Briefing on Woodlands and Flood Risk Management; December 2015

Introduction

Recent events have focused attention on flood risk management and the scope for greater working with natural processes. Specifically, there has been a call for more planting of trees within upland catchments to hold back floodwaters and reduce flooding downstream. This briefing describes how trees can contribute to flood risk management, where they can help, and what is being done to support woodland creation for flood alleviation.

How can trees help?

There are a number of ways that trees can reduce flood risk[1]. Firstly, trees generally evaporate more water than shorter vegetation, which can reduce the volume of flood water draining from the land. Secondly, soils under woodland tend to be better structured than under other land uses, enabling more rainfall to enter and drain through the soil. This promotes the retention of water within soils and delays its passage to watercourses. Thirdly, trees, shrubs and deadwood along streamsides and within floodplains exert a greater drag on flood waters compared to grass, delaying flood flows. Lastly, a tree cover can decrease soil erosion and the delivery of sediment to watercourses, which helps reduce siltation and thereby increases the capacity of river channels to convey flood waters downstream.

What is the evidence?

The different ways that trees can affect the natural soil and water processes involved in the generation and conveyance of flood waters are well understood. This knowledge is supported by evidence (mainly modelled) showing that these effects have the potential to reduce flood flows within smaller catchments (<100 km^2)[2,3,4,5]. The scope for trees to alleviate flooding, however, declines with increasing catchment size and there is little evidence of tree cover exerting a significant impact at a larger scale. This is partly due to the more restricted presence of woodland, its variable distribution, and wider range of factors influencing flood risk within large catchments.

Another key factor is the size of flood event. The ability of woodland to reduce flood flows appears to decline with increasing size of event, although evidence suggests that it may be possible to exert a significant effect even on relatively large floods. Modelling studies suggest that woodland can influence events with a probability of occurring once every 100 years or greater[2,3,4,5].

It is impossible to generalise about the size of reduction in flood flows that woodland could deliver as this depends on a large number of factors that vary between catchments. Values predicted by modelling studies range from close to zero to as much as 40-50%[2,3,4,5], with higher values linked to the complete afforestation of headwater catchments (<10 km^2) with damaged/compacted soils.

A number of catchment studies (<100 km^2) are in place to demonstrate how land use and management affect flood flows. This includes the Defra funded 'Slowing the Flow' project at Pickering in North Yorkshire, where the integrated application of a range of land management measures is being tested[5]. Key woodland measures involve the planting of riparian woodland and installation of 'leaky' large woody dams, as well as an innovative trial of timber 'bunds'. These are designed to complement other techniques, including the construction of a large flood storage area within the floodplain.

What role could woodland play in flood risk management?

Woodland creation is one of a number of potential options for managing flood risk. Opportunities to achieve a sufficient level of woodland creation to make a difference are likely to be greatest for affected communities within smaller catchments (<100 km^2). By way of example, the distribution of catchments <100 km^2 in area in Cumbria, where there may be scope for woodland creation to reduce flood risk, is included at the end of this document.

There is much less scope for woodland planting to alleviate flooding in major towns and cities located downstream in larger river catchments, where there will be a continued reliance on conventional flood defence infrastructure. However, co-ordinated and appropriately located woodland creation could be used to complement the effectiveness of conventional measures, especially to help address expected increases in flood risk due to climate change.

Does it matter where woodland is planted?

The location, type of woodland and the way it is managed all influence its ability to affect flood flows. Location is particularly important as this has the potential to both increase as well as decrease flood risk. The most effective locations are thought to be areas with soils that have a high propensity to generate rapid runoff, along or across pathways where overland flow is concentrated, along streamsides, and within floodplains. Areas where woodland could have a negative effect are where slowing the flow could synchronise rather than desynchronise downstream flood flows, where bridges and culverts are very vulnerable to blockage by woody debris, and where properties or infrastructure could be affected by the backing-up of waters upstream of floodplain woodland.

Opportunity mapping

Opportunity mapping has been developed by Forest Research to help identify, map and target areas where woodland creation would be most effective for reducing flood risk[6]. It has been applied to a number of catchments and regions in Great Britain, as well as across the whole of England. The maps utilise a range of measured and modelled spatial data concerned with flood generation and conveyance, together with information on potential constraints and sensitivities to woodland planting.

Another advantage of opportunity mapping is the ability to overlay target areas for flood risk management with those where woodland creation could provide other water and wider benefits, such as helping to control diffuse water pollution and restore riparian and aquatic habitats. This allows the maps to identify priority locations for new woodland to deliver potential win-wins for a range of ecosystem services.

How can we promote woodland planting to reduce flood risk?

Woodland planting is limited by economic and other considerations. In particular, landowners and farmers are likely to be resistant to land use change unless it is economically attractive. Raising the value of woodland grants can help to promote better targeting of woodland creation for water. The Forestry Commission in England introduced an enhanced rate of grant in April 2012 to encourage planting by landowners in areas where woodland creation could help to reduce flood risk and/or diffuse pollution, as identified by a national opportunity map. This resulted in 1,857 ha of woodland creation in target locations across England. The replacement Countryside Stewardship scheme is also designed to incentivise planting for multiple benefits, with a focus on delivering water, biodiversity and cross-cutting objectives. Following its introduction in February 2015, applications have been received for planting 180 sites totalling 1,300 ha in area. While much more needs to be done to achieve a sufficient level of planting to make a difference for flood risk management at a catchment scale, a good start has been made.

Research and development

More research is needed to better quantify the location, scale of delivery, and physical benefits of woodland creation for flood risk management, as well as for providing a range of other ecosystem services. Further development of mapping, modelling and decision support tools would also assist planners and managers with identifying and evaluating the best locations for new woodland as part of the Government's overall approach to flood risk management.

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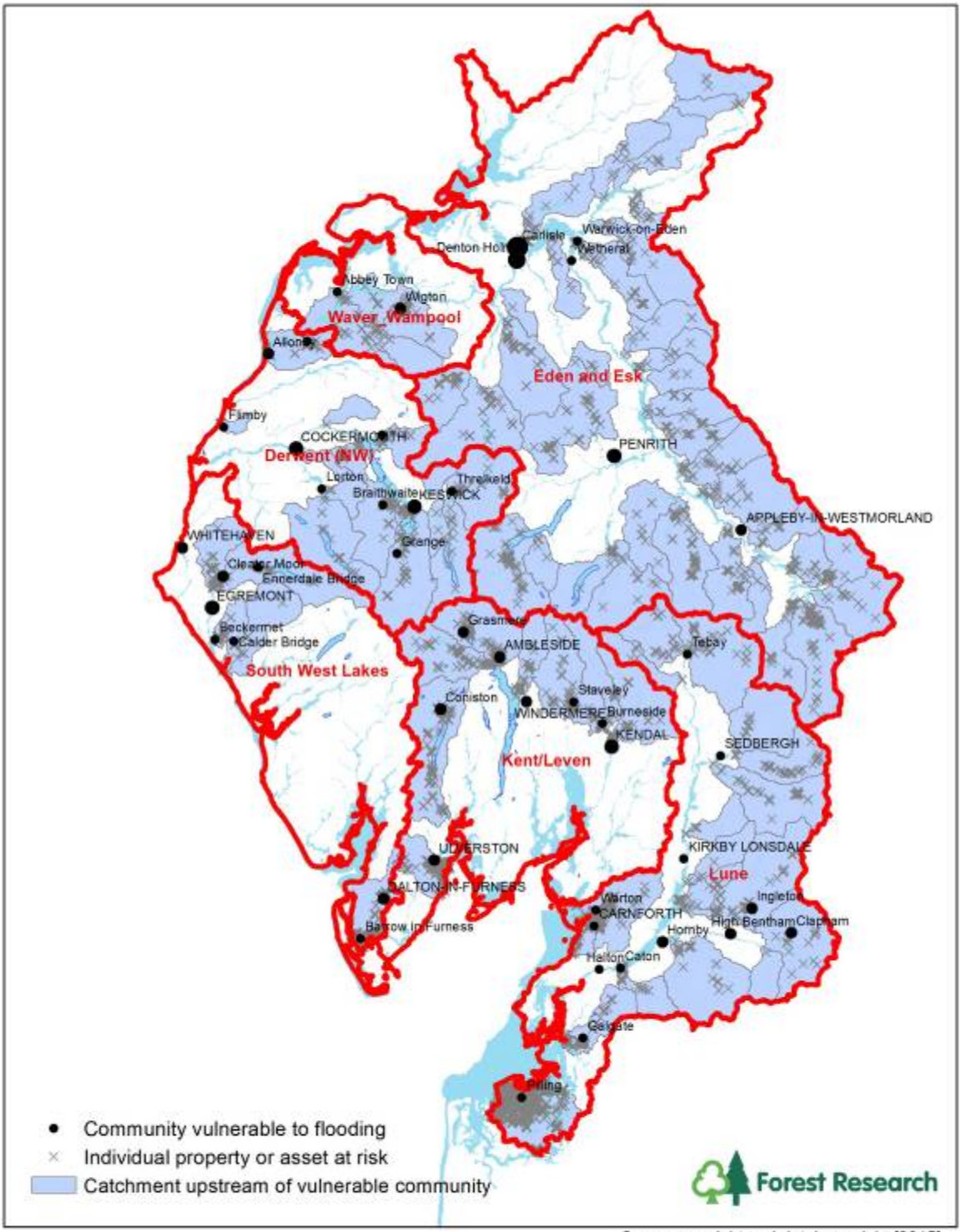
References

[1] Nisbet, T.R., Silgram, M., Shah, N., Morrow, K. and Broadmeadow, S. (2011). Woodland for water: woodland measures for meeting WFD objectives. *Forest Research Monograph, 4*, Forest Research, Surrey (156 pp).
[2] Nisbet, T.R., Thomas, H. (2008) Restoring floodplain woodland for flood alleviation. *Final report for the Department of environment, food and rural affairs (Defra), Project SLD2316.* Defra, London.
[3] Odoni, N.A. and Lane, S.N. (2010) Assessment of the impact of upstream land management measures on flood flows in Pickering using OVERFLOW. *Contract report to Forest Research for the Slowing the Flow at Pickering Project.* Durham University, Durham.
[4] McIntyre, N. and Thorne, C. (2013) Land use management effects on flood flows and sediments – guidance on prediction. CIRIA Report C719. CIRIA, London.
[5] Nisbet, T.R., Roe, P., Marrington, S., Thomas, H., Broadmeadow, S. and Valatin, G. (2015). Slowing the flow at Pickering. *Final Report on Phase II for the Department of environment, food and rural affairs (Defra), Project RMP5455.* Defra, London. See: http://www.forestry.gov.uk/fr/slowingtheflow
[6] See: http://www.forestry.gov.uk/fr/opportunitymapping



Distribution of catchments of around 100 km2 or less where there may be scope for woodland creation to reduce flood risk.

0 5 10 20 30 km