

# How Forests Help Cities Manage Water



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## The Challenges of Flooding in Cities

Paris spent several days on high flood alert this January, after some unusually heavy rain. The amount that fell in December 2017 into January 2018 was the second highest in the same period since the winter of 1935 to 1936 (Meteo France, 2018). The River Seine peaked at 5.84 metres on 29 January 2018, up from its normal level at this time of year of 1.5 metres, forcing authorities to suspend traffic, close railway stations and schools, and

evacuate 1,500 inhabitants from their homes. The city suffered significant economic consequences as tourist boats were shut down and inland waterway cargo transport was out of business for weeks. Floods like these are anticipated to become more frequent in Europe with climate change (EEA, 2017), making their effective management one of the most pressing challenges facing European cities.

Winter rainfall is expected to get heavier across much of Europe by up to 35% towards the end of the century, compared to 1971-2000 (EEA, 2017). After long periods of heavy





► rain, the land becomes saturated with water, preventing subsequent rain from soaking into the ground. Short but intense rainstorms generate floods in a similar way – the rain falls faster than it can permeate the soil, instead flowing over the land surface and rapidly creating a flood (Archer and Fowler, 2015). In cities, the impermeable roads, footpaths and buildings likewise prevent rain from infiltrating into the soil. Instead, the water flows quickly over these hard surfaces, picking up oil, sediments and other pollutants, and carrying them to rivers and storm drains. Increasing urbanisation means more natural surfaces are concreted over, making flooding more likely.

Because of these climatic changes and urbanisation, flooding is becoming one of Europe's most costly natural disasters, causing loss of life and economic damage. A 2014 study predicted that, in the European Union, average annual economic losses from floods would rise from 4.6 billion euros between 2000 and 2012 to 23.5 billion euros by 2050 (Jongman et al., 2014). The damage to property and infrastructure and losses of agricultural crops and livestock are expensive to repair. Moreover, the disruption to services prevents normal economic activity resuming, as witnessed in Paris.

The direct impacts on people is significant too: the European Environment Agency estimated that more than 2,000 people were killed and 8.7 million affected by river and coastal floods in the European region between 2000 and 2014 (EEA, 2016). On top of losing homes and possessions, people affected by flooding are exposed to contaminated drinking water, electrical hazards while cleaning up, and other health risks. Mental health is also often affected, with some people developing mild depression and other disorders. These impacts have social and economic costs due to lost working days and the costs of healthcare. When floods occurred in England in 2007, public health costs were estimated at £287 million, 9% of the total cost of the flood (WHO, 2013). These high health, social and economic costs, particularly in cities where people and



economic activity are concentrated, make it imperative that we redouble our efforts to reduce flooding and its impacts.

### Trees provide Multiple Benefits in Cities

Managing urban flooding has relied traditionally on intricate systems of dykes, flood walls, dams and reservoirs, while the pollutants it carries are removed from water by complex treatment processes. Although these technologies have facilitated the development of many European cities, flood protection structures are often not designed for the large floods that will be more frequent with climate change, and merely move the problem downstream. Treating highly polluted water becomes expensive, and even advanced treatment plants have no effect on the dirty floodwaters that run straight off the land into rivers.

This is where trees come in. City planners are increasingly looking to nature, including urban forests and street trees, in combination with wetlands and other nature-based solutions, to help relieve some of their water-related burdens. Reducing flooding using nature works by restoring the natural hydrological processes that slow down rainwater and allow it to soak into the ground. Leaves and branches catch falling rain, which can then drip off slowly over time, and trunks and roots increase the roughness of the land surface, slowing down the water flowing over land. Rain falling where trees are planted can infiltrate into the soil more easily than the rain that hits roads and the other hard surfaces abundant in cities.

A 2013 study of street trees found that trees planted in grass plots allowed 100% of rainfall to soak into the soil. Even trees planted in bare soil reduced the proportion of rainfall flowing over the surface by 62% compared to asphalt without trees (Armson et al., 2013). Through these processes, urban trees can work in combination with traditional flood defences to reduce the likelihood and magnitude ►



► of localised flooding (Depietri et al., 2012). The Danish city of Aarhus, for example, has incorporated this idea into its municipal plan, which aims to double the forested area in the municipality between 2012 and 2030, including planting trees specifically to slow down flood waters.

Trees planted in and around cities, as well as other nature-based solutions, offer a host of benefits beyond their contribution to reducing floods. Their shade helps to cool hot city streets, and they can be planted in areas where people congregate or spend time outside, like at bus stops. They can also help to filter pollutants from the air – a high density of urban trees has been associated with lower rates of hospitalisation from asthma in areas where air pollution is high (Alcock et al., 2017). And being able to walk, meet friends, and exercise amongst nature, even in cities, benefits our mental health (WHO Regional Office for Europe, 2016).

These combined benefits have significant economic value too. In the London Borough of Hammersmith and Fulham, 565 trees and shrubs were planted in deprived areas of social housing. In combination with other measures, such as creating grassy basins and rain gardens, they led to 100% of rain falling on the area being diverted away from the storm drain system, reducing the risk of flooding. This and the newly attractive surroundings for residents, training schemes for local young people and the many other advantages of the project added up to a total benefit of £4.39 for every £1 invested (Groundwork, 2016).

### Forest Landscape Restoration for Managing Water

Cities do not exist in isolation: with water, everything is connected – what happens upstream affects the land and waters

downstream, where many cities are located. Deforestation in upstream hills has a particularly important effect on water quality. When rainwater flows over deforested land, it erodes the bare soil, leading to higher sediment loads in rivers. When this land is used for agriculture, pesticides, fertilisers and manure are also washed into rivers and carried downstream.

Conscious of the major benefit that forests provide in filtering sediments and pollutants from runoff, cities are increasingly interested in the watersheds that their drinking water comes from. Currently, a third of the world's cities obtain their drinking water from protected forests (WWF, 2003). In 2008, the Colombian capital of Bogotá established a water fund, which subsidises long-term land conservation in upstream watersheds, both within the city limits and in lands protected at national, regional and local level, to deliver high-quality drinking water for the more than

8 million people living in the region. This effort prevents an estimated 2 million tons of sediment from entering the city's water sources, saving up to \$4 million per year that would be otherwise spent on water treatment facilities (TNC, n.d.). Vienna's drinking water similarly comes from mountain springs in forested areas, now designated as water protection zones. The low-impact forest management in these zones means that Vienna's water is drinkable straight from its source, although it is still purified to guarantee safety.

**1/3 of the world's cities obtain their drinking water from protected forests**

When it comes to the role of watershed forests in preventing floods, the picture becomes more complicated, as these large-scale forests interact with the water system in a different way to the trees and small-scale forests found in cities. For example, deforestation, and the resulting change in land use, affects both rainfall patterns and how that rain is transported to rivers once it falls. It is thought that expanding forest cover upstream only helps to reduce small, localised floods in small watersheds (CIFOR, 2005). We still need more research on the relationship between forests and floods to understand how these complex processes work at large scale, particularly over the long term (IUCN, 2017).

Nevertheless, forests outside cities also support carbon storage, biodiversity, provision of food and medicines, livelihoods for local people, and spiritual, educational and aesthetic values. To maintain these benefits, and because forests are inherently valuable, the

International Union for Conservation of Nature (IUCN) is supporting the restoration of the estimated two billion hectares of land around the world that are deforested and/or degraded (WRI, 2013). The Bonn Challenge is a global effort to bring 150 million hectares of this deforested and degraded land into restoration by 2020 and 350 million hectares by 2030. It was launched in 2011 by the Government of Germany and IUCN, and later endorsed and extended by the New York Declaration on Forests at the 2014 UN Climate Summit. IUCN is the Secretariat of the Bonn Challenge.

IUCN's Forest Landscape Restoration approach, promoted by the Bonn Challenge, aims to restore forest functionality across a large area of land to enhance habitat quantity and quality for biodiversity, mitigate climate change, and benefit local people. It involves planting trees, allowing forests to naturally regenerate or other options depending on the needs of a particular location. ►

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- ▶ Effective Forest Landscape Restoration yields \$7 to \$30 in economic benefits, including from cleaner water, for every \$1 invested. Countries like Costa Rica and South Korea show that large-scale forest restoration is possible – Costa Rica increased its forest cover from 29% in 1991 to 54% in 2015 (WRI, 2017), while South Korea achieved an increase from 35% to 64% between 1953 and 2007 (WRI, 2013). Although 40% of Europe's land is currently forested, only 3% of that is undisturbed by human activity, and increasing urbanisation and demand for timber, and the threat of climate change, are putting European forests under pressure (EEA, 2016). Forest landscape restoration measures are needed to protect these forests and the benefits they provide, both in and out of cities.



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### The Benefits of Forests, in and out of Cities

As water-related challenges become both more common and more damaging, it's important that combinations of management strategies are used effectively, with forests playing a strong role. In cities, this requires strategic spatial planning to ensure that forests and trees are well placed to intercept rainfall and prevent it flowing overland and causing

damage. Furthermore, they should be designed to connect habitat across the city and with its surrounding areas to enhance biodiversity. To protect the watershed forests on which cities rely, strong partnerships with authorities at regional and national level are needed, as well as with other local authorities outside the city.

Protection and restoration of forests is promoted by the European biodiversity policy framework. Target 2 of the EU 2020 Biodiversity Strategy requires that “by 2020, ecosystems and their services are maintained and enhanced, by establishing green infrastructure and restoring at least 15% of degraded ecosystems.” The EU Strategy on Green Infrastructure similarly encourages the systematic development, preservation and enhancement of green infrastructure, including urban forests and trees, to restore healthy

ecosystems and stop the loss of biodiversity, with added benefits for flood management. Protection of existing forests is equally important – the EU Forest Strategy promotes sustainable management to balance the various demands made on them and safeguard their biodiversity. Together, these strategies recognise the value of Europe's forests and other natural capital, and ensure their protection to maintain the benefits they provide to society.

Effective implementation of these policies and of initiatives such as the Bonn Challenge contributes to Europe's efforts to tackle climate change, including meeting the goal of the Paris Agreement to keep the rise in global temperature to well below 2°C above pre-industrial levels. For example, as part of the UK's 7<sup>th</sup> National Communication under the United Nations Framework Convention on Climate

Change (UNFCCC) submitted in December 2017, Scotland has set the long-term target of 10,000 hectares of new woodland per year, which will further increase to 15,000 hectares per year from 2024. These targets are part of efforts to mitigate climate change by capturing carbon from the atmosphere and storing it in forest ecosystems. Reducing the impacts of climate change, including the heavier rainfall predicted for much of Europe, requires

mainstreaming adaptation in other policies. Forests can play a strong role here too – the EU Forest Strategy also aims to ensure forests' capacity to regulate water quality and quantity.

To realise these plans and policy commitments, we need to continue to advance scientific understanding of the complex relationships between forests and water, and to produce good evidence of the other benefits

forests provide. We need to translate this science into guidance on how forests can be best managed and restored to maximise those benefits in ways that take account of the local context. IUCN works to ensure that scientific knowledge can be easily used by decision makers, and seeks to showcase the achievements of cities, regions and countries in protecting and restoring forests to produce clean water and manage flooding for all. ☺



The International Union for Conservation of Nature is the global authority on the status of the natural world and the measures needed to safeguard it. It provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together. The IUCN influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.