Technical Note **TN646**

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River floodplains and natural flood management on farmed land

SUMMARY

- **Natural flood management involves working to restore natural processes by taking a catchment wide approach to flood risk management. Floodplains and other habitats on farms can be managed to slow or store water in catchments, reducing flood risk.**
- **Floodplains are often composed of a number of farmland habitats rich in wildlife, both on the surface and in the valley gravels. Natural wetlands are an increasingly rare habitat. If allowed to flood naturally, floodplains can help prevent environmental damage, losses to agriculture and damage to property.**
- **Rain water should be managed on ground closest to where it falls and not just on ground where it is having a damaging effect, which can be several miles away downstream.**
- **Achieving natural flood management, involves a complex mix of agricultural, environmental, forestry, financial and social components. It makes economic and environmental sense that future emphasis should be on targeting natural solutions to floodplain management and surface water flow rates as well as engineered flood defences.**
- **Floodplains should be managed as an integral part of the wider catchment and not be viewed as somehow devolved from it.**
- **Working in co-operation with adjacent farming units across a floodplain, can help prevent damage to neighbouring properties.**
- **Low lying arable ground subject to periodic flooding should be considered for arable reversion to grass or floodplain woodland.**

Introduction

Floodplains are an important component of a river catchment. The floodplain offers land management areas for; flood water retention, food production, carbon sequestration and wildlife conservation. Natural flood management (NFM) as part of a sustainable flood management programme, offers opportunities for multifunctional floodplain activities.

Historically, rain falling in the wider countryside (on farmed land outwith towns and hard surfaces) was absorbed by the various habitat

Rivers often flood naturally onto adjacent floodplain areas

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components that formed the landscape and run-off into rivers was relatively slow. In more recent times, rain falling on upland, mixed and lowland farmland has behaved differently. The rainwater now runs off more quickly into the nearest drainage channel. This has come about through a combination of more extreme rainfall events and changes in land management practices. The effects have in some cases contributed to flooding downstream. In the uplands, overgrazing and soil compaction by livestock can occur. Drainage channels created on peat bogs, unimproved hill ground, improved grassland and within large conifer plantations, have speeded up the flow of water to the lowland areas. In the lowlands, arable crops and temporary grass has replaced permanent pasture and grazing marsh on floodplains, reducing the floodplain's natural water storage capacity. The trend of sowing crops in autumn (with resultant exposed soils over winter, with a loose soil structure) as opposed to spring cropping (with over winter stubbles and soils with a more stable soil structure) has had a similar effect. Compaction on low ground soils, through regular trafficking of farm machinery, can be considerable. Field tramlines can act as conduits for water with suspended nutrients and silts to enter adjacent watercourse, leading to diffuse pollution.

The effects of climate change are having noticeable impacts on our weather patterns, leading to ever more erratic and extreme rainfall events, with subsequent flooding. The need to reduce flood damage to property, cultivated land and semi-natural habitats is increasingly important. This can be achieved by slowing the rate of water flow from the surrounding catchment (temporary storage) and by storing water on the floodplain. Utilising natural solutions are considered to be an important and sustainable way of managing flood waters. The underlying geology (and soils) within a catchment has a significant impact on how flood waters behave, the sediment load the waters carry and the amount of damage the floods cause. Areas of exposed deep glacial drift deposits can be sources of sediment input to the waterway, as can areas of weathered, friable and unconsolidated bedrock. Grass covered or tree covered soils, offers reduced potential for sediment loading. The amount of suspended sediment itself can have a significant erosive effect on downstream banks.

The purpose of this technical note is to highlight what farmers can do to manage floodplains more sustainably and also what measures can be taken to 'slow the flow' of water onto the floodplain from land within the wider catchment. Only floodplains within the wider farmed landscape are discussed and not floodplains within the urban environment or at the coast.

Definition of a river floodplain

A floodplain is the area of relatively level ground near a river or a stream which is naturally affected by flooding if the river rises above its banks. The floodplain stretches from the banks of its channel to the base of the enclosing valley sides and experiences flooding during periods of high rainfall. It includes the flood way, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not usually experience a strong current.

Floodplains are made up of sediments left behind by a river, as it slowly evolves within the valley floor environment. The actual river channel through a foodplain is usually only a small part of the total water flow, much of which will actually be within or beneath the flood-plain gravels and soils. During flooding, erosion typically occurs at the outside of a meander bend, with sediments such as gravel being left on the inside of the bend. Over many years, vegetation colonises such deposited sediments and in time the stones, sands, silts, clays and organic matter builds up to create the soil on the floor of the floodplain. Floodplains thus generally contain many layers of sediments, often extending below the bed of the stream itself. These accumulations of sediments are usually important aquifers and often contain many species of soil and freshwater invertebrates which occur naturally in the river and which are beneficial for soil health.

Definition of a river flood event

When a river or stream overflows its banks (which may have been artificially raised) and submerges the adjacent land, this is termed a flood event. If the volume of water flow exceeds the capacity of the river channel to contain it; then flooding will occur. Flooding however, is a natural process that plays an important role in maintaining a diversity of habitats. New habitats are created through sediment deposition, whilst old habitats are destroyed through erosion. As the landscape has become increasingly managed by man, it is the interaction of water with land, which has become less natural over time. Flooding can cause significant structural damage to agricultural land and property. Arable soils on floodplains for example, can be washed away in extreme flood events.

Floodplain habitats

River floodplains typically contain a diverse mixture of different habitats, termed a habitat mosaic. The mosaic of habitats, is the result of land management (ie; farming, forestry and conservation) and natural processes (ie: channel braiding, ox-bow lakes, erosion, deposition and natural regeneration). A typical floodplain, on a major river system in Scotland, is often a mix of: wet grassland and scrub, riparian woodland, dry unimproved or species rich grassland and agriculturally improved land such as arable ground or pasture. Managing each of these habitats individually, without the use of fencing, can be challenging. Because rivers and streams generally flow through a number of different properties within a catchment, the need for neighbours to work co-operatively, to manage these habitats, is becoming especially important.

Priority habitats and species

Several priority habitats and species of conservation concern included within UK, Scottish and Local Biodiversity Action Plans, can occur on floodplains. Habitats such as waterside margins, wet grassland, marshy hollows and wildflower rich grassland, are important places for mammals such as Otter and Water vole, for insects such as butterflies and bees and for breeding bird species such as Snipe, Redshank, Lapwing and Curlew.

Managing floodplains and restoring natural river processes at a local level

Where feasible, entire floodplains could be allowed to flood naturally. Old style river levees or floodbanks could be breached in places and reduced in height to allow flood water to flow in behind. This way, the flood water can spill out onto the floodplain during smaller flood events. It will also allow water to flow back into the drainage system at a slower pace after the main flood event. When river banksides are to be protected, the use of 'hard' engineering works such as stone filled gabion baskets and concrete walling should be avoided where possible. The construction of hard channelling usually does not control really big floods and it merely exports the immediate erosion and deposition problems downstream to another's land. 'Soft' engineering solutions such as tree planting, timber bank protection and bank reprofiling

should be considered instead. To avoid any potential Cross Compliance regulation breaches, the Scottish Environment Protection Agency (SEPA) should be consulted prior to undertaking any river engineering work. In addition, an assessment should be made of any possible changes in flood risk for properties if any alteration is made to flood banks.

'Traditional river-works' such as straightening out natural meanders, dredging the main channels, removal of river gravel and removal of pools and riffles etc, all speed up the water flow rates and erosive capacity of the river. These works have led to loss of wildlife habitats such as spawning gravel beds and emergent vegetation. Over-steepened banksides are often a noticeable outcome of such works, which in turn provides more 'unconsolidated' material capable of moving downstream during flood events. Legal requirements are in place to protect the riverine environment. It is important to consult the relevant statutary body before in-stream works are undertaken.

Cross compliance and GAEC

Land managers in receipt of agricultural support payments, should be aware that maintaining semi-natural habitats in 'Good Agricultural and Environmental Condition' (GAEC) is a standard requirement under Cross Compliance regulations 2005 (updated 2007). In addition, Statutory Management Requirements (SMR's) for the conservation of flora and fauna are also enforceable and details can be found on the Scottish Government website under 'Cross Compliance guidance'. The Water Framework Directive (WFD) has its own set of regulations for work relating to watercourses and water bodies; The Water Environment (Controlled Activities) (Scotland) Regulations 2011. A number of General Binding Rules (GBR's) are operational to this effect.

Rules, regulations and legal requirements

Legally, the Water Environment Water Services (Scotland) Act (2003), driven by the European Water Framework Directive (WFD) and the Flood Risk Management (Scotland) Act 2009, places responsibility upon local authorities and other public bodies, to promote sustainable flood management.

Natural flood management techniques at a catchment level

Natural flood management techniques are one way to reduce flood risk and will be used in addition to other techniques such as engineered flood defences, as part of a sustainable flood management programme. The long term objective of reducing water flow rates and flooding events in the lowlands, involves developing deeper, more organic rich soils, in the uplands to absorb and slow run-off. To be wholly effective, natural flood management, needs to be done on a river catchment (or sub-catchment) scale and may require cooperation between land managers within the river catchment to restore natural processes.

Restoring natural river processes can be good for the environment. Encouraging natural river processes to develop can also be good for the farm business, by removing the need for regular and costly flood damage repair work. Techniques for 'increasing flood storage' are best applied in the middle and lower reaches of water catchments, where gentle gradients combined with wider floodplains can allow water to collect over a large area. Techniques for 'slowing the flow' are best applied in the upper reaches of water catchments. To achieve this aim, a number of positive land management steps can be taken:

1. **Slow the water flow through existing grazed gullies and hill cleuchs-** Organically rich woodland soils can help filter rainwater (and snow melt) and fallen branches and leaves can provide a series of natural dams along water courses, which allows woody debris to build up. Stock fences can be erected around existing grazed woodlands in the uplands, which can help stabilise the soil and encourage the natural regeneration of trees. This will also allow a deeper soil layer to develop. New native woodlands can be planted into gullies and cleuchs. Suitable trees species include: Sessile Oak, Ash, Rowan, Gean, Downy birch, Hawthorn, Hazel, Aspen, Holly (Scots pine in the Highlands) and Blackthorn. In the lowlands, riverine woodlands can help reduce sediment input into streams, which can cause the river to become shallower.

Fencing off existing woodlands and establishing new cleuch (or gully) woodlands, can help reduce sediment loading into the river system

2. **Across the open hillside, plant new native or mixed woodlands and fence them off from stock-** The ground under a woodland canopy can have a deep litter layer and a rich soil ecology. The increased depth of the soil layer within these woodlands, allows the water to be absorbed and flow more slowly. The woodland canopy slows the rate of water infiltration. Tree roots help slow the rate of water through the soil by taking up water through transpiration and releasing it back to the atmosphere through evaporation. There is potential in Scotland, to plant up areas of species poor acid grassland with native trees. In time, such woodlands can be grazed and managed as wood pasture as well as providing shelter, game shooting, harvestable timber and wildlife habitat. Small woodlands generally increase the overall capital value of the farm.

3. **Apply appropriate stocking levels-** The numbers of grazing livestock on hill ground and in-bye fields can have a significant impact on vegetation type and structure. Heavily grazed grassland swards can suffer from soil compaction. Appropriate grazing levels should be applied to agriculturally unimproved land as well as agriculturally improved land. The effects of deer and rabbit pressure on vegetation should also be considered in any land management programme.

4. **Restore wetlands and create ponds-** Consideration should be given to blocking some existing drains to allow the ground to become more like a wet sponge. Old hill drains and 'grips' could be infilled or left uncleaned. New ponds and shallow scrapes can help reduce flow rates in periods of high flood water. Some ponds may be natural 'ox-bows' – old water channels which already retain considerable wetland, plant and wildlife value. Ponds almost

always add more water storage capacity to the river system. 'Dry ponds' can be created in the landscape, especially in low lying, off-stream areas that fill up naturally, in periods of high rainfall, that then dry out slowly.

Creating ponds on floodplains can help water storage

5. **Reduce erosion and sediment input-** Along watercourses, where long stretches of bank are eroding, consider planting a mix of native broadleaves, so their roots can help to stabilise the banksides. Watercourses can be fenced off from grazing livestock and managed by occasional cutting, grazing or tree planting. Care should be taken however not to create too much shading effect. A ratio of approximately 6 shaded sections of banks to 4 unshaded is a useful guide. This prevents further input of soil and gravel into the river system, which increases the risk of flooding. It is natural however, to have some areas of active erosion, particularly on the outside of meander bends.

Fencing off watercourses stabilises bank sides, reducing sediment, faecal and nutrient input

6. **Plant floodplain woodlands and create 'leaky barriers'-** Floodplains are vital water storage areas. Reduce the level of flood banks and plant with native trees such as Willow, Rowan, Downy birch, Alder and Ash and shrubs such as Hawthorn and Blackthorn. Trees on a floodplain (floodplain woodland) act as a natural barrier to rising water levels by trapping material and preventing more flooding downstream. Similarly, on sloping land, wide hedges can be planted across slopes, which can help increase infiltration and reduce surface water flows and sediment loss.

Recently created floodplain woodland, watercourse meanders and water storage ponds

7. **Block or redirect drains and ditches within Forestry areas-** Blocking drains in forestry plantations helps reduce surface water run-off rates. Forest drains can be realigned to slow down surface run-off and ensure water is discharged slowly into buffer areas (at least 10m in width) and not directly into watercourses. This also greatly reduces diffuse pollution. The Forestry Commission's *Water and Forest Guidelines* should be followed in all cases of new or re-planting.

8. **Allow floodplains to flood naturally-** Allow natural flood water to spill out over the adjoining land. Here the river will lose its velocity and suspended silt will settle out. Levees could be removed completely or breached in sections and reduced to a low height, low enough to allow flood water to overtop quickly but high enough to let it percolate out afterwards. Floodplain wetlands could be established by disrupting drainage pipes.

This river is covering its entire floodplain area (across the entire valley floor) in times of very high rainfall events

9. **Restore natural water channels-** Rehabilitation of watercourses from fast flowing straight canalised ditches with steep sides, to slow flowing meandering watercourses with shallow banks, helps water retention and reduces flood damage downstream. Advice and authorisation from SEPA should be sought prior to any proposed in-stream work commencing. It may be possible also, to use existing land-forms to provide off-line temporary storage in 'dry' ponds.

Recreating a meandering stream where only recently, there was a canalised ditch.

10. **Arable reversion to grassland-** On ground liable to high velocity flood events, arable cultivations should cease and the field be sown to permanent grass and managed as grazing land. Soil erosion and soil loss within river catchments can be a real issue.

An arable field after an extreme flood event with top soil completely removed

The top soil from the field (above) was deposited in a woodland at the downstream end of the field.

Grants and other support

Financial assistance for some of the work suggested in this technical note, may be sought through the Scottish Government Rural Development Programme.

Further information

Further information on managing floodplains and flood water, can be sought from the following organisations websites
Scottish Agricultural College (SAC) http://www.sac.ac.uk
Scottish Government (SGRPID for agri-environment information) http://www.scotland.gov.uk
Scottish Environment Protection Agency (SEPA) http://www.sepa.org.uk
Scottish Natural Heritage (SNH) http://www.snh.org.uk
World Wildlife Fund (Scotland) http://wwf.org.uk/scotland

References

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Nature's Place for Water - Working with nature to reduce flooding. The Wildlife Trusts

Catchment scale approaches to restoring rivers with coarse sediment problems. University of Durham

Adapting to Climate Change- UK Climate Projections. Department for the Environment, Food and Rural Affairs

Restoring floodplain woodland for flood restoration. Department for the Environment, Food and Rural Affairs

Sustainable flood management in Scotland. Royal Society for Protection of Birds

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