Tearmann: Irish journal of agri-environmental research, **7**, 1-10, 2009

Sustainable grassland systems in Europe and the EU Water Framework Directive – Conference overview and summary

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Abstract

The International Conference on 'Sustainable grassland systems in Europe and the EU Water Framework Directive' took place at Teagasc, Johnstown Castle, Wexford from 12th to 14th November 2008. There were approximately 150 participants from Europe, the USA and New Zealand. Most of the invited papers are published in this conference issue. The main aim of the Conference was to identify the challenges that the Water Framework Directive (WFD) presents for grassland agriculture and to help guide the implementation of cost effective mitigation measures. The Conference focused on nutrient (mainly nitrogen and phosphorus) loss from grassland and the implications for sustainable production and water quality. This paper summarises the main points and outcomes of discussions and recommendations from the Conference.

It was concluded that it is difficult to link the management practices on individual fields or farms with the effects on water quality and ecological conditions in surface waters at the catchment-scale. There is a need to identify areas of highest risk of nutrient loss from point and diffuse sources to a waterbody of vulnerable status and then to focus mitigation measures in the critical source areas, where there is the greatest risk to water quality. Participants agreed that there can be a substantial lag time between the implementation of measures and improvements in water quality. A participatory approach at local level, with personal contact, is considered more productive for securing a positive response to adopting measures. Concerns were expressed that maps and models may be misinterpreted. It was recommended that estimates of accuracy should always be shown when presenting map data and modelled results. Success stories in reducing nutrient loss to water were reported and examples from Denmark and Switzerland were outlined. There is no consensus about the most important mitigation options; they will vary for different situations. The effective implementation of the Nitrates and Urban Waste Water Directives should go a long way towards meeting farming obligations under the WFD. The need for adaptive integrated management was recognised. How mitigation measures can be compared across a wide range of agricultural systems in several EU states, has not yet been explored and to achieve this, further cooperation on the most appropriate options is needed. Similarities and differences between the situation in New Zealand and the USA compared to the EU were also presented and discussed.

Key Index Words: Grassland, Water Framework Directive, soil, filtration, agriculture and environmental policy.

Background

The future of the EU population will be dominated by global change issues, including fossil fuel depletion, the need for alternative energy sources and an adequate supply of safe, quality food. Meanwhile, the world population is increasing and land and nutrient resources are diminishing. The pressures are increasing on water quality due to the combined effects of climate change and land use changes. The impact of these issues on agricultural production, water quantity and quality, and the capacity of agriculture to respond will be critical. An adequate supply of good quality water is fundamental for good ecological conditions in water bodies, human health and welfare. While agricultural production requires a clean environment, particularly adequate clean water free from chemical and microbial contamination, it also contributes to pollution, such as nutrient enrichment of both ground and surface waters.

Agricultural production is facing many challenges including the need to comply with new national, EU and international policies and legislation. For example, the EU Nitrates Directive (Anon., 1991) is being transposed into laws of EU member states, including into Irish law in 2006 (Anon., 2006). For the first time this sets legal limits for the quantities of nitrogen (N) in fertilisers and manures that can be spread on agricultural land and times prescribed for when they cannot be spread. Chemical phosphorus (P) fertiliser can only be applied if soil analysis shows a need for it.

The WFD is now in an advanced stage of implementation. It states that all waters must reach 'good ecological status' by 2015. This will be measured by using a comprehensive set of chemical and ecological standards that are being developed for water bodies throughout the EU. Each member state must implement a programme of measures to ensure that these ambitious targets are attained. All sectors including agriculture will have to play their part. Prior to the adoption of the WFD by the EU Council in 2000, there were about 20 EU Council Directives and 10 EU Council Decisions in operation in member states, aiming at protecting water quality (Anon., 1992). The primary objective of these polices and legal instruments is to ensure a clean and healthy environment for people and nature. The WFD, taking a holistic approach, attempts, through a single piece of ambitious and innovative legislation, to achieve good ecological and chemical status for all waters by 2015. Before this 2015 deadline, River Basin Districts must implement programmes of measures by 2012. Therefore, all catchments must comply with the WFD requirements in the same timeframe regardless of vulnerability or lag time. However, some have questioned if the WFD ambition is realistic and whether it can be achieved by 2015, what the economic costs and benefits might be, and how they should be fairly distributed among land and water interests (Moss, 2008).

Globally most grassland is devoted to the production of meat, milk, wool and leather. Agricultural yields from tillage are often much higher than those from grassland with up to 100 times greater edible dry matter production per ha from wheat than from meat. The profitability from grassland-based beef and sheep production is low (FADN, 2006). However, in addition to the agricultural produce, grassland also has the capacity to provide valuable environmental dividends. These include flood reduction, reduced soil erosion, increased biodiversity, increased soil organic matter and the potential to sequester carbon.

Farmers often rely on the EU single farm payments to remain viable. Thus, the economic situation on many grassland farms presents real challenges when it comes to implementing new environmental measures without financial support. For example, in Ireland, farmers have made large investments in the past two years to upgrade farmyards, build additional manure storage and purchase low emission slurry management technology with the aim of protecting the environment. By learning from this experience we can inform future strategies that aim to protect water quality.

It can be estimated that as much as 1000 ha per day of farm land in the EU is being removed from agriculture for building and other developments (Lexer and Banko, 2008). World population is expected to grow from 6 to 9 billion in the next generation. Agriculture will be required to produce additional food from a decreasing land base while at the same time achieving higher environmental performance standards. Set against a climate of high and increasing fertiliser costs, managing nutrients on the farm can generate significant cost reductions. This is a win/win situation for agriculture and the environment. Current estimates predict that there are only about 50 years of world rock phosphate reserves remaining at current rates of use, while the production of inorganic N fertiliser uses 1% of global energy (Stark and Richards, 2008).

Introduction to conference

The International Conference on 'Sustainable grassland systems in Europe and the EU Water Framework Directive' took place at Teagasc, Johnstown Castle, Wexford from 12th to 14th November 2008. There were approximately 150 participants from Europe, the USA and New Zealand. The attendees included farmer representatives, research and water basin managers, research scientists and policy makers. Twenty one invited papers and 30 posters were presented. Most of the invited papers are published in this issue of *Tearmann*.

The main focus of the Conference was on nutrient loss to water, particularly nitrogen (N) and phosphorus (P) loss, from grassland systems to surface and groundwater, and the implications for sustainable grassland production and water quality. One of the main aims of the Conference was to identify the challenges that the WFD presents for grassland agricultural systems. A further aim was to highlight the tasks ahead for the scientific community, which can help guide the implementation of cost-effective measures as well as monitoring water quality response to mitigation measures. Once highlighted, these issues will help to underpin sustainable European grassland agricultural production systems that are competitive on the world market and fulfil environmental obligations placed by the WFD.

The 21 invited papers were presented in three sessions, namely:

Session 1, Economic and environmental drivers for intensive grassland in the EU and beyond (6 papers);

Session 2, Water quality standards and risks under WFD (4 papers);

Session 3, Implementation of measures and associated water quality responses (10 papers).

This summary paper provides an overview based on the presentations and discussions at the Conference rather than a systematic summary of the 21 papers and 30 posters presented.

Abstracts of all papers and posters presented can be accessed at:
www.teagasc.ie/publications/2009/20090106/.

Linking field and catchment

An important conclusion from the Conference was that it is generally difficult to link the management practices on individual fields or farms with the effects on water quality or ecological conditions in surface waters at the scale of the entire catchment. There is a need to identify areas of highest risk of N and P loss from point and diffuse sources to a waterbody of vulnerable status. Mitigation measures and resources should be more focused in these critical source areas, where the greatest risk to water quality is likely. At the same time, this could be controversial as restrictions and modifications to farming may be spatially concentrated rather than evenly distributed.

In Ireland the percentage of river channel classified as unpolluted increased from 66.9% in 1995-1997 to 71.4% in 2004–2006. This is mainly associated with a decrease in the moderately polluted category which decreased by 4% (Clabby *et al.*, 2008). This improving trend in Irish river water quality will contribute to meeting the requirements of good status but the main challenge is the 2015 deadline. Differentiating point and diffuse sources of pollution is important for evaluating water quality responses as point sources normally relate to direct discharges to rivers and groundwater and, once mitigated, should have relatively fast response times as the transport pathway is rapid. In contrast, diffuse nutrient emissions to water have more complex transport pathways. For diffuse sources of pollution the water quality response time to changed agricultural practices varies from long (centuries) to short (days to years) and depends on the pathway of water and nutrient movement. The pathways are faster for overland flow and tile drains but can, in some conditions, be substantially longer for deeper leaching and groundwater movement. The transport pathway lag times are influenced by soil and subsoil type, hydrology, hydrogeology, meteorology, climate and nutrient storage along the transport pathway. The interactions of all these factors contribute to the uncertainties in relation to land-use impact on water quality. These interactions need to be understood in order to evaluate the effect of different mitigation options on diffuse nutrient pollution from grassland agriculture.

There was considerable discussion at the Conference on the use of maps produced by the European Environmental Agency (unpublished oral paper by Robert Collins, EEA, www.teagasc.ie/publications/2009/20090106/) and other sources and how these are used to identify vulnerable and impacted waters. Concerns were expressed that maps and models may be misinterpreted and that it is important to know the potential errors and the appropriate spatial resolution. It is important to underpin each map with the methodology and assumptions it is based upon. Ideally estimates of accuracy should always be indicated when presenting map data and modelled results.

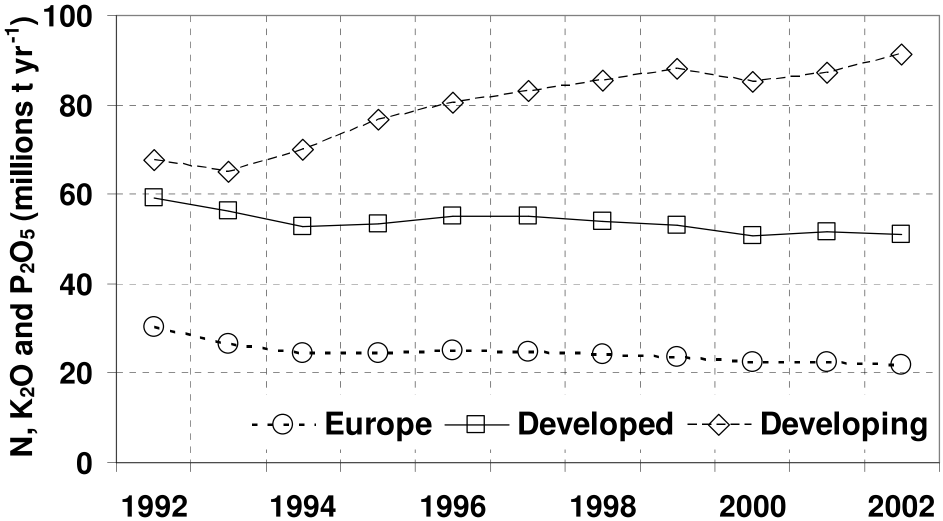
Mitigation options

The implementation of the Nitrates Directive in the EU has focused on more efficient use of nutrients on farms through restrictions on the quantity and timing of fertiliser applications coupled with the recovery of nutrients in organic manures. In the period 1992 to 2002 total annual fertiliser consumption decreased by 8.1 and 8.3 million tonnes (t) yr^{-1} in the developed countries and Europe, respectively (Figure 1) whereas global consumption has increased by 23.8 million t yr^{-1} in developing countries (http://earthtrends.wri.org). The increasing use of fertiliser in developing countries is likely to lead to increased nutrient loss to water in these areas similar to what has occurred in developed countries in recent years.

Many mitigation options documented in fact sheets were discussed and are being developed and expanded on an ongoing basis (e.g. COST Action 869). Success stories were reported, for example Lake Sempach in Switzerland, where goals for reducing P loading of the lake set 25 years ago have been achieved by implementing targeted measures, including subsidies for reduced P in feed (http://www.sempachersee.ch/pdf/zustand_see.pdf).This was achieved without eliminating intensive animal production in the catchment (Herzog *et al.*, 2008). At a larger scale Denmark has succeeded in reducing agricultural N pollution to surface waters by more than 40% since 1989, with the implementation of five National Action Plans and several mitigation options, without reduction in plant and animal production (Kronvang *et al.*, 2008).

At this stage there is no consensus or certainty about the most important mitigation options (Herzog *et al.*, 2008) and they will vary for different situations. However, it is necessary to make a start, and a better understanding of the most appropriate options for different situations will develop over time so long as adequate monitoring and evaluation arrangements are put in place. A number of options are required to help reduce nutrient

Figure 1: Total annual nitrogen (N), potash (K_2O), and phosphate (P_2O_5) chemical fertiliser-consumption in agriculture in Europe, Developed and Developing Countries in millions of tonnes per year (data source, accessed Jan. 2009:(http://earthtrends.wri.org/searchable _db/index.php?theme=8).



emissions from various farming practices and an integrated multidisciplinary approach is needed to improve water quality.

It was concluded that there is a need to take account of risks and vulnerability, for example, there can be high P losses to a surface waterbody on heavy soils with poor drainage. High overland flow intensities can cause soil and P erosion. In contrast, on free draining soils high nitrate-N loss in land drainage water is often more likely than on wet soils. In addition, where nitrate (NO_3) loss to water is low, emissions of the potent greenhouse gas nitrous oxide (N_2O) are likely to be high and vice versa (Richards *et al.*, 2009). Phosphorus can also be lost in relatively large quantities from agricultural land because of P transport through macropores, particularly where artificial drainage has been installed.

It was emphasised that there is still a degree of uncertainty with aspects of the various mitigation options available and some believe that we are sailing uncharted waters. The need for adaptive integrated management was recognised. It is necessary to identify mitigation measures for a particular site, assess the anticipated benefits of the measures and finally monitor, model and track what happens in order to make the necessary adjustments. This should be an iterative process with lag and response times factored into predictive models (Watson *et al.*, 2009). Tools for evaluation are available, ex-post and ex-ante, from simple indicators to complex models that can help with stakeholder decision making (Vertès *et al.*, 2009).

It is clear that there is a lack of long-term experience and real life examples with many mitigation measures. Long-term monitoring is important to detect trends against the large temporal variability that occurs. How mitigation measures can be compared across a wide range of agricultural systems in several EU states, has not been explored. To achieve this, further cooperation on the most appropriate mitigation options for a particular type of farm management is needed, for example, permanent grassland. This cooperation should provide more successful examples with more statistical confidence in a shorter time period.

Situation in other regions, New Zealand and the United States of America

The papers presented and discussed during the Conference indicated that both similarities and differences exist between the situation in New Zealand and the USA compared to the EU.

In general, New Zealand has better water quality than the EU but there are reports of impacts from agricultural activities on water quality (Quinn *et al.*, 2009). The adoption of grassland intensification (increased N and P fertiliser consumption, irrigation and stocking rate) took place a generation later in New Zealand than in the EU. The New Zealanders are now catching up and could be faced with the same problems as the EU in the future. They have now the opportunity to learn from other regions, including Europe and the USA.

Research on the mainly grassland catchment of Lake Taupo in New Zealand, found that it can take 30 to 50 years for nitrate from grassland to reach surface water and it may take a similar time for improvements to become evident. Dairy farmers and milk processors in New Zealand appear to be more proactive in dealing with risks of N and P loss to water than their European counterparts. There is a strong awareness of the importance of unpolluted water in maintaining the 'green clean' image of New Zealand dairy products for consumers. Increasingly farmers in New Zealand have to implement measures to protect water quality. The government and the agricultural industry are working together to reduce nutrient loadings in selected sensitive catchments such as Lake Taupo, where it is planned to reduce manageable N loadings by 20% through an N cap and trade programme (Quinn *et al.*, 2009).

In the USA, livestock and poultry production have had a negative impact on water quality in many catchments, due to nutrient enrichment. Consequently the US Environmental Protection Agency requires nutrient management plans for large animal production operations. Federal and University researchers in the US have established the National P project (NPP) to monitor and assess the impact of land management practices on P losses (Sharpley *et al.*, 2002). A Watershed Agriculture Project (WAP) in New York has developed strategies to lower excess nutrients, sediment and pathogens entering water in the Catskill region, which provides drinking water for New York City (Dell *et al.*, 2009). WAP has supported site-specific research with individual farmers to develop comprehensive farm management plans to maintain both farm production and environmental protection. Dell *et al.* (2009) recommended that the EU should consider a similar cooperative research and implementation programme that provides incentives for best management practices to reduce pollutant sources through grants and cost-share schemes. The assessment of impacts of these measures is considered to be a major challenge.

Studies in the USA have shown that there is order in the usually complex estuarine waterbodies (Glibert, 2009). They are influenced by biological, chemical and physical factors that interact in the delivery of multiple sources of nutrients and their transformations. The ecosystem response to nutrient enrichment is highly variable and dependent on the location along the estuarine continuum. It is necessary to manage estuarine water quality by a consistent but not necessarily uniform strategy which should be tailored to the specific conditions in the estuary in question (Glibert, 2009).

Communication with stakeholders and perceptions

There was strong consensus among the Conference attendees that a bottom-up or participatory approach is more successful when attempting to improve farm management practices associated with protecting water quality. It was considered important to plan carefully how research scientists, farm advisers, policy makers and the farming community communicate when implementing measures to improve water quality. This was particularly evident from the Lough Melvin project which used an intensive advisory approach (Schulte *et al.*, 2009).

Some regions find it easier to obey rules than others in the EU depending on many factors, including social and historical background and how communities traditionally relate to local and national authorities (e.g. in Copenhagen pedestrians generally stop for a red light even in the absence of traffic, but this is not always evident in Dublin). A participatory approach at local, community level, with a personal contact may be more productive in getting a positive response to adopting measures.

There is sometimes a perception that farmers managing the most intensive enterprises benefit financially from development that can lead to nutrient enrichment of water while more extensive farmers are losing out. The perception appears to be that limitations in production may not be compensated for by agri-environmental and cross-compliance measures and this perception merits consideration.

Conclusions

Environmental policy is now a major influence on agricultural policy in the EU and elsewhere. The effective implementation of the Nitrates and Urban Waste Water Directives should go a long way in reducing the burden of implementing the WFD and minimise the extra requirements in river basin management plans.

The Nitrates Directive action programme permits 170 kg manure N per ha, with up to 250 kg manure N per ha with derogation in some member states, and this appears broadly correct (Schröder *et al.*, 2009). However, it may be too high on sandy soil and too low on clay soils (mineral fertiliser N between 100 and 150 kg per ha). It may be more appropriate to have different limits for different situations (e.g. clay or sandy soil, high or low rainfall, good or poor growth). However, this would be very difficult to implement, as differentiated regulations would create uneven playing fields for dairy farmers within regions, member states or at least Europe as a whole (Schröder *et al.*, 2004). There is not yet enough monitoring information to be sure that current measures will be adequate to meet the requirements of the Nitrates Directive.

Not all waterbodies should be treated similarly. Waterbodies with high water quality status are most at risk as these have highly sensitive ecologies, which when lost from the system, cannot easily be returned to the same high status. Lough Melvin, in Ireland is an example where important fish species could be at risk (Schulte *et al.*, 2009). Thus such highly sensitive ecosystems must be prioritised in the implementation of the WFD and the importance of these sites needs to be effectively communicated to all stakeholders.

On vulnerable soils, intensive grazing results in higher nitrate losses than mechanical harvesting of grassland and feeding of herbage to cows confined indoors (including recycling manure to the fields), although this entails much higher costs. Management solutions to lower the detrimental impacts of intensive dairy production on water quality (to comply with WFD) need to be appropriate to particular circumstances, including climate and soils (Humphreys *et al.*, 2009).

It is clear that improvements in water quality and the achievement of good status will take time. All participants agreed that there can be a substantial lag time between the implementation of measures and associated improvements in water quality. These lag times are effected by many physical, biological and chemical factors which must be taken into account when assessing the efficacy of measures. The deadline of 2015 is a challenge and everything cannot be achieved at the same time; part may have to wait for later WFD cycles (every 6 years).

What was learned at the Conference can give pointers for the future and a meeting on this topic in the next 2 or 3 years could help in reviewing progress and planning for the future. Delegates from INRA in France indicated that they would explore the possibility of holding a follow on Conference on the topic of grassland and the WFD in two or three years (2010 or 2011), if it is considered necessary and helpful. They would welcome suggestions and help from interested scientists and others.

Many of the case studies presented at the Conference demonstrated clearly that a catchment approach to improving nutrient management practices does work. Where good communication and trust is established between local stakeholders, farm advisors and researchers, significant improvements in management practices can be realised.

It is critical that all future agricultural research programmes are proofed against the objectives set out by the Water Framework Directive. This will ensure that future research findings are relevant and contribute to the real challenges faced by agriculture and the wider community.

Acknowledgements

The authors wish to thank the invited speakers who presented papers at the Conference and provided helpful suggestions for this summary paper. The poster presenters and the other participants at the Conference provided valuable information in discussions that helped with the success of the Conference and with this paper. Funding from the Irish National Development Plan is acknowledged.

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