms and burrowing animals into the soil – allows the water to be easily absorbed. The root systems of trees (living and decaying) act as conduits to extensive aquifer systems. Cracks in the bedrock or masses of sand, gravel or other mineral substances act like sponges to hold tremendous quantities of water. Because water travels through forest soils slowly and is filtered during the journey, it often enters aquifers in a relatively pristine condition.

One-quarter of all Canadians rely on groundwater for domestic use. For example, most of the water supply in the Kitchener-Waterloo area of Ontario (population about 270,000) comes from an aquifer. The quality of water replenishing such reservoirs, then, must be carefully safeguarded. Most of us, however, consume water from the surface. The safety of such sources is better protected when the headwaters – the areas where water starts to collect into streams – are forest-covered. Infiltration can be hindered by unsound forestry and agricultural practices, and also by urban development. When the layer of organic matter is cleared away or the ground is compacted as a result of road building or machinery movement, absorption occurs less readily. In deforested regions, as the water is drawn out and the soils above become compacted, aquifers may become significantly and permanently depleted.

The extensive root systems of trees are able to draw up water stored deep in the ground. Obviously this explains why they are able to survive drought more successfully than smaller, more shallow-rooted plants. Any water drawn up by a tree's roots and not used by the tree itself is returned to the atmosphere through the surfaces of the leaves as vapour. "Transpiration," as this process is called, profoundly affects climate. A mature tree might transpire about 900 litres of water in a day. Magnify this output across an entire forest, and the effect of so much groundwater being released is significant. On a hot, sunny day, low-growing plants in an open field will transpire the water available to them very rapidly. Once the moisture is used up, the temperature of the air above the field will rise. Temperatures in a forest will stay cooler for a much longer period of time, because the trees can draw far greater amounts of water, and the leaf surfaces provide a vastly larger area from which water can evaporate. Transpiration then keeps a forest relatively cool. Roughly three-quarters of the precipitation falling on a forest is returned to the atmosphere through evapotranspiration. That is, water is *transpired* through the tree's system, and *evaporates* from the surfaces of the leaves.



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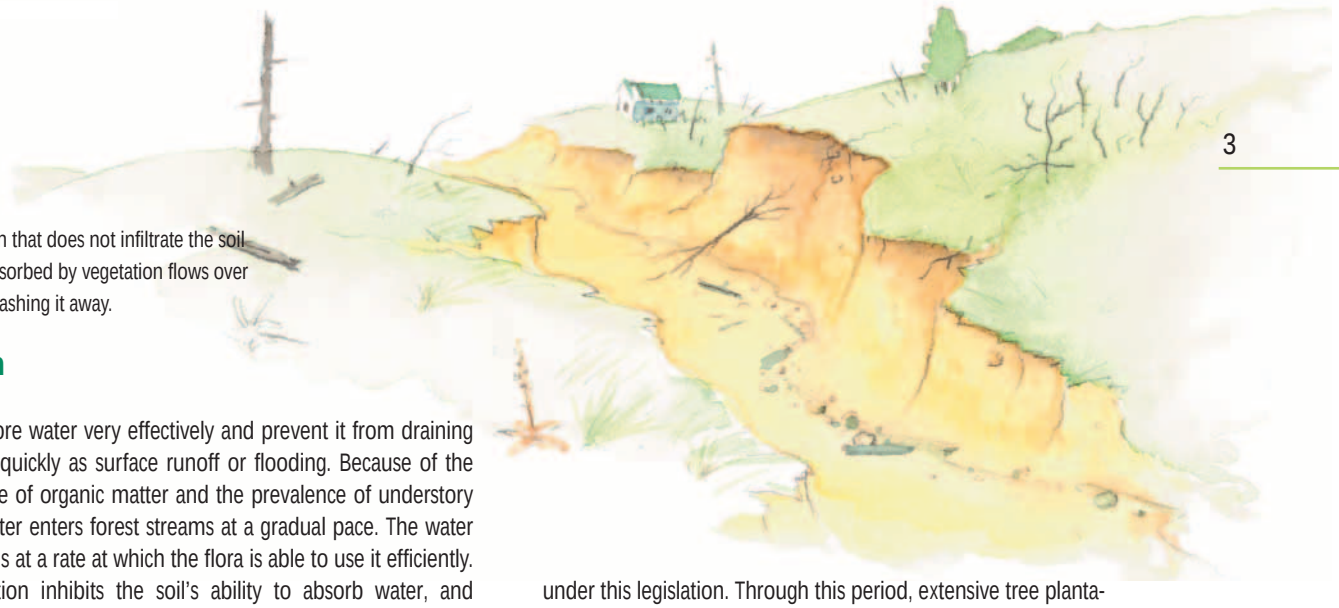

Precipitation that does not infiltrate the soil or is not absorbed by vegetation flows over bare soil, washing it away.

Erosion

Forests store water very effectively and prevent it from draining away too quickly as surface runoff or flooding. Because of the abundance of organic matter and the prevalence of understory plants, water enters forest streams at a gradual pace. The water thus travels at a rate at which the flora is able to use it efficiently. Deforestation inhibits the soil's ability to absorb water, and increases the rate of runoff. In the event of a heavy rainfall or snowmelt, erosion is inevitable. Not only is this water carried away and no longer available to whatever vegetation remains, but it carries with it fertile topsoil that may have been accumulating for millennia. The landscape is disfigured by gullies, and costly damage to human property can occur.

Of even greater concern is the detrimental effect on water quality downstream and on groundwater. Pollutants are rapidly washed into watercourses, threatening entire ecosystems. Surface drinking-water sources may be contaminated. When a great volume of precipitation cannot be absorbed into the ground at a gradual rate, water levels in streams and rivers are prone to rise rapidly. This may result in flooding, collecting and concentrating pollution, and endangering human life.

As early as the 1870's, much of Southern Ontario's original forest cover had been lost. In some counties - notably Simcoe and Northumberland - sandy soils and hilly terrain made agriculture an unsustainable enterprise; much land was left fallow and, without sufficient vegetation to encourage infiltration of precipitation, erosion was inevitable and widespread. The *Ontario Tree Planting Act*, passed in 1883 (superceding a less comprehensive act of 1871), encouraged landowners to plant trees along the perimeters of their properties. A financial incentive of 25 cents per surviving tree was paid three years after planting. Building on this wisdom, the *Counties Reforestation Act* (1911) and the *Reforestation Act* (1921) enabled County, then Provincial governments to reforest and manage lands deemed unsuitable for agriculture. By 1940, twelve counties were participating in programs under this legislation. Through this period, extensive tree plantations were established which still stand today. The primary aim of such planting was, as the Department of Lands and Forests stated in a 1947 publication, "putting marginal or sub-marginal farm land into the production of a crop from which revenue may be obtained."

Of secondary and tertiary importance were reclaiming land from erosion damage and protecting the watersheds. Even though thousands of hectares of red pine plantations did not constitute restoration of the original woodlands, erosion was dramatically reduced. Evapotranspiration increased. And now, decades later, many of these plantations have been colonized by other species of plants, as natural regeneration and succession takes place.

Only with the establishment of Ontario's Conservation Authorities in 1946, was there some action to legislate the protection of the province's watersheds. It is the mandate of Ontario's more than 300 Conservation Areas (administered by 36 different Conservation Authorities) to "ensure the conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs."

Before European settlement, more than 90 percent of southern Ontario is estimated to have been forested. Less than 0.07 percent of the land area is in old growth forests now. Much land has become reforested, largely through natural regeneration, as marginal farmland is abandoned. These young forests are beneficial to the hydrologic cycle and limit erosion in the same way the plantations of Simcoe County do. Unfortunately, plantations lack the complexity of older-growth forests and may take hundreds of years to reach a state of old growth once again.

The Lesson of Walkerton

The safety of groundwater for human consumption has become an issue of great concern to Ontario citizens and legislators. The Walkerton tragedy forced people in this province and far beyond to re-examine the sources of their drinking water. In May 2000 the subject literally became a life and death matter in Walkerton (population 4,800), the county seat of Bruce County. Following a large rainfall, seven people died and more than 2,300 others became ill. The cause of the tragedy was ingestion of *E. coli* (*Escherichia coli* 0157:H7), a very harmful strain of bacterium that had contaminated one of the wells from which the town was drawing its water. The source of the bacteria was manure spread (according to accepted methods) on a farmer's field.

In the aftermath of the tragedy, a judicial inquiry took place, headed by Mr. Justice Dennis R. O'Connor. The two-volume *Report on the Walkerton Inquiry*, published in 2002, sums up the proceedings. The inquiry found that poorly trained operators of the water-treatment facilities and inadequate inspections by Ministry of the Environment officials were in large part to blame. Of the 93 recommendations made in Part Two of the report, protection of water sources was deemed to be the most important: "Drinking water sources should be protected by developing watershed-based source-protection plans. Source protection plans should be required for all watersheds in Ontario." The root of the problem was ultimately the contamination of groundwater in that area.

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Illustrations by Clive Dobson

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The Federation of Ontario Naturalists (FON) protects Ontario's nature through research, education, and conservation action. FON champions woodlands, wetlands and wildlife, and preserves essential habitat through its own system of nature reserves. FON is a charitable organization representing 25,000 members and supporters and 125 member groups across Ontario.

Fact sheets in this series include:
Cores and Corridors: The Importance of a Green System in Southern Ontario
Forest Fragmentation
Introducing Old Growth – The Ultimate Forest
10 Ways to Save Your Local Woods (and Water!)
Urban Forests: An Important Part of Our Natural Heritage
Making the Connection Between Woodlands and Water

Woodlands At Risk is a 32-page full colour booklet about the threats to southern Ontario's woodlands, available from FON.

If you wish to support FON or learn more about current conservation issues in Ontario visit: www.ontarionature.org

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