The deadly impact of deforestation on water scarcity in Africa

Douglas Sheil, Forest Ecology and Forest Management Group, Wageningen University & Research, PO Box 47, 6700 AA, Wageningen, The Netherlands; Center for International Forestry Research (CIFOR), Kota Bogor, Jawa Barat, 16115, Indonesia; Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, P.O. Box 5003, NO-1432, Ås, Norway.

A changing climate poses severe challenges and dangers.

- Two-thirds of the world's population already suffers seasonal water scarcity. Per capita global freshwater reserves halved between 1960 and 2016, and many groundwater reserves will soon be depleted.
- Over the last century, droughts have caused at least eleven million deaths. Floods have caused seven million deaths. Half a billion people were left in need of emergency aid. Extreme heat events have impacted millions more.
- Such conditions fuel conflict and migration, and have stalled the achievement of the United Nations Sustainable Development Goals.
- Many of the world's most vulnerable people live in Africa, which has a population of 1.2 billion people today and is still growing fast. Climate change in combination with population growth will exacerbate these problems.

The tropical leaf-covered "water-sharing coolers"

The multiple mechanisms, processes and associated feedbacks, by which tropical forests influence climate and water availability remain incompletely understood, but recent years have brought significant advances. We now recognise that these forests provide year-round cooling and stabilise temperatures. Reduced tree cover is generally associated with increased local temperature and temperature variation, and reduced evapotranspiration leading to less cloud, lower humidity and modified patterns of rainfall. Weakening monsoons have also been correlated with deforestation. Typically, when around 50% of tropical forest-cover is lost, local temperature increases by around 1°C, with much greater overall variation (peak highs and lows), and an estimated 18% or more of current global warming reflects these land cover effects (i.e. distinct from greenhouse effects). If we consider impacted locations and heat extremes these forest effects dominate.

The majority of rain over land derives from evaporation from land, though contributions vary with location, season and wind patterns. Most of the evaporation from land derives from forest and tree cover. Air that passes over forests captures more water and produces more rain than air that passes over open vegetation.

Researchers often rely on simulation models to predict the climate impacts of land cover change. Despite many uncertainties, such simulations can provide plausible results, for example, indicating that large-scale tropical deforestation can reduce local rainfall by 40% or more.

The Central African forests and regional climate

Estimates suggest that 83% of West African and 93% of East African tropical forests have been cleared since 1900, while Central Africa, which has approximately 90% of the remaining forest in Africa, has been more stable until recently. Although the region still possesses nearly two million km^2 of closed humid forests, around 10% was lost between 2000 and 2014 and deforestation is increasing.

Simultaneously, Africa's climate is warming, drying and becoming less predictable. The Sahara Desert expanded by approximately 10% over the twentieth century. Rainfall has declined around the Niger Basin, the Congo Basin and the Gulf of Guinea and also throughout West Africa where extreme rainfall events have become more frequent. Modellers generally ascribe these rainfall trends to climate change, shifts in ocean currents and atmospheric circulation, but they are also consistent with the consequences of forest loss.

Much of the rainfall within Africa is recycled. Dependencies change with location and seasons. Atmospheric tracing methods indicate that Central Africa serves as a distribution hub for the continent's atmospheric moisture. One tracing study estimated that 40% of South Sudan's rain came from Central Africa, another estimated 47% for the rain over Ethiopian Highlands, while comparable values occur across the Sahel. Dependencies work both ways with around half of the recycled rain falling within the Congo Basin arriving from outside it.

The Congo Basin's hydrology is less studied than other equatorial areas. Overall, the Congo forests appear hydrologically more vulnerable than those in the Amazon and Asia as the region's rainfall is only just sufficient to maintain its forest. Any decline in rain, such as may occur through reduced rainfall recycling from forest cover loss is a concern as theory shows the resulting feedbacks can tip the system from wet to dry.

The potentially severe impacts of deforestation

Africa's forests sustain and stabilise the region's climate and hydrology, providing major benefits on multiple scales. If degraded, such benefits will decline, and may be lost, with potentially severe consequences. Even without additional land cover change, the potential magnitude and rate of predicted climate change pose a major threat to Africa. Protecting, maintaining and restoring tropical forests offer a cost-effective means to use the stabilising feedbacks provided by tree cover to combat global climate change and protect against regional water scarcity, unreliable rainfall and heat extremes.

Changes to these forests will impact rainfall, temperatures, and water security throughout the continent. The many uncertainties lead to varying opinions regarding the scale, nature and proximity of these threats. Nonetheless, in some credible scenarios, these impacts are severe, rapid and already underway. Whatever weight one might give the likelihood of these scenarios, unless they can be ruled out, they require recognition. Reducing risks requires maintaining forest and forest functions through large-scale forest conservation and suitable land-uses, such as agroforestry, that coexist with forest and sustain tree cover. The costs of addressing these risks are dwarfed by the possible costs of their neglect.