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Oral

Presentations

Abstract number 0 - FARMING WITHIN ENVIRONMENTAL BOUNDARY CONDITIONS: DEVELOPMENTS AND CHALLENGES

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Mankind is changing the environment at an ever increasing rate and it is facing more and more the consequences of these changes both locally and globally. Agriculture is one of the human activities that on one hand is essential for providing food, fibre and energy, and on the other hand may have a detrimental impact on the environment. With a growing world population and increasing wealth the demand for agricultural goods will continue to rise. This will take place in the context of increasing pressure on water, land and energy resources, and changing climatic conditions. The challenges for agriculture are to meet this demand within the environmental boundary conditions set by society. This is becoming ever more difficult as many of the most obvious, simple and cost effective measures to limit detrimental effects have already been implemented.

The Land use and Water Quality (LuWQ) conferences aim to discuss the entire policy cycle for water quality improvement. This cycle includes problem recognition, formulation of technical options, the process of policy development, interaction with policy makers, stakeholders and pressure groups, policy implementation, monitoring and research. This conference also aims to intensify contacts, on the one hand, between scientists with a background in natural sciences and scientists with a background in social and economic sciences and, on the other hand, between scientists, water managers and policy makers.

This presentation will outline the topics to be presented at LuWQ2015 conference. It will demonstrate examples of successes and failures of implementation of Good Agricultural Practices, agri-environment measures and the intentional and unintentional consequences of agricultural policies for the environment.
The Netherlands, for example, has successfully limited the leaching of nitrate to groundwater; however nutrients loads to surface waters, particularly phosphorus, are still too high.
In Denmark, a new era of targeted management of agriculture was the outcome of a Commission on Nature and Agriculture established by the Danish Government in 2013. Their White Book points to the need of increased growth and better environment through more targeted and efficient regulation using advanced technological mitigation methods that are implemented intelligently according to the local natural attenuation capacity for nutrients in the landscape.
In New Zealand, the Lake Taupō Protection Trust has recently proudly announced the achievement of agreements to meet the target 20% (170 tonne a year) reduction in the 'manageable' fraction of the nitrogen load to the iconic lake. This goal will be achieved through the purchasing of land and land use changes. While the policy is considered a success, it is also acknowledged that this approach due to its cost of NZ$79 million for a 3400 square km catchment cannot be a template for the numerous other catchments in the country facing water quality deterioration.

The presentation will also give an overview of outstanding issues at national and international levels. These include the harmonisation of obligations stemming from environmental directives, designing and implementing tailor-made, verifiable measures, addressing the knowledge gaps hampering progress in improvement of water quality, and new upcoming challenges. An example of such new challenges, as well as of an agricultural policy resulting in potentially detrimental environmental effects, is the abolition of milk quotas in the European Union (EU) in 2015. The quotas began in 1984 as a response to

the so-called EU 'milk lakes' and 'butter mountains' caused by milk overproduction. The 1984 quotas resulted in a decrease in the number of dairy cows.
In the Netherlands, among EU other countries, the abolition of the EU milk quota system per 31 March 2015 has – as expected – already resulted in a sharp increase in the milk production by an increase in the number of cows. It is now being feared that this production expansion will lead to a failure of present environmental policies that aim for 'good status' for all water bodies in the European Union within the coming 12 years.
As for Denmark, although nitrogen and phosphorus emissions to surface waters have been successfully reduced with, respectively, 50% and 56% during the last 25 years the implementation of the EU Water Framework Directive goals of achieving at least a good status in Danish streams, lakes and estuaries call for further reductions of N and P loadings from both point and diffuse sources. This is a huge challenge as the easily implemented regulations in agriculture have already been applied during the last 3 decades general management of agriculture.
In New Zealand, the Government has formulated the twin challenge of doubling the country's export earnings from primary production by 2025, while maintaining or improving water quality. The land area used for dairy farming has increased from 2008 to 2012 by approx. 160000 ha and total dairy cow numbers have increased from 4.25 million to 4.78 million. The majority of this increase occurred in the South Island by conversion of former sheep and beef farms, often enabled by irrigation. In contrast, most of the increases in the North Island are due to conversion of plantation forestry land. It still has to be seen whether improved management practices and innovative mitigation techniques will be sufficient to achieve the formulated water quality goal.

Abstract number 4 - IMPACTS OF CLIMATE CHANGE ALONE AND WITH AGRICULTURAL LAND USE CHANGE ON SURFACE WATER QUALITY

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The Altmühl watershed (980 km2) in Bavaria was selected to quantify the impacts on the surface water quality due to a suite of climate and land use changes to 2050. Seven regional climate models (RCMs) for the time horizon 2041-2070 were applied to the hydrological model Soil and Water Assessment Tool (SWAT) to determine their impacts on total phosphorus (TP) and on nitrate nitrogen (NO3--N). Compared with the reference simulation (1971-2000), the impacts of climate change adversely affected surface water quality; mean annual changes at the outlet were simulated in the range of -183 to +222 Mg/yr for NO3--N loads; and from -9 to +2 Mg/yr for the TP loads. The mean monthly NO3--N loads increased significantly from July to September (up to 0.21 ±0.07 kg/ha). The mean TP load was significantly higher (0.08 ±0.04 kg/ha) during November.
Three agricultural land use change storylines were developed with local stakeholders and were spatially distributed with the CLUE-S land use model. Each land use scenario raster layer was applied in SWAT with each RCM simulation respectively, to examine the compounded effects of changes that may occur. The combined impacts showed a further deterioration of the water quality, whereby the mean annual NO3--N loads increased 3 fold, and TP loads 8 fold: the range of simulated annual changes in NO3--N loads of +62 to +672 Mg/yr; and TP loads of -1 to +17 Mg/yr at the outlet. The months from May-November had significantly higher simulated NO3--N loads compared with the reference simulation. As well, nutrient loads were transported into the streams for a longer period during the year. The water

quality criterion of 50 mg/L for nitrate (11 mg NO3--N/L) was surpassed every month, especially from October to December. TP loads were significantly higher from May-September and in November. Mean TP concentrations were significantly higher in June-August and in November. For every month the TP concentrations were higher than the 0.05 mg/L water quality criterion. Surface water quality was degraded by the impacts of climate change alone, and to an even greater extent through the combined impacts of climate with agricultural land use changes. In the basin, silage corn was responsible for the greatest TP loss, while winter wheat was the main crop contributing to NO3--N loads. Hotspots of future land use change were identified that may be targeted to reduce nutrient loads.

Abstract number 14 - FACTORS INFLUENCING THE ADOPTION OF DIFFUSE POLLUTION MITIGATION MEASURES BY FARMERS IN ENGLAND

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With a range of different mechanisms available to encourage the uptake of farm practices which help mitigate diffuse water pollution, deciding which is the most appropriate one for particular measures poses a challenge to policy makers (McGonigle et al., 2012). Whilst many measures remain voluntary, evidence regarding the relative importance of advice provision, economic incentives and regulation is crucial to aid decision making.

Research conducted as part of the Demonstration Test Catchment (DTC) project has explored the factors influencing farmer adoption of diffuse water pollution mitigation measures through three related surveys. Over two hundred farmers and farm advisors participated in interviews from three contrasting regions of England: the grassland dominated North West; the arable dominated East Anglia; and the mixed and dairy farming of the South West.

Results from the two farmer surveys provide a baseline regarding current agricultural practices, insight regarding farmer attitudes to the adoption of other mitigation measures in the future and understanding of the motivations and barriers to the adoption of specific measures such as, cover crops, sub soiling and farm infrastructure. Results from the farm advisor interviews revealed the types of mitigation measures being recommended by various advisors, which mechanisms (regulatory, financial incentives, signposting or voluntary approach) are being used to encourage uptake of measures, and whether differences occur between sources of advice.

Drawing together these results, analyses have been conducted to determine what is required to encourage adoption of specific mitigation measures and where provision of advice appears necessary, which advisors are most suitable to deliver such information. Results highlight different combinations of mechanisms are required not only for each of the mitigation measures but also within the different regions surveyed. Findings will be of benefit to researchers, policy makers and farm advisors, particularly aiding decision making with respect to strategies for future implementation of programmes of measures under the Water Framework Directive.

McGonigle, D. F., Harris, R. C., McCamphill, C., Kirk, S., Dils, R., Macdonald, J., & Bailey, S. (2012). Towards a more strategic approach to research to support catchment-based policy approaches to mitigate agricultural water pollution: A UK case-study. Environmental Science & Policy, 1–11. doi:10.1016/j.envsci.2012.07.016

Abstract number 17 - STUDY ON THE QUALITY AND POLLUTION CHARACTERISTICS OF GROUNDWATER IN HUTUO RIVER ALLUVIAL PLAIN IN NORTH CHINA PLAIN

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As the main industrial, agricultural, and drinking water source in the Hutuo River alluvial plain area in North China Plain, the groundwater has a direct bearing on the residents' daily life. In order to investigate the groundwater quality under the influence of human activities in this area, the authors collected 482 groundwater samples for tests and analyses. The evaluation using the improved fuzzy mathematics evaluation method shows that the samples whose quality exceeds grade III account for 21.5% of the total samples, and they are mainly distributed in the industry concentration area and on both sides of the sewage disposal river. Furthermore, the water quality in the alluvial-proluvial fan axle area is even worse than that in the middle and rim areas. The factors that mainly affect the water quality are the inorganic matters such as the total dissolved solid, total hardness, iron, manganese, and nitrate nitrogen. The organic matters with high detection rate include chloroform, carbon tetrachloride, carbon dichloride, ortho-dichlorobenzene etc. Computation with EPI Suite software shows that the GUS value of the component with high detection rate is comparatively high and the value has high consistency. Based on an analysis of the chemical component detection and the exceeding-standard factors of the groundwater, the authors found that the primary hydrogeological environment and the effects of the human activities are the important factors leading to the detection and exceeding-standard phenomenon of the toxic metals, trichlorine, and organic matters.

Abstract number 20 - SCIENCE MEETS POLICY: A CASE STUDY FROM A REGULATED WATERSHED, JORDAN LAKE, NORTH CAROLINA

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Jordan Lake is an important source of drinking water for multiple communities (> 250,000 people) and is located within a rapidly urbanizing watershed. Unfortunately, the water quality of the lake is impacted by excess nitrogen and phosphorus. In order to reduce nutrient loading to the lake from point and both agricultural and urban nonpoint sources, state regulations were developed and promulgated; point and non-point sources are expected to reduce nutrient loading by specific amounts that range from 0-35% nitrogen and 0-5% phosphorus. In addition, the regulations allow the urban community to buy nutrient credits (water quality trading) from the agricultural community in the form of riparian buffer installations. Recent multidisciplinary research in this watershed has explored the interconnections between conservation practice adoption, farmer preferences, economics, and potential water quality protection. Water quality modeling suggests that nutrient loads are reduced in agricultural areas relative

to urban areas and thus the impact of conservation practices on agricultural lands may be less than practices implemented in urban areas. A detailed key-informant survey of farmer decision-making relative to conservation practice adoption and trading has documented that views about conservation practice adoption are complex and vary based on farmers' experiences, social-networks, and personal beliefs about each practices' utility, impact and outcomes. Socioeconomic analysis indicates that despite general support for water quality improvements, the majority of farmers were disinterested in participating in the trading program for financial, environmental, and pragmatic reasons related to the specifics of the trading program. Furthermore, many agricultural fields have no nitrogen credits to trade and those that can trade have only a small amount. Lastly, economic analysis indicates that the price of nutrients available for trades will eventually be too high for trades to occur, especially when the costs of trading are considered and agricultural land dwindles. In addition, a survey of local farmers showed that they would require a significant financial premium above the cost of conservation practices to adopt them since they are unfamiliar with the conservation practices and perceived financial and personal risk in the program parameters. Financial compensation from developers increases the likelihood of participation, but will likely be insufficient to initiate enough trades in this region. Considered collectively, these findings suggest that water quality protection may be undermined because of insufficient analysis of water quality trends, land owner preferences, and poor economic feasibility of the water quality regulations.

Abstract number 21 - WATER QUALITY COMPLIANCE CHECKING FOR THE NITRATES DIRECTIVE – A DISCUSSION IN THE NETHERLANDS WITH SCIENTIFIC, MANAGERIAL AND POLITICAL DIMENSIONS

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The European Nitrates Directive aims at the reduction of nitrate pollution by agriculture. It obliges Member States to abate and prevent water pollution and to monitor the effectiveness of the actions carried out to comply with the Directive. To ensure that these obligations are met, the Netherlands monitor nitrate concentrations in water leaching from the root zone. This on-farm monitoring is carried out by RIVM within the Minerals Policy Monitoring Programme (LMM). The Loess region, in the southern part of the Netherlands, is the smallest of the four LMM regions. Within this region, the Province of Limburg and the Water Supply Company Limburg (WML) have also their own monitoring programmes. The Province of Limburg carries out a comparable monitoring programme called the 'Soil Moisture Monitoring' (BVM). BVM focuses at agricultural fields on the so-called plateaus. These plateaus cover about two-third of the LMM Loess region. The Water Supply Company Limburg is responsible for the project 'Sustainable Clean Groundwater' (DSG). DSG aims to ensure the protection of groundwater resources. The project is carried out in co-operation with farmers within the groundwater protection zones.
At the beginning of 2014 a discussion took place in the Dutch Parliament about the monitoring technique used within LMM in the Loess region. An exploratory research of WML had shown that a technique recently implemented by WML in the DSG project resulted in 30-40% lower measured nitrate concentrations than concentrations measured with the technique used within LMM. The last 15-20 years

nitrate concentrations in the Loess region have decreased to levels not much above the standard of 50 mg/l. As a consequence, a relatively small difference between techniques may lead to opposite conclusions. In case of the WML method, the conclusion is that almost no additional measures are required, while in case of the LMM method, one concludes that still additional measures are needed. WML, the Province of Limburg and RIVM are currently carrying out research, together with other relevant organisations, to determine the extent and cause of this difference. From 2014 onwards, farmers in the Loess region are confronted with additional measures that limit both the use of animal manure and of artificial nitrogen fertiliser to a greater extent than in some other regions. Therefore, the outcome of this research is quite relevant for farmers in this region. This paper will discuss the scientific, managerial and political dimensions of this research.

Abstract number 23 - IMPLEMENTATION OF THE EUROPEAN NITRATES DIRECTIVE VIA SOIL N SURPLUS-BASED APPLICATION STANDARDS

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Four consecutive European Nitrates Directive Action Programmes have contributed to a gradual reduction of nitrate nitrogen (N) leaching from the root zone of farm land in The Netherlands. However, the threshold value of 11.3 mg nitrate-N per litre upper groundwater is still exceeded at about 50% of the farms in the sand region. An extensive national monitoring programme on commercial farms has demonstrated that nitrate concentrations are positively related to soil N surpluses on these sandy soils. The programme has indicated that a similar N surplus results in a relatively low nitrate concentration under poorly drained grassland and higher concentrations under well drained arable land. The N surplus itself is determined by the amounts and type of N inputs and their timing and placement. Besides, crop species differ in terms of their ability to recover soil mineral N and to allocate the recovered N to harvested plant fractions. Each crop species is hence associated with a typical soil N surplus and thus nitrate concentration. Crop responses and hence soil N surpluses may also differ in function of soil quality and management quality, to complicate things even further. The Dutch government has defined numerous crop-type specific and soil type-specific N application standards, based on these many factors. To yet limit the number of N application standards, generic assumptions have been made, based on extensive averaging and aggregation. Consequently, the targeted threshold value of 11.3 mg nitrate-N per litre will be met at greater spatial scales only and not in each individual field, farm, sector or even small subregion. This implies that the set of N application standards may be unnecessarily stringent for one farm and too mild for another farm. The above relationships have been integrated in a model. The present paper will show the rules underlying that model and present the results of various scenarios..

Abstract number 25 - DENITRIFICATION IN SHALLOW GROUNDWATER AT DAIRY FARMS IN THE SAND REGION OF THE NETHERLANDS; RESULT OF 20 YEARS OF MONITORING

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In the eighties of the previous century simple empirical models were used to predict nitrate leaching from nitrogen use, soil type and crop type. These predictions were made for deep, well-drained sandy soils. However, it was known that in case of shallow groundwater tables, less nitrate leached than predicted due to denitrification.
The influence of soil drainage, i.e. the depth and the seasonal variation in groundwater level, on nitrate leaching was investigated already in 1988. Groundwater of grassland fields was sampled for chemical testing from hand-drilled boreholes at 10 dairy farms in the sandy region. In each bore hole, soil drainage was estimated and classified. For each soil drainage class (SDC), a mean nitrate concentration was estimated taking into account differences in grazing and fertilisation. For each SDC, a nitrate concentration ratio (NRC) was calculated with the highest nitrate concentration of the highest SDC (deep, well drained soils) as denominator. NRCs can be regarded as denitrification factors. These NRCs were used as model parameter in the simple empirical models to predict nitrate leaching for different SDCs. These NRCs are still used nowadays (2014) to predict nitrate leaching and to derive nitrogen use standards for upcoming programmes of measures.
Regular, yearly monitoring of shallow groundwater in the Sand region for trend analysis started in 1992. During the 1992-2013 period
334 different dairy farms were sampled resulting in 2171 farm samples in total. These data are used to report about the impact of programmes of measures to the national and the European authorities, e.g. the Nitrates Directive article 10 reporting, but also to calibrate and validate mechanistic leaching models such as STONE. This database is used to verify the validity of the 1988 NRCs, derived at that time on the basis of limited information.
In contrast to the measurements in 1988, the SDC's for the period 1992 – 2013 were derived from maps instead of individual SDC values from bore holes, and also not only grassland was sampled as dairy farms comprise on average 20% arable land, mainly silage maize. Moreover farm mean nitrate concentrations were used. Still, an effect of soil drainage on nitrate leaching was found and this effect does not differ clearly from the 'old' NRCs. In addition, the effect of SDC on nitrate leaching appeared consistent between years. The current use of the 'old' NRCs in empirical nitrate leaching models seems therefore acceptable.

Abstract number 26 - TESTING THE EFFICACY OF ON-FARM POLLUTION MITIGATION MEASURES IN AGRICULTURAL CATCHMENTS OF THE HAMPSHIRE AVON DEMONSTRATION TEST CATCHMENT

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Many rivers across England and Wales are experiencing excessive inputs of nutrients, faecal waste and sediment from agricultural land. Despite the resulting environmental impacts, there is a renewed focus on the intensification of agricultural production to improve food security in the context of projected

population growth. As a result, balancing agricultural productivity with resource protection is high on the political agenda, and the need to assemble improved information on the efficacy of targeted on-farm pollution mitigation measures is key to informing the debate on production versus environmental burden.
In England, four Demonstration Test Catchments (DTCs) have been established as sentinel, landscape-scale experimental facilities for assessing options to mitigate agricultural pollution of watercourses. As part of the Hampshire Avon/Tamar DTC programme, a research studentship has been used to compile a toolkit of methods, including source fingerprinting, for testing the effectiveness of on-farm pollution control measures. These measures include: stream bank fencing, riparian buffer strips, ponds and wetlands, farm track re-surfacing, improved slurry stores, and the installation of swales. The toolkit aims to be sustainable, affordable, reliable and replicable.
This contribution provides a case study of findings and presents data from an experimental on-farm site following two years of intensive monitoring and sampling, where a severely degraded farm track was resurfaced and a pond settling-system was installed. Data have shown significant changes in sediment quantity and quality in the river since data collection began in December 2012, including changes to the sediment sources. A number of pragmatic methods have been employed as a user-friendly toolkit for monitoring watercourses and this toolkit is applicable at broader spatial scales.

Abstract number 29 - HOW DOES EUTROPHICATION AFFECT BIOGEOCHEMICAL CYCLE CHANGE IN INLAND WATERS?

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Recent some researchers suggested that inland waters including rivers, lakes, and groundwater may act as a transport pathway for both water and dissolved substances and play some role in continental biogeochemical cycling, so-called boundless carbon cycle (Cole et al., 2007; Battin et al., 2009; Tranvik et al., 2009). The authors have developed process-based National Integrated Catchment-based Eco-hydrology (NICE) model (Nakayama, 2008a-b, 2010, 2011a-b, 2012a-c, 2013, 2014, 2015; Nakayama and Fujita, 2010; Nakayama and Hashimoto, 2011; Nakayama and Shankman, 2013a-b; Nakayama and Watanabe, 2004, 2006, 2008a-b; Nakayama et al., 2006, 2007, 2010, 2012), which incorporates surface-groundwater interactions and can simulate feedback between hydrologic-geomorphic-ecological processes. NICE incorporates 3-D groundwater sub-model and can clarify lateral subsurface flow has also important role on the hydrologic and biogeochemical cycles (Nakayama, 2011b; Nakayama and Shankman, 2013b), which extends traditional dynamic equilibrium with atmospheric forcing (Maxwell and Kollet, 2008). In this study, NICE was coupled with biogeochemical model to incorporate the biogeochemical cycle including reaction between inorganic and organic carbons in biosphere including surface water and groundwater. This improvement in hydrologic non-stationarity and the coupling with biogeochemical cycle showed some effect on variations of CH4 flux in wetland which is sensitive to fluctuations of shallow groundwater. The model also simulated CO2 evasion from inland water in global scale, was relatively in good agreement in that estimated by empirical relation (Aufdenkampe et al., 2011). Further, the authors tried to clarify why and how the expected CO2 evasion might decline as inland waters become polluted with nutrients and eutrophication increases from agriculture and urban areas (Pacheco et al., 2013), and the degassing might be overestimated as a result of organic acids and considerable variations depending on the values of the coefficients employed (Abril et al. 2015). This advanced eco-hydrologic and biogeochemical coupling model would play important role in re-evaluation of greenhouse gas budget of the biosphere, quantification of hot spots in boundless biogeochemical cycle along a terrestrial-aquatic continuum, and bridging gap between top-down and bottom-up approaches (Cole et al., 2007; Battin et al., 2009; Frei et al., 2012; Regnier et al., 2013; Kiel and Cardenas, 2014).

Abstract number 30 - WILL CLIMATE CHANGE SOLVE THE EUTROPHICATION PROBLEM?

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Due to climate change, groundwater levels and stream flow are expected to decrease in the mid-latitudes of Europe. This has in fact already been observed in Northeast Germany. We studied its consequences for the eutrophication of streams and lakes.
Groundwater and stream water quality has been monitored at 29 groundwater wells and stream water sampling sites since 1998 in the Uckermark region, 90 km north of Berlin. About 70% of the area is intensively used by agriculture. However, nitrate concentration alone was not a good indicator for the effects of land use in this region. Stream water nitrate concentration did also depend on the contribution of deep anoxic groundwater discharge with high denitrification capacity. In addition other effects might have played a role. Thus instead of focusing on single solutes, Isometric Feature Mapping was applied, a non-linear variant of the Principal Component Analysis. It aimed at disentangling different effects on groundwater and stream water quality.
The 1st component obviously reflected the effects of agricultural contaminants loading on groundwater and stream water. All major streams exhibited long-term trends that were approximately synchronous with groundwater levels: The lower the groundwater head, the less the agricultural contaminant loading. Low groundwater level came along with periodical desiccation of the upstream reaches of the streams when the upstream parts of the catchment were hydraulically decoupled from the streams. A model study using the HydroGeoSphere model confirmed that during these periods groundwater flowpaths towards the stream changed considerably, involving more the deeper parts of the aquifer and thus better buffering the agricultural solute loading. However, this effect seemed to be fully reversible during longer wet periods.
In contrast, the 2nd component seemed to reflect the redox status of the groundwater and the extent of denitrification and corresponding sulphide oxidation. Again a clear trend was observed at several sites. But this trend was not related to groundwater head. Instead, it indicated a long-term and steadily increasing tendency to more oxic conditions and thus decreasing denitrification capacity in the deeper aquifers.
To conclude, changing meteorological conditions and subsequent decreasing groundwater levels and periodical desiccation of upstream reaches of the streams had an impact on stream water quality. But this effect was entirely due to changing hydraulic conditions rather than to biogeochemical processes and seemed to be fully reversible. In contrast, our results indicated a decreasing denitrification potential in the deeper aquifer independent from climate change effects.

Abstract number 31 - POTENTIAL IMPACTS OF LAND USE ON ECOSYSTEM SERVICES ALONG THE SOUTHERN COAST, SOUTH AFRICA

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The provisioning of freshwater is a vital hydrological ecosystem service delivered by groundwater, recognizing groundwater quality as an important aspect of groundwater assessments. Land use activities impose a great risk to the pollution potential of groundwater, which is critical to be considered. Groundwater is connected with hydrological landscapes including coastal marine and estuarine ecosystems. These ecosystems support healthy habitats, also considered an essential hydrological ecosystem service which requires high water quality. Submarine groundwater discharge (SGD) is a process transferring groundwater from land to sea, resulting in constant modifications of coastal groundwater quality, and coastal marine and estuarine water quality, suggesting that it is equally important to assess the risk of land use pollutants introduced into the coastal marine and estuarine environment through SGD. Due to the close connection between groundwater and SGD an assessment of groundwater is required to assess the coastal groundwater water quality and quantity contributing to SGD. The aim of this study is to develop a framework to assess and map the potential effects of land use on groundwater and SGD along the southern coast of the Western Cape Province, South Africa, and to subsequently describe the effects on groundwater quality as a provisioning ecosystem service, and coastal marine and estuarine water quality as a supporting ecosystem service. To achieve this aim groundwater vulnerability maps applying the DRASTIC approach, and risk assessment maps applying the composite DRASTIC approach were created. Furthermore, coastal areas potentially contributing to SGD was delineated and the coastal groundwater quality and quantity potentially contributing to SGD were assessed. This sub-project forms part of the SPACES (Science Partnerships for the Assessment of Complex Earth System Processes) project, funded by the "Bundesministerium für Bildung und Forschung" (FKZ 02WSP1306D), on groundwater/seawater interaction in order to protect and effectively manage coastal watersheds and coastal waters along the southern coast of the Western Cape Province, South Africa.

The results of this framework will assist to describe the study regions' groundwater as a provisioning ecosystem service, and coastal marine and estuarine water as a supporting ecosystem service. Furthermore, this study will provide valuable information for management authorities and stakeholders concerning land use, groundwater, and coastal management strategies.

Abstract number 32 - SUB-BASIN SCALE MODELLING OF NITROGEN AND PHOSPHORUS EXPORT BY RIVERS TO COASTAL WATERS OF CHINA

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Chinese waters of the Bohai Gulf, Yellow Sea and South China Sea suffer today from eutrophication that causes blooms of harmful algae (e.g., cyanobacteria, which are toxic for people). Eutrophication results from increasing availability of nutrients such as nitrogen (N) and phosphorus (P). Chinese rivers have increased this nutrient availability in the seas by transporting considerable amounts of N and P to the coastal waters since the 1970s. Around two-thirds of these nutrients come to the seas from the large rivers: the Yangtze (Changjiang), Yellow (Huanghe), and Pearl (Zhujiang). The drainage basins of these rivers (around 3 million km2) cover one-third of China (around 9 million km2).
The Yangtze, Yellow and Pearl rivers transport nutrients to the Chinese seas originating from agriculture and urbanization. However, the spatial pattern of nutrient sources within large river basins is not well known. This may lead to ineffective management of coastal water pollution. This study aims to identify the locations of nutrient sources within the three large basins in 1970 and 2000. To this end, we modelled dissolved inorganic and organic N and P export by the Yangtze, Yellow and Pearl rivers on a sub-basin scale. First, we divided the drainage basins of the rivers into smaller sub-basins. Next, we calculated river export of nutrients from sub-basins by source using a sub-basin version of the Global NEWS-2 (Nutrient Export from WaterSheds) model. Finally, we analyzed the main locations of the nutrient sources within the river basins.
The results show that dissolved inorganic and organic N and P export by the large rivers increased considerably (at least a factor of 1.5) between 1970 and 2000. At least two-thirds of the inorganic N and P are generated from the downstream areas of the Yangtze, Yellow and Pearl basins in 2000. Middle and downstream areas are major contributors of the organic N and P. Agricultural activities in those areas are dominant sources of the nutrients in rivers. Human waste is an important source of dissolved inorganic P. The contribution of the downstream areas increased during 1970-2000 because of the increasing human activities taking place closer to the coastal waters. This study indicates that management options in agriculture should be directed to the middle (for organic nutrients) and downstream (for inorganic and organic nutrients) areas to reduce effectivity nutrient inputs to the coastal seas.

Abstract number 34 - NITROGEN REDUCTION REQUIREMENTS TO REACH QUALITY TARGETS FOR GROUNDWATER AND THE MARGINAL SEA AND THE EFFECTIVENESS OF WELL-ESTABLISHED AGRICULTURAL NITROGEN REDUCTION MEASURES IN THE FEDERAL STATE OF MECKLENBURG-VORPOMMERN (GERMANY)

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Mecklenburg-Vorpommern is the most north-eastern of the 16 Federal States of Germany, covering an area of about 23 200 km2 with a population of ca. 1.6 million inhabitants. About 62 % of the territory is used for agriculture, whose emissions have contributed to the deterioration of groundwater and surface water quality. At present the achievement of good groundwater status is unclear or rather unlikely for 35 % of all groundwater bodies, mainly due to nitrate concentrations > 50 mg/l. Additionally a reduction of N input into surface is required in order to meet the German quality targets for rivers entering the North Sea (2.8 mg N/L) and the Baltic Sea (2.6 mg N/L).
We used an interdisciplinary model network consisting of a Nutrient balance model a water balance model (GROWA), a reactive nitrate transport model in soil (DENUZ) and reactive nitrate transport model in groundwater (WEKU) to predict the nitrogen inputs into surface waters via six different diffuse input pathways (groundwater, drainages, natural interflow, erosion, wash-off, direct atmospheric deposition on surface waters) and from four point source inputs (industrial effluents, wastewater treatment plants, small sewage treatment plant and separate sewer systems).
Nitrogen reduction requirements to reach quality targets for groundwater as well as the North Sea and the Baltic Sea have been determined in three subsequent steps based on the results of a state-wide status quo analysis of N inputs for the reference period 2010.
• Initially the required N reduction to meet the environmental target value for groundwater has been assessed using a nitrate concentration in the leachate of 50 mg NO3/l as a reference value.
• Subsequently the N reduction necessary to reach the quality targets for surface waters has been assessed using the forecasted N concentrations in surface waters after the groundwater quality target has been achieved as a reference.
• Conclusively, five well-established agricultural N reduction measures have been analysed with respect to their effect on the nitrate concentration of groundwater and N inputs into the North Sea and Baltic Sea respectively without taking the N reduction requirements of groundwater and surface waters specified above into account.

Abstract number 37 - NITROGEN AND PHOSPHORUS USE EFFICIENCIES IN AGRICULTURAL PRODUCTION AND THEIR EFFECTS ON WATER POLLUTION IN CHINA

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The nitrogen use efficiency (NUE) and phosphorus use efficiency (PUE) are generally low in Chinese agriculture as a result of poor nutrient management in intensive production systems. As a consequence, considerable amounts of nitrogen (N) and phosphorus (P) are lost to the environment, including rivers. Some of these nutrients are further transported by rivers to coastal waters. Increasing amounts of nutrients in rivers and coastal waters cause water pollution. For example, excess N and P in the coastal waters of South China Sea have caused eutrophication and harmful algal blooms. A better understanding of how NUEs and PUEs in agricultural production affect water pollution may help to reduce coastal eutrophication in China.
We applied the NUFER (NUtrient flows in Food chains, Environment and Resources use) model using a county database to quantify (1) NUEs and PUEs in agricultural production for nine Chinese Agro-ecological Zones (AEZs) in 1990, 2000 and 2030, and (2) the associated N and P emissions to surface waters. For the year 2030 we explored four scenarios: Business As Usual (BAU), Balanced Fertilization (BF), Precision Feeding (PF), and Manure Management (MM).
Our results indicate that NUEs and PUEs vary among AEZs because of differences in crop and animal production. For example, crop production levels in south-eastern AEZs are higher than in north-western AEZs. The nutrient use efficiencies of agricultural (crop and animal) production decreased between 1990 and 2000 in the nine AEZs. This is mainly caused by a decrease in nutrient use efficiencies in crop production. As a consequence, the total N and P emissions to surface waters from Chinese agriculture increased considerably from 1990 to 2000 (almost by a factor of two for N emissions). Future NUEs and PUEs in agricultural production are calculated to decrease from 2000 onwards in the BAU scenario. The other three scenarios (BF, PF and MM) all project higher NUEs and PUEs than BAU in 2030. Consequently, the total N and P emissions to surface waters are lower in the BF, PF and MM scenarios than in the BAU scenario, because fertilizers are used more efficiently. This indicates that better nutrient management in agricultural production can increase the NUEs and PUEs. This will likely decrease water pollution because of lower N and P losses from agriculture to aquatic systems.

Abstract number 39 - UNCERTAINTY ASSESSMENT OF SPATIALLY DISTRIBUTED NITRATE REDUCTION POTENTIAL IN GROUNDWATER USING MULTIPLE GEOLOGICAL REALIZATIONS

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Nitrate leaching from agriculture is a major environmental problem in the European countries. In Denmark, the young glacial sediments have a high reducing capacity, and a large part of the nitrate leaching is therefore naturally removed by nitrate reduction in the saturated zone. However, heterogeneity in the subsurface leads to large spatial variation in the potential for nitrate reduction within a catchment. A catchment can therefore comprise both areas with a high reduction in the subsurface, as well as areas where nitrate is transported directly to surface waters without significant reduction. Implementing a spatially differentiated regulation on agricultural practice focusing on reducing nitrate leaching on areas with low reduction, would be a more effective approach than the present spatially uniform regulation.

Distributed models can be used to estimate spatially distributed nitrate reduction potential in the saturated zone in order to delineate these areas of high and low nitrate reduction. However, due to insufficient and uncertain data, it is difficult to describe the spatial variation of input data and model parameters. The distributed models therefore lack predictive capability at the grid scale, giving rise to uncertainty on the model estimates. Geological uncertainty is believed to be the main contributor to uncertainty on estimated nitrate reduction.

The objectives of this study were to estimate spatially distributed nitrate reduction potential in Norsminde catchment in Denmark, and to assess the uncertainty on the estimate due to geological uncertainty by using multiple geological models. It was assessed whether the uncertainty could be reduced by using an extensive geophysical dataset in combination with borehole data for constructing the geological models. Finally, an upscaling analysis was performed to analyze how the uncertainty changed with increasing aggregation scale in order to evaluate on the predictive scale of the model.

The study showed a large spatial variation in nitrate reduction potentials in the study area. The uncertainty on the estimated nitrate reduction was large on the original 100 m model scale, but the uncertainty decreased with increasing aggregation scale. The decrease in uncertainty was most apparent the first 500 m, where after the uncertainty started to level off. The results also showed that using geophysical data in combination with borehole data when generating geological realizations was able to decrease the uncertainty on the estimated nitrate reduction. Finally, the results indicate that predictive capability of distributed models is constrained by the spatial resolution of key data such as geology..

Abstract number 43 - ON TRACK IN HARMONIZING AGRICULTURE AND VULNERABLE DRINKING WATER ABSTRACTIONS IN OVERIJSSEL, THE NETHERLANDS

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Since the seventies, in the Netherlands, the agricultural emissions of nutrients and chemicals used for crop protection to water systems has strongly increased. Since the early nineties, these emissions have been reduced by policy measures. In spite of these efforts, water abstraction sites in the sandy areas of the province of Overijssel, the Netherlands, are still experiencing an increasing impact of agricultural emissions on the quality of abstracted groundwater. To meet the requirements of article 7.3 of the WFD, the province of Overijssel assessed the risks on water quality for drinking water abstraction sites in the province. Emissions from dairy farms were indicated as one of the significant sources for which measures were necessary.
In 2011, a project was formulated based on voluntariness and mutual gains aiming at reducing nitrate leaching and N surpluses and increasing the financial benefits of the farmers at the same time. Farmers were invited to join the project and were supported by agricultural consultants. Measures were selected that would contribute to maintenance of the production intensity without violating values for nitrate leaching to groundwater. These values were transposed into operational boundary conditions, i.e. maximum acceptable N surplus (kg ha-1) on farm and on soil scale. The effect of the measures was monitored by the indicators of the agricultural management and the nitrate concentration of the shallow groundwater. The economic impact was established for each farmer based on the measures agreed upon and the characteristics of the farm.
After a period of building trust and increasing awareness, the farmers who accepted the invitation were able to improve their management. N-surpluses of the soil balance decreased from 165 to 159 kg ha-1 in respectively 2012 and 2013. A further decrease in 2014 is expected. The nitrate concentration in the shallow groundwater fluctuated in 2011, 2012 and 2013 between 93 and 104 but tended to decline slightly to 84 mg NO3l-1 in 2014. The potential increase in financial benefits of measures to be implemented in 2015 ranges from € 80 – 135 /ha and € 3,200 - 6,850 / farm for soil measures only and up to 290 /ha and 14,500 / farm including all measures. The preliminary evaluation of the project showed that the farmers saw new opportunities to implement sustainable practices on their farms and that they were willing to develop these further because of financial and societal benefits.

Abstract number 45 - TEMPORAL AND SPATIAL DISTRIBUTION OF NITRATE LEACHING IN MEDITERRANEAN IRRIGATED AGRICULTURAL ECOSYSTEMS

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Nitrogen fertilization plays a contributing role to sustain irrigated crop productivity in the Mediterranean countries. However, improper irrigation together with chemically reactive N fertilizers induces nitrate (NO3) leaching to groundwater and drainage especially during high irrigation demands in summer months. Excess localized rainfall in winter months is also contributing off-site NO3 movement. The aim of our research was to determine the temporal and spatial distribution of groundwater NO3 concentration in the irrigated soils under different crop rotation. The research was carried out in hydrologically defined 9,495 ha of Akarsu Irrigation District, and 108 shallow groundwater wells were monitored four times annually to quantify spatial and temporal distribution of NO3 concentration and loads. Soil, plant and climatic parameters were also measured and recorded four times annually representing the irrigated and non-irrigated seasons (IS, NIS). The average NO3 concentration was higher in April (22.8 mg L-1), rainy season and in July (29.5 mg L-1), peak irrigation season, and lower in September (13.4 mg L-1) and January (12.3 mg L-1). Nitrogen loss as load reached up to 250 kg NO3 ha-1 in 20% of the total irrigated land in July; the same load level was observed in less than 10% of the total area in September, January and April. Wheat, the first-crop corn and citrus in winter to mid-spring and the first- and second-crop corn, melons, soybean, citrus and vegetables in late spring to mid-fall were the main crops grown in the District. These crops received excess amounts of reactive N fertilizers during the early and peak growth stages. Therefore, the groundwater NO3 concentration and the load were not only related to irrigation and rainfall but also to traditional cropping patterns and fertilization practices. Consequently, sustainable fertilizer and water management plans in macro- and meso-scales are needed to reduce groundwater NO3 pollution.

Abstract number 49 - MODELLING AND MANAGEMENT OF NITRATE INPUTS INTO GROUNDWATER AND SURFACE WATER IN SLOVENIA

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The main goal of a research project carried out on behalf of Slovenian Environment Agency was to assess nitrogen pollution of surface waters and groundwater resulting from diffuse sources and point source inputs in the Republic of Slovenia. For the determination of the diffuse N inputs into groundwater and surface water agricultural nitrogen balance surpluses derived by Agricultural Institute of Slovenia were coupled with the hydrological model GROWA-DENUZ/WEKU. Based on GROWA model water balance and pathways for diffuse nitrogen inputs into river systems have been assessed. Travel-time dependent nitrogen degradation in soil and groundwater are modelled using the DENUZ and the WEKU-model.
In this way the actual N inputs into groundwater and surface waters for the diffuse input pathways groundwater runoff and direct runoff (drainage runoff and natural interflow) have been assessed in a spatial resolution of 100 m x 100 m. As point source N-inputs industrial treatment plants, municipality treatment plants and septic tanks have been considered. Results indicate that groundwater and interflow are the most relevant input pathway for diffuse nitrogen inputs into surface waters contributing around 30% each. Treatment plants contribute to about 25%, showing that point source input is significant in Slovenia.
Based on the status quo analysis scenario calculations have been performed, such as the quantification of the N reduction level needed to guarantee nitrate concentrations in groundwater below the EU - threshold value of 50 mg NO3/l. The research project will di-rectly support the implementation of the EU-Water Framework Directive in Slovenia, e.g. as a framework for the derivation of regionally adapted and hence effective nitrogen re-duction measures.

Abstract number 51 - CHALLENGING ISSUES ABOUT SPATIAL HETEROGENEITY AND UNCERTAINTY IN COST-EFFECTIVENESS ANALYSIS WHEN ASSESSING MEASURES FOR WATER QUALITY IMPROVEMENT

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Cost-effectiveness analysis is particularly useful in comparing mitigation measures by providing a rationale for decisions to be taken at the level of agricultural areas for drinking water abstraction. Effectiveness of measures can be assessed for medium-term goals (pressure, practices intensity or risk of transfer) by the use of indicators. However, models are required for assessing final goals (impacts). In addition, questions of spatial and temporal heterogeneity make devising environmental mitigation programmes a complicated exercise. This is because the characteristics of agricultural production (soil

types, slopes, farming systems, proximity to streams...) can vary hugely across a river basin as well as stochastic climatic events within the implementation period of measures. Furthermore, the precise extent of the damage caused to the environment by the use of pesticides is difficult to assess (delay between applications and the appearance of any quantifiable effects, origins of breakdown products).We used the SWAT model for predicting the long-term impacts of mitigation measures on water quality..
Farming systems heterogeneity is addressed by using bio-economic modelling to appraise marginal and total costs of implementing measures. Traditionally the difficulties caused by data availability bring to model "representative" (average) farms and "type" (modal) farms. By using these, geographical information on farm plots and management practices is lost. We overcome these problems by calculating costs at the hydrological response unit level (HRU) which is the spatial unit used by SWAT to calculate flows of water and nutrients
Costs and Effectiveness are best calculated at common appropriate spatial and temporal scales. The sub basin and watershed level appeared to be the more relevant spatial scale while the hydrological simulation period is the common temporal scale used for quantifying total costs. Ratios of discounted sum of annual costs (€) divided by the concentration reduction (g.l-1) summarises results into single useful quantitative indicators for selecting measures. They can be calculated at different scales within a river basin. However, these ratios need to be handled carefully, because of the deterministic approach.
Our modelling framework for cost effectiveness analysis of measures has been applied to different case studies (drinking water abstraction areas) within the Garonne river basin in terms of their applicability, transparency and capability for decision making for reducing water pollution by pesticides. Our results show that it is possible to classify scenarios based on their cost-effectiveness, which can be represented graphically (maps with spatially distributed cost-effectiveness ratios or scatterplots) allowing for rational discussion between stakeholders.

Abstract number 52 - NITROGEN APPLICATION AND ITS EFFECT ON WATER QUALITY IN SMALL AGRICULTURAL STREAMS

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Various strategies to reduce loss of nitrogen (N) from agricultural land have been implemented in the Nordic–Baltic countries during the last two decades to combat nutrient pollution of surface waters. The mitigation methods have led to a significant reduction in the consumption of N fertilizers in some of the Nordic–Baltic countries. The objective of this study was to investigate trends in N application and N balance and their effect on N concentrations in runoff from agricultural areas. Nitrogen balances consisted of N input in fertilizer, manure, deposition and fixation minus N output in yield. The study was based on monitoring in small agricultural streams in the Nordic–Baltic region over the last two decades with corresponding information on average N application (28 catchments) and N balance (27

catchments) for varying periods. Long-term time series (14–22 years) on annual N application was available for 17 catchments and for 14 of these catchments, annual information on N balances were also available for the long term time series. Nitrogen balances showed that on average for this period the N balances varied from −12 N ha−1 yr−1 in Volbu to 132 kg N ha−1 yr−1 in Time, both located in Norway. For long-term time series, we found that the N application rates decreased significantly in six catchments, but increased in five catchments. Hence the results describe the differences in agricultural conditions between countries, caused by e.g. changes in livestock production (Norway), strict regulations of fertilizer application (Denmark) and increased intensity in production (Latvia). The results also showed that for 10 of the 14 catchments with long-term time series, there was no significant relationship between annual N balances and N concentrations. The effect of changes in N balances on N concentrations were significant for four of the 14 long-term time series and showed a positive relationships ($p = 0.0002, 0.0013, 0.0087, 0.0893$) between annual N balances for the agricultural area in the catchments and N concentrations in these streams. The significant relationship between N balances and N concentrations were detected where long-term trends in N balances were identified and where a large change in N balances from a very high N surplus occurred.

Abstract number 53 - INTENSIVE LAND USE AND PROTECTION OF DRINKING WATER SOURCES IN FLANDERS: A BRIDGE OVER TROUBLED WATER

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Around 70% of the drinking water produced by the Watergroep (largest Flemish water company) is extracted from 85 groundwater well sites. Analysis of data of the groundwater quality at the abstraction sites has shown that the intensive land use in Flanders has a widespread impact on the groundwater quality in shallow aquifers. Especially nitrates, sulphates, and traces of pesticides and herbicides or their metabolites are frequently found in the extracted groundwater. In despite of the existing protection programs (e.g. manure restriction plan, pesticide reduction plan, restriction of insecticides,…), little improving trends are observed for the groundwater quality on the well sites. Only for the herbicide Atrazine, prohibited in 2004, the concentrations have just recently lowered significantly. Besides diffuse pollution, also calamities occur in the near surroundings of drinking water wells. In this context mainly spills with mineral oil products, chlorinated hydrocarbons, or pesticides occur.
Concerning the pollution of groundwater, a subdivision can be made between historical and recent impacts on the one hand, and between diffuse and point pollution on the other hand. These different types of pollution request a site specific protection approach, taking into account the local characteristics of the environment and activities around a well site. Therefore, a risk based approach for the protection of the catchment area is developed, as part of the water safety plans. In this approach land use analysis, stakeholder identification and a general and site specific program of actions and measures in the groundwater recharge areas form an important part. To make sure that this risk based approach works, it is necessary that not only drinking water companies act, but that an aimed cooperation is generated with all the stakeholders who can make a difference. Only by involving every influencing actor, effective actions and measures can be set up to improve the groundwater quality. The water safety plans and risk based approaches are a first step to build this brigde over troubled water.
Based on the current observations and risk based approaches the Watergroep composed a list of policy rules to implement. These focus on funding, further prevention and prohibition, cooperation and stakeholder involvement, and nature management and development.

Abstract number 55 - ADDRESSING HIGH NITRATE CONCENTRATIONS IN SURFACE AND GROUNDWATER IN AUCKLAND, NEW ZEALAND

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Nitrate (NO3-) is an essential nutrient for the growth of plants and animals; however its use in the agricultural and horticultural sectors has led to increased nitrate leaching. Elevated nitrate loads into ground and surface water systems can cause nutrient enrichment, resulting in enhanced algae and macrophyte growth, including toxic algal blooms.
Auckland Council's freshwater quality monitoring program (groundwater, springs and streams) has reported elevated nitrate concentrations of up to 29 mg nitrate-N per L in the Franklin district. These concentrations considerably exceed the national bottom line for nitrate toxicity (6.9 mg nitrate-N per L) as set out in the National Policy Statement for Freshwater Management, nitrate trigger values in the ANZECC (Australia and New Zealand Environment and Conservation Council) water quality guidelines (4.9-12.0 mg nitrate-N per L), and the Ministry of Health (MoH) drinking water guidelines (11.3 mg nitrate-N per L).
Intensive market gardening activity in Franklin is implicated as a primary contributor to this issue; however, there is no quantitative data to substantiate this. There is also a scarcity of knowledge of nitrogen cycling dynamics in Franklin soils under this type of land use. Market gardening in the Franklin area is associated with high N-fertiliser application rates throughout the year, which increases the risk of nitrate leaching losses from soil, particularly in winter.
As such, a series of research projects are being undertaken in collaboration with other New Zealand research organisations, with the objective of better understanding N cycling and loss dynamics in these intensively managed soils, and how this goes on to affect nitrate concentrations in groundwater and nearby streams. The research projects include:
• a field trial measuring drainage fluxes and nitrate leaching below the rootzone of potato and onion crops;
• a groundwater ageing study to better characterize groundwater recharge areas, transit times and age in confined and unconfined aquifers; and
• a nitrate source determination study using the 'dual stable isotope technique'. This method uses the isotopic signatures of 15N and 18O to investigate possible sources and transformation characteristics of nitrate in ground and surface waters.
Although nitrate leaching is a widely studied issue in New Zealand pastoral systems, there is comparatively little understanding in market gardening systems. This research is using some novel methods to fill important knowledge gaps in the nitrate contamination issue for the Franklin area, and will have wider applications for other regions of New Zealand.

Abstract number 60 - SULPHATE, A NEW POTENTIAL THREAT TO SURFACE WATER AND GROUNDWATER QUALITY

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Atmospheric emission of sulphur oxides was an important issue in the sixties and the seventies of the last century (acid rain). Technological and regulatory interventions have largely redressed this problem. Atmospheric deposition of sulphur has dropped correspondingly. The decline in atmospheric sulphur deposition to less than 10 kg S/ha has led to sub-optimal sulphur availabilityfor common crops like winter wheat, potatoes and sugar beets. Therefore, the agricultural sector in the Netherlands is aware of the need of sulphate containing mineral or organic fertilisers such as manure and soil improvers. At the same time, agriculture tends to increase the use of ammonium sulphate as a fertiliser, a residual product from chemical air scrubbing systems, abating ammonia emissions from pig and poultry stables at factory farms. Moreover, the sector considers the use of sulphuric acid for the acidification of manure to further decrease ammonia emissions from manure storage and application.
Large-scale application of sulphate enriched manure and ammonium sulphate from air scrubbing systems may affect future groundwater and surface water quality. In this perspective, we studied the trends in sulphate concentrations in groundwater and surface water. We also assessed the impacts of sulphate use on water quality resulting from different scenarios. The study shows that lower sulphate concentrations in surface water and groundwater reflect the decrease in atmospheric sulphur emission and consequent decrease in deposition. Calculations show that, at a national level, the application of drain water from air scrubbing systems will not lead to high sulphate concentrations. However, problems may arise in areas with a high density of factory farms. Large-scale acidification of manure with sulphuric acid and use of this manure, within current nitrogen and phosphorus application standards, will lead to sulphur application far above fertilisation recommendations. Subsequently, this may cause a significant increase of sulphate concentrations in surface waters and groundwater. Under anaerobic conditions in, e.g. surface waters sediments, this may lead to the formation of sulphide. Sulphides may influence surface water ecosystems due to their toxicity. They may also release phosphorus from the sediment, enhancing eutrophication.

Abstract number 62 - SEASONAL VARIATION IN LEACHING WATER QUALITY IN THE SAND REGION OF THE NETHERLANDS

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In the Netherlands, agricultural soils in the Sand region are most vulnerable to nitrate leaching. Effects of the Nitrates Directive action programmes on root zone leaching are monitored with the National Minerals Policy Monitoring Programme (LMM) since 1992. Root zone leaching in the Sand region is measured by sampling the upper meter of groundwater on farms at 16 locations per farm once a year during summer. Since 2004, groundwater is also monitored during winter at a selection of LMM farms,

artificially drained by tile drains or ditches. This winter monitoring allows assessing trends in nitrate leaching to surface water.
The upper meter of groundwater corresponds to the layer annually supplemented by rainfall (average precipitation surplus of about 300 mm/year, and a soil porosity of about 33%). Measured nitrate concentrations depend on the amount of nitrate leached and the precipitation surplus in the foregoing months and years. Therefore, nitrate concentrations will vary in time within a year. However, this variation should be fully in accordance with variation in leaching and precipitation surplus
Yet, when denitrification occurs in the upper meter of groundwater the nitrate concentration decreases as residence time of water in the upper meter increases. Therefore, in case the residence time of the water in the upper meter shows a seasonal variation then a second and in this case systematic seasonal variation in nitrate concentrations will exist in the upper groundwater. Nitrate concentrations in groundwater sampled in a single season could give a false estimate (too high or too low) of the nitrate concentrations that are traveling to deeper drinking water wells. Because groundwater is sampled both in summer and in winter since 2004, it is possible to investigate systematic temporal variations in nitrate concentrations.
Results show that the average summer nitrate concentrations appear to be strongly correlated to the concentrations during the preceding winter season. Nitrate concentrations in groundwater are on average 20% higher in winter than during summer and, therefore, there is a clear systematic seasonal variation. This study shows that the time of sampling should be taken into account when long-term monitoring data are analysed to show the effectiveness of programmes of measures or to estimate nitrate concentrations travelling towards drinking water wells.

Abstract number 63 - NITRATE LEACHING FROM DAIRY FARMS IN THE SAND REGION IN THE NETHERLANDS: CAUSES FOR HIGHER NITRATE LEACHING FROM MAIZE LAND THAN FROM GRASSLAND

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Silage maize is the major arable crop grown on dairy farms in the Netherlands, especially in the Sand region. The proportion of cultivated land covered with silage maize in this region is on average 22 percent. Literature indicates that nitrate leaching from silage maize fields is higher than from grassland. The most common explanations for this difference are: 1) differences in crop characteristics, 2) differences in soil type and hydraulic properties, and 3) differences in farm practices.
In this study we examined the difference in nitrate leaching from maize and grassland on dairy farms that participated in the Dutch Minerals Policy Monitoring Programme (LMM). We focus on farms in the Sand region with fields on which for minimally three subsequent years maize was cultivated. During the 1992-2013 period 330 different farms participated for one or more years. On these farms, root zone leaching was measured by taking 16 or 48 samples of the upper meter of groundwater. Agricultural practices were registered at all farms. Combining all nitrogen sinks and sources for the soil surface balance, nitrogen surpluses were calculated for both grassland and maize land for each farm. In addition, soil characteristics were collected both in the field during sampling (soil profile description, groundwater level) and from soil maps (regional soil type and drainage class).

Results show that the nitrate concentration in water leaching from the root zone on permanent maize fields is twice as high as on grassland. Both the nitrogen use and the nitrogen soil surplus on maize land are smaller than on grassland. Therefore denitrification is thought to be the dominant process to explain the difference in nitrate concentration.
Denitrification is known to be lower for deep, well drained soils than for soil with poor drainage, and to be higher for organic matter rich soils than for organic matter poor soils. In accordance with this, we found that average groundwater levels during sampling for maize fields were deeper than for the grassland fields. Also maize is preferentially grown on the sandier and organic matter poorer soils, whereas grass is more often grown on parcels with organic soils.
However, the differences in soil type and groundwater level between permanent maize fields and grassland are not large enough to explain the differences in nitrate leaching. Therefore, differences in crop and growth characteristics between maize and grass have to contribute to the difference in nitrate leaching.

Abstract number 64 - ASSESSMENT OF COST-EFFECTIVENESS OF MEASURES TO REDUCE N AND P EMISSIONS TO SURFACE WATERS IN UPPER AUSTRIA – A CATCHMENT SCALE APPROACH

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According to Austrian River Basin Management Plan (BMLFUW 2009) about 19% of Austrian surface waters are at risk to fail the good ecological status due to pressures caused by nutrients and organic substances. For those water bodies the reduction of nutrient emissions is necessary to achieve the environmental objectives according to the Water Framework Directive (2000/60/EC). However, the effectiveness of measures especially addressing diffuse nutrient emissions depends on specific local conditions. Which measures are most cost-effective and to which extent the measures have to be applied in different catchments to be in line with environmental quality standards (EQS) requires the application of emission models.
The empirical emission model MONERIS (Behrendt et al. 1991) adapted to specific Austrian conditions was successfully applied to 81 catchments in Upper Austria to reproduce observed mean surface water N- and P- concentration. After initial calibration phase, input data sets have been modified in order to reflect the application of agricultural measures within the catchments. Using the MONERIS model the effects of different agricultural measures derived from the Austrian Program for environmental sound agriculture (ÖPUL) for reduction of N- and P-emissions from agricultural areas could be quantified in terms of total and local effectiveness.
In a first step, the potential of each of 12 and 9 different measures to reduce N and P surface water concentration was tested in the catchments. In a further step, the most effective combinations of measures were evaluated to optimize their application in catchments at risk to fail EQS. The optimization procedure examines the applicability of measures, their necessary local extension, their reasonable mix as well as economic aspects. Consequently the possibility for EQS achievement and the costs for necessary combinations of measures were calculated on catchment scale.

It was found, that "fertilization on soil demand" is the most cost effective measure to reduce N emissions (10-40 €/KgN in 85% of all catchments), followed by winter-greening (30-55 €/kgN in 85% of all catchments). In case of phosphorus cost effectiveness of measures significantly increases focusing on erosion hot spots. Consequently raster based erosion modelling was applied in test areas to quantify cost effectiveness of measures like root crop restriction on steep hillsides and construction of riparian buffer stripes. Results achieved were used for decision-making in action planning of Upper Austria.

Abstract number 66 - AGRICULTURAL PRODUCTION AND WATER QUALITY IN THE WESER RIVER BASIN – CHALLENGES FOR THE IMPLEMENTATION OF THE WATER FRAMEWORK DIRECTIVE

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The aim of the European Water Framework Directive is the achievement of a good ecological potential and chemical status for surface waters, as well as a good chemical and quantitative status for groundwater until 2015. For the river basin Weser the target concentrations will not be achieved by 2015. For some exemptions extended deadlines until 2021 and 2027 are possible. Hence, the aim is to analyze nutrient inputs and nutrient concentrations until 2021 and to conduct scientific analysis for the design of measure plans and their implementation for the Weser River Basin in Germany. A model network consisting of the agricultural sector model RAUMIS, the groundwater balance model GROWA, the nitrate transport model WEKU, the phosphorus transport model MEPHOS and the nutrient emission model MONERIS is further developed and adapted. Results show that the past trend of declining nutrient surpluses will be further continued until 2021, especially when implementing the manure regulation. This also leads to a reduction of nutrient inputs into ground and surface waters. We discuss different assumptions of the implementation of the manure regulation as well as the effect of transportation of manure into different regions. Results show that the target concentrations for the nutrients nitrate and phos-phorous for ground- and surface water will not be achieved in the baseline 2021. The amount of necessary measures on NUTS IV level and the regional hot-spots of nutrient reduction require-ments show that an increase in agri-environmental measures as well as a moderate intensifica-tion of the manure regulation will not be sufficient to achieve the water protection targets.

Abstract number 67 - MULTI-PRONGED APPROACH TO ELUCIDATE NITRATE ATTENUATION IN SHALLOW GROUNDWATER

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It is increasingly being recognised in New Zealand that denitrification occurring in the groundwater zone can result in a substantial reduction of the nitrate load leached from agricultural land before this load can reach water supply wells or discharge into groundwater-fed surface water bodies. This natural attenuation process provides an ecosystem service with regard to the protection of the quality of our freshwater resources that to date has not been adequately accounted for. This is largely due to the major challenges involved in trying to understand and quantify the denitrification occurring in a particular water management zone.
Based on the example of research conducted at the 'Waihora' site in the Lake Taupo catchment, we demonstrate a multi-pronged approach to elucidate the biogeochemical and hydrological controls on denitrification. The site is unique in New Zealand inasmuch as it has allowed investigating shallow groundwater underlying a pastoral hillslope in great detail using 11 multi-depth well clusters (comprising 26 wells in total).
As denitrification is only active under mildly reduced conditions, a systematic approach to characterise redox conditions based on measured concentrations of dissolved oxygen, nitrate, dissolved manganese, dissolved iron, and sulphate provided fundamental initial information on the denitrification potential of the groundwater system.
Determining stable isotope signatures of nitrate (δ15N, δ18O) and excess N2 dissolved in the groundwater can help differentiate between denitrification potential and denitrification that has actually occurred in a given groundwater sample. As the interpretation of these data is strongly dependent on the understanding of the temporal and spatial variation of groundwater flows at the site, hydrological understanding proved critical.
Tritium, chlorofluorocarbons, and silica were determined on selected groundwater samples to gain insight into the distribution of groundwater mean residence times ('ages') at the field site and slug tests provided estimates of the hydraulic conductivity of the different deposits found in the shallow groundwater system.
Given that most biogeochemical and hydrological parameters analysed showed substantial spatial variation, hydrological modelling of the hillslope proved the only promising way to ascertain the overall effect denitrification may have on the groundwater nitrate discharges from this site.

Abstract number 74 - COVER CROPS VERSUS FALLOW: WATER, NITROGEN AND SALINITY INTEGRATED FOR A MORE SUSTAINABLE IRRIGATED SYSTEM

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Nitrate leaching beyond the root zone can increase water contamination and decrease crop available N. Cover crops (CC) used in spite of fallow are an alternative to reduce nitrate contamination, because reducing drainage and soil mineral N accumulation. CC can improve important characteristics in irrigated land as water retention capacity or soil aggregate stability. However, increasing evapotranspiration and consequent drainage reduction, could lead to soil salt accumulation. Salinity affects more than 80 million ha of arable land in many areas of the world, and is one of the principal causes for yield reduction and even land degradation in the Mediterranean region. Few studies dealt with both problems at the same time. Therefore, it is necessary an evaluation of the potential effect on soil salinity and nitrate leaching, in order to ensure that potential disadvantages are compensated with all advantages of CC.
A study of the soil salinity and nitrate leaching was conducted during 4 years in a semiarid irrigated agricultural area of Central Spain. Three treatments were studied during the intercropping period of

maize (Zea mays L.): barley (Hordeum vulgare L.), vetch (Vicia villosa L.) and fallow. CC were killed in March, maize sown in April, and all treatments were irrigated and fertilised following the same procedure. Before sowing, and after harvesting maize and CC, soil salt and nitrate accumulation was determined along the soil profile. The electrical conductivity of the saturated paste extract and soil mineral nitrogen was measured in each depth. A numerical model based on the Richards equation was applied in order to calculate drainage, using daily soil water content measurements, measured with capacitance probes. Results showed that drainage was minimized during the irrigated period, because water adjust to crop needs, leading to soil salt and nitrate accumulation on the upper layers after maize harvest. Then, during the intercrop period, most of salt and nitrate leaching occurred. CC use shortened drainage period, lowered drainage water amount and lowered nitrate and salt leaching than fallow. These effects were related with a larger nitrate accumulation in soil upper layers after CC treatments. But there was not soil salt accumulation increase in treatments with CC, even decreasing after years with large CC biomass production. Then, adoption of CC in this irrigated cropping system reduced water drainage beyond the root zone, salt and nitrate leaching diminished as a consequence but did not lead to salt accumulation in the upper soil layers.

Abstract number 76 - THE KILL DATE AS A MANAGEMENT TOOL TO INCREASE COVER CROPS BENEFITS IN WATER QUALITY AND NITROGEN RECYCLING

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The establishment of cover crops (CC) during fallow periods is considered a technique that may contribute to the sustainability of agroecosystems. Some of their potential benefits are related with water quality and nitrogen (N) recycling in the system. Cover crops can increase water infiltration and thus, increasing soil water holding capacity. Moreover, plant residues covering the soil following CC killing can preserve soil moisture. Likewise, CC uptake and scavenge N, maximizing N recycling in the system and decreasing N leaching risk into groundwater, a threat to the water quality. However, water and N pre-emptive competition with the subsequent cash crop may occur due to depletion of soil moisture and redistribution of N pools. Previous experiments showed that among management practices, the CC termination date might be crucial to control water availability and N competition with cash crops.
A two-year experiment study and modeling simulation were conducted in order to study the effect of kill date in inorganic N and soil water content. Treatments in the field were fallow and a CC mixture of barley (Hordeum vulgare L.) and vetch (Vicia sativa L.) sown in October and killed on two different dates in spring. Aerial biomass and chemical composition of CC were determined at harvest, and ground cover was monitored based on digital image analysis. Soil mineral N was determined before sowing and after killing the CC, and potentially mineralizable N was measured by aerobic incubation at the end of the experiment. Soil water content was monitored daily to a depth of 1.1 m using capacitance sensors.
Results showed that kill date was a means to control soil inorganic N by balancing the N retained in the residue and soil, and showed promise for mitigating N losses. The early kill date decreased the risk of water and N pre-emptive competition by reducing soil depletion, preserving rain harvested between kill dates and allowing more time for N release in spring.
Subsequently, the deterministic model WAVE was applied in order to simulate the behavior of water and soil N, for different CC kill date in different scenarios. Results reinforced field findings, confirming that kill date is a crucial management tool for maximizing the CC benefits in water quality and N profit in agricultural systems.

Abstract number 77 - NEW TECHNOLOGIES TO REDUCE NITRATE LEACHING FROM GRAZED PASTURES

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Nitrate-nitrogen (N) leaching from urine 'patches' and fertiliser N applications is perhaps the most serious environmental consequence of dairy farming utilising direct grazing of pasture. Other significant losses include ammonia volatilisation and nitrous oxide greenhouse gas (GHG) emissions.
Nitrate leaching in particular has become a serious issue for dairy farming n New Zealand in the last decade, due to several factors: (a) the growth in land area under dairy farming; (b) increasing production per hectare resulting from (i) greatly increased fertiliser N use (mainly as granular urea), (ii) the increase in the use of irrigation, (iv) increasing importation of animal feeds, especially palm kernel extract (PKE); (v) the relatively porous nature of many New Zealand soils; (vi) the use of groundwater reservoirs beneath these soils for drinking water and food processing; and (vii) the eutrophication of streams, rivers and lakes.
Two new technologies have recently been developed to substantially reduce nitrate leaching. First, the 'ONEsystem' technology doubles the efficiency of fertiliser urea by applying it in prilled (rather than granular) form, treated with the urease inhibitor nbpt and wetted during application. This technology was released to the New Zealand and Australian dairy markets in January 2015, following successful independent field trials.
Secondly, the 'Spikey' trailor-mounted device detects individual fresh urine patches, and simultaneously sprays them with a patented blend of nbpt, giberellic acid and 'AlpHa' polymeric fulvic acid. This maximises pasture growth and N uptake by the urine-affected pasture, thereby greatly reducing both nitrate leaching and gaseous emissions.The 'Spikey' technology is at the advanced prototype on-farm testing stage. It detects fresh urine patches, with a very high degree of accuracy, by measuring differences in electrical conductivity of the surface soil over very small distances.
Both the'ONEsystem' and 'Spikey' technologies are described in detail in the paper. It is intended to eventually combine the two technologies, enabling urine-patch detection and treatment, and ONEsystem fertiliser N application, to be carried out simultaneously. The total cost to the farmer for using these two technologies together is expected to be considerably less than that of using granular urea alone, due to the 50% reduction in fertiliser N required.

Abstract number 80 - USE OF MODELLING TO PROTECT, PLAN AND MANAGE WATER RESOURCES CATCHMENT AREAS

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To consider large catchment areas as homogeneous spaces and work evenly on their whole surface would inevitably lead to a waste of time and money, with actions that may not be as efficient as wished. Their inner variability (ex: pedologic and geological properties) is actually an opportunity to invest

cleverly on smaller surfaces: every action is not as efficient on every kind of pedologic or geological surface. That way, it is possible to invest in a few well selected zones, where the efficiency would be as if it was invested on the whole catchment area, in terms of environmental results.
The notion of Hydraulic Contributing Areas (HCA) has been developed in order to answer this issue. The transport of most of the mobile and persistent pollutants is first driven by the water circulation, so the concept of HCA is based on the water path from the surface of the soil on the catchment area to the well. The method used for the hydrogeological modeling under Watermodel© offers to develop first the areas of high contribution of the exploited well. Watermodel© calculates, for each point of the catchment area, the contribution to the catched flow.
In the case of the Orvanne valley (catchment area of 23 000 ha at Dormelles, county 77, France in the chalk aquifer (Cretaceous)), the modeling financed by the the Seine-Normandie basin agency showed that 95% of the water pumped at the Dormelles well came from only 26% of the total surface of the catchment area. Consequently, the plan of actions for protection of the water resource will be focused on 93 farmers located on this 26% of the global surface instead of the 250 farmers present on the 23 000 ha.
Another modeling, under the Epiclès© software, allows the calculation for each agricultural plot, of the nitrate leaching concentrations. This calculation is based on the pedologic, climatic, and technical itineraries of the farmers.
The coupling Watermodel©-Epiclès© allows the modeling of the nitrate leaching from the soil to the catchment, validate the initial pollution inventory and simulate also the efficiency of the evolution of farming technical itineraries by testing multiple scenarii.

Abstract number 81 - IDENTIFYING SOURCES OF PHOSPHORUS IMMISSION INTO THE LAKE MONDSEE FROM THE CATCHMENT OF THE FUSCHLER ACHE

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Water quality of the Mondsee is at risk as phosphorus imission has temporarily reached mesotrophic levels. That could lead to algal bloom and thus poses a serious threat to this Alpine lake of high natural value and significant importance for tourism and recreational activities. The Provincial Government of Oberösterreich therefore assigned wpa to start an investigation identifying the main sources in order to prepare targeted mitigation measures for later on. The work focussed on the catchment of the Fuschler Ache, the main tributary to the Mondsee.
In a first step the semi-empiric model MONERIS was used to estimate the contribution of different sources to phosphorus imission into that catchment. That gave about 30% from urban sources, whereas sources like runoff and soil erosion contributed by 65%. Results matched reasonably total annual P-loads as derived from measurements during low and half tide, which are regularly carried out under the regime of the water framework directive. Additional measurements at the Fuschler Ache with a tight time resolution, however, indicated that events leading to a peak water discharge, like high precipitation or snow melt, play a significant role for total annual P-loads. That is currently not adequately reflected by the MONERIS model, which therefore seems to underestimate imission in some cases. It was further concluded that soil erosion and runoff might play an even bigger role than calculated by the MONERIS model.
The second step was therefore intended to narrow down the area where that part of the imission mainly derives from. This was done by spatially distributed emission modelling using the PhosFate model. Results indicate that 67% of the P-load in the Fuschler Ache is emitted from only 5% of the catchment's area. Integrating the results from the PhosFate model into the calculation done by MONERIS gave a reasonably better match with measurements including peaks of high water and P-discharge.

As a follow up to the modelling a verification of the findings was attempted through a field survey. A special concern in that regard was the fact that land cover within the catchment mainly consists of grassland and forest, which are typically attributed protective effects with regard to erosion and run off. The survey, however, documented that clearly visible erosion marks and areas where runoff obviously occurs may be indentified in the field even under grassland and that PhosFate may serve as a fingerpost leading to such hotspots within a catchment.

Abstract number 82 - TWO MONITORING NETWORKS IN AGRICULTURE DOMINATED WATERS IN THE NETHERLANDS FOR ASSESSING THE EFFECTIVENESS OF NATIONAL AND EUROPEAN LEGISLATION ON NUTRIENT AND PLANT PROTECTION PRODUCT APPLICATION

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Both nutrient and Plant Protection Product (PPP) emissions to groundwater and surface waters are a major drawback of the highly productive agricultural sector in The Netherlands. The resulting nutrient and PPP concentrations in water resources threaten their ecological, industrial, and recreational functions. To mitigate problems occurring with both these groups of substances, legislation on application in agriculture was enforced in The Netherlands already decennia ago. In recent years, this national policy was increasingly influenced by EU legislation like the Water Framework Directive and EU regulation 1107/2009 concerning the authorisation of PPPs. The results of this legislation are evaluated periodically by assessing the water quality status and trends in agriculture dominated waters. Based on these evaluations new policy measures are formulated. However, the monitoring locations used are not always fit for purpose; in general they are part of a regional monitoring network meant to investigate the general water quality in an area. As a result, these locations are often influenced by a variety of crops and by other sources like effluent from sewage treatment plants, urban runoff, and diverted river water. This hampers a proper evaluation of for instance the manure policy in the case of nutrients or the authorisation of crop-specific applications in case of PPPs.
The presented study aimed to develop monitoring networks for both nutrients and PPP's in collaboration with the Dutch regional water authorities, with the main objective to evaluate manure and PPP policy. After a thorough evaluation of the existing monitoring datasets, we were able to select ca. 170 monitoring locations for nutrients and ca. 100 locations for PPPs in agricultural dominated waters. In this presentation the prerequisites and principles for both networks are presented. The data analysis results (compliance with water quality standards and trends) from the nutrient network will be presented in more detail.

Abstract number 83 - PREDICTING THE EVOLUTION OF PESTICIDE METABOLITE IN SPRING WATER BY COMBINING LABORATORY TESTS, FIELD SAMPLING AND NUMERICAL SIMULATIONS

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Metolachlor-ESA, a major metabolite of the corn herbicide s-metolachlor, has begun to appear in worrying concentrations of up to 1000 ng/l in some tapped springs of the Luxembourg Sandstone aquifer. S-metolachlor has been applied increasingly to corn cultures previously treated with atrazine, which was banned from use countrywide in 2005. Because of the hydraulic inertia of the aquifer (mean residence times of five years and longer) and its importance as a drinking water supply for the country of Luxembourg, rapid action was deemed necessary to determine whether contamination by metolachlor-ESA was due to the temporary activation of preferential flow paths after storm events and restricted to "reactive" springs, or a first warning for a long-lasting pollution of the majority of the springs draining the Luxembourg Sandstone caused by a dramatic change in pesticide application practices.
We investigated the transport of metolachlor-ESA in the soil and in the aquifer of the Luxembourg Sandstone using a combination of field survey, laboratory experiments and numerical simulations. Because soil and aquifer compartments are both major controls on the formation and transport of metolachlor-ESA, an integrative approach was adopted to predict future trends for different scenarios ranging from business-as-usual to an immediate ban of s-metholachlor in spring protection zones.
Twelve springs covering a large range of metolachlor-ESA concentrations were sampled weekly to characterize the pesticide dynamics and determine the fast-flow contribution to total discharge (both in terms of water and pesticide fluxes). Degradation experiments in the laboratory with a radio-labeled precursor established the transformation kinetics of metolachlor-ESA in soils. Long-term soil leaching under different management scenarios were simulated with the pesticide fate model PEARL calibrated using the data from the laboratory experiments and the spring monitoring. Finally, the evolution of metolachlor-ESA concentrations in spring water was predicted for each management scenario using a lumped-parameter model to take into account the distribution of transit times from the different agricultural plots of each recharge area to the spring outlet.

Abstract number 87 - USE OF A FERTILISER ALLOCATION MODEL FOR THE EVALUATION OF IMPACT OF FARM PRACTICES AND POLICY MEASURES ON FERTILISER USE, NITRATE RESIDUES AND NITRATE LEACHING

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In the area of fertilisation, a large quantity of detailed information is available in Flanders, on one hand about farms, such as yearly production, use, transport and storage of manure and cultivated parcels, and on the other hand about agricultural parcels, such as yearly information on crops and applicable fertiliser standards, spatial information on size and location. However, information concerning fertilisation at parcel level is missing. In order to evaluate the impact of policy measures and farm practices at different levels (manure surpluses, nitrate residues and leaching, water quality,…), an educated estimate of the spatial distribution of fertiliser applications would be very useful.
Therefore a fertiliser allocation model (BAM) has been developed in MS Access. Starting from the available information at farm and parcel level, BAM makes a reasoned estimate of the quantity and type of fertiliser that is applied on each parcel and of the time of application. BAM calculates for each fertiliser type (liquid or solid manure from cattle, pigs, poultry, compost, mineral fertilisers,…) the total amount used per farm and per year and assigns it to the agricultural parcels of each farm, taking into account the crops, the corresponding fertilisation standards and expert knowledge of common farming practices.
The fertilisation doses calculated by BAM were validated using data of parcels of the derogation monitoring network which is followed up by the Soil Service of Belgium (Vandervelpen et al., 2011). The results showed that the applied manure types were, in general, estimated correctly. On average, the N-fertilisation doses estimated by BAM were slightly lower than the fertilisation declared by the farmers. The P-fertilisation doses were, on average, estimated more or less correctly. This validation proved that BAM can be used for scenario analysis.
In a next step, BAM has been used to evaluate the effects of different farm practices and policy measures in an extensive scenario study on fertiliser use in Flanders.

Abstract number 88 - BIOGAS PRODUCTION FROM COVER CROPS: ASSESSING EFFECTS ON WATER QUALITY IN FIVE FIELD EXPERIMENTS IN AUSTRIA

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Biogas production from field crops has been progressively criticised for competing with food production. In addition negative effects on water quality caused by high fertilizer and manure inputs are presumed. Synenergy, a project funded by the Austrian Klima- und Energiefonds, was therefore initiated with the aim to develop viable and sustainable alternatives by using catch crops for biogas production instead of foodcrops. The assessment of effects on water quality has been one of the tasks within Synenergy.
The investigations were based on field trials carried out at five sites in different agro climatic regions in Austria during 6 years. The experimental setup included black fallow, catch crops for green manure (as commonly grown within the regime of the Austrian agro environmental program ÖPUL) and catch crops grown for the purpose of biogas production. For the latter different crops and crop mixtures were compared. Only catch crops for biogas production were fertilized. Effects on ground water were assessed by continuous measurement of the soil water content at various depth, measurements of soil nitrate and nitrogen uptake by plants. The data was applied to a numerical soil-plant model (SIMWASER/STOTRASIM) calculating nitrate leaching. The effects on surface water were assessed by constantly monitoring the development of plant cover and applying this data to the BoBB soil erosion model.
According to catch crop and site conditions harvest was up to 7 t/ha DM with an average of 4,5 t which corresponds to a gross yield of 1300 m3 methane or a net yield of 1000 m3. On that basis catch crops on 15% of the agricultural land would provide sufficient fuel for the total food and catch crop production.
As compared to black fallow catch crops mitigated effects of nitrate leaching and soil erosion in any case. The purpose of the catch crop, however, can make a difference, which was essentially related to the fact that for biogas production a high yield is desirable. This was mainly achieved by early planting and late harvest. Especially for catch crops growing from late fallow to spring a longer growing period is feasible if harvested instead using it for green manure. As an effect lower nitrate concentrations in the soil were observed. The earlier development and longer lasting plant cover reduced soil erosion by 15 – 25%. A fertilization by 50 kg N/ha for harvested catch crops did not have negative effects on nitrate leaching.

Abstract number 90 - POLICY EFFECTS, CHALLENGES AND FUTURE SOLUTION SCENARIOS FOR IMPROVED N MANAGEMENT AND N EFFICIENCY IN DENMARK

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This presentation presents results from The Danish Nitrogen Research Reliance (www.dNmark.org) including effects of the Danish policies to mitigate N pollution, and solutions scenarios for significantly improved N management and N efficiency. With more than 60% of the land farmed, with vulnerable freshwater and marine environments, and with one of the most intensive, export oriented livestock sectors in the world, the nitrogen (N) pollution pressure from Danish agriculture is severe. Consequently, a series of policy action plans have been implemented since the mid 1980s with significant effects on the surplus, efficiency and environmental loadings of N. In summary, the average N-surplus has been reduced from approximately 170 kg N/ha/yr to below 100 kg N/ha/yr during the past 25 years, while the N-efficiency has increased from around 20-30% to 43%, the N-leaching from the root zone has been halved, and N losses to the aquatic and atmospheric environment have been significantly reduced. This has been achieved through a combination of approaches (ranging from command and control legislation, over market-based regulation and governmental expenditure to information and voluntary action), with specific measures addressing the whole N cascade, in order to improve the quality of ground- and surface waters, and to reduce the deposition to terrestrial natural ecosystems. However, there is still a major challenge in complying with the EU Water Framework and Habitats Directives, calling for new approaches and technologies to mitigate agricultural N losses and control N flows.

Abstract number 91 - A TOP DOWN ANALYSIS OF CONTROLS FOR CATCHMENT NUTRIENT EXPORT

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Nutrient exports from catchments significantly affect downstream water quality and ecosystem health. There is hence a need to better understand and classify catchment nutrient export dynamics in terms of

catchment functions (such as nutrient mobilization and retention) to predict the response of these functions to changing boundary conditions. However, the complexity of catchment structure and the multitude of the processes involved challenge this objective. One approach to meet this challenge is a top-down, data-driven analysis of integrated catchment responses, such as discharge and solute concentration time series. For top-down analysis, different catchments are compared to identify key variables governing catchment response. We conducted a multi-catchment study applying top-down methods to analyze nitrate concentration and discharge time series from streams draining nine catchments in central Germany. The studied catchments, ranging from "pristine" mountains to agriculturally-managed lowlands, span gradients in land use, geology, and climatic conditions. We hypothesized that land use type is the main control on stream nitrate concentrations and catchment export behaviour, with more chemostatic export behaviour occurring in catchments with higher percentages of agricultural land use due to the presence of large nitrate stocks that effectively function as an unlimited nitrate storage. Consistent with this hypothesis we found that median nitrate concentrations were positively correlated with the percentage of agricultural land use in the different catchments despite differences in catchment climatic and geological conditions. Magnitude and direction of concentration-discharge relationship was evaluated using the slope b of the linear regression of log nitrate concentrations vs. log discharge as a metric for export behaviour. All catchments exhibited a positive slope b indicating concentrations increase with increasing discharge. The slope b was positively correlated with the percentage of agricultural land being artificially drained, which suggested that a higher share of drained agricultural land within the catchments results in a more dynamic export behaviour. Thus, a high percentage of agricultural land use, and subsequent higher nitrate input and storage, does not necessarily lead to chemostatic export conditions. While median concentrations were a function of agricultural land use, concentration dynamics and export behaviour were controlled by the presence of artificial drainage as the dominant input pathway of nitrate to surface waters. These results illustrate that it is feasible to use a multi-catchment top-down analysis to evaluate both dominant controls of nutrient export and the importance of land management on nutrient dynamics in the receiving surface waters.

Abstract number 93 - TILE DRAINAGE MONITORING – A COMPLEMENTARY TOOL TO ASSESS AGRICULTURAL MEASURES AIMING TO REDUCE NITRATE EMISSIONS TO SURFACE AND GROUNDWATER?

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In a pilot project funded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management we investigated if and how tile drainage monitoring could complement existing monitoring networks in order to assess the effectiveness of agricultural measures that aim to reduce nitrate emissions to surface and groundwater.
Regular reporting about the nitrate situation on national level is based on status and trend analyses of data from Austria's surface and groundwater monitoring. However, in groundwater, due to considerable mean residence times, the effectiveness of measures can only be assessed with a certain delay in time. In surface waters, mixing processes might mask the effects of implemented measures. Tile drains on the other hand act like preferential flow paths accelerating the transport of nutrients and other agrochemicals

through the hydrological system potentially enabling a more immediate assessment of the effectiveness of measures.
Based on our investigations at three Austrian test sites we concluded that in certain areas - characterized by intensive farming, wet soil conditions and the exceedance of nitrogen threshold values at monitoring sites - tile drainage monitoring can improve the evaluation of agricultural measures applied.
Such a monitoring needs to address area-specific nitrogen loads based on continuous, multiannual measurements. For a meaningful interpretation additional information on fertilizer application, crop rotation and weather conditions need to be collected with sufficient temporal resolution.
We provide evidence that regular random sampling as it is often conducted to reduce costs, severely over- or underestimates actual loads since peak nitrogen loads are coupled to runoff events. Based on such an approach comparison of the impact of different measures or agricultural crops on nitrogen loads would be difficult.
We show that focused on management-and weather-specific periods characterized by substantial nutrient loads in seepage water, tile drainage monitoring with sufficient temporal resolution is a useful tool to evaluate the effectiveness of measures on nitrate emissions to surface and groundwater. Based on results achieved, we developed recommendations for an adapted drainage monitoring strategy in Austria.

Abstract number 94 - MODEL PARAMETER UNCERTAINTY ANALYSIS FOR AN ANNUAL FIELD-SCALE P LOSS MODEL

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Phosphorous (P) loss models are important tools for developing and evaluating conservation practices aimed at reducing P losses from agricultural fields. All P loss models, however, have an inherent amount of uncertainty associated with them. In this study, we conducted an uncertainty analysis with the Annual P Loss Estimator (APLE) model, an empirically-based spreadsheet model developed to describe annual, field-scale P loss when surface runoff is the dominant P loss pathway. We first estimated and evaluated model parameter uncertainties associated with five internal regression equations used by APLE to calculate total soil P from measurements of soil clay content, organic matter, and labile P; the P enrichment ratio determined from erosion rates; concentration of P in runoff calculated from labile soil P; and partitioning of P between runoff and infiltration for applied manures and fertilizers based on runoff ratio. Our analysis included calculating parameter uncertainties and 95% confidence and prediction intervals for five internal regression equations in APLE. We then predicted P loss while including uncertainties in both model parameters and model inputs and compared the relative magnitude of these sources of uncertainty to the overall uncertainty associated with predictions of P loss. Good correlations between predicted and observed data were found, though a significant amount of observed variability was not captured by the equations. This resulted in uncertainties in predicted P loss ranging from 5 to 50 %. Results from this study highlight the importance of including reasonable estimates of model parameter uncertainties when using models to predict P loss. Our results also demonstrate how the estimation of model parameter uncertainty can identify model limitations.

Abstract number 95 - MODELLING SCENARIOS IN ARCNEMO IN PREPARATION FOR EUROPEAN LEGISLATION: A POLICY PERSPECTIVE

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In order to substantiate the agricultural measures for the Nitrate Directive action programs and WFD river basin management plans on a regional scale, the Flemish Environment Agency initiated a project at the end of 2011 to develop a new spatially distributed mechanistic nutrient emission model for the Flemish region in Belgium. The requirements for the model were that the model needed to be able to calculate the water, N- and P-balance of the soil for the agricultural, as well as the water flow and transport of N and P to the surface water land in Flanders. The model had to be based on the available data in Flanders about the parcels, farms, soils, climate, … for the whole region. The model had to be designed in a way that it allowed the government to calculate a broad range of measures and scenario's , including long term effects on surface water inputs. In 2014, a first release of the model named ArcNEMO was available.
In preparation of river basin management plans 2016 to 2021 and the actualization of the Nitrate Directive action program for Flanders, different scenarios were set up to be run with ArcNEMO for the period 2010 to 2031. The different scenarios are classified in 3 types:
- Variation in the quantity of applied fertilization (fertilization standards)
- Variation in fertilization types and practices (animal manure vs chemical fertilizer, time of fertilization)
- Variation in agriculture practices (eg. buffer strips, catch crops, …)
The project will be finalized in the first semester of 2015. An overview of scenarios will be given and insight about how scientists, model developers and policy makers have come to a final set of scenarios. The ArcNEMO results for the relevant scenarios will be presented and explanation will be given about how the results were accepted and interpreted by the involved scientists and policy makers. The process will be evaluated, leading to recommendations to use modelling for future policy development.

Abstract number 96 - SOURCE FILE APPROACH FOR THE PROTECTION OF FLEMISH GROUNDWATER RESERVES FOR DRINKING WATER SUPPLY

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Water safety planning is an essential instrument developed by the drinking water supply sector in co-operation with the Flemish authorities for guaranteeing the future production of sufficient drinking water of qualitative good status. In the scope of the production chain – from source to tap - source protection is an essential first step, for example, leading to minimization of cost-intensive water purification systems. Source protection means identification of possible hazards followed by risk assessment and risk management by control measures. Drinking water abstraction site specific source files are implemented. These source files form the missing link between the European Drinking Water Directive and the European Water Framework Directive objectives. Source files will help defining measures to be taken in function of the art. 7-implementation (WFD). Concerning groundwater, a new definition and delineation of safe guard zones is necessary, contrary to existing protection zone concepts. Until now Flanders works with the classical three zone system for groundwater, the so-called type I protection zone, directly around the abstraction well (24 hours travel time), the type II bacteriological zone (60 days travel time – max. 300m for phreatic aquifers) and the type III chemical zone (max. 2km distance for phreatic aquifers). Some specific measures are already implemented in these zones, for example the restricted use of pesticides or the prohibition of direct discharge to groundwater. However, despite of taken measures, monitoring of raw water at some vulnerable sites shows the frequent occurrence of pollutants that have to be removed or diluted to reach acceptable quality levels for drinking water. There is need for a good definition of capture zones, a profound risk assessment in relation to the activities inside these zones and, in a further step, the definition and implementation of measures/actions to be taken to protect groundwater reserves on short- and long-term. To paint a picture of the importance of groundwater-related source files, around 50% of produced Flemish drinking water is derived from groundwater resources. Groundwater abstraction for public drinking water production takes place at 126 sites situated in 23 of 42 Flemish groundwater bodies. Main focus is given to around 60 production sites in vulnerable phreatic aquifer systems, due to possible ‘short-term’ effects. Capture zones have been delineated by particle-back-tracking-modelling including travel time distribution up to the water shed. All available and necessary information on DSPIR is collected, e.g. historical, present day and future land use, diffuse and point pollution sources etcetera…

Abstract number 97 - FLORIDA-FRIENDLY LANDSCAPING: A GRASS-ROOTS WATER QUALITY PROGRAM

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A landscaping-based water quality and conservation program run by the state of Florida is described. Florida's sunny, subtropical climate, with mild winters, help make it an attractive place to live within the United States. Despite Florida's abundant rainfall (1372 mm statewide annual average), which supplies water to myriad lakes, rivers, and groundwater aquifers, the current population of 20 million residents within 7.1 million households greatly taxes available water resources and pollutes both surface and ground waters. To address these challenges, which will become even more acute as its population grows to nearly 26 million over the next 25 years, the state of Florida has enacted a statewide water conservation and protection program called Florida-Friendly Landscaping™ (FFL). FFL is administered by the University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) with state and federal funding provided by the Florida Department of Environmental Protection and the US Environmental Protection Agency. FFL provides educational outreach and tools for using Best Management Practices (BMPs) for use by both residential homeowners and commercial landscape workers to create and maintain quality landscapes through appropriate landscape design while reducing nonpoint source pollution through reduced water, fertilizer and pesticide use. The FFL program is implemented through a statewide network of Extension agents affiliated with the University of Florida, who also coordinate an extensive volunteer network of over 4000 citizen Master Gardeners; and through cooperative arrangements with the landscaping industry, which employs thousands of workers who are trained through the Green Industries Best Management Practices (GI-BMP) program. Florida state legislation passed in 2009 found that FFL serves a compelling public interest in water conservation, protection, and restoration, that participation by homeowners associations and local governments is essential, and that deed restrictions or local ordinances may not prohibit FFL use by homeowners. Additional FFL legislation requires GI-BMP training for all landscape workers who apply fertilizer commercially, with subsequent licensing by the Florida Department of Agriculture. The GI-BMPs provide proper fertilizer and pesticide methods, as well as proper irrigation design and maintenance. To date, the UF/IFAS FFL program has trained over 33,000 landscaping workers in the GI-BMPs. Recent estimates for just a small part of Florida have credited the FFL program with reducing annual nitrogen loading to surface waters by over 28,100 kg, which equates to nearly $30 million that would be required to implement structural or operational pollution prevention measures such as stormwater ponds or street sweeping.

Abstract number 98 - TOWARDS EFFECTIVE LEGISLATION TO MITIGATE THE IMPACT OF SOIL P ON WATERBODIES IN NW EUROPEAN AGRICULTURE

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Phosphorus (P) is considered the main limiting nutrient for algal growth in freshwater systems (Correll, 1998). Many waterbodies in North West Europe exceed the environmental P thresholds required for good ecological status (EEA, 2015). Agriculture is considered one of the major sources of P enrichment but the diffuse agricultural P losses can be difficult to tackle. In contrast to nitrogen (N), there is no European P directive, or other specific overarching P regulation for agriculture in the EU. Several EU Member States seek to address agricultural P losses by national or regional legislation, but this P legislation differs widely between countries and regions (Amery & Schoumans, 2014). Even in NW Europe, where widespread high soil P contents provide strong justification for P regulation, legislation varies from no direct regulation to strict maximum P application rates. Current regulations focus largely on mitigating current P losses, limiting field P application rates of chemical fertiliser and/or manure to reduce direct P losses and further soil P build-up. However, legacy soil P, hydrology, transfer pathways and connectivity are equally or more important factors affecting P loss, but these are seldom considered in P legislation.
Information regarding the development of P legislation and current regulations were gathered for six NW European countries and regions: Flanders (Belgium), The Netherlands, Northern Ireland (UK), England & Wales (UK), Denmark and the Republic of Ireland. The legislative P controls adopted in the six case-studies are considered in relation to the relative importance apportioned to current P pressures, legacy soil P levels and hydrological factors influencing diffuse P transfers. For example, in some countries maximum P application rates have been regulated according to the amount of legacy P already present in the soil. Approaches are discussed for integrating legacy soil P, hydrology, transfer pathways and connectivity into legislation in order to effectively reduce soil P losses.
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Abstract number 99 - MANAGING METALDEHYDE IN THE RIVER WID – IMPROVING WATER QUALITY THROUGH VOLUNTARY CHANGES TO SLUG CONTROL PRACTICES

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Slug control, to safeguard crops in order to achieve maximum yield, is an important consideration for farmers. Slug pellets containing metaldehyde as the active ingredient have the largest market share in the UK. However, metaldehyde is very soluble in water, difficult to remove through the drinking water treatment process and its largely autumn-based application, on a widespread area of wheat and oilseed

rape, has resulted in English water companies recording failures above the 0.1µg/l EU Drinking Water Standard.
Essex & Suffolk Water set up the Managing Metaldehyde in the Wid Initiative to engage with farmers and their advisors in a small catchment on the specific issue of slug control. The aim was to evaluate the effectiveness of subsequent voluntary changes in practice employed by farmers in the River Wid catchment and to see whether metaldehyde concentrations below 0.1µg/l could be achieved in catchment watercourses during the autumn of 2014.
Before harvest 2014, the Initiative engaged with 70 of the 101 holdings over 20ha, covering 83% of the catchment area. Discussions with farmers covered the issue of metaldehyde in water and the practical cultural and chemical control methods that the farmers and their agronomists could employ over the autumn in order to improve water quality.
Farmer feedback survey results in January 2015, revealed many farmers had changed their slug control practices as a result of the Initiative, including: employing widespread seedbed consolidation; operator training and machinery calibration; no longer incorporating slug pellets with oilseed rape seed at drilling and switching to use either a 1.5% metaldehyde or ferric phosphate based pellet.
Water quality data showed these changes did reduce metaldehyde concentrations in the Wid catchment. An average 79% improvement, compared to a control catchment, was seen during the early part of the season (2nd September – 7th October). Overall the metaldehyde concentrations in the River Wid at Writtle during autumn 2014 were comparable to the 'dry autumn' of 2010, while rainfall and soil conditions were more akin to the 'wet' autumn of 2012, illustrating the water quality improvements arising from the Initiative. Metaldehyde concentrations did exceed 0.1µg/l, immediately following heavy rainfall events, but levels had fallen below 0.1µg/l by 1st December at the catchment outlet.
The Initiative shows that awareness and adoption of good agricultural and agronomic practice has the potential to deliver a measurable reduction in metaldehyde concentrations, and contribute to achieving compliance with the 0.1µg/l EU Drinking Water Standard.

Abstract number 101 - SELECTING AND TARGETING BEST MANAGEMENT PRACTICES FOR MULTIPLE POLLUTANTS IN A DRINKING WATER SUPPLY CATCHMENT USING THE CaRPoW MODELLING FRAMEWORK

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Water companies are increasingly adopting catchment management as an approach to improve raw drinking water quality. Yet the heterogeneity present in large drinking water supply catchments and the range of pollutants that must be addressed makes it difficult for companies to select and spatially target interventions. Due to this there is a need for methodologies that assess key multiple pollutant risk processes within a generic framework.
The CaRPoW (Catchment Risk to Potable Water) framework has been developed to disaggregate and compare multiple pollutant risks in drinking water supply catchments. The framework breaks down pollutant risk according to the principles of the Source-Mobilisation-Delivery continuum (e.g. Haygarth et al., 2005). This allows for the key components of risk to be determined and compared for multiple pollutants so that interventions are suitably selected.

Spatial modelling methodologies at a field scale resolution were developed for application within the CaRPoW framework for pesticides, nitrogen, phosphorus and suspended sediment. Methods were applied to the River Ugie, a 335 km2drinking water supply catchment for the town of Peterhead in the North East of Scotland. Results were compared against annual pollutant loading data derived from a spatial monitoring programme within the catchment.
Annual catchment loads predicted by the models compared well to the observed loads within the uncertainty ranges for most pollutants. Linear regression analysis highlighted significant ($p < 0.05$) spatial relationships between aggregated model risk at the sub-catchment scale and observed loading data for approximately half of the pollutants modelled. Where spatial risk was not well correlated it is likely that input data resolution were not high enough to determine spatial risk e.g. information on the application of spot applied pesticides. Spearman's rank correlation showed significant spatial relationships ($p < 0.05$) between the risk outputs of some pollutants (e.g. the pesticides Chlorotoluron and Metaldehyde, Phosphorus and Suspended Sediment) which outlines the potential for multiple benefits from intervention implementation.
Overall the approach has given Scottish Water (the water supply company) a better insight into the spatial diversity of multiple pollutants risks in their catchment. This has allowed them to focus efforts and investment when land owners apply to the company for funding for water quality improvement interventions.
Haygarth, P. M., Condron, L. M., Heathwaite, a L., Turner, B. L., and Harris, G. P. (2005). The phosphorus transfer continuum: linking source to impact with an interdisciplinary and multi-scaled approach. The Science of the total environment, 344(1-3), 5–14.

Abstract number 102 - MODELLING THE EFFECT OF CLIMATE, LAND USE AND LAND MANAGEMENT CHANGES ON WATER QUALITY IN A HEADWATER AGRICULTURAL CATCHMENT

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There is considerable demand for governments to meet national-level water quality targets for surface waters, in order to comply with the European Water Framework Directive. Diffuse water pollution from agriculture is one of the contributing pressures, with sediment, phosphorus (P) and nitrogen (N) presenting key stresses. Modelling nutrient transfers in agricultural catchments involves many

uncertainties, including understanding the P biogeochemistry, which may alter when climate, land use or land management changes take place. There are many drivers for land use and land management change, including economics, policy and climate change. This study investigates the effect of climate change, land use and land management change scenarios on the water quality in a small headwater agricultural catchment.
The Soil and Water Assessment Tool (SWAT) is a process-based semi-distributed water quality model. It was used in this study to model daily nutrient loads in the Morland catchment (12.5 km2), a sub-catchment of the Eden basin, Cumbria, UK. At present, the catchment is predominantly under improved grassland, with a small area of arable land and some woodland. High temporal resolution data (30 minute) of rainfall, flow, sediment and P concentration at the outlet of the catchment have been used to calibrate the model for the hydrological year 2011/12, and test it for the hydrological year 2012/13. Land use and land management changes were then included in the model. The changes were based on land use and land management scenarios for the 2050s under climate change, determined by expert elicitation. The model was run using both present day driving conditions (present climate) and future driving conditions (climate change scenarios). Observed nutrient loads at the catchment outlet were 1650 – 1850 kg yr-1 (1.3 – 1.5 kg ha-1 yr-1). Under present day climate conditions, the tested land use and land management scenarios indicated increased P transfers, with P loads heavily dominated by large rainfall events. This indicates the important contribution of land use and land management in understanding and mitigating nutrient transfers from agriculture in the future, and hence their effect on water quality at the catchment scale.

Abstract number 104 - ORGANIZING THE INFORMATION FOR THE MANAGEMENT OF PROTECTED AREAS AT EMBEDDED SCALES: AN APPROACH BY SCENARIO USING DATA WAREHOUSING

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The preservation of water resources is of major concern in the Charente river basin, SW France. To help the local managers to reconquer a good biological status for water resources and to preserve a quality of the resource suitable for drinking water supply, we developed a method of assessing the environmental impact of alternative scenarios of agricultural practices. This integrated assessment combines typologies of agricultural systems on the area, the calculation of environmental indicators, an integrated modeling using an agro-hydrological model (SWAT) and an economical one in order to assess the cost-effectiveness of some spatialised scenarios. This method is applied to a protected area, the AAC Coulonge St Hippolyte (360 000 ha). In this context, the data warehousing is used to create decision-making tools and to evaluate the potential impacts of the evolution of agriculture on the area. The goal is that people in charge of public policies could take more informed decisions when managing sensitive areas or implementing mitigation measures.
Different methods of clustering and spatial analysis, combined to surveys among farmers and experts are used to define a relevant typology of agricultural systems, using a specific approach by type of soil and rotations. Some alternative scenarios for agriculture changes are built using expertise and discussion with stakeholders. The effectiveness of mitigation measures on the reduction of pesticides transfers to freshwaters is assessed when applied on the whole area or within sub-basins. The scenarios can be combined and applied on a range of selected sub-basins or in sensitive areas. However, this approach

requires an effective information system that can process for each scenario all the relevant information at embedded scales: the scale of the sub-basins for action by farmers and the scale of the whole area for public decision making.
To this end, an environmental information system is created using spatial data warehouse technology. This system allowed qualifying agricultural activities, depending on each scenario, along with river basin characteristics and the indicators resulting of the assessment: values of the environmental indicators, fluxes and costs estimated by the two models. The axes of analysis allowed providing results at different levels of integration, for several dimensions e.g. time, spatial scales or pesticide type, leading to a clearer understanding of the impact of mitigation measures. Various hypotheses can be tested, helping decision-makers respond to special requests from stakeholders.

Abstract number 105 - ACTION PLANS AGAINST NON-POINT SOURCE POLLUTION FOR THE PROTECTION OF DRINKING WATER CATCHMENT AREAS

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Pesticides, nitrates… These chemical products spread on lands are able to migrate deeply and to degrade on a long time groundwater, which is widely used in France for drinking water. Among the objectives of the Ministry of Ecology, 1000 priority catchments for water production (including 500 catchments called “Grenelle catchments”) are expected to have action plans against non-point source pollution. To this end, different tools were developed by BRGM in partnership with ONEMA for catchment area delineation and vulnerability mapping and for analysis of mitigation measures efficiency on water quality.
The efficiency of actions plans against non-point source pollution to improve the water quality of a groundwater catchment area is hard to assess. Indeed, physical and chemical processes involved in nitrates and pesticides migration are complex in heterogeneous environmental compartments (soil, unsaturated zone, saturated zone). In addition, inputs and rainfall change each year and impact the flow of pollutants into the soil and groundwater.
The first part of the study consisted in making an inventory of mitigation measures and monitoring indicators of these actions. From case studies, we identified the required parameters to assess the efficiency of action plans. We observed that the effects of action plans on water quality for nitrates vary widely as each case study is specific. It can be explained either by the system response time or by the action plan itself. For pesticides, for most of the case studies, action plans are limited to agroenvironmental measures, and the available data did not enable to really evaluate their effect on water quality.
This work is a good illustration of the difficulty of implementing efficient action plans and evaluating them (complexity of processes, lack of data, lack of actions follow-up) but it also shows that mitigation measures which are adapted and implemented over the long term can have a real effect on quality of catchment for drinking water production. So, some examples will be discussed, in particular from Eau de Paris. The city of Paris is supplied by groundwater at 50% and the water quality of springs used is monitored since more than a century. A focus on the first results of action plans on the water quality will be made.

Abstract number 106 - TERRESTRIAL SOURCES OF UREA TO WATER IN A MIXED LAND USE WATERSHED: IMPLICATIONS FOR NITROGEN MANAGEMENT

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A global increase in the use of urea-based commercial fertilizers and manures has been implicated in increasing occurrence and toxicity of harmful algal blooms. In this study, we sought to identify urea sources and characterize fate and transport processes that control urea concentrations in surface water and ground water systems of a mixed land use watershed that flows to the Chesapeake Bay in Maryland, USA. Laboratory, plot and field studies showed that loss of surface applied urea via runoff that was observed in this study is far less than the 3–5% loss that is commonly reported in the literature. Watershed monitoring of streams and agricultural drainage ditches revealed higher concentrations of urea originating from agricultural areas during storm flow conditions, but urea concentrations in streams were generally higher in summer months than spring when urea is surface applied. The chemograph for urea in an agricultural drainage ditch during a major summer storm event showed an initial flush of urea during the beginning of the event, lower concentrations later during the event, and rising urea concentrations in stagnant water in the ditch following the return to pre-storm conditions. Field monitoring data and the results from mesocosm studies confirm that urea forms in saturated sediments within 8-hours of inundation, and the highest concentrations occur in organic-rich, agricultural ditch sediments. The cumulative evidence from this study supports the hypothesis that in situ production of urea forming as a result of microbial reactions in wetlands and in stagnant water in open drainage ditches is a potential major source of urea loads to coastal waters at the mouth of this mixed land use watershed. Globally, agriculture's contribution to increased occurrence and toxicity of algal blooms resulting from increased urea concentrations in coastal waters may derive from the general increase in total nitrogen use that supports in situ production, not the increased adoption of urea forms of nitrogen fertilizer. Policies that restrict the use of urea-based fertilizers and manures would not affect autochthonous sources of urea and would do little to reduce urea loadings that result in harmful algal blooms at the mouth of this watershed. Instead, improved nitrogen use efficiency and ditch management to reduce the occurrence of stagnant surface water appears to be a better strategy for reducing urea loading to coastal waters.

Abstract number 110 - MODELLING LONG TERM MITIGATION MEASURE SCENARIOS FOR ASSESSING IMPACTS OF NON-POINT SOURCE POLLUTION: APPLICATION ON TWO SURFACE SOURCE WATER PROTECTION AREAS, COULONGE AND SAINT HIPPOLYTE (FRANCE)

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Non-point source pollution from agricultural practices and urban uses is of serious concern within the agricultural areas of the Poitou-Charentes region, in the southwestern part of France. During the past decade, numbers of catchments dedicated to supply drinking water have been closed down. Since the water demand skyrockets during the touristic summer season that is the very same period of low flows, most of the Charente river main streams and tributaries are running dry or face very low water flows. In addition pesticide and nitrate measures show abnormal peak concentrations above the European drinking water standards.
In response to this situation, the regional Adour Garonne Water Agency has set up a collaborative programme with local water and agricultural stakeholders, and researchers in order to design environmental friendly agricultural mitigation measures and assess their impacts on the surface and ground water quality so that to maintain drinking water within standards.

In an integrated modelling approach, the agro-hydrological physically based model, Soil and Water Assessment Tool (SWAT), coupled with an application named GenLU2, developed at Irstea Bordeaux, has been implemented to simulate long term impacts of pesticides on soils and water bodies. The scenarios with measures include Best Management Practices such as pesticide/fertilization reductions, filter strips, pesticide or crop substitutions, lengthening of crop system rotations. These practices and cropping system changes are implemented into the model with GenLU2.

Assessment of impacts by the SWAT model is carried out at the watershed level, a relevant scale, recognized as the most effective unit for managing protection of water resources. The modeling approach enables to identify the most contributive areas amongst the 106 sub watersheds constituting the protected area of circa 4,000 km², where best management practices could be the most efficient, in terms of decreasing the amount of nitrate and pesticide concentrations in streams. The effects of mitigation scenarios are quantified relatively to the baseline scenario that is representative of the actual agricultural practices and urban uses.

Abstract number 116 - ASSESSMENT OF THE FIFTH NITRATE ACTION PROGRAMME ON THE USE OF ANIMAL MANURE AND THE WATER QUALITY

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The Netherlands' fertiliser policy is aimed at not exceeding the national phosphate limit and at reducing leaching of nitrate groundwater and transport of nutrients to surface waters to satisfy water quality

objectives. Under Article 5 (7) of the Nitrates Directive, Member States must review and if necessary revise their action programme at least every four years. The evaluation of the River Basin Management Plans for the purpose of the Water Framework Directive requires information about the potential and actual reductions, as a result of the fertilizer policy, of the nutrient emissions to surface waters.
The permissible fertilization rates of the fifth Action Programme (NAP) were imposed to the MAMBO model which computed annual application amounts of mineral fertilizers and animal manures to the soil. These results were used as an input to the STONE model to predict nitrate concentrations and nitrogen and phosphorus loads on surface waters. The effects of the 5th NAP (period 2014-2017) on the manure application rates and on water quality is compared to the effects of the restrictions of the 4th NAP (period 2009-2013).
The most important changes in the legislation of the 5th NAP are at sandy soils: 1) a reduction of the derogation from 250 to 230 kg ha-1 nitrogen for dairy farms in the southern and eastern regions; 2) a 20% reduction of nitrogen application standards for green maize and most arable crops; 3) a higher nitrogen equivalency value of pig manure. For grassland on marine clay soils the nitrogen application standards was increased by 35 kg ha-1. The MAMBO model computed as a result of tightening of the legislation a decline of 5 – 20 kg ha-1 of the nitrogen application rates on sandy soils. The effects of the tightening of standards are weakened by the substitution of pig slurry by cattle manure which has a higher leaching potential.
After a long period of maintaining the fertilisation rates of the 5th NAP, the average nitrate concentration in the sandy areas is expected to amount ca. 50 mg L-1, although the nitrate target level will not been achieved in the southern region. The tightening of the application standards for sandy soils results to a reduction of less than 3 mg L-1 national level. A slight improvement of the surface water quality as a consequence of the tightening of application standards is predicted. For the marine clay areas a slight deterioration is expected.

Abstract number 117 - DYNAMICS OF FAECAL POLLUTION INDICATORS IN SURFACE WATER DRAINING AN AGRICULTURAL CATCHMENT

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Anthropogenic land use causes a substantial part of faecal pollution input to catchments and river basins. The water quality of discharging- and consequently receiving-streams of agricultural used catchments may be heavily affected by the load of pathogenic microorganisms, caused by spreading of e.g. slurry. Particularly relating to point sources and diffuse pollution from agricultural areas the near-real time detection of fecal pollution in surface waters has high potential for use-orientated protection of water resources. On-site detection of enzymatic activities has been suggested as a rapid surrogate for microbial pollution monitoring of water resources (e.g. using enzymes like glucuronidases (GLUC), galactosidases, esterases). Due to the possible hourly measurement intervals, enzymatic methods have high potential as near-real time water quality monitoring tools.
This presentation describes results from a long termed field test of rapid on-site determination of enzymatic activity (GLUC) in stream water. For twelve months, two ColiMinder devices (Vienna Water Monitoring, Austria) for on-site determination of enzymatic activity were tested for stream water monitoring at the experimental catchment HOAL (Hydrological Open Air Laboratory, Center for Water Resource Systems, Vienna University of Technology). The devices were overall able to follow and reflect the diverse hydrological and microbiological conditions of the monitored stream during the test period. Continuous data in high temporal resolution captured the course of enzymatic activity in stream water during diverse rainfall events. The method also proofed sensitive enough to determine diurnal fluctuations of enzymatic activity in stream water during dry periods. The method was able to capture a seasonal trend of enzymatic activity in stream water that matches the results gained from Colilert18 and ISO 16649-1 (TBX-Agar) analysis for E. coli and coliform bacteria of monthly grab samples. Furthermore the comparison of ColiMinder data with measurements gained at the same test site with devices using the same method but having different construction design (BACTcontrol, microLAN) showed consistent measuring results.
It can be concluded that rapid on-site detection of enzymatic activity is applicable for surface water monitoring. The tested devices provide a complementary on-site monitoring parameter with high potential. Rapid on-site GLUC measurements determined dynamics of potential faecal pollution of stream water in diverse temporal scales. Continuing investigations will differentiate the influence of hydrological catchment conditions and land management procedures (e.g. slurry application, plowing) on these dynamics.

Abstract number 118 - LYSIMETER SITE WAGNA: COMPARATIVE ASSESSMENT BETWEEN CONVENTIONAL AND ORGANIC FARMING REGARDING WATER BALANCE, NITRATE LEACHING, CROP YIELD AND ECONOMIC PROFIT

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The agricultural test site Wagna consists of 32 test plots (1.000 m² each) and is located approximately 30 km south of Graz, Austria. Since 2005 conventional and organic farming are being applied, i.e., half of the plots are cultivated conventionally (mean nitrogen rate of 118 kg/ha/a applied according to "Richtlinien für die Sachgerechte Düngung"; nitrogen losses due to volatilization deducted) and half of them organically. The two crop rotations consisting of maize-triticale-maize-oil pumpkin are cultivated with varying starting crops each year and four repetitions. Two of the plots (one of each cultivation strategy) have also been equipped with high precision lysimeters (1 m² surface, 2 m depth) to measure seepage water and nutrient leaching towards groundwater. The lysimeters are weighable with a tension-controlled lower boundary condition and can be cultivated with standard machinery (e.g., tractor and plough).
The lysimeter measurements at Wagna test site show that both cultivation strategies lead to nitrate concentrations in the seepage water which are generally below the groundwater nitrate threshold of 50 mg/l established by the EU Groundwater Directive. While the mean seepage water rates of approximately 360 mm/a are similar for both cultivation strategies, the nitrate concentrations in the seepage water are different. The conventional cultivation strategy results in a lower mean annual nitrate concentration of 26 mg/l in the seepage water than the organic farming strategy with 40 mg/l on average. Although the organic farming strategy in Wagna applies only 50 kg/ha/a nitrogen within an eight year period (i.e., approx. 6 kg/ha/a nitrogen on average), the typical cultivation of legumes between cash crops leads to high nitrate leaching rates under certain conditions (e.g., in the years 2009 and 2013). Crop yields from organic farming are on average 17% lower for maize, 21% lower for oil pumpkin and 49% lower for triticale compared to conventional farming. In contrast to the yields, the present study shows that for the location of the test site Wagna, Austria, the economic profit of the organic farming strategy is generally higher than for conventional farming. However, results are strongly dependent on the market prices, which may vary significantly from year to year.

Abstract number 121 - HOW CAN WE ENHANCE THE ECOSYSTEM SERVICES PROVIDED BY BUFFER STRIPS?

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The Danish Parliament adopted in June 2012 a Buffer Strip Act that required 10 m mandatory buffer strips (BSs) to be established along all watercourses and lakes with a surface area greater than 100 m2 from 1st September 2012. The main reasons for deploying the 50,000 ha of BSs was to reduce nitrate-N leaching and phosphorus (P) loss via surface runoff to surface waters as no farming activities were allowed in the BS concerning use of fertilizer, spreading of manure, spraying with pesticides, etc. It was, however, questioned if BSs can also reduce N losses. The international literature gives an overwhelming support to their functioning for reduction in sediment and especially particulate P losses. However, their functioning for dissolved P and nitrogen is more questionable when comparing studies from the international literature. In Denmark, many farmers were against the introduction of BSs as a general mitigation measure for several reasons. The most used argument in the public debate was that BSs in general are not very efficient for reducing N and P losses to surface waters which was originally the argument behind the BS Act from the Ministries of Environment and Food and Agriculture. A desk study had been made prior to the adaptation of the law that showed 10 m BSs to be able to reduce the N loading with 40-50 kg N ha-1 of BS and 0.04-0.4 kg P ha-1 BS. The total reduction from the BSs established in Denmark in 2012 would then amount to 2,000-2,500 tonnes N and 2-20 tonnes P. The intense public debate in Denmark made the Parliament to adopt a new BS law in June 2014 to be implemented in August 2014 that reduced the total areas with mandatory BSs along watercourses from ca. 50,000 ha to ca. 25,000 ha and at the same time they reduced the width of the mandatory BSs from 10 m to 9 m. The aim of this presentation is to share the experience gained in Denmark on establishing mandatory BSs. Furthermore, we will show some preliminary results from two newly initiated research projects that studies how to enhance the ecosystem services provided by buffer strips.

Abstract number 122 - USING A CLIMATE FORECAST SYSTEM TO REDUCE DISSOLVED INORGANIC NITROGEN RUNOFF TO THE GREAT BARRIER REEF

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Dissolved inorganic nitrogen (DIN) in runoff from sugarcane farms has been highlighted as posing a significant risk to the long term sustainability of the Great Barrier Reef (GBR). To investigate the impact of sugarcane nitrogen fertiliser management practices on runoff DIN loads we develop a daily model of runoff DIN concentration based on the equivalent of 25 individual years of field experimental runoff data in the GBR. Runoff DIN concentrations were related to nitrogen fertiliser application rates and decreased after application as a result of time and rainfall. Fertiliser form (granular / liquid) also affected the DIN runoff concentrations and hence two DIN concentration models were developed.
The granular DIN concentration model was tested against an independent field dataset and was found to provide reasonable estimates of runoff DIN concentrations based on a number of modelling efficiency score results.
These simple models of runoff DIN concentrations were combined with a calibrated daily water balance cropping model (HowLeaky) to investigate temporal aspects of sugarcane fertiliser management. The simulation study found that timing of fertiliser application was less important at lower rates of fertiliser application (85 kg N /ha) than conventional fertiliser application rates (170 kg N /ha). Nitrogen fertiliser application in December (wet season) led to the greatest risk of high DIN loads in runoff, and this was further exacerbated in years with a climate forecast for wet conditions. The potential utility of a climate forecasting system such as SPOTA-1 to predict coming wet years and to improve fertiliser management decisions is demonstrated. Such a system could be used by land managers to reduce late season fertiliser application rates in high risk years when the cane yields, and therefore crop N requirements, can decline by up to 50%. It is predicted that the selection of fertiliser rates based on the forecast climate conditions would result in markedly reduced runoff DIN loads, with no impact on cane yields.

Abstract number 123 - EVALUATION OF MEASURES TO REDUCE GROUNDWATER NITRATE CONCENTRATIONS BY COUPLED REGIONAL GROUNDWATER MODELLING

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For many European countries nitrate leaching from the soil zone into the aquifer represents the most important threat to groundwater quality. This is a non-point source pollution situation and measures to safeguard drinking water supply from shallow groundwater (i.e. change of agricultural production) have to be investigated at the regional scale.
In this context we sequentially couple the unsaturated seepage water movement and nitrogen fate model SIMWASER/STOTRASIM with the saturated groundwater flow and solute transport model FELOW to simulate groundwater nitrate concentrations. Due to the depth of the groundwater table and mainly coarse and sandy soil conditions there is no influence of groundwater on surface processes. To account

for the unknown regional distribution of crops grown and amount, timing and kind of fertilizers used a stochastic tool is developed that generates sequences of crop rotations derived from municipal statistical data.
Within this study the impact of 3 alternative scenarios of agricultural production on groundwater nitrate concentrations are investigated: (i) applying optimal crop specific fertilizer rates within the entire aquifer, (ii) replacing growing of crops in 10% of the agricultural area that shows the highest leaching of nitrate from the unsaturated zone by grassland and (iii) sowing winter hardy catch crops to minimize nitrate leaching from fallow land. These scenarios have been run at two different aquifers in Eastern Austria that show dissimilar soil and climatic conditions as well as crop patterns.
The results indicate that the impacts of the explored measures strongly vary in time and space. Reducing the area of crop production will only lead to a meaningful decrease of the groundwater nitrate concentrations if the fields that are simulated with grassland are clustered within the model domain. The highest impact can be achieved by using maximum crop specific fertilizer rates and this outcome is even reinforced by combining it with sowing winter hardy catch crops. Furthermore, for consistent evaluation of the measures the contribution of nitrate mass by lateral groundwater flow and by vertical groundwater recharge have to be distinguished at each aquifer location. In one of the examined aquifers overall drinking water supply would not be feasible without numerous gravel dredgings that act as nitrogen sinks.
The results nicely reveal that the coupled simulation of the temporal and spatial groundwater nitrate distributions based on reliably calibrated models is an unrivaled approach to provide scientific sound basics to resolve conflicting regional land use interests.

Abstract number 124 - AN EMISSION-BASED APPROACH FOR REGULATION OF NITROGEN LOSS FROM AGRICULTURAL LAND TO SURFACE WATERS

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In order to mitigate eutrophication problems in Danish costal waters, nitrogen loss from Danish agricultural lands to marine waterbodies has been reduced by 50% over the past thirty years. This has mainly been achieved by implementing nationwide regulations regarding agricultural nitrogen use and farming practices during this period. Because of substantial variability in geology, hydrology, and vulnerability to eutrophication, overregulation occurs in some catchments while nitrogen loadings fail to

reach environmental targets in others. This is not cost effective, and the cost effectiveness of nationwide regulation will be even poorer as further load reductions are implemented. Therefore, this study aims to develop concepts for an emission-based regulation of nitrogen loss from agricultural land to surface waters on the scale from individual farms to sub-catchments. The emission monitoring concepts are demonstrated in a pilot study in three catchments differing in geology and hydrological conditions. The overall aim is to develop a new regulatory system, where farmers are regulated based on their actual nitrogen emissions, rather setting a quota for their nitrogen application to their crops.
The project investigates three concepts for quantification of nitrogen emissions from single farms or sub-catchments. i) Measurements of soil mineral nitrogen content (N-min). In this concept, N-min in the autumn is used as a proxy for nitrogen leaching. The relation between autumn N-min and nitrogen leaching is established by measuring N-min on experimental plots, in which leaching is measured with ceramic suction cups. From the measured N-min and knowledge of the nitrogen reduction in the hydrological system, the nitrogen loading to surface waters can be estimated. ii) Measurements of nitrogen transport in tile drains. Monitoring wells have been established at the outlet of tile drain systems in two of the experimental catchments. In these catchments tile drains are a major conduit between fields and surface waters, and nitrogen loss from a single farm can thus be monitored by measuring the nitrogen flux through tile drains. Novel techniques for quantifying nitrogen transport in tile drains are also tested. iii) Measurements of nitrogen transport in streams. In all three catchments a network of hydrometric stations has been set up, subdividing the three catchments into several sub-catchments. Stream nitrogen transport is calculated from intensive measurements of stream discharge and stream nitrogen concentration. Hence, the nitrogen loss from agriculture to surface water can be estimated on the sub-catchment scale, which may involve only one or a few farms.

Abstract number 127 - A NEW MONITORING APPROACH IN STREAMS FOR DETECTION OF N EMISSIONS FROM AGRICULTURAL AREAS TO SURFACE WATERS

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In recent years large focus has been placed on exploring different mitigation measures that can assist in reducing the N emission from agricultural areas to surface waters. However, due to the spatial variability in landscape, geology and hydrology significant differences exist in the vulnerability of catchments to intense agricultural activities. Therefore, a significant challenge remains with designing and developing monitoring programs that can assist in accurately capturing both the temporal and the spatial dynamics in water flow and N concentrations in streams, ultimately assisting in giving accurate estimates of the N emissions from farms in sub-catchments. Therefore, the overall focus of this study is to i) develop a monitoring program for measuring water flow and N concentrations in streams draining three pilot test catchments covering a gradient in geology, soil types and hydrology and ii) test the monitoring program through a three-year period of intensive discharge and N concentration measurements in streams.
The design of the monitoring program has been based on already existing detailed streamflow discharge and N concentrations measured as part of the Danish National surveillance program. Based on these data and information about the catchment runoff characteristics a statistical analysis was conducted to evaluate the influence of both flow regime, number of direct discharge measurements, number of water

samples and different load estimation methods for calculation of daily N transport. Then, to test the monitoring concept, three hydrological different catchments in Denmark are studied during the period 2014-2017, each catchment being approximately 15 km2. In the three catchments, hydrometric stations have been established at the outlet of the drainage networks where continuous measurements are made of water stage. In addition, daily composite water samples and weekly grab samples are taken and weekly discharge measurements conducted. Furthermore, the three selected catchments are divided into five-six sub-catchments where weekly grab samples of stream water are taken and biweekly discharge measurements conducted for later calculation of daily flows. The water samples are analysed for different N forms, allowing quantification of the total N emissions from both the sub-catchments and the entire catchments. It is expected that the first results from the stream monitoring program can give an overall picture of the spatial and temporal variability of the N concentrations and loads within each catchment and between catchments and constitute a platform for evaluating the developed monitoring and source apportionment approach for detection of N emissions from agricultural areas.

Abstract number 136 - POLLUTION SOURCES APPORTIONMENT BY DISSOLVED PHOSPHORUS EMISSIONS: AN APPROPRIATE BENCHMARK OF THEIR CONTRIBUTION TO THE RESERVOIRS EUTROPHICATION

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Many sources of pollution in the reservoirs and lakes watershed may contribute to the eutrophication of water in varying degrees. About significance of phosphorus sources decides emitted forms of phosphorus mainly, but it also affects localization of sources in the watershed, seasonal intake, amount of retention elements between source and the reservoir etc. Characterization of each dissolved phosphorus (or BAP) emissions source allow to standardize the input of all source types and allow the simple modelling of the impact on the state of the target reservoir.
The paper presents the results of application of method of eutrophication potential assessment based on the emissions of dissolved phosphorus in the pilot basin of drinking water reservoir Stanovice and in a large basin of reservoir Nechranice located in the northwestern part of the Czech Republic, in the Ohre river basin district. The evaluation was based in application of static descriptive simulation model of water quality from VSTOOLS family developed by T. G. Masaryk Water Research Institute, Prague. The simulation model allow determining target phosphorus concentrations representing good potential in terms of Water Framework Directive (WFD) in the water reservoir and assess whether to reduce inputs of eutrophication effective phosphorus form in the watershed is necessary. In the next step, the model allow to simulate the effect of dissolved phosphorus emissions of various anthropogenic sources of phosphorus, including their transformation in the river network and finally compiles a list of hierarchized importance of individual sources. The last separate module enables to simulate the influence of appropriate types of measures to reduce phosphorus emissions and check their effectiveness. The results of simulations show that this simple model as a supporting tool for programme of measures under the Water Framework Directive can be used effectively.

Abstract number 139 - TARGETED REGULATION OF AGRICULTURAL N LOAD TO DANISH MARINE WATERS

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Nitrogen (N) loading from diffuse sources to Danish marine waters was reduced by 41% in the period 1990-2012 by a suite of general measures. However, further reduction could be required to reach the quality goals of the EU Water Framework Directive. The existing regulation requires a sub-optimal fertilization leading to yield reductions and low protein content of the crops. A more differentiated regulation could combine optimal fertilization on most fields with a low loss of nitrogen to marine recipients.
Two model prototypes was designed to environmentally differentiate the farm specific N-load and replace the current general measures, taking into account 1) targets of N-loading to marine recipients and 2) properties of the catchment regarding N-retention from the field to marine recipients.
The first model distributes part of the N-application quota evenly among farms in a catchment – the remaining part is differentially distributed depending on the N-leaching and N-retention properties of the soil of each farm. In this model, farmers can choose to increase their N-quota by implementing measures to reduce nitrogen leaching from arable land, i.e. establishing wetlands, using catch crops, reduction of fertilizer-N, etc. The second model distributes the allowed N load of the aquifer evenly between the farms. In this model farmers can meet the required maximum N load by use of measures and through best management practice. The two models were tested in a case study involving 30 farmers, representing different types of agriculture, from 3 different catchments with different N-loading targets and N-retention properties. Each farmer was asked to prepare plans for crop rotations and N-reducing measures for each of the models and for different levels of N-loading targets, optimizing economy and yield under the given circumstances.
Results show that 50-90% of the participating farmers will increase their economic income and be able to reduce or maintain current N load compared to the present-day regulation, while few farms experienced a significant economic loss. In order to meet the required N load or obtain higher N-quota, farmers generally placed N-reducing measures in areas with low N-retention, if possible on the farm in question. Especially measures as catch crops and early sowing of winter cereals were widely used, while wetland establishment was popular especially on drained areas in one of the catchments.
The consequences of differentiated N load regulation were found to be more pronounced with the second model compared to the first model.

Abstract number 141 - STUDY OF NITRATE TRANSFER IN THE UNSATURATED ZONE OF TWO AGRICULTURAL PLOTS (NORTHERN FRANCE)

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The impact of fertilization in water quality trough the unsaturated zone (i.e. soil and subsoil up to the groundwater) is always difficult to predict because several interrelated processes are occurring. These processes are not only linked to agriculture practices but also to climatic and geological environment. The forecasts are also made complex because these processes vary with time. Indeed, concentrations in the unsaturated zone and in groundwater are the result of the farming practices of several years or even more.
This study surveyed various plots in Picardy (North of France) on chalky substrate to better understand the impact of agricultural practices on the (possible) changes in water quality.
Surveys were conducted on an agricultural plots with a cultural marker (major change in farming practice). These surveys allowed establishing nitrogen profiles in soil at different depths. Studying these profiles, it is possible on the one hand, to evaluate the present stock of nitrate in the unsaturated zone, and on the other hand, to estimate the speed of transfer of these nitrates.
Soil profiles show that concentrations fluctuate in response to agricultural practices varying over the years and also in response to rainfalls. For the study plots, nitrate inputs to soil are less important today than in the past. However, they remain higher than those observed in the plot without fertilization used as a reference.
Thanks to the data provided by the farmer, values of nitrogen fertilization have been used to calculate the surpluses and deficits of fertilization, year by year and culture by culture on the plot. A good correlation between the farmer practices and the concentration of nitrogen in the soil was found on the period 1990-2013. This work shows the impact of the fertilization on soil over several years.
In the surveyed plots, the speeds of nitrate transfer could be estimated (around 0.6 m/year). Taking into account the thickness of the unsaturated zone (several tens of meters locally) and low estimated speed, the impacts of environmental actions on the water quality could be highly delayed . In the studied plots, where the transfer matrix is preponderant, the impact of current practices would be visible in only approximately 50 years.
The findings of the project are valid for the investigated plot only. The change of scale from the surveyed plot to the entire water catchment was not performed during the project.

Abstract number 142 - QUANTIFYING TEMPORAL CHANGES OF NITRATE LOADS IN INTENSIVELY USED AGRICULTURAL LANDSCAPES OF THE SEMIARID MEDITERRANEAN TURKEY

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Irrigated agriculture is necessary for productivity of major crops grown in the semiarid Mediterranean regions. With increasing land use and intensive crop production, however, rain-fed and irrigated agriculture cannot be sustainable without fertilization. Nitrogen (N) fertilizers are extensively used in the agricultural landscapes of the semiarid Mediterranean including Turkey, causing an increase in the nitrogen pollution in the terrestrial and aquatic environment. Objectives of this study were to (1) make a water balance work in a large scale irrigation scheme to assess sustainability of existing irrigation management and (2) quantify nitrogen balance elements for sound and effective nitrate loads monitoring in irrigation return flows (IRFs). The research was carried out in an irrigation catchment (Akarsu Irrigation District, 9 495 ha), located in the Mediterranean coastal region of Turkey, in 2013 and 2014. Irrigation waters diverted to the catchment, and drainage waters generated by the District were measured hourly at the corresponding flow rate gauging stations. Rainfall was recorded at the meteorological station located in the catchment. Irrigation water samples were collected biweekly, drainage waters daily and rainfall samples at every rain-event. Nitrate concentrations of the collected water samples were determined and used in load calculations. Basic hydrologic water balance work resulted in rather low closure errors of 12 and 8% in 2013 and 2014, respectively, indicating that sound and effective nitrogen balance work could be performed at the catchment level. Cropping pattern in the catchment had no effect on the diverted irrigation water amount during the observation period. Leaching fraction was around 59 and 51% in 2013 and 2014, respectively, indicating poor irrigation water management and rather high drainage fraction (DF>%43). Drainage was inversely proportional with the yearly rainfall. Fertilizer application was 307 and 297 kg N per ha, plant uptake 190 and 186 kg N per ha in 2013 and 2014, respectively. Nitrogen balance work was resulted in a closure error of 31 and 39% in 2013 and 2014. Nitrogen losses to the drainage systems were low 17 and 10% during the respective wet and dry year as total of 52 and 29 kg N per ha in the consecutive years. The results suggested that water management was not only a problem, but N fertilizer management was also a challenging issue to set the scene for sustainability of agriculture at the catchment level.

Abstract number 145 - SEASONAL VARIATION IN NUTRIENT EXPORT FROM AGRICULTURALLY-DOMINATED WATERSHEDS IN THE NORTHERN GREAT PLAINS, CANADA

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Non-point nutrient sources are difficult to quantify and manage because they come from activities dispersed over wide areas and are variable in time due to the role of weather in determining the frequency and intensity of runoff. In regions that experience annual weather extremes, non-point inputs should mirror the seasonal hydrologic pattern of high discharge during spring snowmelt (March-April), smaller discharge with occasional rainfall-induced spikes during summer (May-August) and fall (September-October), and low or no discharge during winter when river channels are frozen all or in part. Our aim was to quantify patterns in phosphorus (P) and nitrogen (N) concentrations and export across hydrologic seasons for rivers in the northern Great Plains of Canada, as part of a larger project to assess the importance of non-point source nutrient export to a large hyper-eutrophic lake, Lake Winnipeg.
Intensive water quality sampling was conducted in 10 sub-watersheds of the Red River, Manitoba, Canada over 3 years (2010, 2013, 2014). Water level was measured daily and converted to discharge by correction for change in catchment area between the sample site and a downstream discharge survey station. Grab water samples were collected for total P (TP) and total N (TN) on at least 30 occasions per site every year. Load was calculated as the product of discharge and nutrient concentration, with concentrations linearly interpolated between the nearest two samples for dates without chemistry data.
Patterns in discharge, nutrient concentrations and nutrient loading were strongly influenced by the snowmelt period. For the three study years, 82% of the annual river volume, 78% of the annual TP load and 85% of the annual TN load were, on average, delivered during snowmelt. Concentrations of TP and TN varied among hydrologic seasons but showed more variability and larger values during winter and snowmelt, with peaks of 2.12 mg L-1 TP and 14.01 mg L-1 TN. TP and TN exports were significantly correlated with agricultural land area (specifically canola and small grains) and fertilizer application.
Our results showed that nutrient export from northern Great Plains rivers is strongly influenced by seasonal hydrology, with snowmelt being a critical period. The flat topography and semi-arid to sub-humid continental climate of the northern Great Plains results in unique patterns in annual discharge and nutrient export, which has implications for design and implementation of appropriate management practices to minimize nutrient export to proximal and downstream aquatic ecosystems.

Abstract number 151 - LONG TERM TRENDS IN NITRATE IN DANISH GROUNDWATER AND DRINKING WATER

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The Danish water supply is solely based on simple treated groundwater, and protection of groundwater has therefore a high priority. At the same time, Danish farming is among the most intensive in the world threatening the groundwater resources in regard to e.g. nitrate leaching. Numerous waterworks and wells

have been closed due to nitrate pollution, and approximately 15% of the area of Denmark has been classified as nitrate vulnerable groundwater abstraction areas (Hansen & Thorling, 2008). Since the 1980s, regulations implemented by Danish farmers have succeeded in optimizing the nitrogen (N) management at farm level. The N-surplus (N-output/N-input) has significantly been reduced, the farming N-efficiency has increased, and the N losses to the aquatic and atmospheric environment have been significantly reduced (Dalgaard et al., 2014). Accordingly, since the 1980s the overall national upward trend of the nitrate concentrations in oxic groundwater has been reversed (Hansen et al., 2011). Locally, nitrate trend analyses in monitoring wells have shown a more varied pattern with both upward and downward nitrate trends depending on the age of the groundwater and local agro-hydro-geochemical conditions (Hansen et al. 2012). Therefore local groundwater protection action plans are being carried out in order to further protect drinking water resources from nitrate pollution. In general, public water supply nitrate concentrations in drinking water have been decreasing since the 1970s mostly due to structural changes at the waterworks. On the other hand the nitrate concentrations in drinking water at the numerous small water supplies in Denmark show an increasing trend (Schullehner & Hansen, 2014).

Abstract number 152 - GLM ANALYSES OF FIELD AND LARGE LABORATORY PLOT EXPERIMENTS AND THEIR USE TO CALIBRATE SURFACE PHOSPHORUS LOAD MODEL FOR THE WATERSHED OF LAKE BALATON

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Numerous measures were implemented until the early 1990s to prevent external phosphorus load to Lake Balaton, Hungary. Measures did not include coordinated actions between agricultural and water quality policies. However, phosphorus (P) use in the 1990s dropped to almost zero. However, the rebound in the Hungarian plant production is rather spectacular recently and that entails higher fertilizer use. On the other hand, water quality has improved very much compared to the late 1980s but it is still eutrophic-hypertophic in most of the lakeshore zone. Our hypothesis is that the water quality is at severe risk without the implementation of targeted agri-environmental measures and this requires modelling based analysis of hot spots from where significant amount of P may originate.
Four experimental sites were selected which represent full range of texture classes (loamy sand, silt-loam, loam, clay-loam). Plot experiments (5x2 m) were carried out with 60 mm.h-1 simulated rainfall for three sites and 60-90-120 mm.h-1 for the loamy sand site on slopes with 6-19 % angle. The experiments were repeated on 3-4 plots and in 3-5 consecutive simulations until uniform runoff rates were reached. Runoff and soil and P loss were measured in 1-2 minute intervals. Bulk soil samples were carried into the laboratory from three sites (except loamy sand) and the same experiments were repeated in a laboratory big-box setup (3x1x0.5 m) where the upper 25 cm was the collected soil sample and the lower 25 cm was sand. Free draining was ensured from the boxes. Slopes were the same as in the field experiment and a uniform 13 % slope was also used for better comparison. GLM analyses were preformed with the pooled data set which is a suitable method to analyse continuous and discrete influencing variables in one model. The results from GLM analysis were used to parameterize hydrologic response units in the SWAT model and this GIS model was calibrated against long-term daily water monitoring data representing runoff and load conditions from a 1500 km2 section of the western sub-watershed.
Our analysis demonstrated that eroded silt-loam soils even with moderate slops may pose extreme potential for diffuse nutrient load from cropland. These kinds of soils are not common in the western sub-watershed but they are widespread in the southern sub-watershed. However, there is no daily water monitoring data available there thus modelling approaches should be used to target agri-environmental measures.

Abstract number 153 - MOBILIZATION OF NICKEL IN A GERMAN AQUIFER INDUCED BY INDUSTRIAL AGRICULTURE?

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Leaching of nitrate from agricultural land to groundwater and the resulting nitrate pollution are a major environmental problem worldwide. The Emsland landscape is in northwest Germany and is characterized by industrial livestock farming. As a re-sult, nitrogen loads resulting both form inorganic fertilizers and application of ma-nure are high. Not surprisingly, nitrate concentrations in the unconsolidated sandy aquifers are high often exceeding the threshold of 50 mg/l nitrate. In such an aqui-fer, since about 15 years rising nickel concentrations are observed. In some wells, the threshold of 20 µg/l nickel is significantly exceeded. Hence, the groundwater has no drinking water quality. The reasons for the elevated nickel concentrations are unclear. However, since there is an accompanying increase in the sulfate con-centration of the groundwater, the following hypotheses arises: (i) nickel-containing iron-II-sulfide (e.g. pyrite) compounds are present in the aquifer and (ii) in the ab-sence of oxygen, these compounds are microbially oxidized with the consumption of nitrate, i.e. by a pyrite-driven denitrification reaction (chemolithotrophic denitrifica-tion); (iii) by dissolution of pyrite, nickel is released into the pore water. This study deals with the verification of these hypotheses. An exploration drilling was per-formed (65-m depth) in a "nickel-contaminated" sandy aquifer in Emsland. Sediment chemistry was extensively investigated (e.g. pH, texture, organic and inorganic car-bon, total sulfur and nitrogen, sulfide, several iron fractions, mineralogical composi-tion). First results revealed the presence of reduced inorganic sulfur compounds (sulfide).

Abstract number 155 - EVOLUTION OF AGRICULTURAL P-LOSS RISK ASSESSMENT TOOLS

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The Phosphorus Site Index (PSI) was developed as a tool for use by farm managers and conservation planners to rank agricultural fields based on relative risk for phosphorus (P) movement from agricultural production fields to surface water. The PSI was designed to be applicable across a wide range of landscapes and agricultural production systems, to be user-friendly and to require minimal input of unique data beyond that readily available to the farm operation, such as the common management practices being used, soil P analyses, and timing and rate of manure applications to the field. The PSI has been a component of agricultural nutrient management planning in Maryland (Chesapeake Bay Watershed, USA) since its development in 2000 and this P-loss risk assessment tool has been continuously modified in an attempt to increase relative precision and accuracy. Recently, major modifications were made to the PSI calculation, including a shift from a multiplicative model that produced a single average risk assessment for a given production field to a component model structure that generated field specific P-loss risk potentials for three primary P-loss pathways. The resulting updated P-loss risk assessment tool was renamed the Phosphorus Management Tool (PMT). The

preferable method for evaluating the accuracy of the PMT's P-loss risk assessment was to calibrate PMT assessments to field-measured P loss data. However, edge-of-field P loss data was scarce and, thus, modeled P-loss data was used to calibrate the PMT risk assessment tool. The Annual P Loss Estimator (APLE), a validated field-scale P loss quantification model that runs on an annual time step, was used to calibrate the PMT. The APLE model quantified P loss through particulate and dissolved P transport in soil erosion and surface runoff and attributed edge-of-field P losses to soil, manure or fertilizer sources. The evolution of field-scale P loss assessment tools has been rapid. Substantial advances in risk-prediction accuracy have been realized as a result of calibrating the PMT P-loss risk assessment tool with the independent, validated, process-based APLE model.

Abstract number 158 - CROP RECOVERY OF LABELLED-15N URINARY NITROGEN FOLLOWING SIMULATED WINTER FORAGE GRAZING

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In Canterbury, New Zealand, sowing a spring brassica crop is a popular option for dairy cow wintering management providing feed at a time when reserves are low. However, the intensive winter forage grazing system has a high potential for nutrient loss, and gaseous and leaching losses of N increase disproportionately with stocking rate and increasing fertiliser-N use. Some studies have identified that the wintering component can represent as much as 60% of the dairy system's total annual N leaching but typically, from less than 15% of the dairy system area. Elevated nitrate concentrations in drinking water (>11.3mg NO3--N/L) may deem these unsafe for consumption by humans and livestock. Furthermore, elevated NO3--N concentrations in surface waters may cause excessive aquatic plant growth and algal blooms, causing eutrophication. Developing mitigation strategies and technologies to improve N cycle efficiency in soils is critical to minimising environmental damage, and ultimately improve the efficiency and sustainability of NZ agriculture.
Winter forage grazing (WFC) systems represent a new challenge to reduce N losses from an intense event that occurs over the peak leaching period at times of minimal pasture growth. The use of a catch crop sowed following grazing and/or the application of the nitrification inhibitor, dicyandiamide (DCD), may offer a mitigation strategy and technology to reduce N leaching losses. We report the results of a field lysimeter study to measure the N balance of a winter application of labelled-15N urine (350 & 700 kg N/ha) after simulated WFG and its capture by late winter sowing of either oats (Avena sativa) or Italian ryegrass (Lolium multiflorum). We also measured the effect of a single application of DCD (20 kg/ha) on gaseous N2O and nitrate leaching losses, in particular.
Results of the 15N balance for soil, plant, gases (N2O and N2) and leachate showed that leaching losses comprised about 30-34% of total-N applied in the urine and were similar for both rates of urine-N application and plant species. Applying DCD reduced N leaching loss by ~50% for the oats but less so for the ryegrass although establishment issues for the latter may have affected the result. Although leaching losses were relatively high, the late sowing of the oats and ryegrass meant significant leaching occurred prior to crop establishment. DCD application slowed the nitrification rate of the urine-N and enabled greater uptake of N by the crop when better growth conditions prevailed in the spring months.

Abstract number 159 - COMMUNITY-LED COLLABORATIVE WATER QUALITY LIMIT SETTING IN CANTERBURY, NEW ZEALAND

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Historically, New Zealanders, have in large measure, defined themselves by the quality of their natural environment. However, in the last two decades, the impacts of diffuse agricultural pollution have forced a re-think about the degree to which issues such as nutrient contamination need to be addressed. Initial management response for catchments approaching sustainability limits was to adopt a "decide and defend" approach to policy interventions. This led to a highly acrimonious, litigious resource management environment with poor decision making, inefficiencies and damaged stakeholder relationships. The response to this "hurting stalemate" was a fundamental shift in the approach to water quality management both nationally and regionally. Design and implementation of a collaborative process for limit setting is most advanced in Canterbury, where the magnitude and impact of nutrient over-allocation was recognised first. Through a broad stakeholder engagement process, the Canterbury Water Management Strategy was developed as a guiding instrument for water management. The strategy re-focuses both the process and the locus of the water resource debate and effectively shifts decision-making responsibility from the water resource management agency to local communities. At the heart of the strategy is a set of guiding principles and ten targets. Principles and targets encompass social, economic and cultural values as well as environmental ones. Implementation of the strategy is via ten water management zones, each of which is overseen by a zone committee representative of communities of interest in the zone. The initial focus of zone committee work has been the development of an implementation programme, essentially a statement of community issues and aspirations with respect to their water resource. Zone Committees have also chosen to lead the process by which those aspirations are given effect to through statutory plans. In doing so, the committees have sat at the centre of a much wider community discussion of values, objectives, methods and time frames, particularly in relation to water quality limit setting. In effect, those discussions represent rich, and increasingly sophisticated interactions between the community, policy designers and technical specialists. The role of the latter is to inform those discussions in a way that helps communities navigate through complex, uncertain, multi-dimensional problems. Technical input includes the integration of biophysical, economic, cultural and social elements. The limit setting process, in this context, requires a highly flexible and adaptive approach but some guiding principles are emerging from the experience to date.

Abstract number 160 - THE MATRIX OF GOOD MANAGEMENT PROJECT: CO-PRODUCED SCIENCE FOR POLICY

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In 2011, the national government in New Zealand gazetted a national policy statement requiring water quantity and quality outcomes to be agreed for all waterbodies, and quantitative catchment limits set to meet these outcomes. Concurrently, there has been both national and regional guidance that all farmers should be operating at good management practice (GMP) as a minimum.
Although there are some rich pockets of narrative information in New Zealand on GMPs, there is no consistency on what constitutes GMP between agricultural industries or even within industries with different GMPs used for different purposes. In addition, and critical for the purposes of setting output-based catchment limits for water quality, we don't know how GMPs mean translate into quantitative nitrogen and phosphorus losses on the farm.
The Matrix of Good Management (MGM) project brought together six agricultural industries, three research institutes and regional government with the task of designing and producing industry-agreed GMPs and estimating their nutrient footprint across soils, climates and land uses in Canterbury.
A co-production approach was taken for the project despite both time and trust issues. The agricultural industry-good bodies are central to the success of managing diffuse pollution from agriculture. Having these industries at the heart of the design and production of GMPs and the process for foot printing them, is seen as pivotal for implementation and achieving real change 'on the ground'. The benefits of co-production were further recognised with the decision to co-produce the policy framework for implementation with stakeholders.
The information from the MGM project will provide a minimum standard of operation for all farms in the region and an important input to community discussions on water quality limits.
This paper examines learnings for co-production of science for policy, and outlines the science undertaken for the MGM project.

Abstract number 161 - SUSTAINABLE CATCHMENT MANAGEMENT? MAKING PROGRESS IN ESTABLISHED PROGRAMMES

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The principles of catchment management are well understood in theory and practice. Initiatives in many countries have shown how programmes can be implemented effectively through a holistic, ecosystems

view of landscape, achieved through working with communities to shared goals. For water, it brings together water quality and availability with other long term environmental services at the catchment scale.
To address agricultural impacts in catchments, a mix of voluntary and regulatory measures has been shown to be very effective in engaging farmers, raising their awareness and delivering actions to reduce pollution.
The key success factors for such work are becoming better understood; especially the value of a long-term approach to help farmers develop sustained changes in farming practices for environmental and business benefits. Similarly critical is the integration of evidence into delivery programmes to inform planning, delivery and evaluation. This also has a long term to allow for programmes of work to be base-lined and the outcomes to be measured over a sustained period.
There are, however, questions about how programmes develop to ensure they continue to be effective and provide value for money and continue to engage the whole farming community in developing innovative and creative solutions to local issues.
This paper will draw on the experience of the Catchment Sensitive Farming programme in England which has been working with farmers since 2006 to reduce diffuse pollution to help meet Water Framework Directive water quality objectives.
The programme is facing a number of questions as we develop a long term view of sustainable farming. For example:
How do we sustain the benefits already accrued?
How do we define the water quality benefits from future work?
How to we provide an integrated solution to deliver ecosystem services but with focus and clarity of message?
How do we reach all members of the farming community that may need our assistance?
This paper will consider the challenges in the context of the Catchment Sensitive farming programme.

Abstract number 164 - A PRAGMATIC METHODOLOGY FOR HORIZON SCANNING OF WATER QUALITY LINKED TO FUTURE CLIMATE AND LAND USE SCENARIOS

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Future climate and land use changes will have implications for water quantity and quality and could make attainment of targets, such as those set by the EU Water Framework Directive, harder to achieve. High uncertainty in how climate and land use will change, coupled with the extreme complexities of modelling multi-pollutant water quality on larger scales, means that it is difficult to factor future changes into policy decisions. This study set out to develop a new approach to provide a simple means of horizon scanning likely directions of change of pollutant responses, at a national scale, to different future scenarios for climate and land use. This would address a methodological gap in modelling caused by the impracticalities of applying physically based multi-pollutant modelling tools at large scales and enable end-users, such as regulatory agencies, to better understand broad-scale implications of climate and land use change scenarios for water quality. The approach taken was to identify a set of key climate and land use change drivers, for a range of different pollutants, that would impact on their sources and transport processes. For the climate component, net changes in mean annual runoff and seasonal precipitation were identified as the principal drivers affecting pollutant availability and transport. Changes between different land use types were assessed for their likelihood of increasing or decreasing different sources of pollutant. The climate and land use drivers were used to construct transition matrices which were applied to spatial maps, depicting possible future climate and land use change scenarios, to evaluate directions of change in water quality risks. A range of different pollutants was considered, including N,

P, C, suspended solids, pesticides and faecal indicator organisms. An example set of change scenarios was developed for Scotland based on data from the UKCP09 climate projections and land use changes linked to the Scottish Government's Land Use Strategy. The results highlighted differences both between different pollutants and also between the climate simulations explored in the study. The design of the tool was co-constructed with practitioners from the Scottish Environment Protection Agency (SEPA) who have already used them and found them to be a valuable tool for use in a policy context to assess the potential scale and location of likely future changes in water quality.

Abstract number 166 - EVALUATION OF THE N EFFECT OF THE DANISH ACTION PLANS: 25 YEARS RESULTS OF MONITORING

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During the past three decades eight Action Plans for the Aquatic Environment (APAEs) have succeeded to reduce the diffuse nitrogen (N) load to Danish surface waters. The APAEs precede the implementation of the Nitrate Directive, the Water Framework Directive (WFD) and include the Danish code of good agricultural practice. The measures implemented cover a N-quota system that includes mandatory N application standards per crop, specific requirements for utilization of the nitrogen content in manure, closed periods of manure application and for tillage, catch crops, conversion to organic farming, afforestation, reestablished wetlands, and mandatory buffer strips along vulnerable streams and lakes.

Effects of the introduced mitigation measures are controlled in a comprehensive nation-wide monitoring programme for the Aquatic Environment that was established from 1989 and covers among others leaching from the root zone, load of nutrients to groundwater and to marine waters.

Measured and modelled results from the monitoring show that the implemented measures effectively reduce the diffuse N load; i) a 50 % reduction in nitrate leaching from the root zone; ii) a 41 % reduction in the riverine flow weighted N concentrations to the coastal waters, and that the N concentration in near coastal waters has been almost halved. In case of groundwater a decreasing trend in nitrate concentration is observed in 44 % of the youngest groundwater (0-15 years) and in 9 % of the oldest groundwater (25-50 years). The results give a strong indication that N regulation of Danish agriculture has a measurable impact on the N load to both groundwater and surface waters in Denmark.

The Danish experience demonstrates that it is difficult to implement measures which allows some freedom for the farmers and still has the expected effect on reducing the nitrate leaching. Therefore, the APAEs has been evaluated regularly in order to adjust measures or to decide on new initiatives. These evaluations were carried out by scientists, and they also proposed scenarios as a background for decision makers on future regulations. Furthermore, different stakeholders were involved during this process.

The policy measures implemented to date apply equally to all farmers in the country. New and more targeted measures, e.g. constructed wetlands, nitrogen filter techniques to drainage waters, intelligent buffer strips and proposed by farmers extended use of measurements are discussed in order to meet the ND and WFD objectiv of good chemical and ecological status for the aquatic environment.

Abstract number 167 - DISTINGUISHING BETWEEN THE EFFECTS OF FERTILIZER POLICY AND WEATHER VARIATIONS ON NITRATE CONCENTRATIONS AND LOADS TO SURFACE WATER IN THE NETHERLANDS

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In the Netherlands, evaluations of the effects of the fertilizer policy are supported by model simulations. Nitrate concentrations in groundwater and nitrogen and phosphorus loads the surface water are predicted by the STONE model. STONE is a dynamic model and contains a detailed description of soil processes. The predicted concentrations and loads are strongly influenced by weather variations. Because of this, it is sometimes difficult to distinguish between the effects of tightening of fertilizer standards, the effects lagging behind of historical manure surpluses and the effects of weather variation.
A method was developed to be able to distinguish between these effects. The STONE model is executed 30 times with a climate series of 30 years. In each of the successive runs the starting year is chosen one year later than in the previous run, where the first part of the series is replaced to the end of the series. The result of the 30 runs gives apart from the average value per year also information on the probability of the concentrations and loads in a future year.
Results of this method are discussed for the current practice and the impact of the fertilizer policy on predicted concentrations and loads to surface waters in Netherlands.
The method is discussed by comparing to method used for the interpretation of the monitoring data. Weather effects in monitoring results are excluded by factors derived from simulated index concentrations. The index concentrations are the result of simulations with an inert tracer which accounts the weather effects on water contents and transport fluxes, but does not account for the effects on the biological and chemical processes in soil. Therefore, the newly developed method with 30 repeated calculations can lead to other results than the correction on the basis of the index concentration.

Abstract number 170 - BUILDING TOWARDS A CONCEPTUAL MODEL FOR PHOSPHORUS TRANSPORT IN LOWLAND CATCHMENTS

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The release of P to surface water following P leaching from heavily fertilized agricultural fields to groundwater and the extent of P retention at the redox interphase are of major importance for surface water quality. We studied the role of biogeochemical and hydrological processes during exfiltration of groundwater and their impact on phosphorus retention in lowland catchments in the Netherlands. Our

study showed that the mobility and ecological impact of P in surface waters in lowland catchments or polders like in the Netherlands is strongly controlled by the exfiltration of anoxic groundwater containing ferrous iron. Chemical precipitates derived from groundwater-associated Fe(II) seeping into the overlying surface water contribute to immobilization of dissolved phosphate and, therefore, reduces its bioavailability. Aeration experiments with Fe(II) and phosphate-containing synthetic solutions and natural groundwater showed that Fe(II) oxidation in presence of phosphate leads initially to formation of Fe(III) hydroxyphosphates precipitates until phosphate is near-depleted from solution. Continuing Fe(II) oxidation after depleting in dissolved phosphate results in the formation of Fe(III) oxyhydroxides. A field campaign on P specation in surface waters draining agricultural land showed, additionally, that in a large majority of surface water sampling locations the total-P concentration is strongly dominated by particle bound P. Sequential chemical extractions on suspended sediments samples revealed subsequently that iron-bound P was the most important particulate P fraction. Between 75 and 95% of the total-P concentration in the water samples was iron-bound particulate P. After the turnover of dissolved P to iron-bound particulate P, the P transport in catchments or polders is controlled by sedimentation and erosion of suspended sediments in the water body. Shear flow-induced surface erosion of sediment beds upon natural discharge events or generated by pumping stations is an important mechanism for P transport in downstream parts of catchments or polder outlets where flow velocities are high enough to exceed the critical shear stress for surface erosion. The flow velocities in headwaters like drainage ditches are generally much lower and not high enough to cause a bed shear stress that exceed the critical shear stress. We, therefore, hypothesize that floc erosion, which is defined as erosion at condition where the bed shear stress is less than the critical shear stress, and advective flow of exfiltrating groundwater through the bed sediment are major controls on the suspended sediment and particulate P dynamics in these headwaters.

Abstract number 176 - MODELLING NUTRIENT TRANSPORT AND GREENHOUSE GAS EMISSIONS IN MANAGED ARABLE SOILS WITH A FULLY COUPLED HYDROLOGY-BIOGEOCHEMICAL MODELLING SYSTEM AT CATCHMENT SCALE

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The use of mineral nitrogen fertilizer sustains the global food production and therefore the livelihood of human kind. The rise in world population will put pressure on the global agricultural system to increase its productivity leading most likely to an intensification of mineral nitrogen fertilizer use. The fate of excess nitrogen and its distribution within landscapes is manifold. Process knowledge on the site scale has rapidly grown in recent years and models have been developed to simulate carbon and nitrogen cycling in managed ecosystems on the site scale. Despite first regional studies, the carbon and nitrogen cycling on the landscape or catchment scale is not fully understood.
In this study we present a newly developed modelling approach by coupling the fully distributed hydrology model CMF (catchment modelling framework) to the process based regional ecosystem model LandscapeDNDC for the investigation of interaction of hydrological processes and carbon and nitrogen transport and cycling. The study focused on water and nutrient displacement and resulting greenhouse gas emissions in a virtual catchment.

The catchment consists of several hundret polygons vertically stratified into soil layers. Ecosystem states (soil water and nutrients content) and fluxes (percolation, interfow and evapotranspiration) are exchanged between the models at high temporal scales (hourly) forming a 3-dimensional model system at catchment scale. The water flux and nutrients transport in the soil is modelled using a 3D Richards/Darcy approach for subsurface fluxes with a kinematic wave approach for surface water runoff and the evapotranspiration is based on Penman-Monteith. Biogeochemical processes are modelled by LandscapeDNDC, including soil microclimate, plant growth and biomass allocation, organic matter mineralisation, nitrification, denitrification, chemodenitrification and methanogenesis producing and consuming soil based greenhouse gases.
The landscape hosts intensively and extensively managed arable and grassland ecosystems and illustrates the effect of coupled process-based modelling including fertilizer induced direct N2O emissions, hydrological nutrient transport and redistribution, productivity gradients and indirect N2O emissions due to nutrient displacement and the effect of buffer stips for nutrient retention into open waters at catchment scale. The model application will also present the effects of different management practices (fertilization rates and timings, tilling, residues management) on the redistribution of N surplus within the catchment.

Abstract number 177 - COMPARING TWO APPROACHES FOR ESTIMATING NITRATE LEVELS IN UPPER GROUNDWATER IN DUTCH SANDY SOILS

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Nitrate is still one of the major problems in groundwater and surface water in the Sand region of the Netherlands. Nitrate leaching is monitored in agricultural areas as well as in nature areas. Different approaches are available to estimate areal and period mean nitrate concentrations. This study compares two statistical modelling approaches for estimating mean nitrate levels in the upper meter of groundwater under agriculture and nature in the Sand region of the Netherlands.
Monitoring of the agricultural area is carried out within the Minerals Policy Monitoring Programme (LMM). In the 2007-2009 period, the upper meter of groundwater was sampled at about 200 farms in the Sand region each year. Samples were taken at 16 locations per farm. For nature areas, a similar programme, the Acidification Monitoring Programme (TMV), is carried out at about 150 sampling sites. Nature sites were sampled only once during this period; half of the locations in 2007 and the other half in 2008. Ten samples are taken at each nature site. Nitrate concentration is determined in individual samples on-site with the Nitrachek reflectometer. In addition, data for soil type, groundwater tables, land use characteristics, nitrogen application and atmospheric nitrogen deposition were available from maps to explain and estimate nitrate concentrations. These variables are either of categorical or continuous nature.
The first approach uses the nitrate concentration at each sampling point, by means of regression kriging. The number of available samples for the study period was around 19 000. The target grid cell size was 25 by 25 meters. The model that was constructed for this is a simple linear regression model, using additive terms without interactions.
The second approach exploits period mean values of farms and sites. Therefore, the available number of response values for modelling is smaller, being only the 200 farm values and 150 site values. The target grid cell size for estimation in the second approach is 250 by 250 meters. The model that was used in this second approach explicitly aims at interactions between the available variables.
The differences in the modelling approaches are explained, and outcomes of both approaches are compared and cross-validated with the original measurements. Finally, the usefulness of the two different model outcomes for policy evaluation purposes will be discussed.

Abstract number 181 - HUMAN IMPACT ON CARBON, NITROGEN AND PHOSPHORUS EXPORT IN THE RIVER THAMES, UK, FROM 1867 TO 2012

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Since the late 19th century humans have exerted unprecedented influence on the natural environment due to impacts of large-scale mechanized agriculture and rapid urban population growth, which have translated directly into adverse impacts on water quality. In this paper we present land-use, land management and population datasets for the River Thames in the UK and develop semi-physically-based models to relate these to changes in fluvial concentrations and fluxes of nitrogen, carbon and phosphorus.
We show that nitrogen concentrations and fluxes are largely controlled by the impacts of large-scale agricultural production, namely the balance of ploughing and fertiliser applications. Phosphorus concentrations and fluxes are closely controlled by discharges of sewage and other domestic wastewater effluent, rising dramatically in the early 1950s to a peak in the 1990s which rapidly recedes following introduction of the EU wastewater treatment directive. Carbon concentrations and fluxes are strongly influenced by land use changes and by increasing urbanisation.
Overall, we demonstrate how dramatic negative effects can result from large-scale shifts in agricultural practice – effects that remain intractable, particularly with respect to nitrogen. We also show the success of legislation targeted to reverse the negative impacts in respect of phosphorus. We discuss the implications of these findings, and the likely prognosis for coming decades under existing scenarios of change and regulation.

Abstract number 182 - WHERE SHOULD WE PUT OUR RESOURCES? THE IRISH APPROACH TO CHARACTERISING CATCHMENTS AND TARGETING PROGRAMMES OF MEASURES

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Ireland is adopting a three-tiered risk assessment approach to characterising catchments for selecting targeted programmes of measures under the WFD. Tier 1 risk assessments are carried out nationally at the waterbody scale and are based on water quality and quantity monitoring data, including status, trends and capacity to absorb additional impacts. Tier 1 is a screening exercise and an automated tool has been developed to assign each water body to one of three risk categories: 'At Risk', 'Not at Risk', or 'Review', where risk means risk of not meeting WFD objectives.
Tier 2 assessments are carried out at the sub-catchment (100 km2) scale where waterbodies At Risk or

for Review have been identified. The objective is to determine where and why the waterbodies are At Risk and to identify the potentially significant pressures. Assessment techniques include developing conceptual models of how the sub-catchments function and utilising a load apportionment model to determine the primary activities causing the problems. All waterbody types are included in an integrated, four dimensional, risk assessment process. Where diffuse contaminants are the issue, a newly developed catchment characterisation tool (CCT) is utilised to determine the critical source areas (CSAs), i.e. the places in the catchment that contribute disproportionately large amounts of the contaminant of concern. The CCT has been developed for CSAs for nitrate and phosphorus, for both groundwater and surface water receptors. Additional modules for CSAs for sediment and pathogens may also be considered in the future. The CSAs, and the relevant large or small point sources suspected to be causing impacts are highlighted for Tier 3 assessments.
Tier 3 assessments are carried out 'on the ground' by local authority staff and may include, for example, catchment walks, investigative monitoring and compliance checks. The objective is to identify the significant pressures, i.e. the activities that are actually causing problems, and specific mitigation measures.
The measures are then considered at the whole of catchment scale, in the context of socio-economic, political and technical feasibility factors. The outcomes form the basis of catchment, and ultimately river basin management plans. Implementation will be achieved using a combination of statutory, community engagement and voluntary adoption programmes. A Catchment Management Network has been established as a stakeholder engagement platform.
This three-tiered characterisation process is part of an integrated catchment management approach which is being adopted to achieve the best environmental outcomes in a holistic way with limited resources.

Abstract number 183 - IDENTIFYING ECOLOGICAL THRESHOLDS FOR LAKE PHYSICO-CHEMICAL PARAMETERS INFLUENCED BY LAND USE

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Land-use changes have repercussions on lake water physico-chemical parameters which impact aquatic communities and lentic ecosystem functions. For sustainable management of lakes, it is necessary to identify ecological thresholds of man-influenced limnological parameters, beyond which ecosystems are not resilient anymore and may be considerably modified. A way to detect thresholds is to relate physico-chemical and biological data from a large number of lakes presenting various degrees of human alteration. In this study, a database of more than 300 lakes located in France was analyzed, including water quality measurements and community composition of three biological compartments: phytoplankton, macrophytes and fishes. The method of gradient forest was used to detect in environmental gradients some critical zones, where the rate of compositional change of the communities is highest and which can be interpreted as ecological thresholds. It appeared that physico-chemical variables had not the same importance for the three biological compartments. Thresholds were found for various parameters, like total phosphorus or dissolved nitrogen but consistency among compartments was found for only a few parameters, like water transparency. These thresholds will be used for the development of physico-chemical indices of lake ecological status in the implementation of the WFD. Moreover, the statistical modelling of lake water parameters from land use and hydromorphological variables will help to estimate site-specific reference conditions and to identify the most determining anthropogenic factors responsible for the degradation of lake water quality.

Abstract number 184 - AQUATIC ECOSYSTEMS UNDER INCREASING PRESSURE? ENERGY CROPS AND PESTICIDE CONTAMINATION OF STREAMS

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Biomass provides two thirds of the total energy produced from renewables in Europe. The share of bioenergy from energy crops is growing rapidly. The cultivation of annual energy crops usually takes place in intensive agricultural production systems, which use pesticides to control weeds, diseases and insect pests. Pesticides are major stressors in freshwater ecosystems and have adverse effects on aquatic communities. Therefore, given the environmental pressures arising from pesticide pollution from current agricultural food production, the question arises whether the future energy crop expansion will lead to an increase or decrease in the amount of pesticides being released in our freshwater systems.
However, it is impossible to give a simple answer to this question. A vast variety of plants can be used to produce bioenergy and their pesticide demands varies widely. To gain a better understanding of the potential effects caused by the pesticide demand of the main annual energy crops in Germany, we analyzed different cultivation scenarios and their consequences for pesticide exposure of freshwater systems as well as their ecological relevance for a key animal group, macroinvertebrates. We used the GIS-based Runoff Potential model to assess the potential exposure of stream sites to runoff-induced pesticide input for different cultivation scenarios. The potential exposure, the so-called Runoff Potential, is calculated by using a simplified mathematical formula and spatial data on land use, precipitation, soil characteristics, and slope. Pesticide application data was based on statistical data for Germany for the years 2011 and 2012. Additionally, we assessed the potential effects of the pesticide input on the macroinvertebrate community using substance-specific toxicity data. In a last step, we discussed the importance of our findings for freshwater management and bioenergy production.

Abstract number 185 - A QUICK SCAN TO REDUCE P EMISSIONS FROM AGRICULTURAL SOILS TO SURFACE WATER

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Leaching of phosphorus (P) from agricultural soils is an important factor determining the surface water quality in the Netherlands. The ongoing reduction in P application rates will prevent a further enrichment of the soil with P and improve surface water quality in the forthcoming decade. However, these measures are not sufficient to reach surface water quality standards of the European WFD in 2015

in all sensitive areas. Geographically differentiated information on the effect of different mitigation options on the P emission is essential for a cost effective implementation of the water framework directive.
A quick scan of the effect of five promising mitigation measures in 2027 (manure policy, controlled drainage, mining, improvement of the soil structure, converting agriculture to nature) has been carried out for the Netherlands. Basis of this quick scan is a detailed map of the present P emissions to surface waters, based on the observed P contents in the soil and the simple emission model PLEASE (van der Salm et al., 2014). PLEASE is a static model which as such cannot be used as a tool to predict future P emissions. To predict reductions in P emissions this model has been combined with simple rules based on more detailed models (national emissions model STONE) or expert knowledge.
Strong differences were found in the effect of a selected measure. The median reduction of the five measures is close to zero, whereas the 95 percentile ranges from 0.2 kg/ha for the present manure policy to more than 4 kg/ha for mining. Selecting the right measure at the right place is thus of utmost importance to decrease the emissions in a efficient way.
The effects of the measures show distinct regional differences. Improving the drainage system, by converting conventional drainage to controlled drainage, is the most promising measure in the western and northern part of the Netherlands. In the sandy parts of the country, mining (no P- application) and the transformation of agriculture to nature have the largest impact on P losses. The effects of the current manure policy are minimal. The average reduction in P emission in the Netherlands in 2027, as a response to the most efficient measure, is 25%. Phosphate losses to surface waters mainly occur in a narrow zone across watercourses. In large parts of the Netherlands this zone is less than 5 m. wide. Measures might thus be partly restricted to these zones.

Abstract number 186 - PHOSPHORUS MONITORING AND MODELLING IN LOMBARDY REGION, ITALY

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Phosphorus management for profitable crop production and water quality protection is now a concern in in the more intensive agricultural area of the world. Even if the main source of P losses from cropland are due to surface transport, P transport in unsatured zone could be important, because dissolved P forms have been reported in subsurface drainage waters at concentrations that could cause water quality issues. Few studies have simultaneously measured ground water and soil pore water P concentrations, and therefore, only little information on the potential for P transfer to shallow ground water is available.
In light of this, in Lombardy region and within the monitoring network "ARMOSA" we have measures in two years, in 6 sites and considering 12 cropping systems the P content in the soil water and in shallow water table together with crop development data (yield, phenology, P uptake, etc..) and management data (fertilization etc..). The P dissolved data, obtained with P-specific suction cups sampled approximatively every 3 weeks, showed large variability (from not detectable levels up to 1 mg l-1), according to soil type (minimum levels was recorded in calcareous soils while the higher levels was recorded in sandy soils) and where high amount of P was used as a fertilizer. Relationships between Olsen P and subsurface drainage P amount and concentrations was studied, confirming the very low

leaching of P in calcareous soils independently from soil extractable P concentration.
In the framework of the ARMOSA modelling system we have developed also a set of procedures for the simulation of dissolved P in soil, that demonstrate to adequately forecast the risk of P leaching (with an average efficiency of 0.45). The ARMOSA calibrated model was applied in several agricultural district in Lombardy to assess the potential risk of P leaching, also in a context of the Po Valley derogation at the nitrate directive that allow up to 250 kg ha-1 y-1 kg of nitrogen from organic sources, and to evaluate alternatives to the actual derogation in term of N and P leaching risk. A set of maps of P leaching is produced, allowing the identification of high risk areas.

Abstract number 187 - DEVELOPMENT OF A DANISH NATIONAL NITROGEN MODEL – INPUT TO A NEW SPATIAL DIFFERENTIATED REGULATION

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The nitrogen load to estuaries have been approximately halved in Denmark since the mid 1980ties, but assessments of the ecological status of marine waterbodies indicates that further reductions in nitrogen loadingss especially in some waterbodies are required to obtain a good ecological status according to the Water Framework Directive. Past and current regulations have primarily relied on a general approach, applying same restrictions for all areas independent on drainage schemes,hydrogeochemical conditions and retention in surface waters. Such a general approach is not cost-effective, as nitrogen retention (primarily as denitrification) varies significantly depending on the physical and biogeochemical conditions. If areas with high and low retention can be identified, regulation can be targeted allowing less strict regulation in some areas and focus stronger regulation and mitigation measures in areas, where nitrate leaching is high and nitrogen retention is low.
As a first step in exploring how a differentiated approach can be integrated in national regulation, a national nitrogen model has been developed for Denmark. The model is constructed by linking existing models describing nitrate leaching from the root zone, groundwater transport and reduction as well as surface water retention models. The models are coupled at sub-catchment scale dividing the country into topographic catchments with a mean size of 15 km2, which constitutes the computational units in the national model. Model development, calibration and validation have been performed on measurements of nitrogen transport from 340 streams gauging stations covering approximately half of the total area in Denmark.
The national model is designed to compute the total nitrogen loads to coastal areas and the transport of total nitrogen within sub-catchments, but can similarly be used to compute national maps displaying the estimated nitrogen retention in groundwater, surface water and the total retention from the field to the sea. How and to what extent these retention maps will be deployed in Danish regulation, to be effectuated from 2016, is currently discussed by the political system.
This paper will describe the model concept of the and utilization of the stream monitoring data in the development and validation of the national nitrogen model, as well as the approach and results from the uncertainty assessment related to the national retention maps.

Abstract number 192 - A NATIONWIDE 3D GROUNDWATER SOLUTE TRANSPORT MODEL FOR POLICY EVALUATIONS IN THE NETHERLANDS

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Policy makers at the national level in the field of water quality and ecology in the Netherlands have expressed the need for a nationwide integrated water quality modelling instrument, which gives reliable insights in the relevant policy themes. In recent years, much effort has been put in the realisation of a 3D nationwide integrated water flow model, the National Hydrological modelling Instrument (NHI). The NHI helps answering national-scale policy questions for water safety and water availability. For reasons of consistency and efficiency, it is desirable that the same model is used as input for the water quality calculations. This is not yet the case; the model currently used for nationwide water quality calculations is based on very different concepts. Therefore, Deltares and Alterra are working on the realisation of a nationwide 3D solute transport model, using the hydrological fluxes from the NHI.
This soil and groundwater quality model, temporarily coined NHI-Water Quality (NHI-WQ), consists of ANIMO for the unsaturated zone and upper groundwater, and MT3DMS for the deeper groundwater. ANIMO simulates land management, soil processes and nutrient leaching and serves as the upper boundary conditions for the MT3DMS domain. MT3DMS is worldwide the most commonly used model code for the simulation of reactive transport in groundwater.
Part of the vision behind the NHI-WQ is that it should not only accommodate policy questions at the national level, but at regional and catchment scales as well. This vision is realized by working towards a nationwide database of all necessary data at the highest resolution possible, and using innovative model clipping and scaling software to construct from that database, at runtime, the desired model with extent and resolution of choice. A courser nationwide model and higher-resolution sub-models for specific regions or catchments can thus be derived from the same database and constructed according to the same modelling concepts, creating consistency between national and regional scales.
At the conference, the conceptual design of NHI-WQ will be presented, as well as initial results and plans for further developments of NHI-WQ in the near future.

Abstract number 194 - PROTECTING DRINKING WATER SUPPLY: AN ANALYSIS OF ACTION PLANS AND STAKEHOLDER NETWORKS

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Since WFD the policy for protecting drinking water supply has been enhanced in France. This policy establishes the main components and the different steps for protecting drinking water, and asks for defining and implementing an action plan for each contributing catchment. Despite ambitious objectives, the local implementation is slow. This can be firstly explained by a high diversity of stakeholders involved with local authorities, which are mainly water agencies, agricultural chambers and consultants, authorities at regional and departmental levels. Most of the local authorities do not feel qualified enough for carrying out such a policy, and not really used to deal with technical and political issues related to agricultural non point source pollution. As a consequence action plans are based on regulation and/or agri-environmental measures. More ambitious and complementary measures are sometimes included,

but without any evaluation nor accurate objectives. In the end, action plans reflect a formal implementation of protection rather than a real search for efficiency by defining ambitious measures and the setting-up of a consistent support scheme. Based on ten case studies located in three different regions, three local authorities profiles have been defined: (1) the "passive" ones, not really convinced of the necessity to undertake actions against diffuse pollutions and/or having low level of knowledge to support local reflection, that delegate project management; (2) the local authorities that support local protection approach but that, for different reasons, do not search for an effective action plan, and that only consider an improvement approach; (3) the local authorities that more rarely, aim at efficient actions, motivated by the urgent need of action for preserving threatened resources. According to these profiles, local authorities and their project coordinators will be looking for, more or less actively, mobilizing stakeholders' networks and knowledge that enable to build a strategic management. Reciprocally, institutional stakeholders push for formal or demanding approaches, with most of the time low level of knowledge that could objectivize the relevance of action plans. This analysis contributes to help some key stakeholders in building more efficient action plans.

Abstract number 197 - Indirect nitrogen losses of managed soils contributing to greenhouse emissions of agricultural areas in Austria: Results from lysimeter studies

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A considerable share of greenhouse gas emissions, especially N2O, is caused by agriculture, part of which can be attributed to indirect soil emissions via leaching and runoff. Countries have to report their annual emissions, which are usually calculated by using the default value of 0.3 for FracLEACH, a factor that represents the fraction of nitrogen losses compared to total nitrogen inputs and sources. In our study we used 22 lysimeters, covering a wide range of soils, climatic conditions and management practices in Austria, to evaluate nitrogen losses through leaching and to calculate FracLEACH. The terms of the nitrogen mass balance of the lysimeters were directly measured for several years. Both grassland and arable land plots gave significantly smaller values of FracLEACH than the default value. For grassland, FracLEACH values of only 0.02 were found which varied very little over the entire observation period. For arable sites, FracLEACH values were higher (around 0.25) and showed significant variability between years due to variations in crop rotation, fertilization rates, and yields

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Abstract number 199 - REVIEW OF THE GERMAN EU-NITRATE-MONITORING-NETWORK

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To fulfill the requirements of the Nitrates Directive every four years Member States have to report about the implementation of the directive and the effectiveness of measures. Therefore in 1995 the first Germany EU-Nitrate-Monitoring-Network was established. It consisted of 190 sites distributed all over Germany. For the selection of suitable sites the Federal Working Group of Water (LAWA) gave specific

recommendations. Sites should be situated in areas with significantly elevated nitrate concentrations. Nitrate concentration should exceed 50 mg/l or at least 25 mg/l. Sites should be situated in the uppermost aquifer and should not be deeper than 40 m. It has to be certain that elevated nitrate concentrations are due to nitrogen input from agricultural sources.
According to these requirements the network reflects a "worst case scenario" and is not representative for the nitrate distribution in German groundwater all over. Nevertheless the EU-Nitrate-Network fulfilled the requirements of the Nitrates Directive and could depict the effectiveness of measures to reduce the input of nitrogen to groundwater. Data from this network documented a continuous decrease of nitrate concentration in German groundwater.
Different facts gave rise to the revision of the EU-Nitrate-Monitoring-Network. From 1995 to 2010 the number of sites dropped from 190 to 162 and an additional loss of sites would lead to significant statistical uncertainties assessing nitrate trends as well as the assessment of the effectiveness of measures. The EU-Commission asked for an overview over nitrate concentration in all German groundwater. Therefore additional data from a representative German monitoring network, the so called EUA-Monitoring-Network, were integrated in the last report. The presentation of two different data sets caused misunderstandings and further discussion.
In 2014 the LAWA decided to review the EU-Nitrate-Network and a modified monitoring concept was developed. It was decided to merge the EUA- and the EU-Nitrate-Network. The new network will consist of about 1.200 sites and will representatively reflect the distribution of land use as well as the distribution of nitrate concentration in German groundwater.
For the preparation of the next Nitrates Report only a specific part of all sites will be taken into account. According to the requirements of the Nitrates Directive only sites influences by agricultural use are used to assess the effectiveness of measures and to calculate nitrate trends.
The review of the new network has started in January 2015 and data shall already be used for the Nitrate Report 2016.

Abstract number 202 - EVALUATION OF THE GERMAN FERTILIZATION ORDINANCE AND RECOMMENDATIONS FOR BETTER IMPLEMENTATION

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This contribution will describe key findings of the evaluation of the German Fertilization Ordinance and the scientific and political discussions on the way towards the upcoming reform.
According to the German Fertilization Ordinance (Düngeverordnung, DüV), implementing EU Nitrates Directive in Germany, farmers have to document surface balances for nitrogen and phosphorous, and must not exceed the level of 60 kg nitrogen (after deduction of gaseous N losses) and 20 kg P2O5 per hectare. An evaluation of the DüV by an expert group has revealed shortcomings of the existing implementation of the obligatory nutrient accounting at farm level. Based on this analysis, proposals for improving the DüV in the next reform have been formulated. The next action programme for implementing Nitrates Directive in Germany is still under debate between the EU Commission, the Federal Ministries for Agriculture, for Environment and the Germany regions. The obligatory nutrient balances will be further developed, and complemented by an obligatory fertilisation planning with legal binding input levels.
For the evaluation, authorities involved in control and enforcement of the DüV have been interviewed. Further, farm nutrient balances have been gathered and analysed with respect to reliability, distribution of nutrient surplus in different farm types, and options for reducing the surplus level. Experience from on-the-spot controls shows that beyond verification of the mere presence and completeness of nutrient balances the control of their reliability and truthfulness is complex. Especially in dairy and cattle farms

with high amounts of self-produced forage the estimates of nutrient uptake by forage crops is regularly overestimated.
In the next action programme for implementing Nitrates Directive in Germany, improved obligatory nutrient balances shall be a centre piece for reducing N surplus. For this, the reliability of nutrient accounting has to be increased, especially in dairy and beef production. Nutrient uptake of forage crops shall be verified through cross-checking with forage needs of the animal herd of the farm. When exceeding the maximum surplus thresholds for N and P, farmers should be facing sanctions through legal fines and cross compliance.
Further, technical prescriptions for spreading of liquid manure should allow only emission-reduced techniques. Further, the closed period for spreading slurry on arable land shall be substantially extended to late summer and autumn, and nutrient accounting shall be flanked by an obligatory and harmonized fertilization planning and documentation. How far the calculated nutrient inputs should be made legally binding has been controversially debated.

Abstract number 203 - NUTRIENT EXCHANGE BETWEEN SURFACE WATER AND SHALLOW GROUNDWATER AND DEGRADATION PATHWAYS OF NITROGEN SPECIES IN THE NORTH CHINA PLAIN

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While there is worldwide growing demand for agricultural food production, pressures on water resources increase. This is especially obvious in the North China Plain, where about one third of the annual national harvest of staple foods such as wheat and maize are produced - mainly via irrigated agriculture. In this region, high competing water use between different sectors has led to declining groundwater tables and substantial water pollution in rivers, lakes, and even aquifers. In order to lay the basis for suitable water management and protection measures, it is therefore important to understand how groundwaters and surface waters affect each other in terms of pollutant exchange.
Here, the results of a one-year study on water flow interactions and chemical influences between groundwater and river water at a winter wheat – summer maize double cropping system site, Hebei Province, China, are presented. The study entailed eleven field campaigns during which samples for nitrogen species, major and minor ion composition, and stable isotopes were taken from a river passing directly adjacent to the wheat-maize field, the hyporheic zone below the river, soil water at different depths (0.4, 0.8, and 1.2 m), and groundwater at 2.1 m depth and different distances (1-41 m) from the river bank.
A high degree of interconnectedness between surface water and groundwater with flow from the river into the shallow aquifer was identified. Major inflowing pollutants into the aquifer were nitrogen via vertical transport from the land surface (concentrations in the upper suction cup from 63.0 to 134.3 mg/L NO3-N) and ammonia and nitrate via horizontal transport from the surface water (concentrations between 9.0 and 29.8 mg/L NH4-N and n.d. to 6.8 mg/l NO3-N). Despite these high inputs, both nitrogen species were only detected at much lower concentration averaging at 1.8 mg/L NO3-N and 3.6 mg/L NH4-N in groundwater samples at 2.1 m depth, indicating a high capacity of the system to remove

excess reactive nitrogen. Suggested removal mechanisms supported by modelling include nitrification/denitrification processes, cation exchange, or anaerobic ammonium oxidation (anammox). Despite the current capacity of the soil-groundwater system to cope with incoming pollutants, the intense agricultural use, combined with the large amounts of instreaming ammonium pollution, may pose a future threat to the quality of the shallow aquifer and to the soil in the studied system. Monitoring of the river and groundwater quality and measures for quality improvement of the surface water is therefore recommended.

Abstract number 208 - THIRTY YEARS AFTER THE MANURE LAW IN THE NETHERLANDS: DID WE SUCCEED TO PROTECT OUR GROUNDWATER AND SURFACE WATER RESOURCES?

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The Netherlands is notorious for large inputs of nutrients in intensive agricultural practice in the previous 60 years. However, the country has established action programs to reduce the supply and impacts of nutrients to air, groundwater and surface waters since 1985. This led to a clear decrease in the net surplus of nitrogen in farming. Observations show that the response of N concentrations in many Dutch agriculturally dominated watersheds is relatively fast. However, average summer concentrations of N in these watersheds are locally far above the standard of 2.3 mg N/l, and nutrient loads towards downstream rivers and lakes are high. A clear response of nitrate-N in shallow groundwater (10-25 m depth) was also revealed by age dating the water. However, the water quality response in well fields for public water supply is less convincing, due to mixing of groundwater with a variety of travel times and chemical processes along groundwater flow paths. Using age tracers and flow path models for characterizing those, we demonstrate water quality improvements for some well-studied public water supply well fields. Unfortunately, the average nitrate concentration in upper groundwater in other drinking water protection areas is occasionally still far above the 50 mg/l nitrate standard, especially in areas with sandy soils. This raises the question whether the N reduction measures were sufficient to protect the surface water and groundwater resources from further deterioration.
We used the National Hydrological Model to assess the possible subsurface extension of the agricultural pollution front after 60 and 200 years since the start of modern farming assuming conservative transport. The study shows that large volumes of groundwater are at risk at depths of up to 100 meter and locally more. The risk are confirmed by the observations that drinking water companies have changed their abstraction well configurations over the last 40 years, seeking for well protected and deeper resources away from the agricultural pollution front and other surface induced contaminants. Other mitigation measures included mixing of water of different sources, or changing to surface water sources or artificial recharge. Overall, the fresh uncontaminated groundwater resource is still declining in volume, thirty years after the commence of the legislation. We only recently realized that the highly reactive Dutch subsoil, which promotes denitrification in the groundwater compartment, offers the prime protection of the resource, and allows time for more effective actions to reduce N losses from farming.

Abstract number 210 - EFFECTS OF THE AUSTRIAN AGRI-ENVIRONMENTAL PROGRAMME ON REGIONAL NUTRIENT FLOWS AND NUTRIENT BALANCES

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The Austrian Agri-Environmental Programme is among the biggest programmes in the EU considering the size of the country. A complex set of measures is aiming to tackle greenhouse gas emission, nutrient loss and biodiversity decline. Many of the voluntary measures affect production decisions and decisions on management and intensity of inputs. We analyse the effects of the program on regional nutrient balances for the whole country using an agricultural sector model of Austria. We differentiate between NUTS3 regions and present changes of the balances compared to a situation without the program. Apart from the changes of balances we provide estimates of the total flows of nutrients (from commercial fertilizer and livestock excretion). This information is important because the analysis shows that the programme has two effects: a) Less intensive farming becomes more profitable for farmers due to the programm. b) Production of agricultural commodities is stimulated, as well. The paper quantifies this trade-off and discusses options to further reduce nutrient losses with policy instruments affecting the whole agricultural sector.

Abstract number 211 - AN INTEGRATED IMPACT ASSESSMENT OF CLIMATE CHANGE, LAND USE, AND ADAPTATION POLICIES ON WATER RESOURCES IN AUSTRIA

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Climate change is one of the major challenges of our time and adds considerable stress to the human society and environment. A change in climate will not only shift general weather patterns, but might also increase the recurrence of extreme weather events such as drought and heavy rainfall. These changes in climatic conditions will affect the quality and quantity of water resources both directly as well as indirectly through autonomous adaptation by farmers (e.g. cultivar choices, fertilization intensity or soil management). This will influence the compliance with the good ecological and chemical status according to the EU Water Framework Directive.

We present an integrated impact modelling framework (IIMF) developed in the Aqua-Stress project to tackle those direct and indirect impacts and analyze policy options for planned adaptation in agricultural land use and sustainable management of land and water resources until 2040. The IIMF is the result of an interdisciplinary collaboration among economists, agronomists, and hydrologists. It consists of the bio-physical process model EPIC, the regional land use optimization model PASMA, the quantitative precipitation/runoff TUWmodel and the surface water emission model MONERIS. Scenarios are being developed and parameterized in collaboration with stakeholders in order to facilitate multi-actor knowledge transfer. The set of climate change scenarios until 2040 includes extreme weather events such as dry and wet periods. They are combined with socio-economic and policy pathways. The contrasting climate change scenarios and uncertainty assessment on the model output should enhance the policy relevance of the results.
The presentation particularly tackles the development of interfaces among the research groups, the definition of scenarios based on the demand of stakeholders and first results on the validation of the models. A major advantage of the IIMF is its consistent and quantitative representation of the climate change impact chain: quantified climate change impacts on crop yields are transmitted to an economic land use model to derive quantitative, coherent and consistent land use scenarios on contrasting stakeholder-driven policy portfolios. Hydrological models either support the land use modelling in PASMA or integrate its output to estimate quantitative and qualitative impacts on Austrian surface water.

Abstract number 221 - INDICATORS TO IDENTIFY THE SOURCE OF PESTICIDE CONTAMINATION TO GROUNDWATER

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In Denmark groundwater is synonym with drinking water. The mainstream Danish political approach favors prevention and action at source over advanced treatments of polluted groundwater. The main pollutants are nitrate and pesticides. Pesticides in groundwater can originate from either diffuse or point sources. Point sources are characterized by high pesticide concentrations leaching from small areas, while diffuse sources are characterized by low concentrations over large areas. Some source types can either be termed diffuse or point sources, e.g. line sources (uses at railways) or more intensive diffuse sources (clean keeping of farm yards). It is important to determine the source type in order to make correct management decisions. This project aimed to identify and develop a set of indicators that can be used to determine whether pesticides detected in a groundwater sample (e.g. in a monitoring or abstraction well) originate from a diffuse or a point source.

Historical data on pesticide sales in Denmark are a good indicator of the quantity and types pesticides that have been used over time. A statistical assessment showed that the distribution of sum concentrations and max concentrations clearly show that findings from point sources have higher concentrations than findings from diffuse sources. Here, “high” concentrations are considered to be >

1.0 μg/l, and "low" concentrations < 0.05 μg/l. The number of compounds detected in samples from point sources and diffuse sources also differ. Therefore, a useful indicator for point sources was defined: if a groundwater sample has findings of ≥4 compounds, and/or at ≥ 2 compounds above 0.1μg/l. Model results show that the breakthrough curves from point and diffuse sources differ, with diffuse sources resulting in flat breakthrough curves, while point sources results in steeper breakthrough curve. Model results also show that the spatial variability of pesticide concentration data is different for diffuse and point sources. Large variations of the same compound can indicate a point source. The outcome of the project is a set of indicators the origin of pesticides: from a diffuse source or a point source -and these are shown in the figure below. The indicators can only be used one-way; a "YES" implies the given result, but a "NO" answer does not imply any conclusion on the question posed. The indicators have been used around AArhus to identify whether pesticide findings originate from diffuse sources or point sources. This will have implications for future groundwater protection initiatives.

Abstract number 228 - SPATIALLY EXPLICIT MODELLING OF NUTRIENT AND TRACE ELEMENT INPUTS TO AGRICULTURAL SOILS

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Agricultural soils receive several types of amendments such as commercial fertilizers, animal manure, compost, and waste-derived fertilizers. These materials contain macro- and micronutrients as well as potentially toxic trace elements. If not correctly managed, amendments can severely affect chemical properties of soils and connected water bodies. Thus, their appropriate management is of crucial concern for a sustainable agricultural production.
Fertilization strategy of the farmers is influenced by several factors such as the farm structure and organization, socio-economic boundary conditions, regulation and incentive policies, and the availability of new types of fertilizers. These factors vary in space and time at different scales, from regional to field level. Moreover, pollutant export from agricultural land to water bodies is generally characterized by a high spatial variability, with few critical areas contributing the most. In order to capture the spatial and temporal pattern of element inputs into agricultural soils, predict trends under different scenarios, and support the development of measures to reduce element transport to water bodies and the associated pollution risk, tools are required to combine relevant data sources in a spatially explicit way. We developed a Land Management Model (LMM), a tool that combines geo-referenced farm census data, land use information generated by remote sensing techniques, data on chemical composition of soil amendments, crop nutrient requirements, typical agricultural practices and fertilizer strategies, and expert knowledge. The LMM uses an extensive set of rules implemented in a downscaling algorithm to estimate the application rate of soil amendments and calculate spatially explicit balances of nitrogen, phosphorus and main trace elements at the field scale. We present results obtained for a study area in canton Zurich, Switzerland, that comprises about 60 km2 of agricultural land representing a transition zone between arable and grassland systems with a livestock density close to the Swiss average. Results referring to the past 15 years show a high spatial variability, with hotspots of positive balances indicating areas prone to accumulation of elements in soil and thus increased risk of export to water bodies. Model performance was evaluated by comparison with repeated soil measurements at selected soil monitoring sites. The LMM enabled the assessment of different scenarios in terms of long-term impact on soil chemical quality.

Abstract number 232 - PHOSPHORUS SEQUESTRATION BY OXIDIZING IRON IN GROUNDWATER FED CATCHMENTS

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Losses of phosphorus (P) from agricultural land to surface water may cause impaired water quality. In lowlands with shallow aquifers, the main pathway of P transfer is by leaching to the groundwater. When groundwater surfaces and feeds the streams, it becomes oxic, and the P may interact with redox-active elements such as iron (Fe). We addressed how the fate of P at the groundwater-surface water boundary is affected by that of Fe. We used four lowland catchments fed by naturally Fe-rich groundwater (average: 20 mg/L Fe, 0.4 mg/L P) as study sites.
The mobility of P was studied along the trajectory of draining groundwater: from the subsurface through sediments into open drainage ditches. In the reduced groundwater, the Fe occurs as Fe2+ which is highly soluble. The Fe concentrations gradually decrease as the water flows upward into the drainage ditch: in the ditchwater, which is exposed to atmospheric oxygen, the Fe2+ is oxidized to Fe3+ according to a kinetic process, and the Fe3+ readily precipitates as oxyhydroxides. The P is removed much faster than Fe. The groundwater feeding the ditches contains up to 3 mg/L P, but this drops to less than 0.1 mg/L in the upper layer of the ditchwater. The P is immobilized by oxidizing Fe, either through adsorption on freshly formed Fe oxyhydroxides or through formation of ferric phosphate minerals. In summary, the oxidative precipitation of Fe in drainage ditches is a highly efficient P sink.
In order to quantify these processes at the catchment scale, the composition of groundwater and surface water was monitored at 60 locations throughout the selected catchments. The oxidation of Fe2+ proceeds as groundwater surfaces and flows through the catchment into increasingly larger streams. The gradual removal of Fe from streams is quantitatively explained by hydrological and chemical processes: the travel time of the water in the streams, and the kinetic oxidation rate of Fe2+. The removal of P occurs much faster than that of Fe. The average P concentration in streams (42 µg/L) is one order of magnitude below that in the groundwater feeding the streams (393 µg/L), due to sequestration by the oxidizing Fe. The average P concentration in groundwater largely exceeds the local environmental limit for freshwater (140 µg/L), but in streams, it is below the limit. It is concluded that naturally occurring Fe in groundwater alleviates the environmental risk associated with P in the receiving streams.

Abstract number 246 - ASSESSMENT OF NITROGEN ATTENUATION IN THE SUBSURFACE ENVIRONMENT OF MANAWATU RIVER CATCHMENT, NEW ZEALAND

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A full understanding of the sources, transport, transformation and fate of the nutrients lost from farms to rivers and lakes is a key component of managing and mitigating the likely impacts of these nutrients on water quality and ecosystem health in a catchment. The cycling and leaching of nitrogen from the soil profile (root zone) is reasonably well understood, but relatively little is known about its transport and transformation in the subsurface environment (below the root zone), particularly in the Manawatu River catchment, New Zealand. A large- scale study is underway in parts of this catchment to quantify and understand the attenuation of nitrogen as it travels from farms to surface waters. Our preliminarily analysis in the Manawatu River catchment suggests that nitrogen loads measured in the river are significantly smaller than the estimates of nitrogen leached from the root zone. This nitrogen attenuation capacity appears to vary among the sub-catchments of the catchment. The on-going field observations, surveys and experiments indicate denitrification as a key NO3-N attenuation process in the catchment. Further monitoring, surveys and experiments are being conducted to assess the effects of different hydrogeologic settings on NO3-N transformations in the unsaturated and saturated 'shallow groundwater' of the catchment. This research aims to identify the most critical areas for targeted management and mitigation measures in order to reduce nitrogen loads and their likely impacts on water quality and river health in the catchment.

Abstract number 249 - REAL-TIME-MONITORING OF NUTRIENTS AND PHYSICO-CHEMICAL PARAMETERS FOR DETECTION AND DIFFERENTIATION OF IMPACTS IN SMALL AND MIDDLE SCALE CATCHMENTS

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Real-time measurements in high frequencies do not only allow to bring out the course of concentration changes in surface waters. Furthermore they provide the differentiation of impacts from punctual and diffuse sources as well as the detection of their sources and emission pathways. By dint of mobile measuring stations different parameters such as nutrients, oxygen, temperature, pH value and conductivity are measured online in a 5 to 10 minutes frequency. These measurements are simple, reliable and for the most part low-priced. The evaluation and interpretation of different parameter combinations considering climatic data and discharge allow to draw different conclusions, universal

ones as well as catchment area- or site-specific ones and to detect impacts entered by surface flow and interflow. So it is e.g. possible to differentiate between agricultural discharge and waste water such as industrial and urban waste water or such coming storm overflows. But not only the origin but also the level and duration of impacts can be traced, seasonal variations can be estimated and loads exactly be calculated. The results enable authorities to plan and take effective measures to improve the water quality and support the implementation of the European Water Framework Directive and other demands of water management.

Abstract number 267 - DEVELOPMENT OF IMPACT INDICATORS FOR AGRI-ENVIRONMENT RURAL PAYMENT MEASURES ON WATER QUALITY IN SCOTLAND

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European Commission (EC) agri-environment payments account for around 2.5 billion euros per year and in the context of water quality, the EC require post-hoc evidence (in the form of policy impact indicators) to assess whether these payments are well designed. This paper describes a methodology to provide an impact indicator for rural payments water quality options through the Scotland Rural Development Programme (SRDP) from 2007-2013. The Rural Priority options were grouped into several categories according to likely impact on water quality: Manure/slurry storage; Arable reversion to grassland; Low intensity grazing; Water margins; Organic farming; Create, restore and manage wetlands; Creation and management of woodland; Extended hedges and grass margins; Restoration of floodplains; Biodiversity of in-bye land. The pollutant that is most frequently associated with failure of Scottish fresh waters to meet good ecological status (GES) is phosphorus (P) in the form of inorganic phosphate. A rationale for the estimation of the impact of each of the categories of measure on P loads to water, has been devised. To calculate these impacts of SRDP on P loads on a 1km2 scale a Geographic Information System protocol was developed to process field level data by the Scottish Government's Geographic Information Science and Analysis Team (GISAT) in conjunction with the Rural and Environment Science and Analytical Services (RESAS) division. Data was supplied by the Rural Payments and Inspections Directorate (SGRIPID). The output was a set of maps presenting the impact of these measures at 1km2 scale across Scotland.
Of the measures considered, "Creation and management of woodland" and "Creation, management and restoration of wetlands" were found to have the strongest impact on P loads, each accounting for 45% of the P loads mitigated, Of the 14 Water Framework Directive Priority Catchments, the strongest overall impact of SRDP measures on water quality status was in the Ugie and Buchan coastal catchments, both in the NE of Scotland. An approach for cost:effectiveness analysis (CEA) of SRDP measures for mitigating TP loads to standing waters at catchment scale has also been described, which illustrates the sensitivity of the measures employed to target P load reductions.

Abstract number 271 - THE NEW ZEALAND SUSTAINABILITY DASHBOARD: ONLINE SUSTAINABILITY ASSESSMENT AND REPORTING TOOLS TO ACHIEVE QUALITY WATER OUTCOMES IN A LOW REGULATION POLITICAL ENVIRONMENT

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Efforts to mitigate environmental impacts are increasing globally using very different governance and incentive strategies. New Zealand (NZ) has hardly regulated land use and water quality outcomes and there are no agricultural subsidies, although regulation is now increasing. The European Union (EU) approach is 'top down' in that universal measures are applied across broad areas using regulation and payments for ecosystem services, while NZ has taken a more 'bottom up' approach since the mid 1980s based on modelling soils, climate, hydrological and farming practices, and community set water quality objectives. Therefore, the NZ approach to improve and secure water quality relies on market mechanisms and the active involvement and engagement of agricultural industries working with producers, legislator and society.

In this paper we analyse how the New Zealand Sustainability Dashboard (NZSD), a bottom-up and industry led project could improve water quality. NZSD is a multi-industry and transdisciplinary project aiming at facilitate practical change at the farm level. It deploys a package of tools for sustainability assessment, auditing, reporting, benchmarking performance to incentivise farming change, and learning. It monitors and reports indicators relevant to New Zealand industry, society, ecology, land and water care. It is being developed in close co-operation between industry and academics coving a wide spectrum of disciplines from physics, chemistry and biology through to computing, economics and sociology. Although the primary goal is to empower local producers to improve their management and sustainability, it also allows overseas consumers and governments to benchmark and verify the sustainability credentials of NZ agricultural produce.

We conducted a self-reflexive analysis of the NZSD program, which included stakeholder interviews, observation of industry-driven workshops along with reviews of industry literature and media. We show in this paper how such collaborative and industry driven approach produce legitimate and relevant incentive to change at the farmer level. We also identify success factors and barriers hindering farmer participation and adoption in sustainability programs and in particular the use of sustainability assessment tools. From our results, we derive specific and generic recommendations about the NZSD, and apply these more widely to agricultural industries committed to enhancing their environmental sustainability including water quality. In doing so, we also consider how bottom-up, market-based approaches differ from regulatory governance as practice in the EU, and how these different approaches might influence the development of a more sustainable farming economy in the future.

Abstract number 276 - VULNERABILITY OF DRINKING WATER RESOURCES IN A CHANGING ENVIRONMENT

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The objective of this paper is to assess the vulnerability of water resources, especially of drinking water resources, under climate and land use changes. The developed methodology has been successfully tested in Austria and was also applied at a larger grid scale to South Eastern Europe.
The overall vulnerability of water resources is defined here by a set of four indicators referring to water quantity availability, water quality, ecosystem services (ESS) and socio-economic adaptability. The latter expresses the capacity of a society to cope with adverse impacts by considering mainly the economic potential of the society to invest in additional measures to ensure water provision. Three ESS functions were considered for preservation of water resources: water provision, water regulation and water quality regulation.
In this paper the methodology and results will demonstrated for Austria. The water availability was estimated for Austria by a water balance model simulating local runoff at a 1 km2 grid scale. The spatial water consumption pattern was modelled at the level of water supply associations which are quite different in scale, ranging from the municipal water supply company of Vienna, serving about 1,86 Mio inhabitants to village water suppliers with a few thousand consumers. The largest water consumption originates from industrial demand, while today's irrigation water demand is small in Austria. The water quality and the ESS were related to land use and population density. Considering agricultural activities and hydrogeological features of groundwater bodies a water quality index was estimated. Future land use scenarios were evaluated in accordance with EEA reports and national projections. Population changes are based on the national forecasts up to 2050. These data were upscaled to the water supply association level and combined with the economic indicator.
The climate change simulations were based on ENSEMBLES projections utilising daily and monthly temperature and precipitation values over the period from 1961 to 2050, at a 25-km spatial resolution.
The overall vulnerability, considering quantitative and qualitative water indicators together with ESS and socio economic capacity, was assessed together with its range for each climate change model and land use scenario.

Abstract number 277 - STRATEGIC POLICY DEVELOPMENT FOR THE PROTECTION OF DRINKING WATER IN AUSTRIA

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Due to intensive agricultural activities alluvial groundwater bodies, previously utilised for regional water supply, are endangered by increasing loads of nutrients and pesticides. Hence in Austria one

national strategic policy development focuses on adequate solutions for forested drinking water protected areas (DWPA). This was also part of the transnational SEE project CC-WARE (Mitigating Vulnerability of Water Resources under Climate Change). Austria faces a situation, where a considerable part of the drinking source waters stems from forested DWPA, either in flood plain or in alpine forests, especially in karst formations. Forested DWPA are known for providing good water quality at low costs. Despite this fact the management practices within forested DWPA have to follow clear management guidelines to support the functionality of the forest ecosystems. Within the CC-WARE project such forest management rules were identified and communicated to stakeholders like water suppliers and administrative bodies. As first step a catalogue of adaptive management in forested DWPA was elaborated, which guarantees the state of the art protection of water resources. This catalogue fosters e.g. the prevention of clear-cuts, the improvement of forest ecosystem stability by establishing tree species diversity close to natural vegetation, the creation of a low-disturbance regime by limiting the timber yield percentage or the protection of the natural gene-pool given in old, strong and stable tree individuals. The second step was the creation of awareness about the challenge of drinking water protection in forested DWPA among relevant players. This was achieved by knowledge transfer workshops, where water suppliers and staff from administrative bodies were invited to participate. The discussion among scientists and these groups guaranteed the exchange on the thematic field and provided new views for some of the participants. The experiences and conclusions gained within the project were disseminated to a broader public by structured workshops in DWPAs, press conferences and meetings to promote the idea of water protection at a larger spatial scale. It can be resumed that the process of awareness-raising was an important step towards the establishment of a national water protection policy.

Abstract number 280 - THE IMPACT OF LAND USE CHANGES ON SOIL EROSION AND THE ROLE OF NUCLEAR TECHNIQUES

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Soil erosion, one of the main degradation processes, is a serious agri-environmental problem. Processes of soil erosion and sediment transport are strongly influenced by land use changes and are exacerbated by intensive farming, improper soil management associated with subsistence farming, deforestation, nutrient mining, as well as heavy rains and storms due to climate change. Approximately 1.5 billion people depend directly on the food produced from degraded land. The end results of soil degradation will be food insecurity, productivity decline, biodiversity loss and falling income, and can ultimately result in human migration and socio-political unrest. While most degraded soils occur in the developing world, even the well-managed and relatively fertile farming land of Europe is being degraded at increasing rates. To meet the increased food demand for our rapidly growing human population, “climate smart” agricultural practices must be developed in order to make soil more resilient against land degradation and climate change. The International Atomic Energy Agency (IAEA), in partnership with Food and Agriculture Organization (FAO) of the United Nations through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, assists Member States in combating land degradation, enhancing soil fertility, minimizing soil erosion, and increasing crop productivity using nuclear techniques: fallout radionuclides (FRNs), compound specific stable isotopes (CSSI), 15N, 13C, 18O, and 2H provide critical information on strategically important issues of soil/land. Some of the key results of IAEA Technical Cooperation Projects in the quantifying soil erosion, identifying its source and the impact of soil conservation measures will be shared with the conference audience.

POSTER

PRESENTATIONS

Abstract number 1 - PRESSSURES OF NITRATES IN THE GROUNDWATER BODIES OF THE SPANISH DOURO BASIN

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The Douro Basin River Authority is developing the analysis of hydrogeochemical evolution and current status of the 64 groundwater bodies defined in the Spanish part of the Douro Basin. The study consists in a synthesis of hydrogeo-chemistry hydrogeological units, identification of pressures and impacts on groundwater: definition, delimitation and characterization of qualitative state of groundwater bodies, and the diagnosis and characterization of the presence of nitrates in the aquifers.
It was developed all work relating to water planning process taking into account the Water Framework Directive and water law. It was characterized the various distinct groundwater bodies in the watershed, highlighting the most important issues in relation to quantitative and qualitative aspects that affect them and propose corrective measures and protection, supporting the achievement of environmental objectives required WFD by the year 2015.
Since 2006, it was done semiannual checkup in 408 points that defined several monitoring network quality of groundwater, in order to relate the present state, evolution and contamination process of the nitrates, and specifying, in each situation, the most probably impact in the public supplies, by springs and drilling wells.
In recent controls, it appears nitrate contamination or risk in the groundwater bodies located above all in the limestones of the moors, and in the Tertiary detrital aquifer on the left bank of the Douro center as well as on the right bank of the western section, possibly as a consequence of the dissolution rate of ammonium thiosulfate fertilizers and NPK There appears a tendency to increase in the concentration of nitrate in some catchments of waters bodies of the moors, and a decrease in tertiary aquifers. In general, the water bodies of the alluvial river are in good condition and have no chemical contamination nitrates, possible because of the irrigation are made with surface water, which implies a strong renewal of water and less pressure on groundwater. Just on time, is detected some samples with concentration in excess of nitrate guide value (25 mg/L).
In summary, the plumes of pollution are the result of strong pressures associated with agricultural practices in vast areas of irrigation and strong livestock pressure. The seasonal variations with maxima and minima are tied to farming and weather incidents: fertilization periods imply an increase; on the contrary, if there are not rainfall, or not agricultural activity, nitrate concentrations drop off significantly, reducing the contamination plumes.

Abstract number 35 - DEVELOPMENT OF A CONCEPTIONAL HYDROGEOLOGICAL MODEL FOR THE TEMPORAL EVALUATION OF PROGRAMME OF MEASURES IN THE FEDERAL STATE OF HESSEN

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The purpose of this study was to understand the climate change impacts on Abbay Basin located in Northwest of Ethiopia, using the RegCM3 Regional Climate Model. The RegCM3 model nested with the ECHAM5 General Circulation Model (GCM) were applied. Statistical Down Scaling Method

(SDSM) is applied in order to downscale the climate variables at catchment level. A hydrological model, HBV-96 was utilized to simulate the water balance. In terms of hydrological modeling performance, R2 criteria, the 10 catchments gave generally in the range between 0.60 and 0.81 in calibration and in validation between 0.54 and 0.75, which is good representation of the catchments. The projected future climate variables has two future time series, the first future time series (2031-2040) and the second future time series (2091-2100), for both future time series an increasing trend of potential evapotranspiration in all selected watersheds of Abbay basin is observed and the annual percentage change of PET with respect to the base period (1991-2000) has range between +2.78% and +18.98% at Anger and Beles catchments respectively.

Abstract number 48 - LAND USE CHANGE IMPACTS ON BIODIVERSITY AND WATER QUALITY: A DRYLAND CASE STUDY

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Land use changes are among the most influential factors that trigger an array of consequences significantly affecting ecosystem viability and human wellbeing. Drylands are particularly vulnerable to external stress, with special reference to land use change. The present study was conducted in Sinai Peninsula, one of the driest sites in Egypt. Changes in land use pattern introduced by extractive industries in the study area have had serious repercussions on biodiversity, the quality of life of Bedouin, the main inhabitants of the area, and also on the quality and quantities of water available for agriculture and human consumption. Coal mining, one of the major activities in the area, has been the precursor of massive soil pollution, with total petroleum hydrocarbons, (TPH), one of the main constituents of coal mining. Concentration of TPH, and iron were monitored in the vicinity of the mine, and compared to concentrations recorded at distant areas far from the mine. The concentration of TPH and iron in the close proximity of the mine were 5000 mg Kg-1, and 16500 mg Kg-1, respectively, while the concentrations recorded at 2000 m distant from the mine were 260 mg Kg-1 and 5000 mg Kg-1 for TPH and iron respectively. The impact of soil contamination on faunal population was further studied. Samples of soil from different distances from the coal mine were analyzed and their faunal profile studied. Results shown a positive relationship between proximity to the coal mine and the abundance of soil biodiversity. The lowest number of microorganisms and nematodes were recorded in samples collected from close proximity of the coal mine. On the other hand, the highest number, and most abundant micro organisms and nematodes populations were recorded in soil samples collected from the most further sites from the mine. Moreover, micro organisms collected from the close vicinity of the mine have had some noticeable distortion in their structure, accompanied with malformation. Furthermore, water samples collected from nearby sites showed some residue level of a number of heavy metals, including cobalt, nickel, iron and others, presumably resulted from leachate of the mine and the heaps of coal stored in the open areas around the mine.

Abstract number 57 - WHAT IS THE 'EFFECTIVE AREA' OF A URINE PATCH?

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Cattle urine patches are widely regarded as a key contributor to nitrate leaching in pastoral systems because the N loading (up to 1000 kg N per hectare) in a single urine patch is far in excess of what the affected pasture can utilise, leaving the remaining N vulnerable to leaching. A urine patch consists of a 'wetted area' (where urine is directly voided) and an 'effective area' which also includes an area outside the wetted area (as well as the wetted area itself) that can access urinary N through plant root extension and N diffusion through the soil.
Quantitative data on the effective area is scarce and many studies investigating N cycling dynamics under urine patches have not accounted for pasture uptake and soil N dynamics in the effective area. We present results from a field trial where 15N enriched urine and natural abundance urea fertiliser treatments were applied concurrently to soil under ryegrass (Lolium perenne L.) and white clover (Trifolium repens L.) pasture. The objectives of the study were to determine the effective area of a 15N enriched urine patch and also to quantify pasture response and soil N dynamics in the effective area.
Circular plots consisting of a urine patch 'wetted area' and the potential 'effective area' were established and the pasture and soil N pools were monitored inside three distinct zones. A total of 22% of the urinary 15N was recovered in pasture outside the wetted area, mainly due to surrounding plant root proliferation. Recovery of urinary 15N in the soil was much smaller than in the pasture and was short-lived. Urinary N was recovered in the pasture up to 0.5 m from the edge of the wetted area, resulting in a total potential effective area of up to 2 m2 (up to 6 times the wetted area).

Abstract number 58 - FLOWCAP – LOAD ASSESSMENT WITH PASSIVE SAMPLING IN DRAINAGE EFFLUENT: FIELD EXPERIMENT IN THE MINERALS POLICY MONITORING PROGRAMME (LMM)

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Agriculture is an important source of nitrogen and phosphorus contamination of surface and ground water. Still, in many areas in the Netherlands there is no clarity about the contribution of agriculture in

surface water load compared to other sources of nutrients, such as sewage systems or naturally nutrient rich seepage water.
The Dutch Minerals Policy Programme (LMM) monitors the quality of water leaching from agricultural lands on a national scale, sampling about 450 farms through the Netherlands. Drainage water is one of the water types addressed in the LMM. Concentrations in drainage effluent are measured by grab samples taken with a fixed frequency. This strategy provides trends in concentrations at a regional scale. However, grab samples give only random indications of loads from farm lands at a local scale, due to rather variable concentrations and highly variable discharges of drainage water. To determine the contribution of different sources we would like to measure loads instead of concentrations.
Since 2010 the LMM started in cooperation with other stakeholders* the development of a measuring system (Flowcap) for discharge average concentrations. The Flowcap is based on the SorbiCell, a passive sampler for time average concentrations. SorbiCells are porous cartridges filled with sorbents, designed to retain specific chemicals, in this study phosphorus and nitrate. It also contains tracer salt, dissolving proportionally when water passes the cartridge. The ratio of the mass of the adsorbed chemicals and the sampling volume results in a time average concentration.
The Flowcap is based on the relation between the water pressure and the flowrate through the SorbiCell. The Flowcap is placed at the end of a drainage pipe, holding one or more SorbiCells. The outlet of the Flowcap has the shape of the Eiffel tower, ensuring a profound linear relation between the discharge of the drainage pipe and the sampling rate of the SorbiCell. Thus, the SorbiCell in the Flowcap generates a discharge average concentration and its sampling volume is a measure for the discharge of the drainage pipe: with these data loads can be assessed.
In the past years prototypes of the Flowcap have been tested under field conditions, resulting in some practical adjustments and a new designed Flowcap. In the winter of 2014/2015 this new Flowcap is being tested on three farms in the LMM. This poster will address the results of the latest field experiment.
*SorbiSense-Denmark, Deltares, Alterra, LTO Glaskracht, Waterboard Schieland and Krimpenerwaard

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Abstract number 61 - DEROGATION MONITORING IN THE NETHERLANDS (2006-2012)

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The EU Nitrates Directive obligates member states to limit the use of livestock manure to a maximum of 170 kg of nitrogen per hectare per year. Dutch farms were allowed to deviate from this requirement under certain conditions, and apply up to 250 kg of nitrogen per hectare (since 2014: 230 kg in parts of the Sand Region and in the Loess Region). The Netherlands is obligated to monitor agricultural practices and water quality at 300 farms to which derogation has been granted.
Method and data
The Derogation Monitoring (DM) is a sub-programme of the Minerals Policy Monitoring Programme (LMM). The objectives of the DM are monitoring the water quality on farms and explaining the results in relation to agricultural practices on these farms. Farms are selected by stratified random sampling 261 specialised dairy farms and 39 other grassland farms. The DM distinguishes four main regions: the sand, clay, peat and loess region. Agricultural practice data (for instance farm characteristics, fertiliser usage and crop yields) is available from the Farm Accountancy Data Network (FADN). Calculated is the nitrogen and phosphate surpluses on the soil surface balance. Alongside the input quantities of nitrogen and phosphate in organic and inorganic fertilisers and the output quantities in crops, allowance is also

made for net mineralisation of organic substances in the soil, nitrogen fixation by leguminous plants, and atmospheric deposition. Data on water quality is focussed on the quality of water leaching from the root zone and ditch water. LEI is responsible for collecting and evaluating data on farming practices and nutrient management. RIVM is responsible for monitoring and analysing the water quality at participating farms.
The average nitrate concentrations in ditch water and water leaching from the root zone decreased in all regions in the period 2007-2013. The phosphorus concentrations did not deviate from the average of the preceding period, and displayed no clear trends except an upward trend for ditch water in the Sand Region and a downward trend for ditch water in the Clay Region.
The nitrogen soil surpluses in each region did not change during the period 2006-2012, although the nitrate concentrations did decrease in all regions. A general assumption is that nitrogen excreted during grazing is less efficient for plant production than other fertilisers. Possible causes for the declining nitrate concentrations are a decrease in grazing during the measurement period and after-effects.
The phosphate surplus on the soil surface balance displayed a downward trend. The phosphorus concentrations in water leaching from the root zone in the Clay Region also displayed a significant downward trend. It is unclear if this is caused by decreasing phosphorus surpluses.

Abstract number 65 - IRRIGATION WATERS QUALITY ECOLOGICAL ASSESSMENT AND THEIR IMPACT ON SUBSOIL WATERS

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Heavy metal (HM) compounds are one of the most significant elements of dry land natural waters toxic contamination. Those, unlike organic substances, are not biodegradable. While assessing the natural Ukrainian waters usability for irrigation, the content of the following HM was determined: Zn, Cd, Ni, Co, Fe, Mn, Pb, Cu, Cr.
Alongside with that the irrigation waters quality of practically all main irrigation sources in Ukraine with different anthropogenic burden degree was studied. It was indicated that the water in sources with no significant man-induced impact, is mostly good for irrigation. If the man-made burden increases (regional and local contamination), the notable HM concentration (1,1 – 3,0 times higher than MPC) and water quality deterioration is observed, limiting its` dedicated use, or making it unusable for irrigation. The studies performed confirm that different irrigation sources have individual mechanisms and processes for heavy metal complexes content formation.
Many researchers consider subsoil waters to be biogeochemical barriers, which become even more significant if the anthropogenic burden grows substantially. That is why studying the subsoil waters condition is necessary in the setting of economic activity intensive impact. Our study of HM content in subsoil waters in irrigation area enabled us to establish the following trends: these elements` concentration increase with aridization intensification and mineralization increase; link between HM content in irrigation waters – soils – subsoil waters system». Chemical composition transformation (HM content) of irrigation waters after their movement through soil was noted, indicating significant influence of soil and soil-forming material properties on speed, intensity and direction of migration as well as element accumulation.
Thus, ecological condition of irrigation and subsoil waters in particular region shows natural condition transformation under the impact of man-made and agro-irrigation burden and it is also the water resources integral characteristic. That is why activities related to controlling HM content in irrigation and subsoil waters have special significance, both from the perspective of timely detection of potential negative developments in waters as well as aiming at determining actual irrigated lands ecological-agrodevelopmental condition. Those are to lay foundation for developing and implementing a number of measures to reasonably use, improve the condition, protect and reproduce surface and underground waters, increase irrigated lands productivity and to deliver quality agricultural products..

Abstract number 68 - N AND P CONCENTRATION-DISCHARGE RELATIONSHIPS IN STREAMS: WHAT CAN THEY TELL US ABOUT NUTRIENT FLOW PATHS?

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Waikato Regional Council operates a river water quality monitoring programme where samples are taken monthly at 114 sites and analysed for concentrations (C) of a range of water quality parameters. Water flow (or discharge, D) is measured at or nearby 26 of these sites, which allows concentration–discharge relationships (C-D relationships) to be established.
The overall patterns of the C-D relationships for N and P were surprisingly similar across the region in spite of substantial differences in natural conditions, land use and the potential effect of point source discharges. Statistically significant C-D relationships were found at nearly all sites for total nitrogen, nitrate nitrogen and total phosphorus, although the corresponding coefficients of determination varied widely between nutrients and sites. All but two relationships were positive, i.e. concentrations generally increased with increasing discharge.
Positive C-D relationships are often presumed to reflect that the stream water chemistry at low discharge is dominated by input from the older and less polluted groundwater reservoir, while shallower flow paths (interflow, artificial drainage, surface runoff) transferring younger water that is more enriched with nutrients become more important at higher discharge. We investigated two supplementary parameters (silica, electrical conductivity) to explore whether they can be used to corroborate the presumed flow path/water age relationship.
Stream water silica concentrations can potentially be used as a crude proxy for water age, as the silica concentration of water generally increases with increasing contact time with silica-bearing minerals in the subsurface. Statistically significant negative C-D relationships were found at 18 of the 26 sites, i.e. supporting the presumed flow path/water age relationship. However, the small size of the available data sets (max. n=12 per site) prevented an in-depth analysis. EC is routinely measured and is in the absence of major point sources also primarily determined by the geology. Accordingly, statistically significant negative C-D relationships were found at 22 of the 26 sites, but sometimes low coefficients of determination also limited the utility of this parameter. Ongoing analysis aims at identifying the conditions under which silica or EC data can confidently be used.

Abstract number 69 - THE INFLUENCING FACTORS OF THE FISH INDEX OF BIOTIC INTEGRITY (F-IBI) IN HEALTH ASSESSMENT OF HEADWATER STREAMS

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The fish index of biotic integrity (F-IBI) is a commonly used indicator in river health evaluation, whose influencing factors, have not been figured out clearly so far.

From 2011 to 2012, in two river in the mountainous area of South Anhui, China, the fish assemblages, local habitat factors, tributary spatial positions and types of surrounding land use were investigated in 60 sample segments within headwater streams (including 1st-, 2nd-, and 3rd-order streams). Then four metrics including the Margalef's diversity index, the number of indigenous benthic fish species, the proportion of tolerant individuals and the number of omnivorous fish species, were selected out of 49 candidate metrics to calculate F-IBI scores, which were obtained by the method of continuous rating, with reference points hypothesized according to the surrounding land use.
The results shown that the average score of F-IBI in the Changjiang River was 23.93, while the Qiupu River's 19.75, impling the health of the Changjiang River is better than that of the Qiupu River.
Subsequently, an analysis was conducted on the relationship between F-IBI scores and the factors covering local habitat, tributary spatial position, surrounding land use in each river, whose results are as follows:
1) Spearman's correlation analysis showed that, in the Qiupu River basin, the F-IBI was positively correlated with local habitat factors (i.e. substrate coarseness), and tributary spatial position (i.e. stream order and stream link) ($P<0.05$). While the Stepwise Linear Regression analysis found that the F-IBI of the Qiupu River sample segments was affected significantly by habitat environmental factors (i.e. substrate heterogeneity) and tributary spatial position (i.e. stream link) ($P <0.05$).
2) In the Changjiang River basin, the F-IBI was positively correlated with local habitat factors (i.e. dissolved oxygen, water surface width, water temperature), and tributary spatial position (i.e. stream order, stream link) by Spearman' s analysis ($P<0.05$), while the Stepwise Linear Regression analysis identified that local habitat environmental factors (dissolved oxygen, water surface width) had a significant influence on the F-IBI ($P <0.05$).
3) In addition, the results indicated that the surrounding land use hadn't any correlation with the F-IBI according to above analysis, even though it is the basis for proposing the reference points in F-IBI evaluation.
When the F-IBI is used to evaluate the river health of headwater streams, the specific influencing factors including the local habitat's conditions and its spatial position in river network, have to be taken into consideration.

Abstract number 75 - STATISTICAL TREND ANALYSIS OF NITRATE CONCENTRATION IN ROOT ZONE LEACHING – THE CHALLENGES AT LOWER CONCENTRATIONS

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Nitrate concentrations have been measured in the upper meter of groundwater on farms in the Sand Region in the Netherlands to evaluate the effect of minerals policies since 1992. In the period 1992-2013 average nitrate concentration decreased from above 150 mg/l to below 60 mg/l. Annual variations in groundwater recharge have a major influence on the annual mean measured nitrate concentrations. Dilution of dissolved nitrogen leaching from the root zone varies with the varying amounts of precipitation surplus between years. This annual variation complicates the analysis of trends in nitrate concentration and may blur the effects of measures taken to lower nitrate concentrations.
A calculated indicator for the precipitation surplus is used to index nitrate concentrations for these annual variations in recharge. This indicator is calculated by using data for precipitation and evaporation in a mechanistic soil model for water flow and solute transport. A statistical model is used to estimate nitrate concentrations free from the effects of variation in groundwater recharge. However, in recent calculations the influence of the indicator on the estimated nitrate concentration has become much smaller. The statistical model was no longer able to fully account for the presumed effect of the groundwater recharge on the measured nitrate concentrations in the 1992-1998 period. We postulate that

this diminished effect of the indicator in the statistical model on the estimated nitrate concentrations is due to smaller effects at the lower nitrate concentrations than at higher concentrations. In the past 6 years nitrate concentrations have been on average relatively low and constant, while in the 1990s concentrations were both high and highly variable. A further complication is that the indicator also shows a little less variation during the latter years. In the 1992-1998 period averages at dairy farms varied between 0.59 and 1.81 and between 0.95 – 1.49 in the 2006-2013 period. In this study we look into the options for coping with the challenges that the indicator poses to our statistical model. The goal is the creation of a more robust statistical model for estimating nitrate concentrations and to gain more insight into the soil-water-plant system.

Abstract number 78 - EVIDENCE-BASED SUSTAINABLE PHOSPHORUS USE IN AGRICULTURE IN FLANDERS (BELGIUM)

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Phosphorus (P) is an important nutrient for agriculture but excess P application to soils can contribute to eutrophication of surface waters. Phosphorus fertilisation recommendations rarely take environmental concerns into account (Jordan-Meille et al., 2012). Soil P tests used for soil P content measurements mostly build on chemical extractions for which empirical (not mechanistic) relations with crop responses are determined.
Recently, the Flemish Land Agency (government of Flanders, Belgium) initiated a research project to stimulate sustainable phosphorus use in agriculture. Three research institutes (Institute for Agricultural and Fisheries Research (ILVO), Soil Service of Belgium and KU Leuven) started this four-year project at the beginning of 2015. In the first phase of the project, soil P tests are evaluated in order to select the (combination of) soil P test(s) that best reflect both (i) the P availability for plants and (ii) the risk of P losses towards surface waters at a relatively low cost. Several common and new tests (ammonium lactate extraction, 0.01 M CaCl2 extraction, oxalate extraction, Olsen extraction, etc) are compared in a pot experiment in a depletion scenario and on soil samples from 14 long term fertilisation field trials in NW Europe with reported yield differences due to soil P differences. Suitability of the test is assessed by the correlation with crop yield and the relative width of the 95% confidence interval of the critical soil P content, i.e. the soil P content corresponding with 95% relative yield. Not only single soil P tests but also combinations are evaluated. According to van Rotterdam-Los (2010), especially the combination of a soil P test reflecting P intensity (directly available P) and one reflecting P quantity (P available in the long term) shows promise for describing the behaviour and availability of P. The same tests are also evaluated for correlations with soil P losses by performing soil column leaching experiments under unsaturated conditions. The selected test(s) will be used in the second and third parts of the research project. In this second part, the soil P contents at which yields are optimal and losses still small, will be defined as the target zone. In the third part, we will derive soil P fertilisation advice in order to reach or

remain in the target zone from sorption/desorption experiments and field trials. The outline of this project and its first results for sustainable P use will be presented and discussed.

Abstract number 79 - MEASUREMENT OF AGRONOMIC EFFICIENCY OF NITROGEN INPUT

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Analysis of farming data derived from the Dutch LMM Programme (Minerals Policy Monitoring Programme) showed that the amount of nitrogen surplus in the soil is an important factor for nitrogen leaching. The amount of nitrogen surplus is positively related to higher fertilisation levels and negatively to higher yield levels of crops. By analysing the variation in yield and nitrogen application levels, insight can be gained in the possible amount of the reduction of nitrogen surplus and therefore in improvement of water quality.
Given the variation in application and yield levels some farmers are able to produce a certain yield level with less nitrogen than other farmers even if they produce under comparable conditions. Farmers in the comparable group with the lowest nitrogen input given a certain yield level are 100% efficient. For less efficient farmers it is interesting to learn that the results suggest that they can decrease their nitrogen application and therefore must be able to save fertiliser costs. Decreased levels of nitrogen application will further enhance water quality. This kind of measured efficiency is called the input saving efficiency.
On the other hand it is possible to measure the output increasing efficiency: given a certain nitrogen application level the farmer with the highest yield level is 100% efficient. Famers with a lower yield level must be able to increase their yield level because they produce under comparable conditions. For farmers the output increasing efficiency is more attractive to focus on as it will result in bigger income improvements than the focus on the input saving efficiency. From the environmental point of view the challenge will be to support the farmer to take those measures that reduce nitrogen surplus while maintaining or preferable increasing income.
Based on data from the LMM programme both efficiency scores will be calculated and discussed. The analysis will be focussed on dairy farms on sandy soils as water quality is especially a problem on sandy soils. Dairy farms differ in their ratio of maize and grass land. By using DEA (Data Envelopment Analysis) the nitrogen input and yield level of each farm will be only compared with other comparable farms given their ratio of maize and grass land.
The results on efficiency scores will be discussed concerning variability of efficiency scores between years and their implications for possible improvement of the efficiency scores.

Abstract number 85 - EFFECTS OF DAIRY FARMS LIVESTOCK GRAZING ON NITRATE LEACHING IN THE SAND REGION OF THE NETHERLANDS

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During the 1992-2013 period nitrate concentrations decreased more than nitrogen surpluses on dairy farms in the Sand region of the Netherlands. During the same period livestock grazing declined in favour of an increasing number of non-grazing dairy farms. This follows from the database of the national Minerals Policy Monitoring Programme (LMM). During the 1992-2013 period 329 dairy farms were visited and about 1600 visits were made in total. At each visit 16 samples of the upper meter of groundwater were taken for chemical analyses. Farm management of the foregoing year was registered.
Past research has indicated that nitrogen excreted during grazing is less efficient for plant production than nitrogen applied with artificial fertilisers and animal manure by the farmer. Grazing enhances nitrate leaching. Besides nitrogen use and grazing, soil type, soil drainage, crop type, time of sampling within a year and precipitation surplus influence the nitrate leaching concentration.
Our goal was to find prove in the LMM database that nitrogen leaching has decreased more than nitrogen surpluses because of a decline in grazing.
The farm mean nitrate leaching concentration of a sampling visit was statistically related to grazing. Nitrogen use, precipitation surplus, the soil drainage, the fraction of arable land (silage maize) and the sampling month were added to the model as fixed effects co-variables. As well as for grazing as for nitrogen use different indicators were used. The year and farm of sampling were added to the mixed model as random effects.
The results give no significant evidence for the expected effect of grazing on nitrate leaching while the co-variables do show effects as expected. Only when the year of sampling is left out of the model, it is found that less grazing leads to less nitrate leaching. By incorporating the year of sampling into the model more emphasis is placed on differences in grazing between farms during a year, while by leaving year out of the model more emphasis is put on differences in grazing between years.
Because we have not been able to explain the lower fraction nitrate leaching of lower N surpluses by less grazing, we hypothesized, alternatively, that the most simple reason is a limited amount of denitrification capacity.

Abstract number 89 - INFLUENCE OF AGRICULTURE ON THE QUANTITY OF NITRATES IN DRINKING WATER IN RURAL AREAS IN UKRAINE

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In Ukraine the nitrates continue polluting the groundwaters, which are consumed by the rural population without being purified. Therefore, we have assessed the level of nitrates quantity in the water, which is consumed by the population of the rural areas – from the wells, chinks, springs, rivers and reservoirs.
According to the research, the water from the wells is the most contaminated one by the nitrates. In 2012, on average in 38 % of the wells of Ukraine the concentration (MPC) of nitrates in the water exceeded the maximum permissible concentration – 45 mg/l. The average excess of MPC is 2.5 times.

The largest number of wells with nitrate excess was recorded in the Steppe zone of Ukraine, particularly in Zaporizhia (78%), Mykolaiv (76%), Donetsk (69%) regions. Significant number of wells with the excess of the nitrates of MPC was found in some areas of Forest-Steppe zone - Kharkiv, Ternopil, Vinnytsia regions.
The water form sources and chink is significantly less contaminated by the nitrates – 15% and 11% respectively. The most polluted sources and chunks are situated in the Steppe zone.
The nitrates concentration in the open water sources is much smaller. The rivers, ponds and water utilities are almost not polluted. The main reason that is influencing the difference of the nitrates' quantity levels in the open water is a natural mode of temperature regime and moisture.
More detailed research was carried out in 6 areas of Zaporizhia region. Almost all the water from wells of agricultural landscapes area is polluted by nitrates. In four regions the quantity of the polluted wells varied from 36 to 85%. The nitrate ions concentration in some wells exceeded MPC 3,8 to 25 times.
First of all, such situation is related to situation in villages where water samples were taken. In many wells the water is not purified, the distance between the buildings in the infield territory does not comply with the requirement. Nitrates are not absorbed by soil, therefore they are washed away by rain water easily and migrate to a depth of groundwater.
The excess of nitrates in the water was found only in 2 districts and was higher 2,4 to 4 times.
Therefore, the introduction of the centralized water supply, which could partially solve the problem of the drinking water quality, is now a burning issue for the rural areas.

Abstract number 103 - ZONE IN UNDERSTANDING NITRATE AND PESTICIDES TRENDS IN A FLUVIOGLACIAL AQUIFER OF THE EASTERN PART OF LYON, FRANCE

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The Meyzieu fluvioglacial aquifer of 113 km2 is located at the eastern part of Lyon is composed of sand and gravels. The unsaturated zone has a maximum depth of 80 m depth and is composed of sand and gravels.
Nitrate is the element degrading most groundwater in Meyzieu. Since 2011, monthly monitoring of NO3 is carried out at three sampling points located along the flow lines. Based on the hydrogeological understanding and existing pressure complementary parameters were selected to be analysed in addition to the main contaminant included major elements and some pesticides and their metabolites.
At the sampling point located upstream StExupéry, where the unsaturated zone is of about 40m, the nitrate concentrations are comprised between 20 and 40 mg.l-1 from 2004 to mid-2013. From mid-2013 nitrate concentrations are increasing regularly and are now reaching 70 mg.l-1. This NO3 increase corresponds to an important aquifer recharge following two rainy years.
The interpretation of the chemical data allowed a first understanding of this nitrate increase. There is a linear relationship between NO3 and Cl concentrations. The monitoring indicates a threshold value equal to 30 mg.l-1 from where the relationship between Cl and NO3 evolves. For NO3 concentrations below 30 mg.l-1, the Cl/NO3 ratio is close to 5 and the coefficient correlation is equal to R^2=0.75. For NO3 concentrations above 30 mg.l-1, the Cl/NO3 ratio is equal to 7 and the coefficient correlation is equal to R^2=0.89. The linear relationship between NO3 and Cl indicates that the changes in concentrations can be described by a mixing scheme. Assuming that chloride behaves conservatively in the studied system, the decrease of Cl/NO3 ratio reveals a change in the end-members when the NO3 concentration increases. The year 2013-2014 was particular concerning rainfall, leading to a higher recharge during this time period compared to the previous one. In consequence, we hypothesized that

the changes in the Cl/NO3 reveals remobilization of NO3 stocks present in the unsaturated zone during the period going from June 2013 to nowadays.

Abstract number 109 - IMPACTS OF IRRIGATED-MAIZE FIELDS ON WATER QUALITY IN MEDITERRANEAN CENTRAL CHILE

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In Mediterranean central Chile, there are two main evidences that point out to larger contribution of agriculture runoff and leaching to groundwater and surface water pollution. First, this area comprehends the largest hog population related to food industry, thus consequently having the largest maize production area of the country, including around 5000 small farmers. This crop, which constitutes a monoculture, is systematically N and P over-fertilised, probably causing runoff and lixiviation of contaminants such NO3- and PO43-. Secondly, the NO3- concentrations are showing an upward trend particularly in the Rapel basin, located in the O'Higgins Regions. Elevated levels of N and P forms have been observed in water transported by open drainage channels studied neighbouring the maize fields during 2011-2014. However, these elevated N and P concentrations pointed out by the water monitoring cannot be attributed solely to the over fertilization of the maize fields, since the particular basin dynamics should not be overlook. Additional contribution of N and P forms may be occurring upstream, since the over fertilization practice and the influence of irrigated maize production represent a constant risk of pollution. However, the neighbouring fields were still a non-point source of pollution, as agricultural management of the soil near the drainage channels had a major impact on the load of pollutants transported in the channels which are connected to the hydrological net of the Rapel basin. Overall, the greatest emphasis must be placed on the agronomic management of fields neighbouring drainage channels in order to accurately calculate N and P fertiliser rates and establish mitigation measures. Particularly, a field study showed that narrow buffer strips cover by permanent strip grass removed a significant amount of NO3- after a 3-year period in this Mediterranean area. In addition, participatory research and voluntary programs in agricultural non-point pollution have been carried out with local farmers, showing promising results for reducing N and P loading to water bodies in the Rapel basin.

Abstract number 115 - CONTINUOUS PASSIVE FLUX SAMPLING IN GROUNDWATER: RESULTS FROM A FIELD STUDY IN NORTHERN DENMARK

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Many groundwater reservoirs are at risk of being contaminated with nitrate as a result of intensive agricultural production. It is well accepted that most N entering the soil and thus are responsible for nitrate in groundwater is human-induced. It is estimated that crops on average use only half of the

nitrogen applied, leaving the excess nitrogen available to volatilization, denitrification, leaching, and storing. The European Union has set a limit value for nitrate of 50 mg L-1 in groundwater and member states are required to formulate Action Programs to improve water quality and to monitor the effects of these. However, these monitoring programs are problematic both in term of interpretation and funding. Grab sampling, which is a commonly used method, only provides a snapshot of the nitrate concentration at the sampling time. Further, the sampling frequency is generally not high enough to capture the dynamic behaviour of groundwater fluxes. An increase in sampling frequency is often not an option due to laborious and expensive sampling, sample transportation and analysis.
Using the Fluxsampler, an advective passive sampler designed to be installed in groundwater wells it is possible to measure the flux of nitrate or any other compound of interest, as well as the groundwater flux in the installation period. The Fluxsampler consists of an adsorbent and a tracer salt in a permeable casing. The pressure gradient across the groundwater reservoir creates a flow through the Fluxsampler, where nitrate or the compound of interest is adsorbed, while the tracer salt is simultaneously release proportionally to the water flux. The design of the Fluxsampler also allows for determination of flow direction of the groundwater.
Results from one field study in Northern Denmark will be presented. The arable field was equipped with 12 Fluxsamplers distributed in 6 groundwater monitoring wells. Results will be compared to results from a traditional grab sampling program on the same field.
The Fluxsampler requires no electricity and is designed to be installed in already existing groundwater wells and can remain installed for up to 3 months, to give the average nitrate and groundwater flux during that time. This long installation time will significantly decrease monitoring costs and will enable large-scale monitoring of contaminant and water fluxes in groundwater. This will give valuable input to optimization of fertilizing management and regulatory control.

Abstract number 125 - A DPSIR ANALYSIS OF WATER USE AND RELATED WATER QUALITY ISSUES IN THE COLOMBIAN ALTO AND MEDIO DAGUA (AMDA) AND BAJO CALIMA COMMUNITY COUNCILS

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Colombia, endowed with a wealth of surface and groundwater, is among the richest countries in water resources. The Afro-Colombian social-ecological systems (SES) of the Alto and Medio Dagua (AMDA) and Bajo Calima, located at the Pacific coast, constitute an important portion of the country`s aquatic wealth. The Driver-Pressure-State-Impact-Response (DPSIR) framework was used to analyze water quality problems. The DPSIR analysis revealed that agriculture, mining, logging and infrastructure development constitute important sectoral drivers with some contribution from tourism and fisheries. Pressures include inputs of organic matter, sediment, nutrients and chemical contaminants to the rivers Dagua and Calima , and to the bay of Buenaventura. These produce corresponding state changes of the water bodies. Impacts on Human welfare are expressed in poor public health, reduced food and water security and economic loss. Responses include public protest and campaign, legal actions and policy changes. As a future policy option, the formation of community-based water resources management (CBWRM) is recommended. Further empirical research on these water bodies, especially on Calima river is called for to fill the existing information gap. Keywords: AMDA; Bajo Calima; CBWRM; DPSIR; SES

Abstract number 126 - A DUAL ISOTOPE APPROACH TO ASSESS CONTROLLED DRAINAGE AS A NEW MITIGATION MEASURE

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Drainage of soils by using subsurface pipes is a common farming practice in Denmark where around 50% of the agricultural fields are drained. The drainage systems are often transporting high amounts of nitrate directly from the fields to nearby streams with risk of creating eutrophication of freshwater and coastal water bodies. As the loss of (nitrogen) N from the agricultural fields are the dominating N source to most coastal water in Denmark different targeted mitigation measures that can assist in reducing N emissions to surface waters are highly needed. Previous studies have proven that controlled drainage, where the groundwater table on the fields is increased periodically, is a potential method to ameliorate the loading of nitrate from drain pipes. However, controlled drainage has not been tested in Denmark before, nor has it in previous studies been combined with cultivation of a winter crop. Hence the objectives of this study were to i) investigate if controlled drainage can be used as a mitigation measure for nitrogen management in relation to the extended drainage network existing in a large part of Danish agricultural fields ii) investigate if a dual isotope approach of δ15N and δ18O in nitrate can be used as a tracer for changes in soil N processes when using controlled drainage.
The effects of controlled drainage on N losses were examined during a three year period at three sites in Denmark, two sites on loamy soil with four and two subfields (ca. 1 ha each) and one site on a loamy sandy soil with four subfields (ca. 1 ha each). Drain water flow was continuously measured from each of the 10 subfields. Each week grab and composite (hourly sampling) drain water samples were collected and analysed for ammonium, nitrate and total nitrogen concentrations. Furthermore, groundwater levels were measured in piezometers in each subfield. Each month, a drain water sample from a high flow event and from a low flow event were analysed for isotopic composition of N (δ15N) and oxygen (δ18O) in nitrate. The first year was used as reference period, where data sampling was without controlling the drainage system. During the second and third year the subfields on each field were divided into two groups, one being treated (controlled drainage) and remaining serving as controls (free drainage). Results will be shown from applying the dual isotope technique together with actual N mass-balances from the treated and the control-fields.

Abstract number 128 - GROSS NITROGEN BALANCES FOR GROUNDWATER BODIES IN AUSTRIA

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The current assessment of the chemical status of groundwater bodies in Austria revealed that due to elevated nitrate concentrations, four groundwater bodies will not achieve good quality status according to the EU Water Framework Directive. In additional seven groundwater bodies the threshold value for nitrate (45 mg/l) is regularly exceeded at over thirty percent of the monitoring stations. Therefore, a comprehensive list of measures was defined in the National Water Management Plan 2009. In order to evaluate the nitrogen surplus on regional level (level of groundwater bodies) related to the utilised agricultural area, the calculation of nutrient balances was recommended at least for the most vulnerable areas.
In this project the calculation of the nitrogen surplus related to the utilised agricultural area was carried out according to the ‚Gross Nitrogen Balances'-method of the Eurostat/OECD Handbook 2007. The evaluation covered the period 2009 to 2012 for all groundwater bodies. The input factors mineral fertiliser, farm manure, nitrogen fixation, deposition, sewage sludge and compost were compared to the agricultural output of nitrogen. The distribution of the nitrogen fertilisation rates was carried out predominantly according to the ‚Guidelines for proper fertilisation' (BMLFUW, 2006). Fertilisation rates which aim to achieve higher yields were also taken into account. The difference between inputs and outputs over the analysed period show a typical annual nitrogen surplus which represents the potential risk of groundwater contamination with nitrate.
The results of the nitrogen balance show the highest surpluses in areas of higher live stock densities in Styria, in Upper Austria and in single valleys in Tyrol and in Salzburg. With the exception of the groundwater body „Traun-Enns-Platte", the nitrogen surplus in the most vulnerable areas with high nitrate contaminations, however, is below average. The measured nitrate contaminations in these groundwater bodies is mainly due to a high share of farmland, the often negative climatic water balance and low groundwater recharge rates. In addition, there is a high variability of annual surpluses in the eastern part of Austria, which is mainly caused by the fluctuations in agricultural output.

Abstract number 132 - GREENHOUSE GASES: NITROGEN FERTILIZATION AND CO2 EMISSIONS IN A SOIL CULTIVATED WITH WHEAT (TRITICUM AESTIVUM L.) UNDER CONVENTIONAL FARMING IN MEXICALI VALLEY, BAJA CALIFORNIA, MEXICO

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Greenhouse gases emissions in agricultural soils are associated with the type of soil management, properties, land cover and use of nitrogen fertilizers, which impact on crop yields. Conventional tillage

systems in the production of agricultural crops often, use excessive application of nitrogen fertilizer, which is a source of generation of greenhouse gases (N2O and CO2). There is not information regarding the assessment of greenhouse gases emissions in conventional tillage systems most widely used in the Mexicali Valley. The aim of this study was to evaluate the CO2 emission related to the application of nitrogen fertilizer in a soil cultivated with wheat under conventional tillage in the Mexicali Valley, Baja California. This study was conducted at Institute of Agricultural Science, UABC, located in Ejido Nuevo León, Mexicali Valley, BC, México (32º 20´29" N y 115º 11´81" O). The experimental plot, with a soil Typic Haplotorrert was cultivated with wheat (Triticum aestivum) from November 2013 to June 2014, with application of three doses of nitrogen fertilizer (0, 200 and 400 kg ha-1). Soil samples from each treatment were taken, at a depth of 30 cm, before fertilization (November), after each fertilization (January, February, March) and at the end of crop cycle (June). Soil samples were incubated under 65% of field capacity at a temperature of 30°C. CO2 emanated from the treatments was measured after 4, 22, 46 and 142 hours of incubation. The tendency was described by a lineal function (y = ax + b), with the values of b determined from linear regression, a statistical means trial test was carried out (Tukey □=0.05) to determine if there were significant CO2 emission rate related to doses of nitrogen applied to the soil. The magnitude of the emission of CO2 obtained was 194, 247 and 238 mg/g/h for doses 0, 200 and 400 Kg N ha-1 respectively and there was not significantly different (p> 0.05). A higher dose of nitrogen not necessary correspond a higher magnitude of emission of CO2, at less for soil condition in this experiment. However, the emission rate of CO2 was significantly faster in the application of 400 kg ha-1 of nitrogen, with an emission rate of 48.464 mg CO2/g/h. It suggests that at this nitrogen dose promoted a high activity of the microbial biomass that resulted in an increase in the rate of CO2 emissions. Further stages of this experiment are carrying out.

Abstract number 143 - SEDIMENT-MICROBIAL SOURCE TRACKING (MST) FOR OOSTANAULA CREEK WATERSHED

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Removal of Oostanaula Creek from the Tennessee 303(d) list will require too much efforts in reducing concentration of pathogen indicator (E. coli), Sedimentation, and phosphate. The current restoration plan focuses on promoting Best Management Practice (BMP) to reduce sediments caused by fecal pollution from the activities associated with cattle. However, to effectively implement BMPs, it is critical to identify the sediments caused in specific locations of non-point source pollution problems in the Oostanaula Creek Watershed (OCW). This research focuses on the identification of the sources of suspended and deposited sediment in OCW by Sediment-Microbial Source Tracking (MST) tool. Totally, 70 sediment samples, originating from pasture soils, cattle walkways and creek banks, were collected throughout the upstream and downstream of OCW at the city of Athens. The hypothesis of this study is that the microbial communities among different types of sediment samples are different. After DNA extractions and purification of the sediment samples, 16S rRNA gene amplicons were produced, purified and sequenced on a MiSeq sequencer for high-throughput sequencing analysis. The image data are further analyzed and categorized according to different types of soils by computer software, like QIIME, MGRAST and R package. In addition, statistical analysis, like ANOVA, Shannon diversity and PCA, are currently performed to support the characterization of sediments in OCW. In summary, anticipated results will indicate Sediment MST technology can help matching the consortium of bacteria in sediment materials and contaminating sediment to suggest the origin of sediment pollution..

Abstract number 149 - EXPERIENCES WITH DEVELOPING AND IMPLEMENTING WATERSHED SCALE PROJECTS IN EAST TENNESSEE

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For the past 15 years, the University of Tennessee Extension has been successful in developing and implementing large-scale watershed projects in the Pond Creek and Oostanaula Creek, both in the ridge and valley region of East Tennessee. With support from numerous federal and state agencies, these projects these projects have supported graduate students, Extension personnel and funds to implement best management practices (BMPs) and monitor water quality. Our extension and educational efforts have identified and promoted ways of reducing non-point source pollution have resulted in the adoption of many different types of BMPs by landowners in the target watersheds. Agricultural BMPs that have been established include providing cattle with alternative sources of water, fencing cattle out of streams, providing improved access to streams, growing cover crops, repairing and protecting heavy use areas and applying manures and other fertilizers based on crop nutrient needs.

Abstract number 157 - INVESTING IN OUR STREAM BANKS: THE RIPARIAN PROGRAMME IN TARANAKI, NEW ZEALAND

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The region of Taranaki is one of New Zealand's most productive dairying areas. Dairying in New Zealand is pasture-based year round. In Taranaki, the ring plain around Mt Taranaki (a dormant volcano) provides a fertile and temperate climate for the region's 1,800 dairy farms and 490,000 cows. It is also heavily dissected by its pattern of radial streams. With 13,000 km of stream banks on the ring plain, the average farm has over 7 km of stream bank within its boundaries, with in some cases over 35 km. This brings challenges for managing point source and diffuse runoff pollution and the quality of the receiving waters.

The legislative framework for environmental management, the Resource Management Act 1991, assigns environmental control to regional councils. Up until the 1970s, the streams of Taranaki would run green twice daily throughout the milking season ((September-May), as farmers flushed dairy sheds and holding yards. Farmers were subsequently required to install treatment systems (typically 2 or 3-pond facultative-aerobic ponds prior to discharge to water, or alternatively land disposal of effluent to recover its nutrient value). Despite a doubling of cow numbers in Taranaki over the last forty years, and a huge increase in the use of urea fertiliser since the early 1990s (replacing clover-based nitrogen fixation), water quality in the Taranaki region has remained stable or shown improvement overall (especially by measures of stream health such as macroinvertebrates), with stronger and more significant improvements emerging more recently (2007-2014 data), especially in nutrient levels.

These trends are associated with a voluntary and unsubsidized regional programme of riparian fencing and planting implemented progressively from the early 90s. An increasing rate of implementation means that by 2020, 4500 km of riparian exclusion and 2,700 km of riparian strip planting will have been completed, at an estimated cost to farmers of $NZ 80 million (Eur 52 million).

The poster will provide further information on the riparian programme and its success drivers, the state of and trends in water quality in the Taranaki region, and anticipated new measures for water quality management in the rural sector.

Abstract number 162 - INFLUENCE OF AGRICULTURAL POLLUTION ON VERY SENSITIVE GROUNDWATER BODIES

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The European Water Framework Directive 2000/60/EC (WFD) demands that EU member states establish a good chemical status of all ground- and surface water bodies by 2015. A serious problem related to the possibility of reducing chemical pollution arises in aquifers which are highly vulnerable to pollution due to their specific hydrogeological and climatic properties. In such aquifers, already a considerably small input of pollutants causes a bad chemical status of ground- and surface water bodies. Put into practice, this means that in order to attain a good chemical status of water bodies, agricultural production would have to be practically disabled, since it in most cases puts the most significant pollution load on groundwater.

There are three such especially vulnerable groundwater bodies in Slovenia. One of them is the Dravsko polje groundwater body. The Dravsko polje has a bad chemical status because of two parameters: the pesticide atrazine and nitrates. The concentrations of atrazine and its degradation product desetilatrazine in groundwater have a pronounced decreasing trend and will in the next few years fall below the maximum allowed concentration.

A far more serious problem is the exceeded concentrations of nitrates. Our measurements showed that especially the southern part of the Dravsko polje groundwater body is overloaded with nitrate. The large quantities of nitrogen which are produced here cannot be absorbed by the aquifer system without harm. The research shows that the biggest nitrogen pollution potential in the area is due to cattle and the application of mineral fertilizers. Pig farms are a lesser source; even less nitrogen is produced by poultry, while the share of sheep and goats is practically negligible. The potential of lowering nitrogen emissions from mineral fertilizers is expected to be significantly smaller.

Hydrochemical data show that nitrogen input should be lowered approximately by 1/3 in order to establish a good chemical status of groundwater body. This is a very high degree of reduction, meaning that radical changes in the way of farming in this area would be necessary. Therefore we see a great need for the introduction of animal manure processing technologies in this area, which would enable the reduction of nitrogen leaching into groundwater and into drinking water resources.

Abstract number 165 - PHOSPHORUS WETLANDS AS TARGETED MITIGATION OPTION IN DENMARK FOR REDUCING P-LOADINGS TO LAKES

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The River Basin Management Plan I (RBM-I) adopted as part of the EU Water Framework Directive 2009-2015 in Denmark includes the restoration of up to 3,000 ha 'Phosphorus (P) -wetlands' as a targeted mitigation option meant to reduce the P-loadings to lakes. The recently released RBM-II covering the period 2016-2021 also includes restoration of P-wetlands as 1,500 ha is proposed to be restored.
P-wetlands are constructed in the river valley as periodically inundated floodplain where deposition of sediment-associated takes place normally following a re-meandering of the watercourse that reduces the discharge capacity of the channel. A ten year study (2003-2013) on sediment, nutrient and carbon deposition processes on a temporally inundated floodplain have been conducted following a re-meandered of a ca. 6 km section of the River Odense on Funen in autumn 2003. The deposition was measured during every winter using artificial grass mats deployed in floodplain transects perpendicular to the river channel. The outcome of the long-term sampling efforts regarding deposition patterns on the floodplain, the inter-annual variation in deposition and the accumulated deposition of sediment, nutrients and organic matter for the entire 10 year period will be shown and discussed.

Abstract number 168 - MODELLING NITROGEN FROM SOIL TO SEA IN DENMARK: CONCEPT AND MAJOR RESULTS USING A NEW NATIONAL NITROGEN MODEL

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In order to improve the information on the variations and trends in sources and sinks of nitrogen a new national model linking nitrogen from Soil to Sea has recently been developed in Denmark. The strategic perspectives of the newly developed model include:
On a 15 km2 scale to aggregate modelled data for the hydrological and nitrogen cycle.
To model the Nitrogen sources and sinks by coupling of submodels and then include these models in an overall model.
To link the sources, transport and sinks of Nitrogen for obtaining the resulting net nitrogen load to the Danish estuaries and coastal waters.
To evaluate the modelled Nitrogen transport on measured nitrogen loads from around 300 gauging stations in Danish streams.
To combine modelled and measured Nitrogen loads thereby providing new time series and geographically distributed data for land based Nitrogen loadings to Danish coastal waters

The general modelling concept and overall results will be described. The modelled nitrogen transport on coastal gauging stations will be compared to measured data from the period 1990-2010. For some catchments the model fails to satisfactory estimate the measured nitrogen load or the relative trend in these measurements. This includes some catchments rich in lakes and some catchments in areas where oxidized groundwater are present in deeper aquifers.

Abstract number 173 - CHANGES OVER THE PAST 25 YEARS IN RAINWATER AND GROUNDWATER QUALITY IN NATURE AREAS IN THE NETHERLANDS AS A RESULT OF EMISSION REDUCTION POLICY

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Atmospheric emissions from industry, traffic and agriculture reach the ground elsewhere. Excessive deposition of nitrogen and sulphur induces acidification and eutrophication of the soil. This process adversely affects the quality of soil, water and biodiversity.
Air pollution is a transboundary phenomenon. International agreements have been reached on how to address the issue. The Convention on Long-Range Transboundary Air Pollution (CLRTAP) has been in force since 1983. All European countries, the USA and Canada have signed this convention. More specific agreements have been formulated in a number of different protocols. In compliance with the Gothenburg Protocol, the Netherlands has taken various policy measures to limit air pollution.
The Dutch National Acidification Trend Monitoring Network (TMV) was established in 1989. This network monitors the impact of the atmospheric deposition of acidifying and eutrophying substances on groundwater quality. It specifically monitors the quality of the upper meter of the groundwater under nature areas (forest and heath) with sandy soils. Other than influx from the air, these areas have no other significant sources of acidifying or eutrophying substances, which are responsible for contaminating the groundwater. Between 1989 and 2014, the upper meter of groundwater of 150 locations was sampled 6 times.
Furthermore, for this study 6 locations of the national rainwater quality network were selected, with a sampling period for the acidifying components of 2 weeks.
Our analysis of the measurements shows that rainwater quality and groundwater quality in nature areas have improved significantly over the past 25 years. The impacts of lower emissions of nitrogen and sulphur are found in rainwater, shallow groundwater and groundwater at 10 m below the surface. In 2014 the median N concentration in rainwater decreased by 44% compared to 1988, while the S concentration dropped by 81% during the same period. The median concentrations of N and S in the upper groundwater decreased by 61% and 54% between 1988 and 2014.
A location-wise comparison of the observation data from 2014 and 1989, using a paired samples t-test, revealed that the pH was significantly higher in 2014 than in 1989, while the nitrate, sulphate and aluminium concentrations were significantly lower ($\alpha < 0.05$).
The analysis of the combined observations shows that the measures taken to reduce emissions have resulted in less acidification and eutrophication in nature areas with sandy soil.

Abstract number 175 - OPTIMIZING SHORELINE PLANTING DESIGN FOR URBAN STORM WATER SYSTEMS: ALIGNING VISUAL QUALITY AND WATER QUALITY

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Stormwater systems are widely used in urban areas to collect, control, and treat stormwater, as well as add aesthetic appeal to the landscape. The dual objectives of flood control/water treatment and aesthetics can create conditions at odds for the optimal performance for either objective. Current stormwater pond design and management tends to emphasize aesthetics and associated economics but there is an emerging need to focus on water quality and a strategy that aligns and balances both water quality and visual appeal. This study used four investigation methods, i.e., focus groups, interviews, case studies, and municipal code review, to determine connections between the two and develop strategies for using aquatic and shoreline plants to improve water quality and visual aesthetics. The investigations focused on themes of aesthetics, nature, design, management, knowledge, economics, and policy. By reviewing design, management, and policy aspects together, our study puts landscape design as an important element in the larger context of social issues with environmentally-friendly landscaping practices. Results for the aesthetics, design, and nature themes showed preferences for open water views, clean water with no algae, neat plantings, colorful flowers, evergreen plants, diverse plants with a variety of textures, mature trees, and views of wildlife. Results for the management, knowledge, economics, and policy themes included issues of nutrient/fertilizer control, weed control, erosion control, maintenance funding, and biodiversity and wildlife habitat. Overall results showed that providing open water views and a well-kept appearance are critical features for acceptance of shoreline plantings as a means to improve water quality. The focus group study, case studies, and code study showed relationships among the three, but also revealed a different perspective from the homeowner, the designer, the manager, and the policy writer. By taking an interdisciplinary approach, improved pond design techniques could be a way to promote landscapes of high visual quality and improve water quality problems. Recommended strategies to align visual quality and water quality include shoreline plantings that meet aesthetic preferences and reduce nutrient loading in the pond to improve water quality. Design techniques should include evaluating the site context and selecting appropriate plant material. The use of shoreline plantings should be promoted as part of an integrated approach consisting of design, management, social marketing, and policy aspects for water quality and protection in stormwater systems and receiving waters.

Abstract number 178 - ASSESSMENT OF GEOSTATISTICS – ARTIFICIAL NEURAL NETWORK OPTIMIZED BY GENETIC ALGORITHM IN SPATIAL ESTIMATION OF SOME GROUNDWATER QUALITY INDICES, CASE STUDY BAKHTAR PLAIN, IRAN

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The increased exploitation of groundwater resources can decrease Water quality in an area. So, water quality assessment is an essential process to protect groundwater quality. In recent years, several

simulation methods are presented to estimate quality parameters of groundwater. In this study, the combination of statistical methods and artificial neural networks has been used to estimate the spatial distribution of some groundwater quality indices such as: sodium (Na), calcium (Ca) and magnesium (Mg) in Bakhtar Plain Groundwaters. For this purpose, we analyzed the interpolation and geostatistic method; then the use of artificial neural networks to optimize the results of geostatistical methods was assessed. Results showed a high accuracy for the optimized hybrid approach by using genetic algorithm to estimate the amount of groundwater quality parameters under study so that the amounts of sodium, calcium and magnesium account were estimated, with coefficients 0.95, 0.90 and 0.93 respectively.

Abstract number 179 - PASSIVE SAMPLING FOR THE MONITORING OF EMERGING PESTICIDES IN THE AQUATIC ENVIRONMENT

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Passive samplers are relatively new tools for sampling micropollutants in waters. Since the appearance of the first passive sampler for surface waters, these tools have quickly become widespread and several associated monitoring approaches have been proposed. As an analytical chemistry tool, passive sampling is used to achieve: (a) pre-concentration of the pollutants to increase the sensitivity of the measurements, (b) the simplification of sample collection in situ, which is particularly important in the case of long-term measurements and (c) reduction or elimination of solvent consumption (green chemistry). Time integrative passive sampling enables the determination of time-weighted average (TWA) concentration of the dissolved phase over extended sampling periods, which is difficult with grab sampling. In addition, passive sampling appears to be a promising approach to determine water quality and to track the mean water concentrations of priority organic pollutants as required in the Water Framework Directive (2000/60/EC). For the determination of TWA concentration, estimation of the sampling rate (Rs) for the compounds of interest is required. The sampling rate is the volume of water from which the analyte is quantitatively extracted by the sampler per unit time. On the above basis, laboratory calibration experiments were conducted in order to determine the sampling rates of selected pesticides using polar organic chemical integrative samplers (pest-POCIS; triphasic sorbent admixture; Isolute ENV+ : Ambersorb 572, 80:20 (w/w), dispersed on S-X3 Bio Beads. The study aims to complete data gaps on sampling rates of pesticides with POCIS samplers. The experiments were performed on the basis of static renewal exposure of pest-POCIS in water samples spiked with a known pesticide concentration under stirred conditions for different time periods up to 28 days. Chromatographic analysis was performed for the determination of pesticides using a high resolution and mass accuracy UPLC-MS-Orbitrap instrument after optimization of the operational parameters. Rs were calculated from the linear plots of the accumulated pesticides in the sampler versus the exposure time. The uptake in POCIS for most of the studied pesticides follows a linear pattern throughout the 28 days exposure. The determined sampling rates (Rs) were applied in a 12-month monitoring study in river Arachthos (Western Greece) and its tributaries. Using the developed analytical procedure, trace levels (ng L-1) of the target pesticides could be determined in surface waters fulfilling the requirements of environmental quality standards of current directives.
Acknowledgments:

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Abstract number 180 - EMERGING PESTICIDES OCCURRENCE IN FRESH WATERS AND SEDIMENTS IN A CATCHMENT AREA DOMINATED BY AGRICULTURE

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Widespread use of pesticides is of vital importance in agricultural production, since their residues may pose a risk to non-target organisms and lower the quality of fresh waters. In Greece, and especially in the North Western region, the irrational use of pesticides has raised concern over the years due to possible pollution of aquatic ecosystems, mainly through discharge of runoff from agricultural fields. Hence, the analysis of pesticide residues in a variety of environmental matrices is necessary to ensure their safety and quality about health standards [1].
In that direction, the use of high-resolution mass spectrometers (LC-HRMS), and especially Orbitrap technologies, enables the acquisition of a theoretically unlimited number of species by means of accurate mass measurements in full-scan mode. This allows obtaining the elemental composition of acquired ions, useful for identification of targeted and untargeted compounds, metabolites, or transformation products [2]. The Orbitrap mass analyzer was first described in 2000 [3] and has now reached the status of a mainstream mass spectrometry technique.
In the present study, water and sediment samples were analyzed for selected pesticide residue contamination. The analysis of a variety of pesticide residues by means of high mass accuracy hybrid linear ion trap-Orbitrap mass spectrometer (LTQ-Orbitrap-MS) is investigated. The identification of the positive findings is accomplished with the data from accurate masses of the target ions, based on the full-scan exact mass measurement of [M+H]+ ions, along with retention time data and characteristic on-source fragment ions.Concentrations detected varied seasonally.
Therefore, data generated in this study are useful as a baseline in formulation of mitigation measures to protect the affected ecosystem from pesticides residues pollution.
Keywords: Pesticides, LC-MS, Orbitrap, fresh waters, sediments
Acknowledgments:
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Abstract number 190 - RESEARCH OF POSSIBLE SOURCES OF PERCHLORATES IN AGRICULTURAL LAND USE GROUNDWATER

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In 2012, perchlorate ions were found in a multi-layers sedimentary aquifer, located in the centre of France in agricultural land use, partly exploited for irrigation and to supply major cities in fresh water.

The concentrations measured in several agricultural and water supply catchments exceed the 4 and 15 µg/L values defined by the WHO (World Health Organization) as toxicity thresholds for infants (and pregnant women) and adults respectively. Nevertheless, considerable uncertainties remain about the sources, fate and transport in the environment of this oxyanion.
In its various salt forms, synthetic perchlorate has been used as an oxidizer in solid propellants for military and pyrotechnic uses, and as a component in air bag inflators. It has also been used as an additive in many others industrial activities. It is also present as impurities in significant concentrations in various products as hypochlorite solutions, chlorinated herbicides and Chilean nitrates. Its manufacture and use has spread in many regions of the world. Perchlorate contamination of waters is a major issue because it is not removed by conventional treatments.
This study aimed to (i) assess the extent of the plume; (ii) make the inventory and locate the current and former possible sources of perchlorate ions; (iii) propose a conceptual scheme explaining the observed contaminations of aquifers. Coupling with a deep inventory of land use and anthropogenic activities, and a CFCs' age dating of groundwater, two sampling campaigns were conducted on more than 70 sampling points. Perchlorate ions and other chemicals suspected as being "high-risk to perchlorate" activity tracers (pesticides, nitrate, bore, chlorate, iodine) were studied using multicomponent statistical tools as log regression. Results suggest that perchlorates may come from 2 different origins: a military source to explain the northern point source contamination and an agricultural source to explain the larger plume. Chilean nitrates might be incriminated.

Abstract number 193 - HIGHLIGHT OF 25 YEARS WITH THE DANISH AGRICULTURAL MONITORING PROGRAMME

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Eight Action Plans for the Aquatic Environment have implemented a wide range of measures to reduce the agricultural load of nutrients to the Danish surface and coastal waters. The effectiveness of the measures is being followed in a dedicated agricultural monitoring program that is carried out in five small agricultural dominated catchments. The catchments are selected to represent the main soil types and the variation in livestock density, crops and climatic conditions found within the country. The monitoring encompasses intensive collection of information on agricultural practice at field and farm level by interviews. Further, the monitoring employs direct measurements of soil water, drainage water, upper groundwater and stream water.
Due to investments in longer manure storage capacity, improved spreading techniques and the implementation of N-quota system Danish farmers have been able to increase the utilisation of nitrogen in manure. Together with an increased use of catch crops the implemented measures contributed to a decreased nitrate leaching from the root zone and a significant ($P<0.01$) lower nitrogen transport in four out of five monitored streams.
The measured nitrate concentrations in soil water (1.0 m below soil surface) have decreased since 1990 approaching the EU Nitrate Directive limit of 50 mg nitrate l-1. For loamy soils the decreasing trend occurred stepwise from an average of 90 mg nitrate mg nitrate l-1 for the five years period 1990/91-1994/95 to an average of 51 mg nitrate l-1 for the period 2008/09-2012/13. For sandy soils the corresponding values decreased from 127 to 78 mg nitrate l-1. In the same period, the nitrate concentration in the upper ground water (1.5-5 meter below the surface) decreased from 42 to 31 mg nitrate l-1 on loamy soils and from 92 to 57 mg nitrate l-1 on sandy soils.

The experience gained from the Danish Action Plans for the Aquatic Environment clearly demonstrates that regulation of fertilizer utilization and utilization of animal manure is an effective measure to reduce diffuse nitrogen emissions from agriculture. However, it also demonstrates the complexity of defining an efficient regulatory system and confirms the need for an effective control measures , and a continuous monitoring and evaluation program.

Abstract number 195 - MODELLING NUTRIENT EMISSIONS IN FRESH WATER AT DIFFERENT SCALES AND FOR DIFFERENT OBJECTIVES

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Water resources are severely affected in intensively managed agricultural catchments, especially due to the increase in fluxes of nitrogen and phosphorus towards surface water bodies, inducing eutrophication and sanitary issues. Following the growing awareness of this issue, a large variety of agro-hydrological models have been developed in the past decade according two axes: primarily for a heuristic perspective, displaying a large variability regarding their rationale, i.e., the way biophysical processes are accounted for (or not), to better estimate the distribution of the transit time or the retention within the catchment, as examples; secondary for operational perspective, as decision support tools for testing innovative scenarios of agricultural changes and contributing in defining a strategic vision for a catchment. These two perspectives are confronted to different challenges which are strongly related to the spatial scales they are addressed to.
At local scale, the objective is to modify agricultural systems and rural landscape. Thus models have to be closer and closer to the reality the farmers have to deal with. As an example, farm models, where technical decision are decided and economic consequences evaluated, have been coupled with an agro-hydrological model, to perform a new model (CASIMOD'N). The originality of this framework is that it combines the use of the model with a participatory approach of scenario building with farmers embarked on an evolution of their systems. The protocol involves iterative steps, and the final objective is to provide a decision support for water policy design at the catchment scale. At national level, the objective is to plan and calibrate measures over large areas and to test their efficiency on water quality. Nutting-N and P models have been developed. They are rough but functional models which take into account the current and past pressure on water quality and estimate point and non point pollution, retention within the catchment as well in rivers for various soil and climate conditions. The challenge of such models is to take into account a typology of agricultural systems so that scenarios can be easily tested. These models, applications and challenges for land and water management will be presented.

Abstract number 196 - ARE SOME PERFORATED RISERS BETTER THAN OTHERS?

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In agricultural areas, there are severe soil erosion problems. They are mainly caused by agricultural practices and drainage. These areas change the quality of water because solids and nutrients in suspension are carried from the fields to the hydrographical network. Water quality decreases. In order

to prevent this, several hydro-agricultural improvements are possible. This includes pounded ditches regulated by perforated risers.
A perforated riser is a vertical pipe which constrains surface water to pass through an underground conduit. When it's installed in an agricultural ditch, its purpose is to reduce the water's flow from rain events. Thus, a sedimentation basin is formed in the ditch where sediments and nutrients partially deposit. This is preventing their exportation from the field to the watercourses. However, in Quebec, the most frequently used perforated riser might be wrongly sized since retention time seems too short for an efficient sedimentation.
The present study aims to evaluate the water filtering efficiency of different types of regulated ditches in agricultural areas. Four different devices were installed: a standard perforated riser, an adapted perforated riser enabling variable flow, a floating skimmer and a control ditch. The main objective of the study is:
Determine and compare, during rain events, the flow, the quantity of suspended sediments, and the concentration of phosphorus and nitrogen discharging of the three different systems and the control ditch.

Abstract number 198 - ASSESSING GROUNDWATER VULNERABILITY TO CONTAMINATION USING THE 'HÖLTING METHOD'

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The so-called 'Hölting-method' has been elaborated in the nineties by the Geological Surveys of the German Federal States (Bundesländer) and was published in 1995 (HÖLTING et. al., 1995). It is a point count system that uses a combined approach considering the entire unsaturated zone. Since its development the method has been modified (WILDER, SCHÖBEL, 2008). At present this method is still relevant in groundwater protection areas by consulting farmers on reducing the risk of nitrogen immission to aquifers. An appliance of the 'Hölting method' in the context of WFD-groundwater bodies that are at risk may be expedient.
The following features were taken into account to determine the groundwater vulnerability: climate, topographic slope, landuse, soil properties, geology, hydraulic conductivity, depth to groundwater table. That means a high coverage of input data is generally necessary.
In a first step the seepage rate is calculated for each polygon of the soil map. The seepage rate and the usable field capacity are used in an assessing matrix for evaluation of the attenuation capacity of the uppermost meter. In a second step the attenuation capacity of the remaining vadose zone is estimated. The resulting points depend on lithology, cation exchange capacity, carbon content and permeability. For both steps the sum of the counted points describes the potential risk of pollutant input to the aquifer. Resulting maps are: a map of seepage rate (groundwater recharge), a map of the frequency of seepage exchange, one of its reciprocal values the resting time in soil and the overall vulnerability map in the sense of the Hölting method. The vulnerability map uses the traffic light colours ranging from very low risk (green) up to very high risk (red). These maps were delivered as GIS files, hence the consultants of the farmers can use them as digital tools.
The presented investigation area is situated at the lower Rhine Basin. It shows a catchment area of wells for the public water supply. Despite of being a groundwater protective area the groundwater is highly polluted by nitrogen components, basically nitrate. The assessment of the groundwater vulnerability using the described method leads to a distinct detection of those sections of land highly at risk. The next major step is the adaption of the agricultural management in order to reduce additional nitrate input in accordance with the state of risk of the land.

Abstract number 204 - EXPLORING THE ROLE OF ROOTS IN SUSTAINABLE AGRICULTURE AND LAND MANAGEMENT

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Roots are a dynamic biological interface between soil and plant that essentially determine water flow in the soil-plant-atmosphere continuum (SPAC). As important modifiers of the soil pore system, plant roots also influence soil hydraulic properties controlling water and solute movement in the field. Due to their hidden but highly heterogeneous and dynamic nature, plant roots are still a research bottleneck for sustainable agriculture and land management.
The interlinked aspects of root management in modern agriculture for an appropriate land use and water quality depend on process understanding and description. Specific farming practices such as crop rotations; conservation tillage, etc. addresses the role of roots in an eco-balance approach for sustainable system productivity, valuable adaptation to stress-prone sites and environments, and sustainable use of natural resources.
Based on the work of Austrian Society of Root Research (ASRR), we identify the key areas of root research in the SPAC that can enhance water efficiency in agricultural land management. In this context we provide an overview of (i) state of knowledge on root hydraulic traits, (ii) the related knowledge gaps currently existing, (iii) recent measurement and modeling approaches to bridge these gaps, and (iv) the expected impact for improved land management with special regard to resource (water, nutrient) use efficiency.

Abstract number 206 - DIURNAL AND SEASONAL VARIATIONS IN EPILIMNION AND HYPOLIMNION TEMPERATURES IN A SMALL POND

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Temperature possesses an important role in the water quality of water bodies. Temperature variations within a year and also within the diurnal cycle affect many physical, chemical and biological processes. In this study, temperature variations in the Borabey Pond in Eskisehir, Turkey, are examined and seasonal and diurnal cycles in different levels investigated. The pond lies 900 meters above mean sea level, in the hills to the north of the city of Eskisehir which is situated in the northwestern part of Inner Anatolia Region of Turkey. The pond has a volume of 1.4 Mm3 with a surface area of 0.16 km2 at highest possible water level. It is an artificial pond constructed by damming a small creek draining an upstream agricultural watershed and its waters are used for irrigation purposes downstream.
The location for the temperature measurements is in the middle of the pond where approximately the maximum depth occurs. Here, the temperature is measured at three depths, at the surface, one meter

below the surface and one meter above the bottom. The measurements are taken at 15 minute intervals with Hobo pendant temperature data loggers. Meteorological measurements are conducted at the same resolution at a weather station situated 300 meters away from the location of the pond temperature measurements. The pond volume and surface area are also monitored.
The high resolution of the temperature measurements enables the construction of detailed diurnal variation cycles, principally for the epilimnion temperatures and interactions with the meteorological variables have been investigated, together with variations in the surface area of the pond. The hypolimnion temperatures, as expected, show small diurnal and seasonal variations. The relationship between the seasonal variations and the water volume in the lake for the hypolimnion temperatures have also been investigated.
This study is supported by the Research Fund of the Anadolu University under Project No. 1206F097.

Abstract number 207 - THE EUTROPHICATION STATUS OF A SMALL POND LOCATED IN AN AGRICULTURAL WATERSHED

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In this study, the eutrophication status of the Borabey Pond in Eskisehir, Turkey is examined and relationships to inputs of contaminants originating in the agricultural watershed are established. The pond is located in a hilly region to the north of Eskisehir which is a large city in the northwestern part of Inner Anatolia Region of Turkey. The pond lies at 900 meters above mean sea level with a volume of 1.4 Mm3, a surface area of 0.16 km2 at maximum water level and is an earthen-dammed water body with its use intended as a source of irrigation water to farmlands downstream. The pond receives runoff from an upstream agricultural watershed principally from fields containing suspended solids, phosphorus and nitrogen from fertilizers and pesticides. The water body serves as a habitat to water birds and is well-stocked with fish.
The 8.5 km2 watershed is drained into the pond by a single ephemeral creek on which a weir has been established for water flow measurements. Bimonthly depth-averaged sampling is carried out in the pond since 2013.
Agricultural activities like field plowing release high amounts of particulates to the stream and consequently to the pond and fertilizer applications deliver nitrogen and phosphorus species to the pond. These plant nutrients are monitored besides chlorophyll-a and based on these, the pond has been found to be a phosphorus-limited water body in relation to eutrophication which is an expected result as it almost completely receives contaminants from nonpoint agricultural sources. The trophic status of the pond has also been determined as mesotrophic based on phosphorus, nitrogen, chlorophyll-a and Secchi-disc depth.
The results above provide guidelines to aid management strategies to preserve and improve the quality of the water of the pond for its intended use for irrigation. Drought is a potential danger in the region and extreme care and good policies are required for the protection of the already scarce water resources.
This study is supported by the Research Fund of the Anadolu University under Project No. 1206F097.

Abstract number 216 - LAND USE CHANGE AND WATER QUALITY DURING THE LAST 25 YEARS IN NORTHERN CHILE – THE ARID HUASCO VALLEY AND ITS LAND USE CONFLICTS

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Northern Chile is facing one of the most severe droughts in its history and, at the same time, a rapid change in land use with increasing threats to the environment and human health. A large reason for this change lies in the national governments goal to make Chile a globally important food exporter, primarily through investments in irrigation techniques. The growing global demand for fruit has led to a vast expansion in agricultural schemes; this trend has led to increasing pressures on limited water resources. Not only water scarcity but also water contamination can have negative effects on farming in northern Chile. Mining, being one of the most important economic sectors, besides agriculture, threatens both surface and groundwater quality. This scenario increases the potential for water use conflicts, which is further compounded by the demand for potable water provided by rivers and groundwater emerging from potentially contaminated mining sites.
Using the case study of the Rio Huasco watershed the above mentioned changes in land use and water quality are examined. This region was chosen as an exemplary case for the development of Chiles arid regions: the valley is located at the southern edge of the Atacama Desert where water scarcity is a major problem. At present the watershed is predominantly used for agriculture. Many small farmers still practice strip cultivation but are pressured to shift towards an international export-orientated future with monocultures. International companies are planning to mine one of the world's biggest gold reserves in the headwaters of the Rio Huasco, which is an additional risk factor for water quality. Whilst the problem of scarce water is complicated by the privatisation of water rights in Chile. Within the watershed the amount of sold water rights already exceeds the real water availability by far.
The aim of this research is to trace historical changes in stream water quality from the year 1990 until today. The data used was provided by the national water authority and was measured three times a year at their control stations throughout the catchment area. Additionally, interviews with experts and authorities provide insights in changes of crop patterns and field size. For the same period changes in agricultural area are detected using multi-temporal satellite image analysis (Landsat, 30m resolution).

Abstract number 218 - RIVER RUNOFF AND NITRATE LOADING SIMULATION FOR THE LAND USE CHANGES IN THE TAKASAKI RIVER BASIN IN CHIBA, JAPAN

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The present study makes an attempt to evaluate the possible impacts of land use changes on hydrologic and nitrate loading responses using a numerical model, available land use, river runoff and nitrogen (N) loading data for a small river basin of 85 km2 named as Takasaki River. The existing land use types in the basin consist of 22.7% forests, 9.0% rice fields, crop lands 33.4%, urban areas 34.1%, and water bodies 0.8%. The nutrient contributions to the river from different Point Sources (PS) and Non-Point Sources (NPS) are accommodated in the developed model. Agricultural areas, forests and urban areas are considered as NPS within the model. N discharges from different land use types have a significant contribution to the river water quality. At this end the updated WEP model is applied to understand the impact of land use changes' contribution to the Takasaki River runoff. There are six land use types are

considered in the model, namely forests, grass and crops, bare lands, paddy fields, urban areas and water bodies. A qualitative analysis of the land use changes is conducted by simulating two land use scenarios within the river basin for the period of 5 years. The two scenarios considered are: Scenario -A: 80% crop area converted into urban areas (urbanization), Scenario - B: 80% crops land area is converted to forests (afforestation). The model was executed with the observed rainfall for 2006 to 2010 to check the variation of river runoff and N loading. The obtained results are compared with the simulation results which are obtained under the exiting conditions of the basin for the aforementioned time duration. For the Scenario – A, the 5 year averaged annual water volume passed through the monitoring point has been increased 2.6 % compared to the calculated results of existing condition while for the Scenario – B, same comparison shows a decrement of 0.12 %. The annual averaged N loading for the Scenario – A shows significant increments compared to the natural condition simulation results. The increments are 23.2% and 4.2% in the A and B scenarios respectively. Such variation in the N loadings of each scenario can be explained by the facts as the expansion, nature of the NPS, their contributions in each scenario and also NPS' highly sensitive to the intensity and duration of the rainfall events and the distribution of NPS in the basin.

Abstract number 219 - SPOT SPRAYING REDUCES RUNOFF OF HERBICIDES

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Rainfall simulator trials were conducted at four sites on sugar cane paddocks in catchments of the Great Barrier Reef in tropical north-eastern Australia to examine the potential for spot spraying of herbicides to reduce the loss of herbicides in surface runoff. To mimic targeted spraying using weed seeking or banded and crop-shielded spraying technology, recommended rates of the knockdown herbicides glyphosate, 2,4-D and fluroxypyr, and the residual herbicides atrazine and diuron were sprayed onto 0, 20, 50, 70 or 100% of the area of runoff plots. Two trials were in plant cane crops with no residue cane trash on the surface (bare - Burdekin and Mackay 2012) and two were in ratoon crops with cane trash residues retained (~100% cover – Bundaberg and Mackay 2011). Simulated rainfall was applied at 70-80 mmh-1 to induce runoff for 20 to 50 min two days after herbicide application, before half-life differences would become apparent. At a fifth site (Bundaberg 2011) samples from natural rainfall runoff were collected opportunistically from treated plots.
Spot spraying reduced the event-mean concentrations of all herbicides in filtered (<0.45 µm) runoff compared with blanket spraying (100% coverage). For most herbicides and sites a significant ($P<0.05$) linear decrease in event-mean concentration in runoff was achieved by reducing the spray coverage and associated load of herbicide in the surface soil, cane trash and weeds. At least a 50% reduction in herbicide loss in runoff could therefore be achieved if the area normally sprayed was halved using precision spray technology for weed control. The rates of herbicide concentration increase with

increasing soil and trash load differed significantly between sites, with lower runoff and higher leaching prior to runoff reducing runoff herbicide concentrations and loads. Most of the herbicides were transported in the water phase (i.e. filtered <0.45 µm) of runoff. However, up to 40% of glyphosate, 47% of AMPA and 36% of diuron was mobilised in the sediment phase from bare soil, demonstrating that erosion control will further reduce runoff of these herbicides. Our analysis suggested that spot or banded spraying of weeds in sugarcane, along with best practice soil management and timing of herbicide application, could contribute significantly to the 60% pesticide load reduction target set for the Great Barrier Reef.

Abstract number 223 - DANISH GROUNDWATER BODIES AND THEIR CHEMICAL STATE

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The Danish Groundwater bodies have been re-designated with the national hydrological model (http://www.vandmodel.dk) as basis to support the next water management plan 2015-2021, as required by the Water Frame Work Directive (EU, 2000). In this process the aquifers in the model were grouped into groundwater bodies in a transparent way by automatic algorithms instead of traditional "expert" judgments. This facilities future updating of the groundwater bodies, as the geological background model for the national hydrological model is updated with new information from groundwater mapping, and other surveys.
In Denmark all waterwork wells, monitoring wells, investigation wells and water samples from the last 40 years or more are public available in the national database JUPITER. The chemical wateranalyses in the database were linked to the groundwater bodies through a process in which the screens in each groundwater well was assigned to a specific geological layer in the hydrological model and thus to a specific groundwater body. All chemical analyzes from the 2000-2013 were used to assess the chemical state of the groundwater bodies. In cooperation with the Nature Agency a manual for the procedures was developed.
The chemical state of a groundwater body is dependent on the land use. If the land use of urban or rural origin causes water quality in groundwater that is not in compliance with the quality standards, the chemical state may be characterized as "poor". Guidance 18(EU, 2009) presents a series of tests to identify the state of a groundwater body.
In the Danish assessment of the groundwater body state, the main principle was that all assessments should be made by a series of algorithms, programmed in such a way that every result is reproducible and any change of the boundary conditions easily could be implemented. The state of the groundwater bodies follows the EU guidance documents and directives as far as the data quality can justify it. Nitrate and Pesticides were the most common reason for groundwater bodies to fail having good state. Background values of a number of natural occurring substances as Arsenic and Nickel were found in order to handle the very diverse natural groundwater qualities across Denmark. Elevated Nickel was found mostly due to water abstraction and acidification.
/1/ European Commission, 2000: Water Framework Directive (2000/60/EC)
/2/ European Commission, 2009: Guidance on Groundwater Status and Trend Assessment, Guidance Document no. 18.

Abstract number 230 - ANALYTICAL EXTRACTION OF ESTROGENS FROM SOIL/WATER SYSTEM

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Estrogens belong to endocrine disrupters and were found in the environment. They may affect the balance of the organisms even at low concentration levels which may be followed by an increased incidence of disease in animals and human beings. In manure applied to the soil for increasing its fertility, estrogens can be found along with antibiotics, urine and other compounds. Interactions between estrogens and other compounds can affect microbial transformation, sorption in soil phase and/or leaching of soil estrogens into groundwaters.
An assessment of extraction methods potencially applicable for description of distribution of estrogens in the soil/water system is presented in this study. The Soxhlet warm and QuECheRS extractions were used for this purposes. The effect of compounds coextracted from water and soil phase having been in mutual contact on LC/MS/MS determination of estrogens was studied for various soil samples with different values of total organic content. The effect of matrices extracted from soil using different extraction solvents was compared. The lowest matrix effect was observed when acetone was used.
Estrogens in water resp.0,01M CaCl2 were added to the sterilized soil and the distribution of estrogens in the system was studied. Estrogens have high sorption affinity to soils according octanol-water partition coefficient and major amount was found in soil phase. The matrix effect on LC/MS/MS analyses of estrogens increased in the case of CaCl2 comparing to pure water.
The measurement of sorption isotherms in 0.01 M CaCl2 environment can cause underestimation or overestimation of estrogen sorption in soil: system water in comparison with pure water environment. Therefore the conditions used for a study of estrogens sorption should be carefully chosen. The autoclave sterilization of soil is needed for sorption studies, because of rapid microbial transformation and degradation of estrogens during sorption experiments.

Abstract number 235 - FILTRATION PROCEDURES INFLUENCE ENVIRONMENTAL MONITORING OF ORTHOPHOSPHATE

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Phosphate is becoming a main water quality determining factor in regions with intensive animal husbandry. Environmental quality limits to control eutrophication in freshwater are commonly based on orthophosphate, which is measured by a colorimetric assay as molybdate reactive P (MRP) following ISO protocols. Surprisingly, sample filtration is not specified in these protocols, and filtration procedures vary among certified laboratories using these protocols. It is well established that MRP includes both free orthophosphate and phosphate associated with colloidal material such as Fe and Al oxyhydroxides, while only a minor part of the organic P is included. The aims of this study were to identify the effect of filtration on MRP in environmental samples, and to determine how filtration procedures in different certified laboratories affect reported data.

In a round-robin test, ten waters were collected from streams in Flanders (Belgium) and sent to certified laboratories. The coefficients of variation in MRP results among the certified laboratory ranged 13-115 %. The same waters were subjected to size fractionation in our laboratory using filtration (paper filter, 0.45 µm, 0.1 µm) and dialysis (12-14 kDa). The MRP concentrations decreased with decreasing size fractionation cut-off. The MRP concentrations in dialysates (14 kDa), which approximated the free orthophosphate, were 3 – 80 % (mean 38%) of the corresponding values in unprocessed samples. This percentage decreased with increasing Fe concentrations, suggesting that the non-dialyzable P was mostly bound to Fe-rich particles and colloids. The MRP concentrations in the 0.10 µm membrane filtered solution only marginally exceeded the free orthophosphate concentrations, indicating that this filtration may be a pragmatic choice to identify the free orthophosphate in freshwater.
In summary, the current protocols for environmental monitoring of orthophosphate yield widely variable results due to P bound to Fe and Al oxyhydroxide particles and colloids. This highlights the importance of more stringent protocols for environmental monitoring of orthophosphate.

Abstract number 236 - A SOIL P-TEST TO PREDICT THE THRESHOLD FOR YIELD DECREASE IN A DEPLETION SCENARIO

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In 2013, only 18% of the measuring points in Flemish surface waters (Belgium) complied with the environmental limit for orthophosphate in surface waters. Agriculture is one of the sectors responsible for these high P-concentrations in surface waters. Phosphorus fertilisation advices can be improved by a correct determination of the threshold for yield decrease in a depletion scenario. The current tests to determine the soil-P are mostly based on chemical extractions and it is questioned whether they correctly predict the fertility when the soil P-balance is neutral or negative. The Flemish Land Agency (VLM, part of the Flemish government) initiated research on this topic to support future policy decisions regarding phosphorus use in agriculture in Flanders.
In this research it is determined which (combination of) soil P test(s) (P-Olsen, Pox, P-CaCl2, P-AL, PDGT) best predicts the P availability in in a depletion scenario. A pot trial with eight agricultural soils in Flanders with varying soil texture (sand, sandy loam and loam) and P availability is set up. Four treatments for each soil are started: with and without P amendment, limiting and more than sufficient nitrogen fertilisation. Perennial ryegrass is grown and is harvested and analysed for phosphorus every four weeks. Frequently harvesting the grass without adding phosphorus to the soils allows P mining. For one year, every two months the P availability in the soils is monitored by the different soil P tests. Crop yield will be correlated to the P measured by the different tests and a threshold value for yield decrease will be determined for each soil. The soil P test with the relative smallest variation in threshold value for different soils will be considered as the best. The pot trial started at the beginning of March 2015 and will end in March 2016, the first results of the pot trial will be presented at the conference.

Abstract number 240 - LAND USE CHANGE AND IMPACTS ON WETLAND ECOSYSTEM IN EAST PART OF MERIÇ RIVER DELTA (TURKEY)

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Eco-system problems regarding wetland have become very important in the flood plain. That is the place where Meriç River meets Ergene River in the Turkish territory in the recent years. The problems result from the land use changing for different purposes. In this research, the direct and indirect reasons causing the ecosystem problems in the wetland such as the land use changing in the area, which is the Edirne-Enez part of Meriç River. The effects of the measures taken in Meriç Valley and its surroundings were investigated.
The basic data collected for this research include the Landsat images taken on the different dates, the usage of 1/25.000 topographic maps and the archives of the Ottoman Empire and those of the Turkish Republic, and the previous ecological studies for Meriç Delta. The Geographical Information System (GIS) and Remote Sensing Technologies were used to determine the land use changes from the past to the present. Those methods were also used to obtain a digital database to make the surface analysis of the flood plain and to measure the differences occurring in the shapes and the areal of the river and lakes.
The results of the temporal and spatial analysis show the types and the limits of some certain landuse changes in the flood plain of the lower Meriç River. It is understood that the flood prevention projects in Lower Meriç Valley, from Edirne city to Enez, have important role on landuse change in Meriç River's Delta. Landuse changing in Lower Meriç Valley flood plain and its delta have triggered to the limnological problems of the Gala Lake and Pamuklu Lake in time, and the degradational changes in wetlands of Meriç River Delta that is significance for indigenous and migratory bird populations and fish. As a pollutant, the impacts of Ergene River on the water quality in wetlands of delta have moved very serious dimensions to the flood plain wetland ecosystem problems.

Abstract number 241 - BIOSORPTION OF IRON AND NICKEL IONS FROM WASTEWATER USING ALGAE THAT THRIVE IN THE INDUSTRIAL COOLING WATER SYSTEM

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The biosorption for heavy metal removal from industrial wastewater is alternative technology that more advantages than other techniques such as low cost, low biological sludge, high efficiency and environmental friendly. The batch biosorption of iron and nickel ions from synthesis wastewater by blue green algae (cyanobacteria) that thrive in the cooling water system of industry was studied as a function of initial metal ion concentrations, bio-sorbent dosage and pH. The contact time of biosorption from synthesis wastewater was compared with industrial wastewater at the optimum condition. The concentrations of metal ions were measured in the aliquot samples using Inductively Couple Plasma-Optical Emission Spectrometer (ICP-OES). The results showed the heavy metal removal is highly effective at low initial concentrations of heavy metals. The optimum pH and biosorbent dosage are 5 and 3 g/l, respectively. The removal process from industrial wastewater showed reduction of Iron level from 31.16 mg/l to 2.66 mg/l and Nickel level from 2.56 mg/l to below maximum permissible limit (less than

1 mg/l) within 24 hours. The FTIR spectra indicated that the functional groups predominantly involved in the biosorption were –OH, COO-, -CN.

Abstract number 243 - EFFECT OF FERTIGATION TIME ON THE MOVEMENT OF NUTRIENTS INSIDE ROOT ZONE AND FERTILIZERS USE EFFICIENCY UNDER SANDY SOIL CONDITIONS

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The aim of this study was increasing the yield of any crop by determination of the optimum time for adding mineral fertilizers and consecrating it in root zone and prevent it from transport out root zone by deep percolation and contaminate of groundwater. to achieve this goal, two field experiments were carried out during growing seasons 2013 and 2014, it executed in research farm of national research center (NRC) in Nubaryia province, Egypt. The following study factors were investigated (1) Fertigation doses : [100%NPK – 90%NPK - 80%NPK and 70%NPK] put as a main plot and (2) Time of Fertigation: [After irrigation directly (control) – After 1 hour from irrigation - After 2 hour from irrigation - After 3 hour from irrigation - After 4 hour from irrigation] put as a sub main plot. The following parameters were studied to evaluate the effect of study factors on: (1) Growth of wheat. (2) Yield of wheat, (3) Application efficiency of mineral fertilizers (4) Irrigation water use efficiency of wheat "IWUE wheat. Statistical analysis indicated that, maximum values of application efficiency of mineral fertilizers, yield and irrigation water use efficiency of wheat were obtained with adding 100%NPK+ After 3 hour from irrigation >90%NPK + After 3 hour from irrigation > 80%NPK + After 4 hour from irrigation and no significant difference between them, this means that adding 80%NPK + After 4 hour from irrigation will save at least 20% from mineral fertilizers and reduce the transportation of mineral fertilizers go out of root zone by deep percolation.

Abstract number 245 - MODELLING INTEGRATED SCENARIOS OF CHANGES IN CLIMATE, LAND USE AND WATER MANAGEMENT FOR THE DEVELOPMENT OF ANTICIPATORY PROGRAMMES OF MEASURES IN EUROPEAN RIVER BASINS

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Changes in climate, land use and cover are known to influence the water quality and quantity of surface and subsurface water. This may have negative effects on biodiversity, water supply and important economic consequences, especially under water scarcity conditions. Since most European freshwater systems are already affected by such problems and face future challenges to various degrees, it is of prime importance, as outlined in the WFD, to work towards improving the situation by means of anticipatory and adaptive policies and practices in the management of land and water use. The aim of the EU FP-7 project GLOBAQUA is to analyse and manage the effects of multiple stressors on aquatic ecosystems in selected river catchments across Europe that suffer from water scarcity. In this context, the changing distribution of land use and the associated use and availability of water are elementary factors. Integrated scenarios of changes in climate, land use and water management are developed based on the new Representative Concentration Pathways (RCPs) and Shared Socio-economic Pathways (SSPs) of the IPCC to take into account both climatic and socio-economic drivers of change. The

scenarios are downscaled to the regional scale and modelled in a spatially distributed manner for the study sites. The outcomes of the climate and land use change modelling set the boundary conditions for all subsequent hydrological and water quality modelling activities, for which first findings are presented. Site specific Programmes of Measures are developed and tested for efficiency in this modelling framework.. Using CORINE land cover data, past land use and cover changes have been analysed in the GLOBAQUA test sites. The results show that significant differences exist between them regarding the prevalent land use transitions, their magnitude and the use of water related to agriculture. One of the case studies is the Ebro River basin located in North-eastern Spain, approx. 85,000 km² big. The driving factors of changes in land use and water management, covering a wide range of biophysical to socio-economic factors, have been determined for the Ebro and ranked according to dominance and sensitivity applying multiple logistic regression analysis. The land use change model CLUE (Conversion of Land Use and its Effects, Verburg & Overmars (2009)) has been set up to model a first land use change scenario for the Ebro basin. According to the preliminary results, the future water consumption in this region will increase due to water intensive agricultural practices.

Abstract number 252 - EFFECTS OF ANTHROPOGENIC DISTURBANCES ON THE SEDIMENT POLLUTION ACROSS MULTIPLE SPATIAL SCALES IN TAIHU BASIN

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Taihu basin, one of the most developed regions in China, is located in the lower reaches of the Yangtze River Delta. The river network within Taihu Basin is complex, with a high density of rivers. The water pollution and eutrophication in Taihu Basin is accelerating with rapid economic development and urbanization. As the carrier of contaminants, sediments are not only the reservoirs of contaminants, but also the potential secondary sources of contaminants in aquatic ecosystem. River sediments, therefore, are important and fundamental subjects for the assessment of human-induced contamination in an area. The inflow rivers in the heavy polluted region (Northern and Western region) of Taihu Basin was chosen to investigate the nutrient and heavy metal contents in sediment. The objective of this research was to identify the sources of sediment pollution, key pollutants, and the critical scale of human impacts. The relationship between land use and sediment pollution were explored in buffers at multiple spatial scales. The results suggested that no single land use type was able to describe the overall sediment pollution. Agricultural land (including paddy field and dry farmland), human-settlement (including urban and rural residential), build-up and vegetation are the most important predictors for sediment pollution variability. The influences of land use on sediment pollution changed with the different sizes of buffer zones. Vegetated land cover has strong negative correlation with all considered variables, especially in 1000m and 1500m buffers, and 500m scale was identified as human disturbances spatial critical scale for Total Nitrogen (TN), Organic Matter (OM), Cd, Hg and Pb. Buffer analysis can provide an effective method to determine the critical scale. According to the regulations of Jiangsu on prevention and control of water pollution in Taihu Basin, 3-grade protected regions were divided to improve water quality, and the 1000m buffers on each side of rivers were confirmed as prior protective region. And our study indicated that the protection the 1000m buffers on each side of rivers is effective in aquatic environmental protection and management. Those results will be useful for understanding the driving mechanism of pollution in Taihu Basin, meanwhile, provide important insights for a better management.

Abstract number 256 - IMPACT OF LAND COVER CHANGE ON SOIL EROSION AND WATER YIELD AT PLOT AND WATERSHED LEVEL IN RUBBER DOMINATED LANDSCAPE

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Land use in Xishuangbanna, SW China, has been dramatically changed over the past 30 years. Rubber plantation combined with tea cultivation boosted from 1.3% to 11.8%, while deforestation decreased the forest cover from 69% to 45%. The major factor affecting hydrological process was land cover change overarching the climate change impact. Therefore large scale conversion of tropical rain forest to rubber plantation may markedly changed the erosion process at plot and watershed level. This study aims at evaluating the effect of rubber plantation on erosion process at plot and watershed level. Treatments with different herbicide application were applied to creat different understory plant cover and to test its impact on erosion; rubber plantations of different age were selected to test impact of canopy: young rubber with open canopy, mid-age with closed canopy and old rubber with dense canopy. The measurements consist of three parts: i) water cycle and ii) soil erosion at plot level, iii) water yield and sediment export at watershed level. Precipitation, throughfall, stemflow and overland flow were estimated for quantification of water cycle. Sediment yield was collected simutaneously with runoff measurement. Factors affecting these two processes like rainfall, ground cover, soil properties were measured to understand the dynamic process. Two watersheds with different fraction of rubber and forest were selected for continuous measurement of water discharge and turbidity in the outlet position to evaluate the water yield and export of suspended solids from rubber plantation and rainforest. From the field survey, at plot level highest erosion was presented in mid-age rubber (277 g m-2) which was 3.5 times and 5 time as much as young and old rubber respectively. Understory plant cover and roots from rubber trees were recognized as two major factors contributing to soil conservation during rubber development. Sediment yield in rubber plantation was 13-66 times larger than in forest. At watershed level, big difference of water turbidity strongly differed at the outlet positions of rubber- and forest-dominated subwatersheds with highest values during storm events: over 1200 NTU for rubber and 400 NTU in forest dominated watershed. By obtaining relation between plant cover and relative soil loss as $A = e^{-0.028PC}$, parameter representing cover management (C) can be set in Land Use Change Impact Assessment (LUCIA) model. Data collected in field will be used to calibrate the model. Then different scenarios can be simulated to estimate impact of land use conversion on hydrological process.

Abstract number 259 - CONSEQUENCES OF CLIMATE CHANGE ON PFLAS (PHOSPHOLIPID FATTY ACIDS) IN LYSIMETERS OF AGRICULTURAL SOILS IN THE PANNONIAN AREA

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Regional climate change scenarios for 2050 predict fewer but heavier rainfall during the vegetation period without substantial changes in the total annual amount of rainfall for Eastern Austria (Pannonian region). An experiment was carried out at the lysimeter station of the Austrian Agency for Health and Food Safety (AGES), comprising the three main soil types of the pannonian agricultural area (Calcaric Phaeozem, Gleyic Phaeozem, Calcic Chernozem) with six replications of each (18 in total). The lysimeter station was covered by a greenhouse whose ventilation panels are automatically regulated in synchronization with rain, wind and temperature sensors. Precipitation rates have been modified according to the predicted scenario for the second half of this century in comparison to the current precipitation pattern.
The overall aim of the project was to obtain more information on possible changes in the soil–plant system due to lasting droughts and heavy rain events.
The analysis of Phospholipid Fatty Acids (PFLAs) should highlight possible responses of the microbial community.
Phospholipid Fatty Acids (PFLAs) are essential structural components of microbial cellular membranes. Phospholipids are present in all cell membranes, except accumulations, and are broken down very quickly after cell death in the soil (White et al 1979; Bobbie and White, 1980; Wu, 2009). Therefore, they are excellent indicator molecules for soil microorganism.
Results: Functional groups of microorganisms are characterized by specific phospholipid fatty acids - the basis of this "pattern" can thus be used as a "fingerprint" of the microbial community structure of a soil sample. PLFA´s have been monitored within the project for three years, three times a year (spring, summer and autumn).
Already after the first few months, a response of the PLFA´s could be detected. Whereas at the beginning of our experiment (in May) no difference between the precipitation treatments occurred, only after 3 months higher biomass levels were measured following the change of precipitation.
Across all three years the PLFA´s were more or less affected by the rainfall treatment and the soil type. There is a variability between the treatment, the soil types and the sampling dates (seasonal and annual).

Abstract number 263 - A SIMPLE WIRELESS SYSTEM FOR REMOTE WATER QUALITY MONITORING IN RURAL AREA RIVERS

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The objective of the project to be presented is the development of an in-situ-wireless-river water-quality-monitoring-sensor system equipped with a web server, based on a microcontroller, storing the data locally (local site) and transmitting them on demand through a WiFi point to point local network to a remote internet endpoint - personal computer station. The later includes a wireless transceiver with directional antennas and gateway between the local network and the University networks (UoI, UoV) as well as internet services, user interface etc. Each point to point connection will comprise a number of repeater nodes including antennas, access points and switches. The in-situ-wireless-river water-quality-monitoring-sensor system as well as the repeater nodes are self powered using solar energy. The system is installed in a number of locations in Vjosë River-Albanian with an internet endpoint at the University of Vlorë, Albania, and in Arachthos River - Greece with an internet endpoint at University of Ioannina. All parts of the system are fixed on the upper part of a small antenna tower including a conical tank filled by fresh river water periodically, 4 times per day by a sling pump (based on Archimedean screw) operated by the water flow. Eight sensors measuring temperature, PH, conductivity, DO, ORP, Ammonium, Nitrate and Chloride are used. Due to the limited sunshine presence in the river gorges the system is active periodically and the data are calibrated locally using lab measurements. Each station is equipped with a GPS receiver to get the proper time and to correct the local real time clocks.
The project is financed in the framework of the Greece-Albania IPA cross border programme 2007-2015 with the project title “Wireless Water Quality Monitoring of Arachthos and Vjosë Rivers (wwqm_avr)” and will be completed by the conference time.

Abstract number 266 - CATCHMENT SCALE COMPARISON OF EFFECTIVENESS OF SEDIMENT FENCES AND BUFFER STRIPS

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A wide variety of mitigation measures have been identified for preventing loss of sediment and particulate P from land to water associated with soil erosion. These include buffer strips, detention ponds, retention ponds, improved cultivation methods and timing (Maetens et al., 2012). One method that is receiving increased attention is the use of temporary sediment fences installed after harvesting of row crops in autumn (Vinten et al., 2014). There is a need to develop design methodology and guidelines for practitioners and farmers, as well as to demonstrate more widely the potential for application of both sediment fences and buffer strips within Scotland, the UK and globally (e.g. in China). This will enable farmers and catchment managers to make informed choices and obtain the environmental impact mitigation sought by the Water Framework Directive and other relevant policies.
This paper will explore the relative cost-effectiveness the two technologies, applied across the Lunan Water catchment in Eastern Scotland, by analysing relative costs and effectiveness on a field-by-field basis. The information can be used alongside assessment of multiple benefits to enable more effective and responsive rural landscape planning.

Abstract number 278 - TOWARDS SPATIALLY DIFFERENTIATED REGULATION OF NITROGEN

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EU member states are challenged by nitrogen loads to estuaries and inland freshwater systems impeding the achievement of good ecological status as required by the Water Framework Directive (WFD). In Denmark nitrate leaching from the root zone has been reduced by 50% since 1987, but additional reductions of 30-50% are required to meet the objectives of the WFD. Achieving such abatements by uniform restrictions for all areas, would be very costly and inefficient as studies have shown that reduction varies spatially depending on the local hydrogeological conditions, the presence and dynamics of drains and hydro-biogeochemical conditions in associated riparian lowlands. Hence, a shift of paradigm in regulation practice is needed, whit a cost-effective regulation accounting for this variability and differentiate the regulations/restrictions between resilient and vulnerable areas. However, the present incomplete knowledge of the redox conditions in the subsurface and the impact of drainage and riparian lowlands on nitrate transport at local scale, impede the design of an optimal regulation at national level.
To advance the understanding of these processes and quantify their impact on nitrate transport and transformation a new strategic research project has been initiated, "TReNDS – Transport and Reduction of Nitrate in Danish Landscapes at various Scales" (www.nitrate.dk). The project will rely on detailed field scale studies supplemented by model simulations and develop methodologies and tools to: i) detect

drain pipe location and quantify their effects on flow dynamics and nitrate transport in the soil-groundwater zone; ii) identify the hydro-biogeochemical nitrogen transformation in riparian lowlands and quantify their impacts on nitrate fluxes to surface waters at catchment scale; iii) locate the depth to the redox interface and establish a methodology to produce an improved high-resolution national map; iv) integrate local-scale drain dynamics and riparian lowland processes in large-scale catchment models; and v) develop and test new principles for national regulations based on control monitoring of nitrate outputs from agriculture utilising local scale data and knowledge.
TReNDS supports a two-tiered approach, where areas subject to further abatement are identified by national screening approaches supported by detailed local studies for the design of optimal measures taking advantage of local data and knowledge.

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