COST Action 869

Mitigation options for nutrient reduction in surface water and

Riparian buffer strips as a multifunctional management tool in agricultural landscapes

April 25-28th 2010, Ballater Scotland

Can we turn this ...

... into this (and what are the benefits?)

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Report

Scope of the workshop

To date working group 4 of the COST Action 869 has examined how the Water Framework Directive has led to a range of mitigation measures being identified, adopted and having undergone preliminary assessment as part of EU wide river basin management planning (RBMPs). It is envisaged that riparian buffer strips can have immediate and long-term benefits for diffuse pollution control, biodiversity and communities. However, the basis on which these buffers are designed and placed in landscapes requires guidance based on scientific understanding and we need to assess and maximise their effectiveness and lifespan in respect of these multiple linked benefits. This workshop will focus on bringing together scientists and catchment practitioners from across the EU to further our understanding of riparian buffer functioning in different situations so that practical guidance may be developed as to their use, design, management and limitations. A specific meeting assessing buffer strips is timely. Buffer strips appear in 70% of the RBMP across the EU and seem to be a readily adopted measure with perceived effectiveness. There are a number of upcoming pieces of EU legislation which will provide tighter restrictions on farming activities at watercourse margins. The COST Action 869 Ballater meeting followed a meeting in Brussels specifically on buffer strips under the partnership of the Water Supply and Sanitation Technology Platform/EUREAU/COPA-COGECA (Feb2010). Research and shared understanding is necessary if the wide-scale uptake of buffer strips into riparian management is to be made most effective in terms of achieving multiple environmental functions.

Participants and meeting schedule

A total of 45 delegates attended the meeting representing 15 European countries. The mixture of people encompassed PhD students, researchers for Universities and Institutes, representation from policy-makers and agricultural advisory services. Twenty four talks were presented in four sessions covering buffer strip use, design and management, assessment and modelling, biodiversity benefits and socio-economics plus nine posters (detailed in Appendix 1). Additionally, a field trip to a site where buffers had been implemented, with a talk from the estate manager, was used as a basis for a half–day's discussion. Finally, a series of break out group sessions and a reporting back was used to arrive at summaries of our current knowledge on buffer functions, management and implementation (reported below).

Summary of knowledge from the workshop

The increasing use of riparian buffer strips is in recognition of the environmental costs of farming activities directly next to watercourses. The dangers of water pollution increase greatly with the proximity of animal access, cultivation, fertiliser and other agrochemical applications to the stream. A more 'natural' style of riparian management provides this 'buffer' capacity by way of a physical border between these agricultural activities and the stream. In terms of the losses of potential-contaminants from the land (sediments, nitrogen, phosphorus, agrochemicals) the buffer is envisaged as a retention and processing zone that can interrupt transport to the watercourse. For sediments and phosphorus this involves capture and storage, but for nitrogen (and potentially) organic contaminants, which may be degraded in-situ, processing may ideally lead to removal from the system. However, studies of nutrients and sediment dynamics in buffer strips show us that these functions of diffuse pollution mitigation are perhaps the most uncertain of all buffer functions. In this meeting we heard examples of how site-specific conditions were key to these processes. As examples, (i) concentration of the most erosive water flow paths (arising due to topography and ploughing alignment) leads to uncertainty in soil erosion trapping efficiencies, (ii) we find it difficult to account for subsurface soil drainage in water transport, and (iii) variability in ground water levels at the land/watercourse border makes predicting nitrogen transformations difficult.

These examples (and others) pose interesting scientific problems. We can model and predict the relevant processes at small scales (scales of metres). However, it remains a challenge to model these discrete, yet influential small-scale processes, to allow predictions at useful landscape scales (in the order of kilometres). This leads to uncertainty in the primary perceived goal of buffer strips, namely diffuse pollution control, despite this being the reason for implementation in much legislation. Future studies at catchment-scales are needed for evidence of diffuse pollution mitigation to supplement plot studies and modelling.

Given this uncertainty in diffuse pollution functioning we should look to maximise the positive aspects of buffers for a wider range of functions. Buffer strips can return a significant portion of the natural functioning of riparian areas, including habitat corridors (or 'stepping stones'), restored connectivity of the watercourse with its flood plain, biological inputs to the water (woody debris, seeds for dispersal), regulation of water temperature by shading and access for community recreation. In these respects, a little extra investment or planning in design and management would allow these 'compulsory diffuse pollution buffers' to achieve a wider set of environmental goals. At present though there is no biodiversity obligation for buffers and limited incentives to achieve these wider benefits. A further problem is the provision of indices for assessment of these wider benefits. These are needed as the basis for communication of, and legislation for, such benefits. In the workshop we heard clear aspects of ecological improvements both for terrestrial habitat (birds and insects) and for the stream ecosystem. There were also reported difficulties in quantifying aspects of ecological success. An example is the conflict between attaining a buffer vegetation community of perceived value and nutrient retention aspirations. Plant indicators of biodiversity (species number and presence of 'prized' species) scored poorly since these types were not suited to greater soil nutrient levels. This is an issue where clearer scientific goals for the ecological status and function of water margins are required.

There needs to be recognition in legislation and from within communities of the value of higher water and riparian environmental quality as a resource (for example through access, fishing, swimming, drinking water provision). In terms of science we need to show how this natural functioning will aid ecosystem resilience to aspects of environmental change, such as overall loss of biodiversity, ameliorating climate change (for example, combating rising water temperatures). Perhaps these integrated benefits require a new style of integrated policy to achieve them.

Providing these wider benefits will entail transaction costs for land managers and these will need to be offset through incentives. In particular, vegetation management (planting and/or harvesting biomass) seems necessary to promote optimum habitat and stop leaching of nutrients (reported for phosphorus) to watercourses. The way to effectively manage this vegetation is not clear, whether manually by cutting and removal, or by allowed grazing. There is also a case that wider buffer strips increase the benefits for habitat and the likelihood of diffuse pollution effectiveness, but this needs to be balanced economically with loss of agricultural productivity. New ideas about offsetting the costs associated with land taken out of production may be explored. These include recycling trapped nutrients back to land (for example phosphorus in sedimentation ponds, or in harvested biomass) and biomass production in buffers (from high quality hardwoods to energy crops). In summary, riparian buffers should not be implemented under the assumption that any of these goals will be achieved by buffers independently of complimentary, wider catchment-scale management. A buffer is unlikely to achieve diffuse pollution goals without being part of a ‘treatment train’ approach that limits the inputs of nutrients into the buffer (for example long term loading of phosphorus into the buffer would lead to soil phosphorus saturation and leaching). Interestingly, there is evidence that ecological aspects of the buffer are maximised when linked with wider catchment management. An example is that bird species utilising the buffer habitat are more successful when crop conditions maximised their hunting potential in the adjacent field. Another is that buffer vegetation biodiversity is enhanced by downstream seeding from pockets of high-value habitat upstream. Hence, linked multiple benefits (achieving diffuse pollution and biodiversity goals) can best be achieved when buffers are implemented through effective landscape planning.

Specific aspects dealt with in the Group Sessions

1. Buffer functions

Function	**Issues**
Water quality	Insufficient knowledge at present, site specific factors important, uncertainty in data and models needs to be communicated, pollutant swapping (e.g. GHGs), insufficient knowledge of N dynamics, problems in long-term nutrient storage (esp. P) leading to leaching, interactions with vegetation management not known, timing and nutrient form of leaching to watercourses important for eutrophication, need more studies especially at catchment scales
Habitat improvement, biodiversity	There is a conflict between nutrients and biodiversity services, perhaps two zone model buffer zone (closest to field) then eco-zone (adjacent to river), need for better modelling, maybe separate farming and areas of nature value to alleviate conflicts?

Shading	Plant tree species to encourage shading and leaf litter/woody biomass inputs, useful to combat temperature increase due to climate change
Flow capture	Useful reconnection of watercourses with their floodplains, fulfils multiple policy objectives, promotes seed dispersal of land plants, linked to wetlands and their potential as bioreactors, does sediment returned to the floodplain bring contamination issues (downstream of WWTP, urban areas etc)?
Carbon sequestration	Buffers have greater topsoil C contents, perhaps interactions with tree planting or leaching as DOC. Does soil C availability and inputs to watercourses promote nutrient processing (e.g. terrestrial or in-stream denitrification)?
Biomass production	May offset economics of land taken from farming, timber production or biofuel crops are examples. Could products be harvested without degradation of the buffer?
Landscape diversity	Need to replace much of what has been lost through agricultural intensification over last 50 years, tools are required for better landscape planning, need to link riparian management with wider catchment management
Cultural services	Hunting species are important (fishing, game birds), public access and recreation, community education (e.g. school groups)

2. Buffer design and management

Design	**Links to function**	**What do we need to know?**
Dimensions, width	Appropriate width depends on purpose, but is not fixed Biodiversity benefits from widening buffer, DP mitigation may reach an optimal width. There is a need to balance width and design to the specific landscape.	Do you have to buffer the buffer to achieve biodiversity or DP goals for narrower buffers? What are the economics of different buffer widths? Is a narrow, continuous buffer better than a wider, discontinuous buffer at hotspots?
Vegetation type	Trees provide leaf litter and shading functions, grasses provide water percolation and erosion trapping functions, shrubs may provide cover for birds. There is a conflict between nutrient enrichment and the type of plants that will grow.	The optimal mixture of vegetation between grasses, trees, hedges etc. Need appropriate set of indicators for ‘valued’ plant species.
Fencing	Necessary to exclude animals that cause bank erosion	Is temporary fencing better than fixed?

Soil amendments	Reactive amendments (e.g. Fe oxides) could be used to help retain phosphorus Could organic matter amendments increase N transformations?	What is the buffer lifespan for P retention with/without amendments?
Topographic and flow structures	Retention ponds, or bunds, leaky barriers may be useful	What are the lifespans before needing emptying?
Management		
Nutrient off-take	This can improve the lifespan of the buffer by removing nutrients	How should it be done to be most (cost) effective?
Grazing	Not in the first year of buffer life, beware of compaction and erosion by animals, requires careful management	
Sediment	Sediment could potentially have high yield of P so part of nutrient recycling Sediment may be contaminated though	Need to establish the cost-effectiveness of recovering the soil and nutrients and putting it back to the land
Vegetation removal	Removal of cuttings may stop P leaching	
Monitoring	There should be some form of observations to establish achievement of goals and hone management	Should we be checking soil properties, biological factors, or water quality?

3. Implementation

Awareness raising

Communication with the farming community is a big effort and needs to be done effectively. Often the people with whom it is most important to communicate (those with the poorest practices) will not negotiate. Wider groups of people need communication with (and between) to better promote general environmental awareness and specifically riparian management. These groups could be farmers, children in farming areas, farming cooperatives, up to supermarket food buyers. Good riparian management may be means for a farmer to visibly improve an accessible area of the landscape and promote a better environmental image for farming. In turn, we (the science to policy community) need to be clear at communicating what we expect from buffers. It is unlikely that buffers will achieve common goals in all circumstances. We need a system for analysing problems in the local landscape and setting appropriate goals. Maybe buffer 'strips' need a new name as 'strip' expresses a conflict in land between farming and the environment. We should consider the use of the term 'buffer zone'.

Incentives

Perhaps there are not sufficient public funds to rely on incentives alone, so legislation and education have their places. However, farmers should be compensated for providing important ecosystem services that are costly, or disadvantage their businesses. We question whether these should be paid on the basis of implementation, or results, though the latter are more difficult to judge and administer a system around. Are current economic instruments appropriate to offset environmental measures such as buffer strips? Allowing activities that produce a profit from riparian areas (biofuel crops, timber, hunting revenue) may help close any gaps. A further aspect could be the improved status of the farmer in the community as a 'land steward' in addition to actual payments.

Legislation and regulation

Regulation may ideally be the last element in the chain, but is necessary since it provides an overall framework. For example basic, expected levels of compliance are mandatory, whilst provision of higher level services is paid for. Over regulation, however, detracts from a sense of 'ownership'. Effective legislation requires clear aims and the tools to access them, lack of conflict between policy areas (for example food security and water quality policy) and minimal paperwork for land managers. Buffers are a specific case that could benefit from joined up policy promoting their potential integrated multiple benefits. Although there are no compulsory biodiversity objectives for buffers, the following key recent and upcoming policy exists for diffuse pollution functions:

- WFD – No explicit buffer regulations, but buffers in 70% of RBMPs. Buffers defined as areas without cultivation, grazing or agro-chemicals
- Pesticides Framework Directive – Obligation to provide 'appropriately sized' buffer zones where pesticides cannot be used. Must be in National Action Plans by 2012
- GAEC – No application of fertilisers near watercourses. Obligation to provide buffer zones along watercourses by Jan 2012 (but 'buffers' and 'watercourses' poorly defined)
- Nitrates directive – in Nitrate Vulnerable Zones. No application of fertiliser near water courses. Legislation already in place.

Further workshop outputs

We are currently finalising arrangements for a special edition of Journal of Environmental Quality. At present (May 2010), we have put a list of 19 prospective titles to the editor for his final approval for the edition. Following this we will invite the submissions to a deadline of Sept 2010, prior to their review and we expect a journal edition in print mid 2011.

Delegates from the Buffers workshop viewing and discussing buffer strip management in the field in the Tarland subcatchment of the River Dee, NE Scotland.

Appendix 1. Workshop Programme

Sunday 25th April

Arrival and pre-workshop meal at 19-30 (Club bar) for 20-00 (Lochnagar Suite)

Monday 26th April (Crathie Room)

09:00 - 09:20	Welcome and setting the scene	Marc Stutter, UK
09:20 - 09:40	Overview of buffer strips in Switzerland	Laurent Nyffenegger, Switzerland
09:40 - 10:00	Buffer zones in Norway	Anne-Grete Blankenberg, Norway
10:00 - 10:20	Nitrogen removal effectiveness in narrow buffer strips: some examples from the river Po catchment (Northern Italy)	Raffaella Balestrini, Italy
10:20 - 10:50	*Coffee break (Lochnagar Suite)*	
10:50 - 11:10	Dimensioning of buffer strips in the Slovak Republic	Jaroslav Antal, Slovak Republic
11:10 - 11:30	How do riparian buffer strips influence the nutrient uptake efficiency of small agricultural headwater streams?	Gabriele Weigelhofer, Austria
11:30 - 12:00	General discussion	
12:00 - 13:30	*Break for lunch (Lochnagar Suite)*	
***Session 2a.* Plot- to catchment-scale evaluations of buffer strip processes and effectiveness**		***Chairperson: Brian Kronvang, Denmark***
13:30 - 13:50	Modular approaches to the control of diffuse water pollution from agriculture: buffer zones, bioreactors, ditches and ponds	Tegan Darch, UK
13:50 - 14:10	Function and effect of vegetated buffer strips on nutrient emission at tile-drained field sites	Johanna Frings and Sandra Schonemann, Germany
14:10 - 14:30	Buffer system implementation with increased infiltration and nitrate retention capacity - A case study from Brittany, France	Andreas Matzinger, Germany
14:30 - 14:50	Are narrow vegetated riparian buffer strips functioning as a barrier against sediment and phosphorus in Scotland?	Marc Stutter, UK

14:50 - 15:10	A rainfall simulation study on P removal in buffer zones amended with Fe and Ca compounds	Jaana Uusi-Kämppä, Finland
15:10 - 15:40	*Coffee break (Lochnagar Suite)*	
15:40 - 16:00	Influence of linear flow structures on the effectiveness of buffer strips	Rosemarie Hösl, Austria
16:00 - 16:20	Water infiltration into soils under riparian buffer strips	Ararso Etana, Sweden
16:20 - 16:40	Representing grassed buffer strips' hydrology in a regional scale model	Aurore Degre, Belgium
16:40 - 17:10	General discussion	
17-30 - 20-00	*Visit to Lochnagar distillery (coach departs front of hotel at 17-30)*	
20-00 -	*Dinner at hotel (Lochnagar Suite)*	

Tuesday 27th April

08:30 - 12:00	Field trip (coach departs 08-30 from front of hotel)	
12:00 - 13:30	Lunch (Lochnagar Suite)	

Session 2b.* Plot- to catchment-scale evaluations of buffer strip processes and effectiveness** — ***Chairperson: Wim Chardon, The Netherlands

13:30 - 13:50	Buffering diffuse pollutants in agricultural catchments at the edge-of-field using constructed wetlands	John Quinton, UK
13:50 - 14:10	Measuring buffer strip efficiency under deltaic circumstances	Marius Heinen, The Netherlands.
14:10 - 14:30	Modelling the effectiveness of unfertilized field edges in the Netherlands.	Piet Groenendijk, The Netherlands.

Session 3.* Managing buffer strips for multiple pollutant and biodiversity benefits** — ***Chairperson: Wim Chardon, The Netherlands

14:30 - 14:50	Are environmental win-wins achievable on Scottish dairy farms	Davy McCracken, UK.

14:50 - 15:10	Importance of stream and buffer zone characteristics for bank erosion and phosphorus inputs to surface water	Brian Kronvang, Denmark.
15:10 - 15:40	*Coffee break (Lochnagar Suite)*	
15:40 - 16:00	Diversity and distribution of riparian plant communities in relation to stream size	John Dybkjær, Denmark.
16:00 - 16:20	Evaluating the effectiveness of buffer strips using riparian plants and beetles as indicators	Jenni Stockan, UK.
16:20 - 16:40	Seed germination from deposited sediments during high winter flow in riparian areas	Brian Kronvang, Denmark
16:40 - 17:10	General discussion	
17:10 - 19:00	Poster session (Lochnagar Suite)	
19:30-	*Workshop dinner (to be seated by 20:00, Lochnagar Suite).*	

Wednesday 28th April

***Session 4.* Combining biophysical knowledge, socio-economics and practicalities.** — **Chairperson: Marc Stutter, UK**

09:00 - 09:20	Cost-effective targeting of buffer strips for phosphorus mitigation: The case of Roscobie Loch	Bedru Balana, UK.
09:20 - 09:40	Buffers for biomass - a review and synthesis of options and practicalities in Denmark	Benjamin Christen, Denmark
09:40 - 10:00	General discussion	
10:00 - 10:30	*Coffee*	
10:30 - 12:00	Break out discussion groups	
12:00 - 13:00	Reporting back	
13:00 - 14:00	*Lunch*	
14:00 - 14:45	Concluding remarks and plans for workshop outputs	
15:00-	*Coffee and departure*	