Climate change, flooding and forests

How can forestry help reduce flooding?

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Many parts of the UK are periodically affected by flooding and the frequency of floods is expected to increase due to climate change. Tree planting and forest management can alter flood flows, although the extent of this depends on many factors. Here we describe the latest understanding of how forestry can help.

Effects of forests on flooding

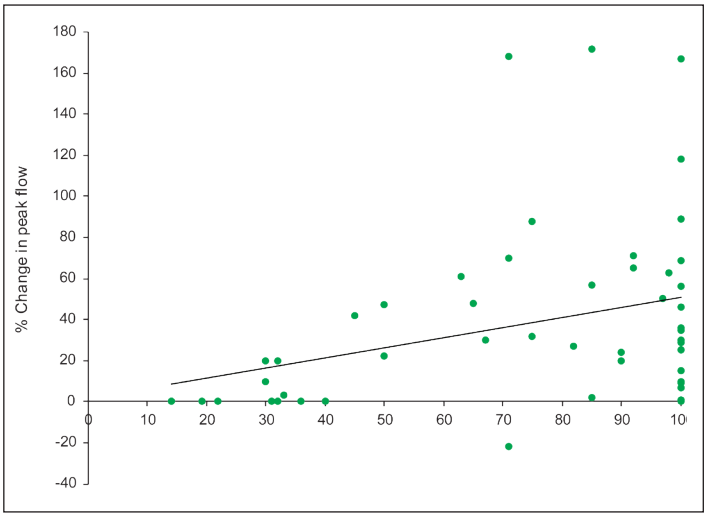
Trees, woodlands and forests are well placed to reduce flood flows and thereby contribute to 'Natural Flood Management (NFM)':

- Trees, which have tall and well-ventilated canopies, can significantly reduce the volume of flood water by evaporating more rainfall than most types of vegetation. Evaporation reduces the amount of storm rainfall reaching the forest floor and results in drier soils that can store more of this water below ground.
- Soils under established forests (forest soils) can readily accept heavy rainfall due to their undisturbed and well-structured condition. Regular inputs of leaf/needle litter and the action of tree roots create an intricate network of large pores, allowing water to pass down into the soil, rather than quickly run off the surface.
- Trees, undergrowth and deadwood on riverbanks, floodplains and within stream channels slow flood flows and increase flood storage. This is most obvious when fallen trees and deadwood form 'leaky woody structures', which hold back and push water out of river channels onto the floodplain.
- The generally well-structured nature of forest soils results in less soil erosion and sediment washing into local watercourses compared to other land uses. This reduces siltation and the need for dredging downstream to maintain open channels to safely convey flood flows.
- Benefits from newly established forests will take time to develop. Practices such as cultivation, drainage and road construction can partially offset or temporarily reverse the benefit, unless carefully managed.

By how much can forests reduce flood flows?

It is difficult to measure the effect of a forest on a flood peak, especially for a large flood, which is a relatively rare event. Most studies have looked at the effect on more frequent, small- to medium-sized floods in small catchments (<10 km^2) and are usually focused on measuring the reverse and quicker effect of tree felling, rather than the longer-term impact of tree planting. Others have used modelling to predict effects based on our understanding of the processes involved. Research shows that the impact of forestry on flood peaks depends on several key factors:

- The extent of forest cover – the greater the proportion of forest covering the land draining to a location at risk of flooding (the upstream catchment), the larger its contribution. Notably, it is difficult to detect a change in flood flows when less than 20% of a catchment is planted or felled. This does not mean that there is no effect



Plot showing the positive relationship between the percentage of a forested catchment felled and peak flows, implying that forest planting will have the opposite effect; this is supported by long-term afforestation studies. Each data point is the measured effect recorded by an individual paired-catchment study. The definition of peak flow varies between studies but are mainly small floods with a recurrence interval of between one and ten years (the highest peak had a recurrence interval of 100 years). Redrawn from Guillemette et al. *(2005): Rainfall generated stormflow response to clearcutting a boreal forest: peak flow comparison with 50 world-wide basin studies.* Journal of Hydrology *302 (1–4), 137–153.*

below 20% cover, only that the effect is small and difficult to measure accurately.

- The size of flood – the larger and more extreme the flood, the smaller the contribution that forestry is likely to be able to make. This reflects the increasing volume of water involved, which can overcome certain forest benefits by saturating soils and submerging or washing-out deadwood.
- The size of catchment – the larger the catchment, the smaller the scope for forestry to reduce downstream flooding. This is due to the increasing dominance of river-channel processes in large catchments (>100 km^2) and the practical difficulty of achieving enough forest cover to have a measurable impact.
- The type of forest and management practices – conifers can reduce flood flows to a greater extent than broadleaves, mainly due to their higher canopy evaporation. Clearfelling will lessen the benefits through the temporary reduction of tree cover.
- The nature of the flood risk – the location and vulnerability of housing or assets at risk of flooding, including the presence of existing flood defences, will determine the degree to which forestry can contribute to flood protection.

Valuing flood benefit and refining the evidence

Research studies have tried to measure the flood-regulation service provided by forests, and a national study generated an annualised central estimate of £89/ha/yr for existing forest cover across Great Britain (based on 2018 prices). This valuation is thought to be conservative and awaits updating.

Government investment in NFM continues to increase as part of a more sustainable and integrated approach to flood protection. This includes support for research, with several major studies under way to improve understanding and our ability to model and value the contribution of natural processes, including new trees, woodlands and forests.

Tree planting on the floodplain can help to slow flood flows and increase flood storage.

More information:

Further details of our work on trees, forests and forestry is available at:

www.forestresearch.gov.uk/research

www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk

https://research.reading.ac.uk/nerc-nfm/

https://post.parliament.uk/research-briefings/post-pn-0623/

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