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NitroEurope IP

The nitrogen cycle and its influence on the European greenhouse gas balance.

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Global Change and Ecosystems

D9.6

Report on the second NEU summer school

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CO	Confidential, only for members of the consortium (including the Commission Services)	☐

EUROPEAN SUMMER SCHOOL

Integrating nitrogen research;
Scales, landscapes and methodologies

Newbattle Abbey College, Edinburgh, UK

1st to 14th June 2008

FINAL REPORT

Overview

The summer school held in Edinburgh in June 2008 was designed to help students to consider issues of integration of their work across different scales, landscapes, and methodologies. It was organised by staff from the NitroEurope IP, but was open to participants from the wider European scientific community. The school was promoted by advertisements on websites and through email distribution lists, and there was a very strong response from participants. Twenty five places were made available, and these were filled more than four months prior to the event. Leading international scientists were invited to contribute to the school, and their support was invaluable in contributing to the success of the school.

The lectures given by invited speakers provided an overview of the most up-to-date science in the area of nitrogen research, and covered a very wide range of topic areas. The summer school was also highly participative, and provided opportunities for students to collaborate during the meeting under the guidance of the lecturing and resident scientists. Students from different backgrounds were be provided with the challenge of putting together different datasets and approaches to the study of nitrogen in order to arrive at an integrated assessment of nitrogen cycling. Four groups of about 4-6 students agreed on topic areas, and worked during the meeting to prepare presentations which were given to an open seminar at the University of Edinburgh at the end of the two weeks.

Bob Rees, Mark Sutton, Mark Theobald, and Stefan Reis
July 2008

Acknowledgements

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Detailed Programme

Date	*Morning*	*Topic*	*Afternoon*
Sun 1		Arrival at Newbattle. Registration and reception from 5 pm	Registration Meal at 6.00 pm
Mon 2	Introduction Mark Sutton Bob Rees Mark Theobald	Registration The nitrogen challenge, NitroEurope, integrating nitrogen research Objectives of the course, methodologies and work-plan	Project work
Tue 3	Dave Reay Jan-Willem Erismen	GHG emissions and climate change policy and IPCC Reduced nitrogen in ecology and the environment. The importance of reduced nitrogen. How is reactive nitrogen produced and how does it cascades through the environment. What are the policy options to combat nitrogen pollution and what are current structures to work towards nitrogen reductions?	Project work
Wed 4	Ute Skiba Christian Werner	Biosphere-atmosphere exchange of reactive nitrogen in Europe Modelling greenhouse gas exchange; the use of process based models	Project work
Thu 5	Pierre Cellier Wim de Vries	Nitrogen flows in landscapes; integrating measurements and modelling Upscaling from the plot scale to the (i) landscape scale and (ii) European scale focusing on the European upscaling of measurements of N compounds and GHGs. Statistical methods, process based models and input data for statistical approaches to validation will be considered	Project work
Fri 6	Visit to local field sites: Easter Bush, Drained plots, Auchencorth and Whim Moss		
Sat 7			

Sun 8			
Mon 9	Tony Edwards Barbara Kitzler	Nitrogen in catchments, nitrogen budgets, land use, and landuse change Nitrogen exchange in forested ecosystems	Project work
Tue 10	Keith Smith Pete Smith	Linking C and N flows in European ecosystems; the importance of the soil environment Predicting change in C an N in the environment; the importance of management	Project work
Wed 11	Robin Mathews David Fowler	The use of agent based models to study N cycling and management in catchments Air pollution and transport	Project work
Thu 12	Liz Baggs Dominic Moran	Using stable isotopes to study N cycling in terrestrial systems A Stern warning: (some) of the relevant economics of climate change	Project work
Fri 13	Workshop presentations and synthesis at the University of Edinburgh/SAC		
Sat 14	End of School		

Participants

The following young scientists participated at the meeting:

	First name	Surname	Organisation/Country
1	Michal	Brozyna	Aarhus University, Denmark
3	Amelie	Cantarel	INRA Clermont-Theix France
4	Julia	Drewar	Centre for Ecology and Hydrology, UK
5	Sylvia	Duretz	INRA, France
6	Rossana	Ferrara	University of Naples, Italy
7	Chris	Field	CEH Edinburgh/Manchester Metropolitan University
8	Mohamed	Ghalaieny	University of Manchester, UK
9	Aranchia	Gonzalez	Centre for Ecology and Hydrology, UK
10	Balazs	Grosz	Istva Univiversity, Hungary
11	Gianpiero	Guida	CNR, Italy
12	Erich	Inselsbacher	Federal Research and Training Centre , Austria
14	Janne	Korhonen	University of Helsinki, Finland
15	Attila	Machon	Istva Univiversity, Hungary
16	Farai	Mapanda	University of Zimbabwe
17	Ana	Meijide	University of Madrid, Spain
18	Ishaq	Mian	York University, UK
19	Michail	Mishurov	University College Cork, Ireland
20	Muhammad	Riaz	York University, UK
21	Ana Paula	Rosa	University of Lisbon, Portugal
22	Brendon	Roth	Trinity College Dublin, Ireland
23	Simonetta	Rubol	University of Trento, Italy
24	Alberto	Sanz CobeÃ±a	University of Madrid, Spain
25	Mark	Theobald	University of Madrid, Spain
26	Esther	Voght	Centre for Ecology and Hydrology, UK
27	Denise	Wagger	Federal Research and Training Centre , Austria

The following staff provided lectures/tuition at the meeting

	First name	Surname	Organisation/Country
1	Liz	Baggs	University of Aberdeen, UK
3	Pierre	Celliere	INRA, Grignon, France
4	Wim	de Vreis	Alterra, Wageningen, The Netherlands
5	Tony	Edwards	Macaulay Institute, UK
6	David	Fowler	Centre for Ecology and Hydrology, UK
7	Barbara	Kitzler	Federal Research and Training Centre , Austria
8	Robin	Mathews	Macaulay Institute, UK
9	Dominic	Moran	Scottish Agricultural College, UK
10	Dave	Reay	University of Edinburgh, UK
11	Bob	Rees	Scottish Agricultural College, UK
12	Ute	Skiba	Centre for Ecology and Hydrology, UK
14	Pete	Smith	University of Aberdeen, UK
15	Keith	Smith	University of Edinburgh, UK
16	Mark	Sutton	Centre for Ecology and Hydrology, UK
17	Mark	Theobald	University of Madrid, Spain
18	Christian	Werner	Institute for Meteorology and Climate Research, Germany
19	Jan	Willheim	ECN, The Netherlands

Output

All of the presentations given by visiting scientists together with presentations provided by individual student research groups have been saved on the NitroEurope website. Abstracts of student presentations made at the end of the School are in Appendix 1.

Feedback

The following feedback was provided by participants at the end of the summer school.

		strongly agree	agree	no strong feelings	disagree	strongly disagree	not applicable
1.	The objectives and content of the school was clearly explained at the outset	6	12	4			
2.	The school was efficiently organised	9	11	2	2		
3.	I found the school intellectually challenging and stimulating	14	8	1	1		
4.	The lecture presentations were good	17	6	1			
5.	In general, I found the level of difficulty in the lectures	11	10	2			
6.	The two most valuable lectures were (please list):						

Baggs 6, Sutton 4, Reay 2, Skiba 4, Smith P 4, Willem 1, de Vreis 6, Smith K 6, Cellier 2 Fowler 3, Kitzler 2, Werner 2, Moran 4, Edwards 2

		strongly agree	agree	no strong feelings	disagree	strongly disagree	not applicable
7.	The teaching aids used (slides, etc.) were effective	9	10				
8.	The field visits were valuable and interesting	3	14	5			
9.	Helpful feedback and support was given on project work	8	9	5			
10.	Overall, I found this a valuable course	18	5				
11.	The final research seminar was valuable and rewarding	8	12	2	1		

Overall comments

No WiFi was a limitation
No time to share interests and possibilities of collaboration.

The course was very helpful for me because I'm just at the beginning of my nitrogen studies.
The field visits were also interesting that me because until now I haven't seen so much.

The school was conducted excellently with optimum speed.

Excellent overall from a personal perspective I would have liked workshops on mathematical modelling of field later e.g. stepwise regression them worked up to landscape modelling maybe with some preprepared datasets. Group work very enjoyable and learnt a lot but took every spare hour more space and social activities e.g. the group dinner on last night might be needed.

Aims of the group project were set too ambitious resulting in loads of work in the evenings breaking up the whole group a bit
Good choice of location out in the green, nice working conditions except Internet
Good idea of having two talks to the day then group work.

I found the school very useful particularly for meeting people in the field and also the seeing much research from angles I had not previously seen it from.

Thank you it was very interesting and useful.

Thank you for everything!

Most of the field visits were valuable and interesting. I did not like the second field site wet grasslands of with a lot of equipment, not explained well after the equipment was not explained at all.

Wrong bus number given
Thanks for all the organisation.

Difficult to go on the place to the airport.

The summer school is a milestone for a future challenges. The school was very helpful and challenging in order to know coming challenges especially with the N cycle, advances in techniques of modelling etc. As a young scientist I learnt a lot on that summer school and I have very good opportunities of networking with leading scientists of Europe and young scientists. I will give my vote of thanks to Dr Bob Rees and Dr Mark Sutton, Mark Theobald and other organisers and presenters.

Lectures were to long, but the audience got bored that there was not much time the real work. It seems that some speakers have been given a topic which was not the thing they were most interested in. Finally they talked a bit off topic about general things they have done. Nice atmosphere nice place. Nice that we chose topics self weekend programme was great. Good idea to work our own data and real problems.

Thank you very much for this nice experience

Projects and important and profitable feedback between lecturers and students. Lecturers were very well afforded and their content was very appropriate for the aims of the summer school.

Perfect setting at New Battle Abey was very conducive to work. Facilitators were very helpful approachable and useful. Internet access slightly lacking.

Started off a bit chaotic but the final outcome of the project work was impressive. The programme of lecturers was very informative and covered a wide range of subjects and contains some high-profile lecturers. The venue was very interesting and was very conducive to working.

I found the second NitroEurope summer school valuable and interesting for my research skills development. The working environment and living conditions were up to the mark. I really enjoyed working in the group as it was the first time to work with really professional people. Thanks to Bob Rees and Mark Theobald for their temp oral and spatial guidance during the summer school.

I found it difficult to carry out the group work because of the different backgrounds interests etc the fact that the projects were very broad. It might have been easier to develop a more concrete task and maybe we would have got that a result. However, I have learned a lot about other people's fields are topics which I was not familiar with it altogether it has been very interesting.

I think the aim of the summer school was accomplished. I have learned a lot during this two weeks despite almost all problems that have made my group work found during the project work. The organisation was good and very helpful at the lecturers were quite interesting and full of new ideas and relevant information for project work.

Suggestions for improving future schools:

Focus on concrete objectives that will motivate people to work harder to reach their potential.
More time for social contact in evenings to talk to other participants in more detail, try to find possible cooperation partners.

Perhaps a reassessment of the final research seminar on project work may be specific data could be requested in advance of the school with particular projects in mind? Thanks.

Not just see the field try the methods!

Role of science in policy makers decision's
Coping with uncertainties.
Gap filling and resource shortages
Can science/research be cost-effective

How to learn from others' mistakes

Better coffee (it's all I can suggest everything was very nice) more place for personal work it was sometimes difficult to find a quiet place.

For project work it is important to have proper access to electronic resources and the Internet.

We can improve it by constant networking collaboration from other academic universities. Poster competitions, research articles etc. It was one of the best summer schools I attended so far thanks a lot to keep it up keep in touch.

At the beginning a real basic lecture of the processes etc. This can even be mandatory
lectures should go deeper into the subject to the current issues. More feedback during the group work. A better way to choose the topics of group work.

Maybe one summer school every two years is not enough it would be a good idea to organise one school each year and giving more chance to everybody to attend at least two summer schools during his PhD.

Collate data for project work well in advance of the meeting to make the process more efficient.

WiFi access

I would like to suggest better IT facility provisions and access to access literature receiving for project work.

Keep some kind of work by participants but maybe more guided walk concrete for such a short period of time.

Try to choose a place in southern Europe so that people northern Europe can see actual field sites.

APPENDIX 1
Abstracts from the end of School Workshop

N budgets for forests and cropland in different climate regions.

Michal A. Brozyna, Mohamed Ghalainey, Janne F. J. Korhonen, Farai Mapanda, Ana Meijide, Denise Wagner

The concern over N losses is increasing because of the high influence that N_2O emission has on climate change and the environmental effects of other N forms such as NO_3^- leaching and NH_3 pollution of air. Moreover, ecosystems respond in various ways to climate change, causing complicated feedback effects both on the ecosystem processes and on climate change. Numerous studies have been carried out to measure different N pools and fluxes in the atmosphere, soil and biosphere. However, not all the different processes of the N cycle are understood, because of the difficulty in measurements of some of the N forms or processes. The aims of this work were to close the N budget in different ecosystems and to quantify the magnitude of each of the pools and processes. Two forests and two croplands, placed in contrasting climatic regions, were studied with the objective of comparing the importance of each of the processes and N pools. For this purpose, measured field data from each of the experimental sites have been combined with the output of the Denitrification-Decomposition model (DNDC).

One of the forests is situated in the boreal zone, southern Finland (Hyytiälä; 61° 50' N, 24°17'E), while the other is in central Zimbabwe (University of Zimbabwe Experimental Station (UZF), 31º05'E, 17º50'S). The two cropland sites are found in eastern Germany (Paulinenaue, 52º41'N, 12º44'E) and at UZF also central Zimbabwe.

The Hyytiälä site has a 45-years old Scots pine forest, managed according to the national forestry recommendations. The dry savannah forest in Zimbabwe (*Miombo* Woodland), with tropical climate, is a protected area mainly used for research purposes. In these forest ecosystems, the main N input is atmospheric deposition. The boreal forest has a naturally closed N cycle as both inputs and outputs are very small and the main N fluxes are internal. However, the savannah forest also receive N input from dry deposition from annual burning of grassland in the vicinity as well as wet deposition, which is lost to the atmosphere as N_2O and NOx.

The Paulinenaue site is an organic agricultural soil in temperate climate, while the cropland site in Zimbabwe is an inorganic agricultural soil in tropical climate. Both sites are planted with maize and non-irrigated, and their main N source is inorganic fertilizer application. In both systems the main N output is the crop uptake but in Paulinenaue site high losses of N through denitrification occur, whereas nitrification is the main process taking place in Zimbabwe. Therefore, N_2O emissions occur in both systems, and with the same N input as fertilizer in both systems, N_2O emissions from the Palineaue site are 5 times larger than those from Zimbabwe.

We conclude that there are high differences in the N-pools and magnitudes of the processes in different ecosystems and across climatic regions. It is therefore important to study the processes in various ecosystems and climates in order to establish future projections and mitigation strategies for these ecosystems to reduce N losses and climate change.

Modelling of plot GHG emissions for different European ecosystems; temporal upscaling and comparison with field measured data

In this study, we applied the DNDC (DeNitrification-DeComposition) biogeochemical model for the evaluation of soil gas fluxes from five different European ecosystems.

The ecosystems studied were semi-natural raised bog and grazed grassland in SE Scotland, a livestock farm with a Cork Oak forest in Portugal, a cultivated, drained bog in Ireland and a semi-natural arid grassland in Hungary. A variety of experimental techniques were used at each location to gather data of GHG fluxes including methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2).

Static chambers were used to sample N_2O and CH_4 emissions, portable infra-red gas analysers used to sample CO_2 soil respiration and at one site an Eddy Covariance tower was used to capture net CO_2 exchange, CH_4 and N_2O fluxes. A laboratory experiment was also used at one location to explore N_2O potential flux in response to varying soil moisture.

Two different DNDC models were used according to ecosystem type; for each location site meteorological data, soil properties and management such as grazing and fertiliser application were input into the model. Model output included daily gas fluxes, soil carbon and nitrogen pools and nitrogen in leachate.

In this project we focussed on CH_4, N_2O and CO_2 fluxes and compared field recorded data with modelled flux. Modelled performance both between the sites and between the gas fluxes. In general CO_2 flux was predicted the most accurately, N_2O was either over or under estimated depending on site but CH_4 was always underestimated.

Methods to improve comparison between field measured data and model predictions are higher frequency of measurements, capturing plot heterogeneity and more accurate parameterisation of model variables to more closely reflect the individual soil properties and vegetation type of each ecosystem.

^{15}N Research: Is it really necessary?

^{15}N has a greater atomic weight than the conventional ^{14}N atom. Being different in atomic weight, ^{15}N isotopes behave identical to ^{14}N atoms in biochemical reactions but can be detected separately. Concentrations of ^{15}N are usually measured as the ratio of $^{14}N/^{15}N$ ($\delta^{15}N$). ^{15}N research in natural and managed ecosystems generally focuses on two techniques; isotopic enrichment and natural abundance studies. In this presentation, we intend to discuss applications of ^{15}N research to the nitrogen cycle pathways at a plot, field, landscape, and even global scale. The advantages and disadvantages of these techniques will be discussed critically along with future challenges and scenarios. We also have looked at trends of ^{15}N research over the past 50 years.

The use of enriched ^{15}N is particularly useful to study the movement of nitrogen through the fundamental processes of the nitrogen cycle. For example net mineralisation can be measured simply from the changes in the NH_4^+ pool, but this does not account for losses through ammonium immobilisation and nitrification. Gross mineralization can be best studied employing the pool dilution technique. These techniques involved the addition of $^{15}NH_4^+$ to the indigenous $^{14}NH_4^+$ pool and changes in $^{14}N/^{15}N$ are measured over specified period taking into consideration the nitrification and immobilization. Natural abundance techniques can also be used to measure gross nitrogen transformations, particularly in combination with other techniques such as $\delta^{18}O$ analysis.

The cost of ^{15}N labelled substrates and analytical cost remain the confounding issue for these techniques. Problem of uneven distribution of applied enriched ^{15}N substrate is particularly challenging at field scale. Preferential use can also occur before establishment of equilibrium between ^{14}N and applied ^{15}N which is problematic for isotopic dilution. In addition to this application of ^{15}N in N-limited systems can lead to over-estimation of gross-mineralization as NH_4^+ consumption can be stimulated upon substrate addition. This can be overcome by using natural abundance techniques but these too are limited. Quantification in fractionation rates has emerged as challenge in recent research work. Use of ^{15}N techniques must be careful to avoid interpreting the data in isolation; often other techniques are required to differentiate sources and pathways effectively.

Currently the field of isotope is very active, facing new challenges. These mainly concern the identification and understanding of new pathways and the appliance of new technologies. New pathways involve denitrification of ammonium to nitrate (DNRA) and the ammox reaction. Innovative technologies include the use of bacteria to convert NO_{3-} to easily measurable N_2O, the use of isotopomers (measuring site preference within molecules), the use of Nano Sims which can scan isotopic surface for the samples and is able to capture assimilatory processes at cell level and the use of N_2/ Ar chambers to measure N_2 fluxes.

We conclude that ^{15}N stable isotope techniques are indispensable for comprehensive understanding of microbial mediated pathways of N cycling both in natural and managed ecosystems, but in general additional techniques are recommended to compliment analysis this work.

Perspectives for the global nitrogen (N)-cycle: Impact of future scenarios

The main objective of this group work was to develop a future conceptual N-cycle 50 years from now. Starting point was a present N-cycle modified after Galloway, et al., 2003 which was re-drawn. Two future scenarios were created under consideration of the IPCC 4th assessment report (2007) and the Millennium Ecosystem report (2005) which both explain four main future scenarios for 2100 and 2050, respectively. Since we were trying to picture scenarios for in 50 years time we developed our own, also under consideration of the Nitrogen Visualisation Tool (ECN, 2007) that models/calculates the global N-cycle in 2030, which we have modified for our purpose. We considered six main drivers for change in N-cycling, namely size of population, energy use (and source of energy), food consumption (and source, e.g. meat), economy (transport), agriculture efficiency and land-use. The two scenarios were constructed using extremes of the driving forces in either direction (for the better and the worse in terms of emissions). The worst case scenario, “Madmax”, is characterised by a large increase in population to 10 billion in 50 years time, energy use still mainly from fossil fuels, inefficient agriculture with a high proportion of meat in the diet, extended transport and a large percentage of land-use for agriculture and biofuel production, whilst the best case scenario, “Neverland”, characterised a world with a decreased population to about 3 billion, energy use mainly from renewable sources, efficient agriculture based on local goods with low meat consumption and little transport and therefore a high percentage of land-use would be nature.

The “Madmax” scenario with more and intensive agriculture would result e.g. in higher NH_3 and N_2O emissions due to fertiliser application and animal waste and therefore promote environmental problems such as eutrophication, acidification and global warming even further. Also higher NO_3 leaching would result in lower water quality. Generally the “Neverland” scenario would result in less emissions and therefore have less environmental impact, e.g. a lower rise in global temperature and better water and air quality. According to the Nitrogen Visualisation Tool the “prosperity index” which is a measure for human health, available food and generally quality of life would be higher in “Neverland” than “Madmax”.