Floods and land management: myths and reality

Flooding can have devastating effects on people's lives and livelihoods and in the future impacts are set to intensify as the frequency of extreme storm events ratchets-up from climate change.

Traditional approaches for controlling floods use methods like making river channels deeper and wider so they carry water away more quickly, raising the banks alongside rivers to stop water spilling out onto the floodplain and regular removal of sediments, water plants and trees to ensure that water always flows away as fast as possible. The problem is that engineering works like these are massively expensive and store-up, and amplify, problems for areas downstream.

An alternative approach is to work more sympathetically with nature: since human's activities like clearing forests and isolating rivers from their floodplains has increased our flooding problems, could putting naturalness back in the landscape reverse these trends?

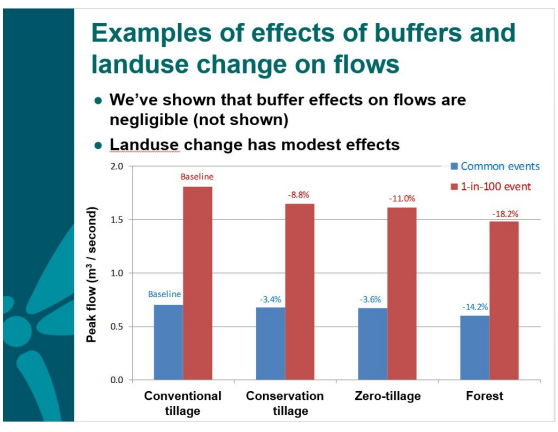
For conservation bodies like ourselves, it's an appealing notion. Not least because there are potential win-wins: natural processes are generally good for wildlife, can help reduce pollution by cleaning-up the water and could provide opportunities to create new high quality wetland habitats.

Freshwater Habitats Trust is an evidence-based organisation and a decade ago, when we first started to consider these issues, it was clear that evidence on the efficacy of natural measures to reduce flooding, clean-up water or enhance biodiversity just wasn't there. To address this we teamed up with the *Game and Wildlife Conservation Trust* and *University of York* and have, for the last seven years, been running a major land management initiative - **Water Friendly Farming**. The project, which is funded largely by the *Environment Agency,* is working in three 10 km^2 catchments near Loddington in the Leicestershire lowlands, to investigate whether in a working farmland landscape we can generate the multiple benefits of protecting freshwater biodiversity, reducing diffuse pollution and holding back flood water. Others involved are University of Sheffield, Oxford Brookes University, Anglian Water, the Welland Rivers Trust and Syngenta who are interested in what the project can tells us about pesticide run-off and amelioration.

As a result of this work we've learnt a raft of interesting lessons – both from our own findings and through gaining an inside track on the results of other studies. The results aren't always what you'd expect: it's clear that in many cases we are still in the early days of finding good-enough solutions - although there are some hopeful avenues.

So here are a few myths, misconceptions and reality checks on some of the key issues relating to flooding, with a focus on our own particular interest - life in freshwater.

1. Does planting more trees reduce flooding? If you cut woodlands down, more water runs off the land, and creates greater downstream flooding, after heavy rain. Conversely, if you create new woodlands this intercepts runoff, reducing flooding. The question is *how great is the effect*? In our Water Friendly Farming project, combined flooding and land-use models indicate that in the typical clay catchments of the Midlands, the effect would be moderate: completely reforesting the landscape would be likely to reduce a 1:100 year flood peak by 15-20%.



Model predictions from the Water Friendly Farming project.

We assessed how changing cultivation methods and completely afforesting a catchment altered runoff. In a typical English clay landscape, completely afforesting the catchment ('Forest' in the graph) reduced the peak flow by less than a fifth. Even when there are a lot of trees, the effects on flows are modest on clay soils.

This is becoming a new area of controversy however. For years the orthodoxy amongst hydrologists has been that forests can't stop big floods – after a certain level of rainfall the sheer amount of water overwhelms the system. See this older document for an introduction to that view: Forests and floods Drowning in fiction or thriving on facts?

Very recently however, some hydrologists have begun to question this assumption - concluding that the analytical methods used for at least 50 years give misleading answers (see http://news.agu.org/press-release/deforestation-in-snowy-regions-causes-more-floods/ for an accessible introduction). If so, forests may have greater flood control benefits than previously assumed – although in extreme rainfall events they are still likely to be overwhelmed. What's perhaps just as pertinent is whether the land-take for reforestation is a generally viable possibility, particularly in the fertile and agriculturally productive lowlands where flooding is most of an issue for people.

2. Do re-wetted bogs and wetlands act as sponges? That bogs and wetlands act as sponges is an appealing idea and seems intuitively obvious. After all, bogs have more water in them than dry land, they look a bit like sponges, and there are plenty of articles out there telling us what they store in terms of 'Olympic swimming pools' worth of water. But like sponges, once they are full, water runs out of them. And, like forests, this is the central question of the debate: how much extra flood water will an already largely saturated sponge hold? At the moment, there's too little evidence available to say with certainty what the effect will be of rewetting bogs but it seems likely that it will be a similar story to that of forests. A rewetted bog will absorb water when it first fills, and like any bog may hold some extra new rain water, but they are already largely 'full'. Here's a useful and semi-accessible technical review of the effect of wetlands, including bogs, on floods: read the Summary and Conclusions on p22.

3. Is creating interception ponds a good *natural flood defence measure?* We know ponds can be great for wildlife, so it would be a real coup if adding new ponds to the landscape could also help store floodwater and reduce flood peaks. Unfortunately our Water Friendly Farming work at Loddington doesn't provide much support for this – at least for agricultural areas. Ponds can help store floodwater water, but you need a lot of very large waterbodies to make a difference, and that requires a lot of land take. At Loddington we created roughly 40 new ponds in corners of fields, intercepting drains, and in patches of woodland, doubling the previous density across the landscape and more or less exhausting all of the landscape opportunities. The result of this (which we've assessed using models which have been calibrated with our detailed field hydrological monitoring data) was a barely detectable impact on peak flows: our new ponds have created about 3000 m^3 of water storage, but to have a useful impact on flood flows we will need at least 30,000 m^3.

4. Is creating interception ponds good for *wildlife?* It's a very widely touted idea that interception ponds created to take urban run-off (e.g. SUDS), or clean-up nutrient polluted farmland run-off, have the added benefits of being 'good for wildlife'. In practice our observations over the last 20 year are that interception ponds start off good but deteriorate rapidly as they begin to fill with polluted sediments. We are already beginning to see this effect in Water Friendly Farming: many of the new interception ponds had wonderful aquatic plant communities in the first year of two, but even after two years some are beginning to decline. Data from our other projects assessing the condition of ponds receiving polluted water support this conclusion.

More positively, adding clean water ponds *off-line* (i.e. doing everything we can to keep polluted water out of them, especially not connecting them to ditches, streams or drains) is having a more beneficial effect. Looking across the whole landscape, the new clean water ponds have increased the number of high quality 'priority ponds' across the landscape (see the UK government definition of a 'priority pond'), and very significantly, they have so far also *reversed a landscape-wide decline in freshwater plant biodiversity that we saw during our 3-year pre-works baseline phase*.

5. Is making rivers more bendy and creating debris dams to hold back water good for wildlife? Making rivers straighter and deeper - which was popular after World War 2 when engineers first got easy access to big diggers - carries water away faster but creates bigger floods downstream. Reversing this by making rivers more bendy seems as though it would obviously be beneficial. However, the evidence - though it has been the subject of a huge amount of scientific study, worldwide for the last 25 years - is mixed. If you make rivers bendy, water *is* slowed down and it can

be more likely to spill out onto the floodplain in flood, if the restoration scheme allows it to do so. Whether this is good for wildlife depends on many factors. Overall, re-meandering straightened rivers has so far had a rather poor record in improving freshwater wildlife which, with a few exceptions (like dams stopping migrating fish from getting to headwater spawning grounds), is much more affected by pollution.

6. Is storing water on floodplains effective? One of the key lessons from modelling in our Water Friendly Farming work, and from other experimental projects, is that providing sufficient *temporary* storage space for high flows is the key to flood reduction. Measures that help to provide this temporary storage - holding the water back just for a few days - are being tested in a number of projects: for example, in our own work in Loddington, and at the National Trust's site at Holnicote in the south-west of England. The technique uses leaky dams (often made of tree trunks) which are placed across the river so that they only block *high* flows. Doing this maximises storage in the upstream river channel, and pushes water out onto the floodplain to store it temporarily behind low grassy dams. We aim to do more of this at Loddington, with computer modelling telling us the places where 'leaky dams' will have the greatest effect, and field observations and research telling us to how these schemes work in practice.

'Leaky log dams' to enhance bankside flooding are placed across and *above* streams to hold back water just at high flows. During heavy rainfall these features help by storing water in the full capacity of the upstream channel. In even heavier rainfall, water is forced out on the floodplain, where it is held for a day or two, leaking away gradually and so reducing the potentially damaging flood peak. Such dams do not block normal flows or drainage, and don't create channel blockages that concern some (though often with little evidence) that log dams in the water prevent migration of fish or other animals.

Water Friendly Farming Project: Loddington, Leicestershire

7. Are flood-storage areas good for freshwater wildlife?

The idea that we can safely store large volumes of floodwater in a controlled way on floodplains is becoming flavour of the month and chimes with many people's aspirations: not only does it make sense hydrologically, but it plays well with the idea of 'natural processes' – and the emotive resonance of 'reconnecting the river with its floodplain'. For conservationists, the idea of more green space for nature is very appealing at a time when even the government admits we are seeing rapid biodiversity loss all around us.

In reality, of course, it's not so simple, and when promoting the idea that new floodplain flood storage areas will bring major benefits for wildlife, we need to be careful:

(i) Floodwater is not always clean water: in the agricultural lowlands it can be very heavily polluted by nutrients from agriculture and sewage works storm-overflows. Pushing this polluted 'brown water' onto the floodplain is *not* a natural process, and in many areas has the potential to be very damaging

to freshwater wildlife, particularly to isolated floodplain ponds which often have exceptionally important wildlife communities; but also to other wetlands, like fens and marshes, which are fed by cleaner water from the surrounds.

(ii) Flood storage areas won't necessarily bring any new wildlife habitat benefits. For example, in our Loddington test catchments, as in other schemes like Holnicote, the flood areas are all existing grassland – specifically chosen to avoid flooding arable land. The majority of floodwater persists for a few days, but then drains away. There is no wetland or terrestrial habitat gain for nature.

There is undoubtedly *potential* for both wildlife and public access benefits from schemes that specifically combine floodplain storage with a change to more natural land use and new wetland habitat creation – but they won't come automatically – and conservation organisations and others will need to push hard to get them.

It's not inevitable, or even likely, that creating new flood storage areas will benefit people and wildlife.

Flood storage areas will usually just be existing grasslands that are covered in water for a few days – with no benefit for wildlife.

Of more concern, pushing *polluted* lowland floodwater out onto the floodplain is not a 'natural process', and has real potential to damage existing high quality waterbodies and wetlands.

There *are* opportunities to use floodplain storage to benefit people and wildlife – but we will have to work hard to achieve them.

8. Do we have really effective flood models? Computer modelling can be a very effective way of modelling catchments to assess the effects of land-management changes for flows, sediment control and pollution reduction. Most of us would think that, in this day and age, our existing flood models would be more than sufficient for this. In fact the hydraulic models used by engineers to design flood schemes have not previously needed to consider land management so don't include it effectively. This is an important practical problem and something we are addressing in our Water Friendly Farming work with Environment Agency funding and the expertise of Prof Colin Brown's modelling team at the University of York: beginning to directly link the land management models and the flood defence models used by the Agency flood engineers so that we can much better explore the options for using the land to store water.

9. Is flooding the biggest problem facing freshwater wildlife and the environment? For people, floods are dramatic events. For wildlife and the natural world floods are necessary for freshwater ecosystems to function properly, and the lifecycles of a huge array of species depend on them. For wildlife, the major problem is not flooding but something much more insidious - water pollution. Unfortunately pollution doesn't make good TV but the need for clean water to help our wildlife thrive is an ongoing and critical issue.

So what should we do? Freshwater Habitats Trust's position is that at the moment we need better models and large scale field trials before we plunge headlong down the route of modifying land use to control floods.

But it's also important not to throw the baby out with the flood water: even in landscapes where working with nature is not the perfect solution for controlling floods, re-naturalising areas could be part

of a combined approach to reducing floods whilst providing other critical benefits. At a time when life in freshwater is still suffering huge stresses, managing the land to reduce pollution, halting and reversing the loss of wildlife that depends on water, rebuilding lost habitats, preventing the degradation of peatbogs and encouraging people to keep in contact with the natural world are all vital aims.

For us the most critical need is to ensure that 'working with nature' actually benefits nature. For freshwater life, a large part of any success in achieving this will depend on getting more clean water into the landscape, not just holding back the polluted brown floodwater.

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