Forest Research

Payments for Water Services: Flood Prevention and Water Quality

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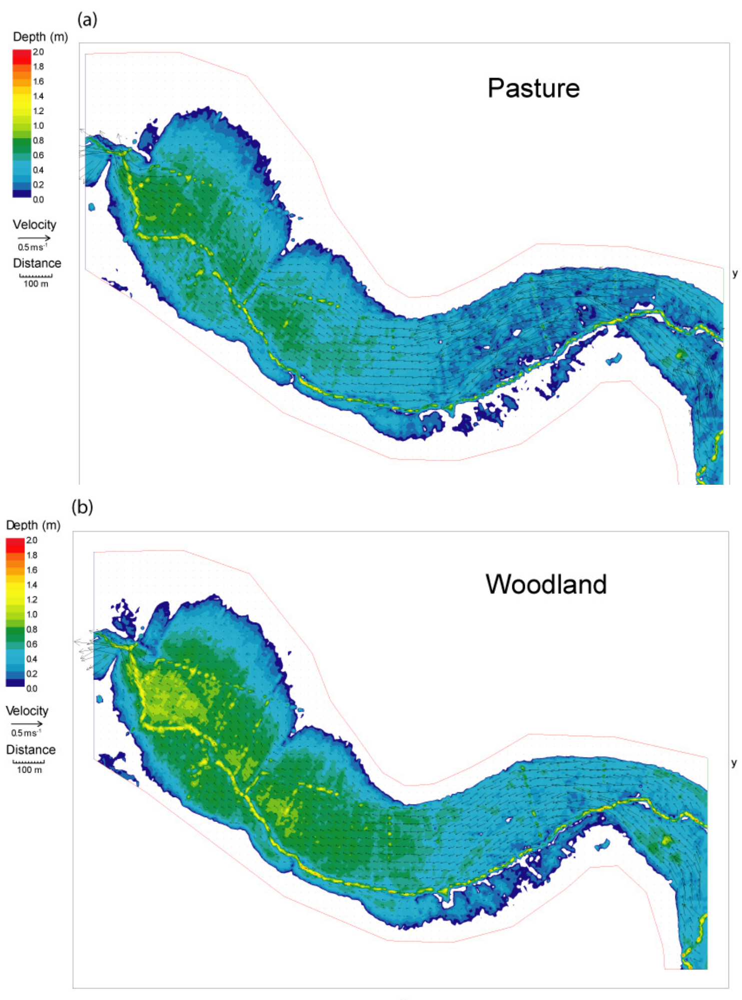
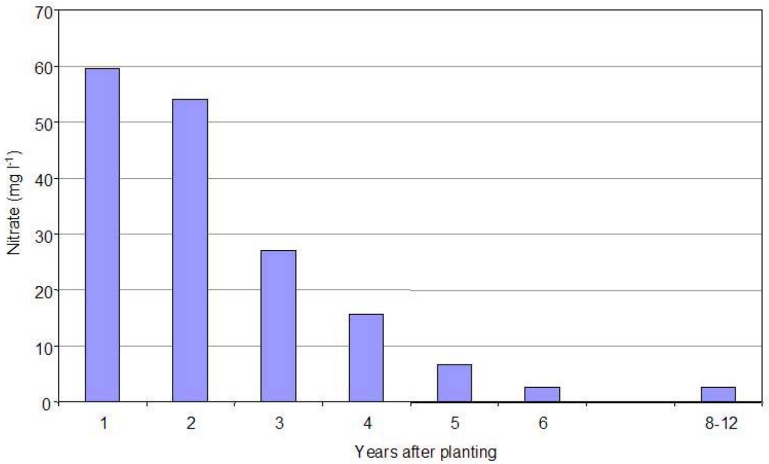
Woodland for Flood Alleviation:



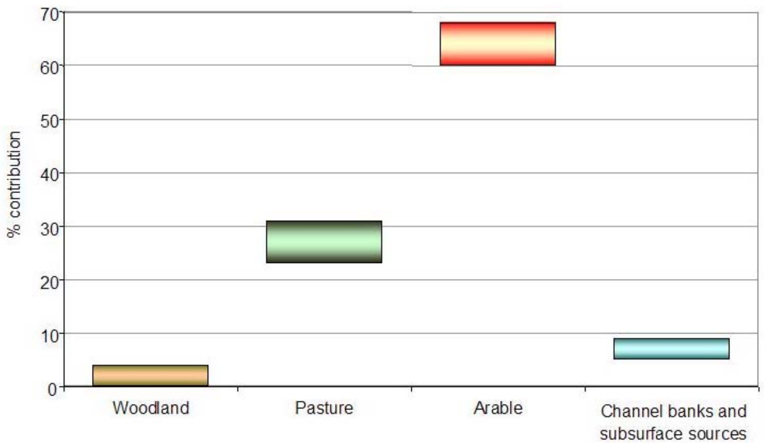
Establishing around 130 ha of floodplain woodland along a 2.2 km reach of the River Cary in Somerset increased the flood level for a 1-in-100 year event by up to 270 mm, raised flood storage by 71% and delayed the flood peak by 140 min in an 80 km^2 catchment (Thomas and Nisbet, 2006).

[Thomas, H. and Nisbet, T. R. (2006). An assessment of the impact of floodplain woodland on flood flows. *Water and Environment Journal*, 21: 114-126.]

Woodland for Mitigating Diffuse Pollution:



[Hansen et al. (2004): Theme 2: Nitrate leaching. In Hansen, K. & Vesterdal, L. (eds.) (2004): Guidelines for planning afforestation on previously managed arable land. *Forest & Landscape*, Hørsholm, 105 pp.]

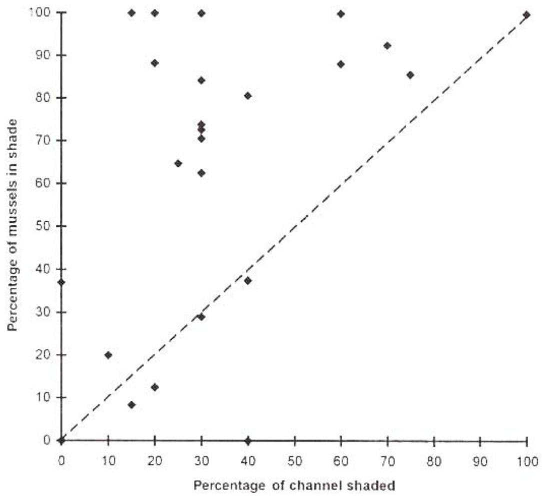


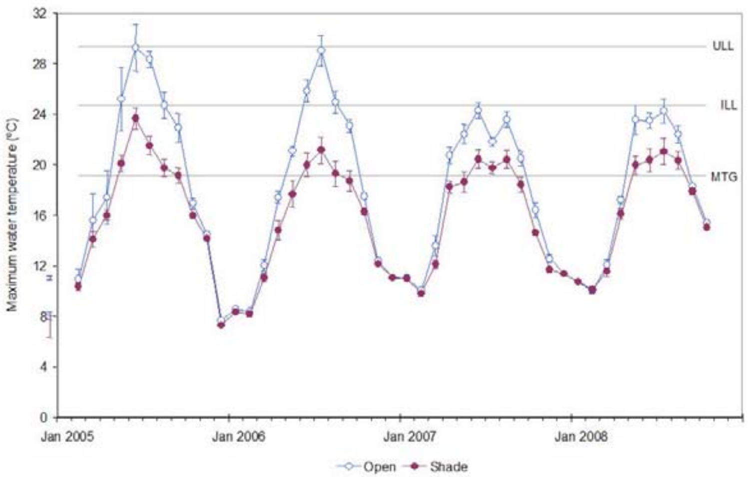
[Collins, A.L. and Walling, D.E. (2007). Sources of fine sediment recovered from the channel bed of lowland groundwater-fed catchments in the UK. *Geomorphology*, 88: 120-138.]

Woodland planting can be very effective at reducing nitrate levels in groundwater. Nitrate concentrations declined by 95% following afforestation of former arable land at nine sites in Denmark (from Hansen *et al*., 2004).

Well managed woodland is usually associated with low sediment losses. Woodland contributed least to deposited fine sediment on the bed of the River Frome in Southwest England (after Collins and Walling, 2007).

Woodland for Protecting Aquatic Habitat:





Freshwater pearl mussel densities have been found to be strongly related to the level of riparian woodland shade (Gittings *et al.*, 1998).

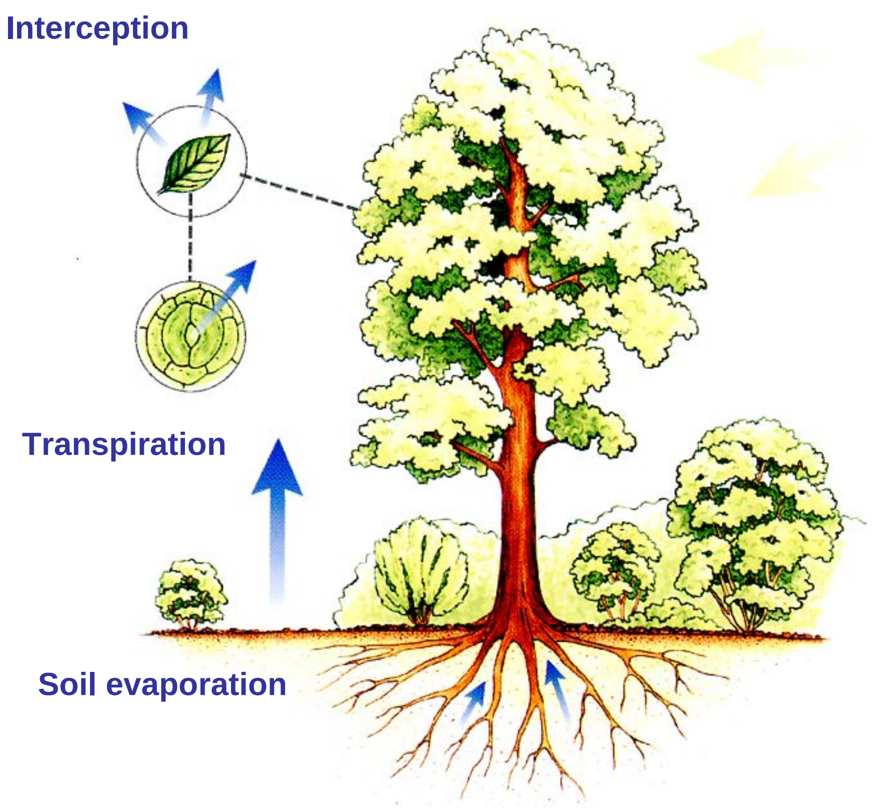
Woodland shade is expected to become increasingly important for reducing thermal stress to freshwater life; shading prevented summer water temperatures exceeding ultimate (ULL) and incipient (ILL) lethal limits for salmonid fish in New Forest streams (Broadmeadow *et al.*, *in press*).

[Gittings, T., O'Keefe, D., Gallagher, F., Finn, J. and O'Mahony, T. (1998). Longitudinal variation in abundance of a freshwater pearl mussel population in relation to riverine habitats. *Proceedings of the Royal Irish Academy*, 98B(3): 171-178.]

[Broadmeadow, S., Jones, J.G.; Langford, T.E.L.; Shaw, P.J. and Nisbet, T.R. The Influence of Riparian Shade on Lowland Stream water Temperatures in Southern England and their Viability for Brown Trout. River *Research and Applications (In press)*.]

Potential Trade-offs - Water Resources:

- Reduced net rainfall due to high interception loss (30-40% for conifers vs 10-20% for broadleaves).
- Increased transpiration loss but depends on available soil/ground water.
- For broadleaves, effect on water depends on species, soil/rock and climatic factors, ranging from -3.2% to +2.5% per 10% forest cover, compared to grass.
- SRC crops of willow and poplar can reduce groundwater recharge by 6.0% per 10% cover compared to cereals.



Case Study 1: New York City - Catskill Watershed Management Programme

Issue: Protecting high quality drinking water supply by preserving natural catchment filtration, rather than face expense of constructing and maintaining new water treatment facilities.

Approach: Local public payment scheme administered by non-profit organisation. Scheme initiated with money from New York City, the State of New York and the Federal Government (now financed by a tax included in New York water users' bills). Mixture of land acquisition (New York City increased ownership from 3.5% to 10.9% of watershed) and three types of payment: compensation (subsidies/logging permits/property tax reduction) or property transfer (land development rights) to farmers and landowners in exchange for agreements to follow BMPs; and development of new markets for non-timber products and timber product certification.

Payments: ~ €1.35 billion invested since 1991, equivalent to €3,257/ha (catchment area = 4144 km^2).

Result: The scheme has succeeded in reducing phosphorus loadings, chlorophyll *a* and water pathogens to acceptable levels.

Case Study 2: City of Aalborg, Denmark - Drastrup Pilot Project

Issue: Protecting groundwater resource from diffuse pollution (nitrate) and provision of recreational facilities.

Approach: Public funded payment scheme to purchase key land areas for water protection and recreation. Converting 900 ha of intensive agriculture into 500 ha of forest (natural broadleaved woodland) and 400 ha of pasture.

Payments: Government funded €402,000 per year from city of Aalborg for land purchase plus €805,000 from EU LIFE project between 1991-2001. Actual costs: €14,000 – 21,000/ha to purchase land, and €3,000 – 6,000/ha for cultivation and woodland planting. Loss of agricultural income = €290 per ha per year; drinking water benefit estimated at €440,000 per year (€490 per ha per year) for reduced water treatment (cost of NO_3 removal estimated at €0.2 per m^3 for > 50 mg/L NO_3).

Result: Nitrate concentration in groundwater has decreased from >120mg/l to <10 mg/l and pesticide use has ceased on the converted areas.

Case Study 3: Thülsfelde in Lower Saxony, Germany; Part of Water4All Project

Issue: Protecting local groundwater resource from diffuse pollution (rising nitrate and pesticide concentrations).

Approach: State administered payment scheme via local co-operatives. Water companies levy water abstraction charge on consumers (“water penny”) and money passed to State to fund land purchase for afforestation and providing advice and compensation to local farmers and private foresters to promote BMPs. Around 500 ha purchased for woodland planting and handed over to National Forest Administration to manage. Conditions include avoiding reduction in groundwater level and no pesticides.

Payments: Local tax: 5 cents/m^3; land purchased for afforestation cost €15,000-40,000 per ha, equivalent to €600 per ha per year over 25 years (minimum project period); Planting cost averaged €5,000-6,000/ha. Agri-environment payments to farmers.

Result: The combined measures have led to a reduction in nitrate concentrations from over 100 mg/l to <50 mg/l (drinking water decree level).

Other Case Studies from Across Europe:

Issue: Protecting quantity and quality of groundwater supplies.

Approach: Mixture of public and private payment schemes; most voluntary but some mandatory. Include support for afforestation, payments for BMP's (eg restrictions on use of fertiliser and pesticides, smaller clearfells) and conversion of conifer to broadleaves (or CCF). Money usually raised by a water levy charged by water companies to consumers (eg €10/yr).

Payments: Money dedicated to, and invested in, afforestation projects by the state and municipalities, or used for annual payments (up to €275/ha) to forest owners for changing forest type and implementing BMP's to favour water. Long term security through 18- or 30-year contracts plus fines for non-compliance.

Common Features of Schemes:

- Woodland planting usually the favoured land use measure (e.g. in terms of cost effectiveness and security of change) to reduce diffuse pollution and protect water resources.
- Co-operation between all main stakeholders: the state, landowners and public; combination of land acquisition and annual payments.
- Raised environmental awareness amongst public through environmental education (‘teaching trails’), including where water comes from and why we need to protect the resource and use water wisely.
- Generated multiple benefits (e.g. in terms of biodiversity, carbon sequestration, recreation, landscape, public health, local house values and wood products), both in the short and longer-term.
- Resulted in major improvements in water quality.

Progress in UK:

- Country forestry strategies reflect the potential of woodlands to deliver WFD objectives, including highlighting opportunities for woodland to reduce the impact of diffuse pollution from agriculture and urban activities, as well as assist flood risk management.
- FC(E) Woodland Creation Grant increasingly reflects water benefits in regional scoring systems but no additional funding provided to secure planting schemes.
- Locational premiums being developed to raise the value of the woodland creation grant to encourage land use change where water benefits are potentially greatest, but limited to one-off payment.
- Despite increasing policy support for woodland expansion for water benefits, the scope for woodland planting remains limited by insufficient financial incentives and wider land use constraints; payments need to better reflect water and other benefits, although land acquisition may be best option.

Conclusions:

- Targeted woodland planting within appropriate catchments offers an effective measure for controlling diffuse pollution, improving river morphology/habitats, and alleviating downstream flooding.
- The main water trade-off relates to the potential for woodland to reduce water yield, however this can be managed by attention to woodland type, design and scale.
- Need to raise awareness amongst policy makers and planners of the benefits of woodland for water, and better co-ordinate woodland and water policies in this regard.
- There is a reasonably good evidence base to inform the future development and implementation of payments for water-related woodland services in the UK; need good demonstration/case study.
- Need to increase financial incentives for woodland creation and link payments to RBMP and CFMP objectives in order to better target the most effective locations for planting (e.g. via locational premiums).