The potential of tree and hedgerow planting to reduce the frequency and impact of flood events in the UK

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- The potential for flood events is increased by current agricultural management practices and climate change.
- Planting trees and hedgerows can significantly increase water infiltration rate into soil and storage thereafter.
- This reduces the potential for surface runoff and overland flow, which is key factor in reducing flood peaks.

Flooding has become a serious problem for the UK in recent years, with episodes of severe flooding, formerly rare events, now increasingly commonplace. In response, substantial effort has been invested into research to determine the factors contributing to this effect to allow suitable management strategies to be implemented.

The principal factors which are accepted to increase the risk of flooding in the UK are climate change and current agricultural land management approaches. Projections for environmental change in the UK indicate that extreme weather events are likely to increase in frequency. Rainfall patterns in particular are expected to change, with high deluge events predicted to become more regular and more severe, leading to increased chance of flood events. In addition to this, land management changes as part of the drive towards agricultural intensification in the latter half of the 20th century, has driven increases in land drainage, livestock stocking densities, and the removal of hedgerows, to create larger more simplified field systems. This in turn has resulted in substantial modification of the UK landscape.

The causes of flooding

Reduced water infiltration and increased surface runoff rates can occur in instances where there are high livestock stocking densities. Local surface runoff rates are higher as a consequence of decreases in soil infiltration rate, porosity, and hydraulic conductivity, alongside increases in soil bulk density, driven by the effects of compaction. In addition, where grazing rate is high, reduced surface vegetation structure can limit the canopy interception storage rate (when water lands on the surface of leaves, which for broadleaf trees can be as much as 10-25% of gross precipitation) and the absence of deep or large rooting species may limit the ability of natural processes to reduce the effects of compaction.

Land drainage may heavily influence the rates at which water enters river systems. In the context of intensive grassland production, sub-surface field drains can alter natural hydrological processes and may enhance the magnitude of peak flows, due to a faster rate of delivery from land to river. A similar effect has also been noted for moorland drainage, which

has been linked to increases in flood frequency. However, this influence is less certain as there is some disagreement in results between different studies, which are likely to be due to differences in soil type between locations and initial soil moisture levels.

In general, woodland resources (a term which when used here, also includes small scale tree planting such as shelterbelts) across the UK have increased since the early 1900s. From a low of about 5% coverage, tree cover is now estimated to be in the region of 14% and 13% for Wales and the UK as a whole respectively. Even though woodland and tree cover has increased in the last century, Wales and the UK remain among the least forested countries in Europe, where the average tree cover is 37%. In addition to the losses of woodlands and hedgerows, numbers of in-field large or veteran trees have also declined as there has been little or no replacement after loss and limited potential for natural recruitment. The loss of large vegetation across agricultural systems, and the influence this can have on hydrology, is perhaps the principal agent influencing the potential for flooding.

How do hedgerows and woodland resources reduce the effects of flooding?

The presence of woodlands and hedgerows can significantly reduce peak water flows through several mechanisms including increased evaporation loses (particularly after canopy interception), increased water storage capacity of soils under tree cover, increased water infiltration potential, and decreased soil bulk density from the influence of root growth.

This has been comprehensively demonstrated by research undertaken at the Pontbren catchment in Wales, in a comparison study which has focussed on a landscape traditionally managed by sheep grazing, with and without tree presence. Here, the planting of a shelterbelt of trees was shown to reduce flood peak magnitude by 40%, by increasing the rate of water infiltration which was shown to be sixty times greater where the shelterbelt was planted, thus decreasing overland flow rate which is considered to be key in lowering flood peaks.

Hedgerow planting also offers similar benefits for potential flood mitigation. Hedgerows are known to be efficient in the storage and slow release of water during heavy rainfall events, with 50 metres of hedge in a 1 ha field able to store between 150 and 375 cubic metres of water. Hedgerows and trees can reduce soil water content from across a field system regardless of slope, by virtue of reducing the ground water content in the immediate vicinity of a hedge or shelter belt. This leads to water being drawn in from the surrounding soil, initiating a gradient of flow towards the hedgerow or tree plantation.

Management and design are highly important for effective tree planting projects. Tree planting configuration can have a significant effect on the infiltration rate, soil bulk density, and canopy interception rate. Research has shown that clumping trees together in a thicket of 5-10 trees may positively influence infiltration rate when compared to evenly spaced single trees. The presence of livestock can also influence the size of effect in terms of flood mitigation, due to the compaction effects caused when animals gather around the base of

trees for shelter and shade. This behaviour may reduce or even eliminate any beneficial effect of the increased tree presence, as where sheep were present, infiltration rates and soil bulk density were shown to be similar to areas without tree cover. This therefore indicates the need to fence around trees, either when planted in clumps or individually, to exclude livestock. Omitting this as part of any tree planting project for the purposes of flood management may significantly limit the benefits which would otherwise be expected. This of course may limit the benefit to livestock of shelter from sun and rain, but may continue to provide shelter from the effects of wind chill.

Future management

The planting of shelterbelts and hedgerows has real potential to offer a land management approach which can reduce the impact of flooding whilst offering limited impact to agricultural production, as the planting scale required to achieve the results highlighted above is relatively small. In addition, planting shelterbelts and hedgerows can also offer several associated benefits in both production and environmental terms, which could also be considered advantageous. These results are also likely to be realised quickly as changes in the rate of infiltration have been observed to act in the short term (2-6 years of vegetation growth), thus rapidly buffering catchments against future high volume rain events.

In addition to this approach, strategies which incorporate the planting of trees with complementary planting of grass species such as Festulolium (a hybrid grass with a large root system developed by IBERS and Rothamsted Research, effective at reducing runoff by improving water infiltration rate), may have even greater potential to limit the effects of predicted environmental change in the future.