STAKEHOLDER POLICY AND RESEARCH INTEREST DOCUMENT

This document outlines some of the main policy concerns and objectives of the major stakeholders in the Macronutrient programme. The organisations include DEFRA, the Environment Agency (EA), the Scottish Government, the Welsh Government, the Northern Ireland Government, and the Living with Environmental Change (LWEC) organisation. Details of the contacts for these organisations are available at
http://macronutrient-cycles.ouce.ox.ac.uk/partners.html

DEFRA

Defra's business plan sets out the following priorities:

- Support and develop farming and encourage sustainable food production
  - Help to enhance the competitiveness and resilience of the whole food chain, including farms and the fish industry, to help ensure a secure, environmentally sustainable and healthy supply of food with improved standards of animal welfare
- Help to enhance the environment and biodiversity to improve quality of life
  - Enhance and protect the natural environment, including biodiversity and the marine environment, by reducing pollution, mitigating greenhouse gas emissions, and preventing habitat loss and degradation
- Support a strong and sustainable green economy, resilient to climate change
  - Help to create the conditions in which businesses can innovate, invest and grow; encourage businesses, people and communities to manage and use natural resources sustainably and to reduce waste; work to ensure that the UK economy is resilient to climate change; and enhance rural communities.

Developing policies that address the range of environmental impacts from nutrient pollution poses a major challenge to Government and the agricultural industry. Addressing multiple pollutants that interact and change form needs integrated policy to meet a whole range of existing legislative requirements. This needs to be underpinned by a strong scientific understanding of the processes governing the emissions of water and air pollutants and greenhouse gasses so that effective mitigation can be put in place that farmers and policy makers have confidence in. This understanding needs to take account of changes in climatic, economic and social conditions.

Defra needs evidence on the impact of land management on the environment as summarised in the table below. Note that this is not a comprehensive list :

Pollutant	**Legislative/ policy driver**	**Timeframe**	**The problem**	**Some major questions**
NO_3	Nitrates directive, Water Framework Directive	Ongoing	NO_3 leaching to surface and groundwater - meeting 50 mg/l standard and not	What are the timescales in which we can expect to measure changes from the point of applying mitigation measures?

			causing eutrophication in water bodies especially coastal and transitional waters. NO3 leaching to groundwater and drinking water supplies.	What is the relationship between the different nitrogen pollutants? What is the best strategy for reducing all of them?
P, NH_4^+, NO_3, sediment and other water pollutants	Water Framework Directive	Need to achieve good ecological status by 2027 at the latest	P and NO_3 are likely to be the main factors Understanding which sources of nutrients are most important in terms of impact on aquatic ecology (septic tanks, STW, farms (tillage/point sources), aerial deposition etc)	How do pollutants interact? Spatial and temporal scales: what level of intervention do we need at what scale to meet targets for 2027? What are the best and worst case scenarios?
NH_3	Gothenburg protocol and National Ammonia Emissions Ceilings Directive	The NH_3 ceiling is likely to come down over the next few years.	NH_3 emissions from agriculture have an impact on human health (causing respiratory problems) and ecosystems following deposition, especially in the uplands. Major emissions come from the dairy, pig and poultry sectors. Pigs and poultry are covered by IPPC regs. Dairy is not currently.	Which mitigation measures are most effective? What are the interactions and trade-offs with other froms of nutrient pollution? How confident can we be in meeting revised ceilings? What can we do about NH_3 emissions from the dairy sector?
N_2O	Climate Change Act and Low Carbon Transition Plan	80% reduction in UK GHG emissions by 2050	N_2O has a global warming potential 300 times that of CO_2. Emissions from soils, especially following the application of fertilisers and manures.	What are the soil processes governing denitrification? What are the interactions with other forms of N? How do N_2O emissions vary spatially and temporally?
CH_4	Climate Change Act and Low Carbon Transition	80% reduction in UK GHG emissions by 2050	CH_4 has a GWP 23 times that of CO_2. Livestock manures and enteric fermentation are a	How can we reduce CH_4 emissions? What are the processes involved (especially in the rumen)?

	Plan		major source.	
Faecal indicator organisms (FIOs)	Bathing waters directive/ Shellfish waters directive	Now	Although not a nutritent, FIO losses to water are often associated with nutrient pollution. Mitigation of nutrient pollution must not increase FIO losses. The revised BWD has tightened bathing water standards so loss of FIOs from farms are now a significant cause of failures.	Where should mitigation be targeted?
All	Common Agricultural policy	CAP is being renegotiated by 2014	There is an opportunity to improve the effectiveness of pillar 1 (including cross compliance) and pillar 2 (including agri-environment schemes) for protecting water and air and reducing GHGs	How should government be encouraging farmers to manage the land to improve the productivity and competitiveness of UK agriculture whilst reducing environmental impact?

DEFRA Main policy priorities concerning nutrients:

DEFRA considers that nutrients can be either a benefit, mainly in the form as support for food production or a problem, as follows;

- N_2O and CH_4 from UK agriculture are powerful greenhouse gases
- Nutrient (N & P) enrichment of transitional and freshwater habitats - algal blooms and oxygen depletion.
- Atmospheric N deposition NO_3, NH_3 and NH_4 - acidification and nutrient enrichment of habitats
- Acidification from N deposition - limiting the rate of recovery of ecosystems.
- NH3 emissions - public health concerns about particulate matter
- High levels of NO_3 - unacceptable drinking water quality.

DEFRA Demonstration Test Catchments

In order to research some of the nutrient issues, DEFRA has funded the demonstration test catchments with the broad aim of providing underpinning research, from farm to catchment

scale, that can inform both policy and practical approaches for the reduction of agricultural diffuse pollution and the improvement of ecological status in freshwaters, whilst maintaining economically viable food production. The DTC catchments will host collaborative research in the longer-term on diffuse pollution from agriculture and establish a sustainable research platform to enable short and longer-term research questions to be answered. The platform will also help with the development of more efficient and effective ways of undertaking research, with the development of better organised interdisciplinary research which informs integrated policy and with the refinement and testing of an improved integrated toolkit for monitoring water quality, environmental and social outcomes and dissemination of the knowledge gathered therein.

DEFRA DTC Modelling Platform: Strategy and Objectives

As part of the DTC Programme models are required to scale up the knowledge generated at monitoring sites to multiple scales within catchments, and to transfer knowledge gained within the DTC to other catchments with far less monitoring infrastructure. Furthermore a decision support role is necessary to synthesise and communicate the outputs of multiple models covering multiple pollutants to stakeholders, operational staff and policy makers in formats that are suited to their needs.

Previously Defra modelling activities have been largely targeted towards specific questions and pollutants, covering disparate scales and time periods. They have often suffered from a lack of testing against data, due to a scarcity of observations. Furthermore our current modelling resource is somewhat atomised, with access limited by institutional boundaries. Where models are shared, version control may be an issue, but also the lack of common datasets to parameterise them means that results are often difficult to compare.

In order to address the above issues a strategy document was drafted by the DTC team in collaboration with the consortia, Defra policy and EA policy/operations staff. The strategy took, as its point of departure, the finding of previous Defra funded reviews of modelling resources and the outputs of a DTC modelling workshop held in May 2010. The draft report was circulated and feedback collated. The findings broadly agree with the recommendations of the Defra Scientific Advisory Council Modelling Sub Group report[1]. The DTC modelling strategy identifies the following broad gaps and opportunities for building on our current modelling capability for air and water pollutants and greenhouse gasses:

- To develop in-house capability in Defra through increased access and understanding of existing models
- To encourage open-source development and code-sharing to increase transparency and scrutiny of underlying assumptions
- To improve knowledge exchange around models and how they work
- To develop the existing modelling resource through expert review, and integration of knowledge from a wide range of sources

The DTC strategy focuses on the delivery of open and transparent tools to translate data to useful outputs for stakeholders. This should be achieved in the main by bringing together existing resources to cover multiple pollutants, running the models on common data sources (e.g. through the emerging DTC data infrastructure), and summarising their outputs with user friendly front ends. Wider activities in the UK could be harnessed for delivery, including the

[1] http://sac.defra.gov.uk/sub-groups/modelling-sub-group/

wider data sharing agenda and developments of cloud computing 'models as web services' approaches (including but not limited to the NERC environmental virtual observatory pilot).

Defra's current priorities for developing modelling capacity for macronutrients and other water and air pollutants are summarised below. Work should aim to improve the robustness and reliability of the diffuse pollution models used to inform policy and delivery. This needs to cover several areas:

1. **Modelling to 'scale-up' research from DTC sub-catchments:** developing approaches and tools (incorporating appropriate uncertainty frameworks), to improve our capacity to understand the likely effectiveness of policy over:
    a. **Spatial scales:** To interpolate observations at the field/ sub-catchment scale to (1) catchment and (2) national scales. This would use data gathered in DTC and NERC Macronutrient Cycles programme to provide evidence on the probable effectiveness of measures in delivering reductions in multiple pollutants at different scales.
    b. **Temporal scales:** (1) To improve the resolution of our predictive capability and understanding of short-term, event-driven fluxes in emissions to water and air. (2) To provide an indication on the likely timescales that improvements in water and air quality and could reasonably be expected to be delivered.
    c. **Interactions and trade-offs:** between multiple pollutants, and between environmental impacts and agricultural production.
    d. **Mitigation measures:** Disaggregate the cost-effectiveness of individual measures from measurements at the outlets of catchments where multiple measures have been applied, building on conceptual modelling underway through DTC.
    e. **Source apportionment:** Modelling to predict the probable contributions of different sources or nutrient pollution over the spatial and temporal scales.

    Approaches should build on our existing modelling capacity e.g. using ensemble approaches to combine multiple models.
2. **Communicating modelling capabilities and outputs:**
    a. Better cataloguing of model metadata (including details of the primary purpose of the model, known limitations and caveats for use) to help decision makers select the right tool for the job.
    b. Development of decision support/synthesis tools to translate complex multi-model output into information which is targeted to key stakeholder groups (operational staff, policy makers, farmers etc.)
    c. Investigate ways of developing modelling approaches that integrate numerical data with alternative 'soft' information sources including local knowledge etc. This includes investigating ways to improve the way in which users interact with models.
3. **Improve our confidence in predictions through testing and parameterisation of models:** using data-sets collected in the DTC and Macronutrient Cycles programme catchments to:
    a. Parameterise and run models,
    b. Ground-truth and test the modelling resource at our disposal, setting realistic confidence intervals on our estimates.

    Analysis of the discrepancy between models and outputs should challenge our conceptual models of catchment function, and improve both our understanding and model representations over time. A risk based evidence approach should be

encouraged, using the distribution of multiple model outputs as a basis of decision making.

It is intended that any models, tools or data developed through DTC will be open-source to allow iterative developments and to allow wider scrutiny by the research community.

ENVIRONMENT AGENCY

Main policy priorities and research interests

- The main legislative drivers for nutrient control include WFD, UWWTD, Nitrates, Marine Strategy Framework Directive, OSPAR and Habitats Directive (where eutrophication prevents favourable conservation status).
- Nutrients from diffuse and point sources are the most common cause of water body failure under the Water Framework Directive.
- 28% (1,969) of surface waters fail for nutrients which are linked to 31% (722) of surface water bodies with a biological failure.

Research interests

- To date, the ecological consequences of enhanced N and P loads and concentrations have been considered separately. More attention needs to be paid to their combined effects, and interactions with the Carbon cycle.
- We need to improve our understanding of the fate, behaviour and transport of nutrients from land to sea in order to reduce uncertainty in risk and impact assessments, source apportionment, and to target solutions more cost-effectively.
- Reductions in river and groundwater nutrient levels to meet current standards could be cost prohibitive in some areas. We need evidence on measures to deal with point source, agricultural and non-agricultural diffuse nutrient pressures, including cost and effectiveness, especially tackling multiple pressures and in the context of ecosystem services.
- We need to consider a range of management options, and engage with and influence partners to deliver environmental objectives.
- We need to know how long after measures are implemented we can expect to see changes in WFD status. This will inform objective setting, monitoring post-measures and allow us to manage external expectations.
- EA involvement is as an end user to help guide the research and transition to operational need. In-kind support (data, current applied research, catchment demonstrations, policy/research expertise, etc)

Current EA Initiatives

- Statutory Drivers (point source controls / NVZs / Habitats consents review / WFD / N & P standards)
- Diffuse sources - Catchment Sensitive Farming (codes of practice/nutrient management plans/farm visits)
- Demonstration Test Catchments (evaluate success or otherwise of interventions)

- Research to determine good ecological status and development of classification tools under WFD

SCOTTISH GOVERNMENT

Main policy and research priorities

- The nature of the interface between the air and terrestrial systems – this is poorly understood;
- The current disconnect between air quality monitoring and atmospheric disposition communities and data;
- The lack of information at the catchment-scale;
- The problems of Scotland's nutrient-limited, organic, acidic soils (peat) and freshwater;
- The implications of N deposition, forestry, and extreme events.

More detailed policy requirements include:

Water supply & renewable energy:

- Improved environmental sustainability and resource efficiency of water and energy supply chains. Including how the use of renewable energy sources will impact on the environment (including GHG emissions, waste disposal), and more accurate data on Scotland's contribution to global carbon emissions from water and energy supply chains.
- How the regional/spatial differences across Scotland with respect to variations in its soils, environment, climate and land use, presents both constraints and opportunities for land use, environmental protection/management, climate change mitigation/adaptation.

Diffuse pollution and water quality

- Evidence on effectiveness of existing measures (including wetlands and riparian zones) to minimise diffuse nitrate pollution in NVZs, and of other diffuse pollution legislation.
- Improved understanding of the role of land management and climate change on total diffuse pollution loads in Scottish freshwaters and coastal waters.
- Scenarios to explore risk and impact of changes in water quality (including eutrophication, microbial water quality, acidification and ecological quality) in response to land use and climate change.
- Identification of opportunities for diffuse pollution measures to deliver multiple objectives (including for flood control, economy, amenity, livestock biosecurity and biodiversity), and to avoid unwanted pollution-swapping.

Land use, Greenhouse gas emissions and climate change

- Improved knowledge and better data sources to reduce uncertainty in the inventory of GHG emissions from soils, vegetation, land and land use change, and for understanding the impacts of climate change upon these emissions
- Reduction of GHG emissions and/or enhancement of sequestration from rural land
- Identification of possible climate change adaptation actions in the land use sector, their costs and impacts, synergies and trade-offs with climate change mitigation actions, (including crop and livestock production systems, tourism and recreation industries, forestry, game management and other land uses)
- Integrated and holistic assessment of all impacts of adaptation and mitigation measures, including e.g. air quality, water quality, human health and biodiversity.

Biodiversity

Diffuse pollution in general and nitrogen impacts in particular as a driver of biodiversity decline.

Soil-water-air interface

- Identification of key processes and pathways at the soil/water/air interface which may be affected by changes in land use, pollution, or climate change, and which impact on environmental quality.
- Prediction of the likely impacts of specific scenarios of land use change, management practice, policy or climate change mitigation measure upon the soil, water, air interface. Including rate, direction, key determining steps and thresholds for change and the temporal and spatial implications for Scotland's environmental quality. (includes atmospheric deposition and application of waste to land).

Ecosystem Services Approach

Using the Ecosystem Services concept as a framework for holistic, integrated assessment of the broad range of impacts from land management policy/actions, in order to understand the potential trade-offs, to deliver multiple benefits from management/policy actions (e.g. biodiversity alongside water quality benefits), and to identify risk of and ways to avoid disbenefits (e.g. unintended pollution swapping). (This should include benefits for biodiversity, amenity, soil protection, water quality etc. and disbenefits due to airborne particulates from biomass combustion).

NORTHERN IRELAND

Main policy issues and research interests

Policy relevance

Water Quality The two largest lake systems within the UK, Lough Neagh and Lough Erne, are located in Northern Ireland and together they drain 40% of its land area. Each is hypertrophic-eutrophic, primarily driven by excessive phosphorus (P) inputs, as are 65% of lakes greater than 50 ha. Diffuse sources, primarily from agriculture are considered to be largest inputs of P to these lakes. To meet targets set by the Water Framework Directive,

reversing eutrophication and restoring these lakes to standards more appropriate to a mesotrophic status is now a key water quality objective in Northern Ireland.

Where agriculture is a significant source of nitrate (>20%), which it almost always is, reversing eutrophication is also a requirement under the Nitrates Directive (ND). Because of the prevalence of eutrophication, the whole territory of Northern Ireland has been designated as Nitrate Vulnerable Zone under the ND and a comprehensive Action Programme (AP) introduced in 2007 (renewed in 2011). While the focus of the ND is on nitrogen use within agriculture, measures in the AP that govern manure management have been tailored so as to minimise direct runoff of nutrients in manure to water, which should therefore lower P losses.

Additionally a Phosphorus Regulation was introduced in 2007 which requires that the use of chemical phosphorus fertilsers on farms must be in accordance with crop requirements and take into full account current soil P and the availability of P from manures.

Climate change and greenhouse gas emissions. Compared to GB, and due to a relatively low human population density and the dominance of cattle, agriculture in NI makes a large contribution to greenhouse gas emission. An important component of the agricultural inventory of GHG in Northern Ireland is from to nitrous oxide emissions from soils due to the use of nitrogen fertilser in agriculture to soils. Lowering the use of N fertilser therefore offers a way of lowering GHG emissions.

Agricultural economy. The Devolved Administration for Northern Ireland is committed to the maintaining and creating a thriving and sustainable rural community and environment in Northern Ireland. Where nutrient emissions from agriculture to the environment are harmful, the emphasis is devise methods for lowering these without harming agricultural output or productivity.

Examples of this approach are

1) The negotiation with the local animal feed industry of an agreement to lower the P contents of animal feeds, which has lowers the P contents of manures and the risk of over fertilisation and build up of P in soils.
2) The current promotion a Manure Efficiency Technology Scheme (METS*) scheme that provides grant aid for low emission manure spreading machinery (*Funded by the Department of Agriculture and Rural Development (DARD) as part of The Northern Ireland Rural Development Programme.) The METS scheme aims to increase the efficiency of manure nitrogen use by crops, so curtailing runoff losses while also lowering inputs of chemical nitrogen fertilsers that lead to GHG emissions.

Targets

Water quality targets are site specific in Northern Ireland and are set by the competent authority, the Northern Ireland Environment Agency. With respect to nutrients use by agriculture, DARD has two current PSA targets of lowering the P balance of Northern Ireland agriculture to 10 kg P/ha and that for nitrogen to 135 kg N/ha.

Key Challenges.

1. **Improving knowledge base to develop practical measures that will ensure low nutrient emissions to air and water**. With respect to the approval of the Action Programme of ND in Northern Ireland, the EU has requested that the following key research issues are addressed:
    - Impact of spreading manures in October and February
    - Options to better manage dirty water

- Minimising phosphorus losses
- Improving manure-N efficiency and minimising nitrous oxide losses to the atmosphere.
- Environmental impacts of intensive grassland systems under the operation of the ND Derogation*.
- An intensive monitoring programme of mini-catchment monitoring to assess the impact of the Derogation**.

To meet these requests DARD is funding a series of projects through Agri-Food and Biosciences Institute (AFBI). DARD also funds additional monitoring to define the nutrient loadings to Loughs Neagh and Erne. (**As part of the operation of the ND, the Northern Ireland Administration negotiated with the EU an ND Derogation that allows higher organic nitrogen grazing livestock limit of 250 kg N/ha/year animal on grassland farms provided that specific additional measures are adopted.)

2. **Assessing the effectiveness of the current measures in Action Programme**. In recent years the overall nutrient use by agriculture has dropped significantly, particularly for P, with no loss of agricultural output. The full adoption of all measures in the AP date only from 2009 and their effectiveness will be assessed through the current monitoring programme, both statutory and additional programmes, such as mini-catchment monitoring. However there is a need to be able to better determine and quantify key catchment factors that are influencing current nutrient loss rates. These extend to beyond the field environment into the wider catchment, including river and stream hydromorpholgy and the ecological structure of aquatic ecosystems.
3. **The role of terrestrially derived carbon on aquatic ecosystems**. Rivers and lakes in Northern Ireland are noticeably brown due to the presence of high concentrations of dissolved organic carbon (DOC), referred to as peat stain. This DOC reflects high losses of carbon from land to water and has the potential to influence the potential for carbon sequestration by soils. Within a lake such as Lough Neagh how this terrestrial carbon subsidy influences productively has been little studied, particularly in an eutrophic environment where the attenuation of light caused by DOC may limited primary production by algae.