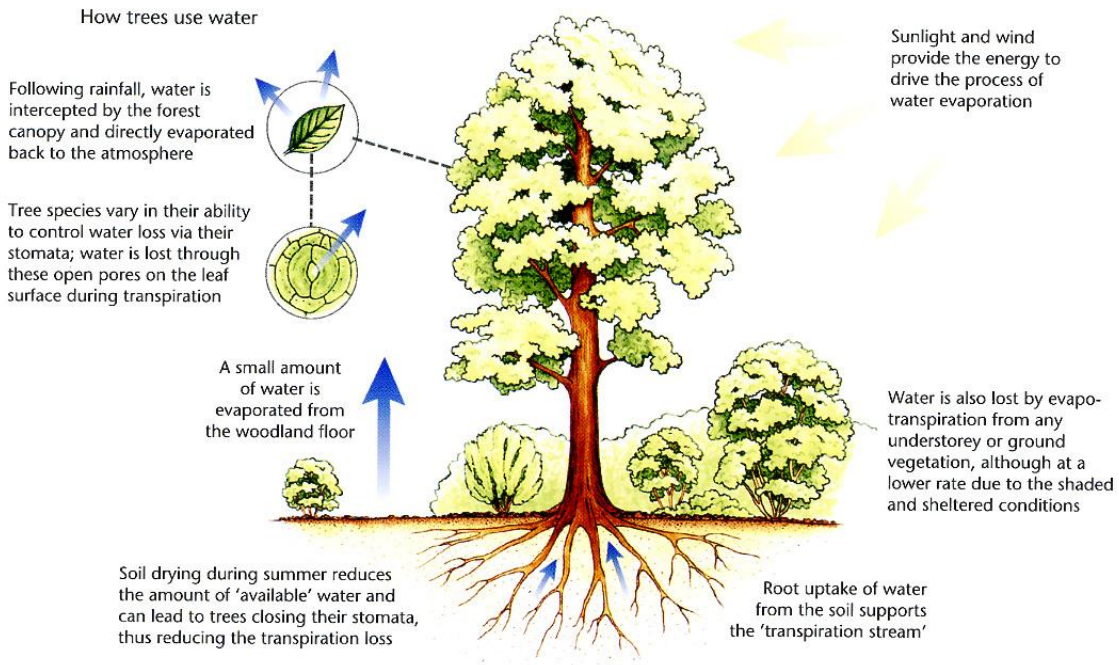
Trees and drought

There seems to be widespread agreement that trees are good and that we need more of them. All the UK administrations have targets for increasing the area of land under woodland, and the restoration of tree cover has been described as one of the most effective strategies for climate change mitigation[1].

However, trees can also have negative effects when water is scarce, so we need a fuller understanding of the impact of forests on both flooding and drought. This briefing sheet by Owen Davies of the Forest Stewardship Council© with input from Forest Research, outlines key issues to consider.

How trees use and lose water

Trees have several processes that play an important role in the availability of water, as show in the following infographic[2]:



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Trees and flood risk

A growing argument advanced for woodland creation is the reduction of flood risk[3]. The ability of forests to reduce flood flows relative to other land uses[4] is based on the greater water use of trees, which reduces the volume of flood water at

source; the higher infiltration rates of woodland soils, which reduces rapid surface runoff and flood generation; the greater hydraulic roughness exerted by trees, shrubs, and large wood debris along streamsides and within floodplains, which acts as a drag on flood waters, slowing down flood flows and enhancing flood storage; and the ability of trees of to protect the soil from erosion and interrupt the delivery of sediment via runoff to watercourses which helps to maintain the capacity of river channels to convey flood waters downstream and reduces the need for dredging. Appropriately sited woodlands can therefore make a beneficial contribution to flood risk management.

Trees and drought

Water scarcity in the UK

UK weather is proverbially variable, and while annual average rainfall has generally increased in recent decades[5], Met Office rainfall anomaly data[6] show plenty of months with rainfall significantly below average. The Standardized Precipitation Index calculated and visualized by the Centre for Ecology and Hydrology[7] shows that even the wettest parts of the country can experience periods which are, relatively speaking, extremely dry. Climate change predictions for the UK, although heavily caveated with regard to the natural variability of rainfall, suggest that while winter precipitation is likely to increase, summer precipitation may well decrease[8]. This potentially increasing likelihood of summer water scarcity means that the role of trees in drought needs to be far better understood.

Trees and evapotranspiration

Water is used, or lost, by trees by evapotranspiration. This is combination of water intercepted directly by foliage, branches and trunks, and lost by evaporation, and water taken up by roots and released through the process of transpiration.

Several factors can influence evapotranspiration rates, especially the interception and evaporation element, with the most significant difference being between confers and broadleaves; in UK studies, conifers have been found to lose 25-45% of annual rainfall by interception, while broadleaves lose 10-25%[8]. Comparisons with grassland are telling. While transpiration is higher for grass, interception is virtually nil. Ranges of annual evaporation losses for different land covers receiving 1000 mm of annual rainfall are 400-600 mm for grass, 400-640 mm for broadleaved trees, and 550-800 mm for conifers.

Trees and water availability

This shows that woodland type has an impact on water availability, but this isn't the only factor to consider; the location of the woodland is also important. The interaction between dominant tree species and woodland location is well summarized in the government's UK Forestry Standard (UKFS) (pp. 184-185)[9].

In short, water yields from upland catchments containing significant proportions of conifer forest are less than those from moorland or grassland catchments, especially in wetter and windier areas, with a 1.5-2% reduction in potential water yield for every 10% of a catchment under mature conifer forest. In drier and less windy lowland areas, interception losses are lower, but tree transpiration rates may be higher due to roots reaching deeper soil water reserves. The net effect may be to reduced potential water yield by as much as 7% for every 10% of a catchment under mature conifer forest.

Annual evaporation from broadleaved woodland is generally lower than from conifers, as interception losses are reduced during the leafless winter period. Groundwater recharge under beech and ash woodland on chalk has been found to be similar or slightly higher than that under managed grassland, but recharge under broadleaved woodland on drier sandy soils is likely to be reduced compared with grass, because the deeper rooting of trees enables transpiration to continue for a longer period during the summer.

The reduction in water yield due to upland conifer forests is thought to have a relatively small effect on summer baseflows in rivers. Baseflows from broadleaved woodland can actually be greater than those from agricultural land due to higher soil infiltration rates and a similar water use. In the lowlands, however, large areas of conifer forest could result in significantly reduced summer baseflows, with attendant impacts on wildlife and water supply.

Good forestry practices

All of this means that the dominant tree species and the location of any woodland need to be considered carefully. As a result, UKFS imposes checks on the creation of new woodlands. The water good forestry practice requirement 13 (p. 172) states that 'Where new woodlands are proposed, the sensitivity of downstream water bodies and wetlands to a reduction in water quantity should be considered; where this is an issue, advice should be sought from the water regulatory authority and conservation agency'. Water guideline 78 (p. 185) states that 'Where the maintenance of water flows is an issue, consult the water regulatory authority (or water utility company) and conservation agency before carrying out large-scale woodland establishment – especially involving conifer or short rotation forestry crops with a high water use; consider the projected impacts on future water yield, including the effects of climate change'.

For existing woods, voluntary Forest Stewardship Council (FSC)[10] Forest Management certification provides an extra layer of safeguarding through the independently audited requirements of the UK Woodland Assurance Standard, or UKWAS[11]. UKWAS requires forest managers to consider the impacts of woodland plans at a landscape level, including catchment level impacts on water flows and flood risk (UKWAS 4, requirement 2.5.2 and guidance). The planning of operations must include taking measures to protect water resources (requirement 3.1.2), and areas and features of critical importance for watershed management must be identified, and their management agreed, in consultation with relevant statutory bodies (requirements 4.5.1(a) and (b)).

Conclusion

The effects of trees can be positive or negative, depending on whether your problem is too much or too little water, on the type of trees, and on the location of woodland. That these factors are recognized and understood by the forest sector is evidenced by the often-heard mantra of planting the right tree in the right place. Large-scale woodland expansion in the direr lowlands, especially with conifers, needs to be approached carefully, and this is reflected in the controls imposed in the standard used by regulators.

Responsible forest management is important everywhere, however, and FSC certification provides independent assurance that woodlands are managed with a view to downstream impacts. Trees are good, and we do need more of them – we just need to think carefully about where we plant them, and how we manage them.

References

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