An appraisal of the Defra Multi-Objective Flood Management Projects, December 2015

As part of its response to the Pitt Review[1], Defra invested £1.7m in three Demonstration Projects. The stated brief for these projects was to:

> "Generate hard evidence to demonstrate how integrated land management change, working with natural processes and in partnership, can contribute to reducing local flood risk while producing wider benefits for the environment and communities."

In achieving this brief, two of the projects also engaged to a significant extent with local communities and land-holders both of whom provided additional anecdotal evidence about the impact of land management change on flood risk.

The Demonstration Projects

- The three projects date from 2009 in Somerset, Derbyshire and North Yorkshire.
- Catchment sizes ranged from 18-90 km^2.
- All three projects were within or bordered on upland areas, with high rainfall and rapid runoff.
- The project in Derbyshire was located in a catchment dominated by blanket bog, much of which was severely degraded.
- The catchments in North Yorkshire and Somerset included areas of moorland, woodland, improved grassland and arable land.

Natural Flood Management

Natural Flood Management (NFM) involves implementing a range of land management interventions with the aim of decreasing peak flood levels experienced by properties and other assets downstream. The aim is to slow the rate of flow and / or store more flood water in the upstream catchment. Between them, a range of NFM measures was implemented in the three demonstration catchments, including:

- Establishing flood storage areas formed by clay or earth banks ("bunds") or by timber walls. The capacity of these bunded areas ranged from 1,300 m^3 to 120,000 m^3
- Creating 'leaky' woody dams both within channels and in woodland areas alongside streams
- Planting riparian and farm woodland
- Restoring degraded moorland by blocking gullies and drainage ditches, by stabilisation and re-vegetation of bare peat, and by establishing no-burn buffer zones alongside watercourses
- Diverting water away from moorland paths and tracks and onto the rough moorland surface, so slowing rapid surface runoff

[1] Pitt, M. 2008. *The Pitt review: learning lessons from the 2007 floods*. http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/_/media/assets/www.cabinetoffice.gov.uk/flooding_review/pitt_review_full%20pdf.pdf

- Improved management of woodland and farmland, including use of soil protection measures and the establishment of buffer zones

Headline findings

Two summary documents[2] published in 2011–2012 present a balanced view of the position at that time regarding NFM. New evidence emerging from these Demonstration Projects since then indicates:

1. NFM techniques can reduce flood risk

   The contribution of several NFM measures has been confirmed, for example:

   - Carefully designed and positioned flood storage areas resulted in a measurable decrease in peak flood flow and height downstream.
   - Statistically validated empirical evidence from replicated mini-catchments show that increased surface roughness of re-vegetated bare peat slows overland flow leading to delayed and reduced peak discharge.
   - It has been shown that water is effectively held back and slowed by a series of leaky woody dams, either in-channel or as an element of adjacent wet woodland.

A woody dam (North Yorkshire project)

   Extrapolation of the measured local effects of a variety of these techniques has shown that flood peak heights may be reduced by 4% or more on a 9 km^2 catchment scale in the Derbyshire project, by 4% on a 69 km^2 scale in the North Yorkshire project and by 25% on an 18 km^2 scale in the Somerset project. These estimated effects apply to significant sized flood peaks in the order of 1 in 25 annual chance of occurring.

   Multiple (or more intense single) NFM measures (carefully-planned and catchment-specific) are more likely to exert a larger positive cumulative effect. More detailed information about the impact of individual measures used by the three projects is published here: http://www.moorsforthefuture.org.uk/sites/default/files/MS4WSymposiumHeadlines.pdf

2. NFM techniques provide a wide range of additional benefits, including:

- Erosion control; sediment trapping; reduced loss of soil/peat particles; carbon sequestration and improved water quality downstream.
- Creation of new habitat, biodiversity gains, aesthetic appreciation, wildlife interest etc.
- Increased understanding amongst communities of the many wider benefits of good land management.

[2] POSTnote no. 396 (Dec. 2011) *Natural Flood Management*, Parliamentary Office of Science and Technology www.parliament.uk/briefing-papers/POST-PN-396.pdf

Upland Hydrology Group (Feb. 2012) *Flood risk, water resource and the uplands* http://www.uplandhydrology.org.uk/wp-content/uploads/2013/12/Runoff-and-the-uplands-Feb-2012_0.pdf

It can be shown that the total value of the flood risk reduction and other benefits arising from these projects substantially outweigh the total costs involved in implementation.

3. NFM techniques can be effective in catchments up to 100 km^2

Previous research had shown that NFM interventions can be effective in catchments of up to 10 km^2. The Demonstration Projects provide evidence that the use of NFM measures can reduce flood flows within catchments of up to 100 km^2. This finding is based on: hydrological data collected in small sub-catchments; up-scaling of these findings through modelling work; and anecdotal evidence from local communities.

However, predicting the effect of NFM interventions in catchments up to 100 km^2 is complicated by the increasing risk of 'synchronisation'; i.e. meeting-up of peak flows from individual rivers and streams. For example locating interventions downstream in the main channel are more likely to cause a meeting-up of peak flows from other sub-catchments upstream of the intervention. Also, slowing down a previously fast-draining downstream tributary catchment would have the same effect. On the other hand, such catchments may also provide opportunities to locate and target interventions to *desynchronise* tributary catchment flows.

4. Local communities can become powerful advocates of NFM techniques

In catchments where flooding is a major issue for local residents, and where a range of assets are at risk, these projects have shown that it is possible, with due care, to successfully engage with land-holders, win their support in implementing various measures, and also raise community awareness of the relationships between land management and flood risk.

Stone gully blocks and early stage re- vegetation (Derbyshire project)

Application of NFM techniques

Smaller catchments (<100 km^2): Carefully planned and catchment-specific NFM techniques are likely to have a role to play in most catchments of up to 100 km^2, by storing flood flows, and releasing them slowly, as part of a wider risk management approach.

Larger catchments (>100 km^2): Opportunities for NFM to contribute may be more limited in catchments greater than 100 km^2 due to the practicality and timescale for achieving large-scale change, although there will still be scope for constructing large flood storage areas and planting floodplain woodland.

Catchments with small communities at risk from flooding: Small communities provide a particular challenge, where the flood risk benefits may not justify the costs of either hard defences or other measures. However, NFM measures can also provide additional 'services' such as clean drinking water, carbon sequestration, recreation, tourism etc. - additional benefits which if properly accounted for can make NFM a cost-effective solution.

Most storm events: While some NFM techniques are likely to become swamped with increasing size of flood event, those that work by increasing surface roughness such as re-vegetation of bare peat on blanket bogs and establishing trees on floodplains will continue to contribute to flood mitigation under most storm conditions.

Part of a Flood Risk Management (FRM) tool-kit: NFM techniques that are carefully planned and implemented on a catchment by catchment basis are a valuable approach alongside more traditional flood risk management techniques.

A flood storage area (Somerset project)

Limitations of NFM

NFM techniques, like other approaches to flood risk management, are not a panacea.

The overall contribution of NFM, as in other approaches, is likely to decline once storm size exceeds a critical threshold.

NFM should be seen as one part of a wider flood risk management approach including engineered hard defences, increasing the resilience of assets vulnerable to flooding, but also steering development away from sites which are most at risk.

The complexity of factors within any natural catchment means that it is very difficult to measure and accurately model the contribution of NFM measures at the catchment scale.

NFM impacts cannot therefore at present be evaluated in the purely quantitative way we might assess an engineering intervention.

Some further points…

1) Wider application of NFM: All catchments are different and the wider application of these techniques should be done with care. However, it should now be possible to carry out a form of NFM 'priority mapping': identifying catchments upstream of communities at risk where NFM interventions would almost certainly be worthwhile, intermediate sites which merit further investigation, and situations where reviewing the possibility of such interventions would probably be a waste of time.

   Identifying priority catchments would initially involve a combination of mapping and local knowledge, followed by scientific modelling and an analysis of cost effectiveness to plan and implement where different NFM measures might be best located to make a difference.

2) Catchment sensitivities: Although NFM techniques generally provide a wide range of other benefits, they will need to be integrated carefully with other land use interests and sensitivities/designations; good partnership working and planning are vital, both at the local and strategic level.

3) Profitability: In some cases, NFM measures will have an impact on profitability and land-holders will seek financial support before they will engage. Other measures can be

accomplished without resulting in loss of income or any other detrimental effect, indeed NFM works will often lead to benefits both to the land-holder and the wider community.

4) Advocacy: NFM needs local advocates on the ground and needs to be explained to land-holders and others in plain language. Much of the information relating to NFM at the moment is aimed at specialist or professional audiences.

Further information on the Demonstration Catchments

A number of reports and detailed background information are available online:

"From Source to Sea" - Holnicote, Somerset

http://bit.ly/1Zpc9u8

"Making Space for Water", Derbyshire

http://www.moorsforthefuture.org.uk/making-space-water-2

"Slowing the Flow at Pickering" – Yorkshire

http://www.forestry.gov.uk/fr/slowingtheflow

The content of this note is based on discussions at a seminar organised by Moors for the Future Partnership and hosted by the University of Manchester in November 2015. The participants were:

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December 2015

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