Water Resources Management in Cooperation with Agriculture (WAgriCo)

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Report on impact scenarios: Definition of scenarios for the economic analysis

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Contents

Introduction

According to the WAgriCo project proposal, Deliverable 7.2 is planned to be a report on impact scenarios: "*FAL shall propose different impact scenarios for the economic analysis, which will be discussed in the local working groups as well as in the international steering committee. FAL will report on the results of the discussion and give an expert opinion on the discussion process. The report will be made available as downloadable pdf.-document on the project website.*" This paper gives an overview over the scenario approach used in the German project part and is the starting point for the discussion with the project partners. A detailed definition of the contents of each of the scenarios will be defined on the basis of local feed backs as well as the discussion of the international steering committee, and will be part of a next work step.

According to the Water Framework Directive CIS Guidance Document No. 1 (WATECO, 2003) scenarios shall be defined to analyse a base situation without additional intervention and different alternative options for intervention, i.e. the promotion of additional water protection measures. The ecological and economic analysis will focus on nitrate emissions into the groundwater caused by agriculture, and on achievement of good status according to WFD article 4 regarding nitrogen pollution of groundwater.

1. Methods and models

There will be two methodological approaches applied for scenario analysis: Modelling of changed framework conditions, such as agricultural policies and market developments, will be performed with RAUMIS (regionalised agricultural and environmental information system for Germany). RAUMIS is an agricultural sector model disaggregated at county level (Landkreis, NUTS 3 level). The model is based on regional statistics and is consistent with the national statistical agricultural account. Input coefficients are calculated according to normative planning data. Because of its spatial resolution at county level the model output is not suitable to derive local information for WAgriCo. Agriculture is depicted in RAUMIS as one regional farm per county, based on land use and livestock statistics and average yields. As in reality there is an aggregate of many different farm types using different soil types and meeting different yield levels, the aggregation problem of RAUMIS would hinder deeper analysis of site and farm specific potentials when running a stand-alone approach.

Therefore, a database and model approach based on an ACCESS databank developed in a research project previous to WAgriCo (Schmidt et al., 2006) will be used to derive base year information on land use, livestock and nitrogen balances with high spatial resolution. For evidence-based regional modelling, information from bookkeeping of about 6.000

farms (for the years 1999/2000 und 2000/2001) has been analysed, especially regarding yields for roughage which are not available from statistics but of mayor importance for N balances, and regarding estimates for mineral fertiliser inputs. Scenario analysis based on this database approach can both be modelled for the base situation in 1999/2003, and for a projection of the year 2015 using information of RAUMIS.

For calculations of scenarios within the WAgriCo project, the above mentioned database has to be further developed. As the database does not yet include cost, only cost impacts of additional measures will be calculated, and also projections, e.g. increase of yields and changes of land use, have to be implemented. Also, the database includes a rough differentiation of farm types at municipal level that should be improved. This is of importance as measures in agriculture start at the farm level, and selection of farms and specific sites is crucial for understanding ecological effectivity of measures. Starting from a highly differentiated representation of agriculture at spatial and farm level, analysis can be performed for the pilot regions Lager Haase, Große Aue and Ilmenau/Jeetzel, for groups of water bodies, and for Lower Saxony as a whole.

2. Sectoral, spatial and temporal scope of scenario analysis

It is planned to depict the whole agricultural sector in Lower Saxony on the basis of agricultural statistics of the farm structural surveys of the years 1999 and 2003. The data are available at the level of municipalities (*Gemeinden*), that is the smallest administrative unit in Germany, equivalent to the LAU 2 level (EU Local Administrative Units ; former NUTS 5 level = Nomenclature of Territorial Units for Statistics[1]). Further, thematic maps for depicting nitrogen emissions due to ploughing up of grassland and arable use of organic soils are used based on GIS data.

Other sources of diffuse nitrogen emissions, originating from other sectors, are not included into WAgriCo scenario analysis (numbers in brackets are valid for Lower Saxony): Small purification plants (0-3 kg N/ha) and traffic/settlements (0-2 kg N/ha). Atmospheric deposition (up to 30 kg N/ha) can theoretically be differentiated into emissions from agriculture and other sources. However, information about real deposition and its origins is rather limited. It is planned to build on thematic maps on deposition elaborated in the FAL Institute for Agroecology.

The definition of priority areas in the WAgriCo project for implementing water protection measures in areas with highest need for action has been performed on the basis of groundwater bodies, land use, soil maps and data on nitrogen immissions in the groundwater. The resulting targeting has a much higher spatial resolution, compared to

[1] See http://ec.europa.eu/comm/eurostat/ramon/nuts/home_regions_en.html

agricultural statistics available at the municipality level. In order to allow for an evidence-based, deeper spatial differentiation of agricultural land use information, FAL has applied for permission to use data of the Integrated Administration and Control System (IACS) with site-specific GIS information on agricultural land use for all farm receiving payments in the framework of the Common Agricultural Policy. IACS data use is still under negotiation with the Ministry of Agriculture of Lower Saxony. Improvements of the available representation of agriculture would be the analysis of site-specific allocation

- of arable crops critical for water protection,
- of set aside (uncultivated as well as with non-food crops),
- of grassland and its change over time,
- of agri-environmental measures relevant for water protection.

The analysis would be concentrated on mass-statistical applications, and no individual data would be revealed, so that data confidentiality will be guaranteed. Further, the potential of IACS data for Water Framework Directive related planning could be explored.

Regarding the temporal resolution of modelling, it is planned to depict agricultural land use on the basis of an average of the years 1999 and 2003. The target year for projections will be 2015, the year for achievement of good status according to WFD article 4.

3. Definition of target values

One main output of the agricultural scenario analysis will be the estimates of regional nitrogen balances, used as input for the hydrological models of Forschungszentrum Jülich. Also, it is planned to reverse the data flow defining target values for the maximum nitrogen surplus at regional level needed for good conditions of groundwater. Maximum levels of nitrogen surplus will be calculated with the hydrological models, so that the economic modelling can analyse whether and how such targets can be achieved and at which cost. The ecological target value will be below 50 mg/l nitrate concentration in leachate on average of a groundwater body. This target definition avoids problems of time lag between decreased emission values and improved status of immissions on the groundwater body, as leachate values react more immediately on changing emissions. For surface water, target levels have no yet been defined.

The agricultural scenario analysis will provide estimates which nitrogen surplus can be expected under defined base conditions, with projections for changed framework

conditions, and with additional water protection measures. Provided that all practicable steps are taken to mitigate the adverse impacts on water quality, exemptions from the obligation to reach good status are possible according to WFD article 4. If the defined target levels can not be achieved until 2015, at least a reversal of trends towards decreasing immissions has to be shown. In case the scenario analysis will show that achievability of target values is improbable, criteria for exemptions, namely regarding technical feasibility and disproportionate cost, have to be discussed.

4. Definition of scenarios

Objective of the scenario analysis is to assess the need for additional interventions ("supplementary measures" according to WFD article 11.2) after basic measures have been implemented in a projection for 2015, considering changes of framework conditions, and to evaluate potentials of such supplementary measures. The gap between the projected state of immissions and the target value for groundwater describes the need for supplementary measures. Further, measures have to be identified which are ecologically effective and economically efficient, i.e. showing a favourable cost-effectiveness (comparatively low cost at a given mitigation of nitrogen surplus), in order to close the gap. Further, spatial and farm targeting have to be explored in order to describe a way of cost-effective allocation of scarce public funds for supplementary measures.

The main basic measure for implementing the WFD is the German Fertilising Ordinance (Düngeverordnung, DüV) in the revised form from 2006. In Germany the Nitrates Directive is implemented through the DüV. Supplementary measures are voluntary agri-environmental measures and technical advice. Analysis will be based on the technical and management-oriented measures tested practically in the WAgriCo project. For these measures and appropriate combinations, additional cost (based on compensatory payments) and impacts on the nitrogen surplus will be calculated. Ecological effects have been assessed in a recent study performed by FAL and INGUS on behalf of the Bund-/Länderarbeitsgruppe Wasser (LAWA) (Osterburg et al., 2007).

Impacts on the nitrogen surplus will be differentiated according to soil properties and especially to farm types.

Categories of farm types, soils and climate:

For farms, a classification according to the main sources of nitrogen is used, which is not completely in line with socio-economic classifications according to EU farm classification based on standard farm income. However, the classification is closer to the problem to be analysed, the nitrogen fertilisation:

- Crop production with < 40 kg N/ha from manure
- Pigs and poultry, with 40-120 kg N/ha from manure
- Pigs and poultry, with >120 kg N/ha from manure
- Dairy and cattle, with 40-120 kg N/ha from manure
- Dairy and cattle, with >120 kg N/ha from manure
- Other farms: permanent crops, vegetables, etc.

The following soil and climate conditions will be distinguished:

- Light/sandy soils, low precipitation (< 600 mm)
- Light/sandy soils, high precipitation (≥ 600 mm)
- Heavy/clayey soils, low precipitation (< 600 mm)
- Heavy/clayey soils, high precipitation (≥ 600 mm)
- Peatlands, organic soils (potential geogenic nitrogen sources)

Scenario definition

The baseline scenario is a projection of the status quo or “business as usual” (BAU), including the existing framework in terms of agricultural and environmental policies, technological and market conditions, and the projection of technological trends (e.g. yields) and of decided policy changes to be implemented until the target year 2015. Implementation of some agri-environmental measures at the scale of the base year 1999/2003 is part of the baseline. However, additional measures for achieving targets of WFD are left out, because they are part of special scenarios. The baseline includes a range of factors, which are difficult to anticipate in terms of their impacts on WFD targets. When adding the different factors and their impacts, the overall outcome gets more uncertain so that a possible positive contribution to water protection due to changing framework conditions might occur, but is not secure enough to build the basis of further planning. Also, it has to be considered that assessing impacts of changing framework conditions on the sectoral nitrogen balance is already difficult, but predicting site-specific impacts turns out to be even more speculative.

Factors forming part of the framework conditions are EU market and price policies and interventions to promote renewable energy:

- Impacts of the 2003 reform of the Common Agricultural Policy, with decoupling of direct payments as main element, and changes of administrative prices for milk and rye as further aspects;

- impacts of Cross Compliance, this is the new precondition for the receipt of direct payments consisting in the compliance with 19 EU regulations and directives the maintenance of agricultural land in "good agricultural and environmental conditions";

- impacts of a milk market reform, as the continuation of the existing milk quota regime is insecure beyond the year 2013, leaving scope for a baseline projection with and without quota;

- impacts of further, substantial support of renewable energy production from biomass, through the German electricity feed in tariffs promoting biogas production, e.g based on maize, and through German biofuel quota supporting the increase of non-food production like rape for biodiesel and cereals for ethanol;

- the EU sugar market reform already has contributed to a decrease of sugar beet area from about 5.6 % of arable land in 2005 to 4.6 % in 2006 in Lower Saxony. However, the substitution of arable crops due to the reform is of minor importance, and sugar beet are more dominant outside WFD priority areas;

- further liberalisation of agricultural markets due to results of the Doha round of negotiation of the World Trade Organisation (WTO) will not be part of a baseline, as the negotiations are actually not finished. However, conflict management under the WTO rules possible will influence the level of protection of EU agricultural commodity markets in future even without a Doha agreement. If other nations are accusing the EU for illegitimate protection of its markets, conflict settlements through WTO panels might contribute to lowering EU tariffs and other trade barriers.

The impacts of these factors will be analysed on the basis of RAUMIS (in cooperation with the project AGRUM Weser in which FAL Institute of Rural Studies is partner), and the range of possible impacts on nitrogen surplus will be assessed. However, this analysis will not provide clear-cut predictions of future emissions, but instead a range of probable outcomes.

As the baseline situation without WFD-related measures in 2015 is rather uncertain, the more important is the assessment of targeted agri-environmental policies for promoting the achievement of WFD objectives and for flanking changes of framework conditions. The main basic measure for implementing the WFD, the German Fertilising Ordinance (Düngeverordnung, DüV), is a mandatory instrument implementing EU Nitrates Directive within the whole territory of Germany. The DüV restricts the maximum input of organic nitrogen from animal excretion per hectare, imposes bans for spreading manure over winter, and on frozen or water saturated soils, and defines minimum distances from surface water for nitrogen fertilisation. Minimum storage capacities for manure of 6 months are separately implemented through legislation of each Federal State of Germany (Land), and this restriction becomes obligatory by the end of 2008.

The reformed DüV (amendments from 13.01.2006 and 27.09.2006) also sets maximum levels for balance of nitrogen (3 year average) and of phosphate (6 year average). The balance for nitrogen is calculated as a net surface balance, after deduction of 'unavoidable' losses of organic nitrogen. The maximum nitrogen net surplus is reduced stepwise starting by 2007 and shall be below 60 kg N/ha by 2011. In addition to this limits for N-surplus, also a maximum level for P has been defined. For livestock farms, especially for those with pigs, the maximum P-surplus will be an additional limiting factor for organic fertiliser input. However, there is no fine foreseen if this target is not reached, and also there are no Cross Compliance sanctions projected. Thus, it is not yet clear how far the new N- and P-surplus related requirements will be a 'should' or a 'must' for farmers.

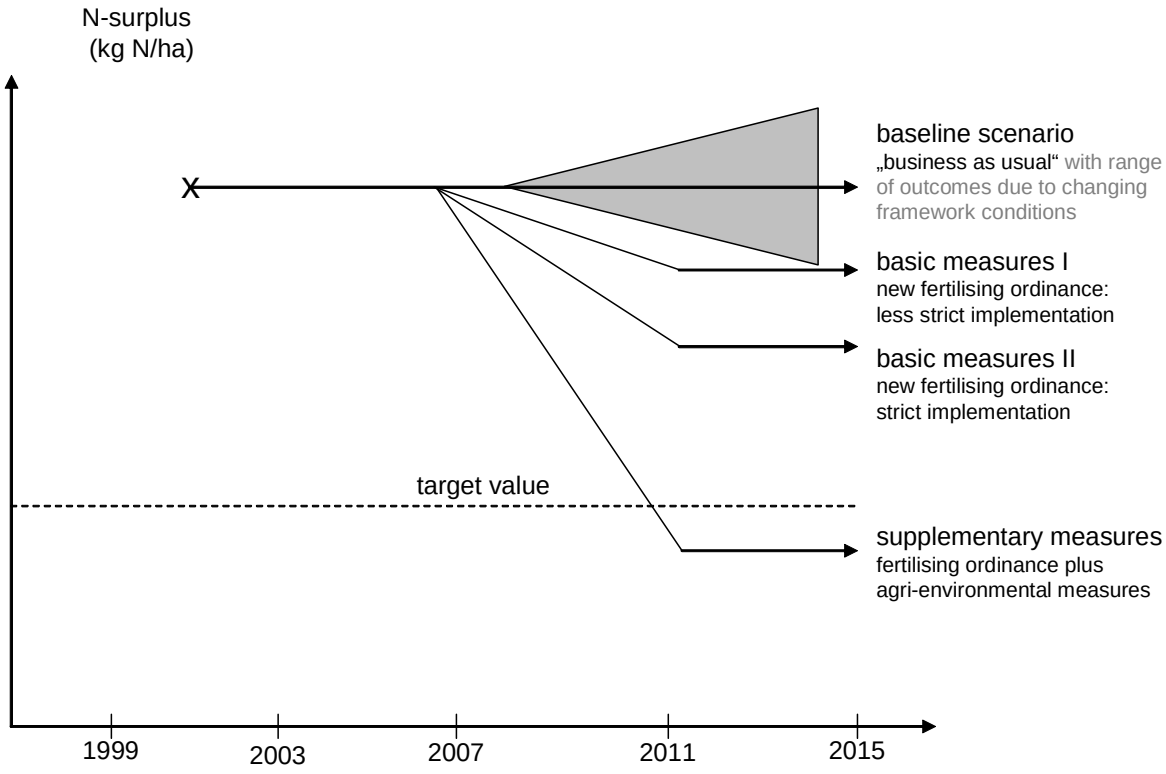
This analysis of the DüV is a 'regulatory impact assessment' anticipating both the way of administrative implementation, control and enforcement, and the expected impacts with regard to the different farm types affected. For this assessment the way of administrative implementation, the particular requirements and resulting restrictions at farm level, and the degree of compliance achieved through enforcement (information, control, and sanctions) are crucial. It is proposed to derive two scenarios of implementing basic measures for WFD, in order to illustrate the uncertainty of regulatory impacts and the importance of the particular way of administrative implementation and enforcement:

- ***basic measures I***: Implementation of the new DüV with less strict rules and enforcement, e.g. without crosschecks on plausibility of balances and without strict follow-up if surplus targets are exceeded;

- ***basic measures II***: Implementation of the new DüV with strict rules and enforcement, e.g. crosschecks on plausibility of balances and enforcement of surplus targets.

In case the WFD targets are not reached through basic measures, supplementary measures have to be implemented. The respective scenario ***supplementary measures*** combine the depiction of basic measures (it is suggested to refer to the scenario basic measures II) with additional agri-environmental measures to be implemented in WFD target areas. The extent of supplementary measures needed depends of the size of the 'gap' between the basic measures scenario and the WFD target level. As there are an infinite number of possible scenarios, it will be simulated and analysed in which way supplementary measures should be selected and implemented. A key question will be the optimisation of allocation of supplementary measures on priority areas and farms with high potential for additional reductions, starting with most cost-efficient measures and thus providing that achievement of the WFD targets is realised at least programme cost.

Figure on scenarios



For the supplementary measures scenario, the correct assessment of cost-effectiveness and the estimation of realistic potentials for implementation of these measures are crucial. Especially the assessment of the ecological effectivity is central as the financial cost of promoting voluntary measures do not vary as much as the environmental impact. There is no certain outcome of implementation of measures, and thus impacts of supplementary measures should be depicted in ***scenario variations for minimum, average and maximum effects***. The determination of technical potential already is difficult, due to the lack of detailed data for farm structure and local land use. Even more challenging is the

estimation of realistic levels of acceptance and thus uptake of voluntary measures at a given set of requirements and compensation payment offered. This leads to the following variations of the supplementary measures scenario:

- ***Supplementary measures I: planner's optimum***: As proposed in the WaterCost project (Interreg North Sea Region), this utopian scenario models that most cost-effective measures are implemented according to their technical potential.

- ***Supplementary measures II: realistic acceptance***: This scenario builds on experiences with acceptance of voluntary water protection agreements in designated areas for drinking water in Lower Saxony. Because the observed rates of acceptance have been achieved over many years within the framework of cooperative water protection and through intensive technical advice, the extrapolation should be treated with caution. However, as there is no model approach available for realistic predictions of acceptance of voluntary measures, there is no other way than to refer to ex-post information and expert judgements.

- ***Supplementary measures II: realistic acceptance and budget***: While the previous variations assume unrestricted public budgets for implementing WFD measures, this scenario adds information on expected budgetary restrictions for expanding supplementary measures, especially resulting from the EU agricultural policy debate on the share of the so called Pillar Two providing funds for promotion of agri-environmental measures.

Expected results of scenario analysis are not a precise prediction of the situation of nitrogen emissions from agriculture due to changing framework conditions and resulting pollution of the groundwater. Instead, possible ranges to be expected will be assessed. The focus will therefore be on basic and supplementary measures targeted at objectives of WFD in order to flank adverse developments and to contribute to achievement of the WFD targets. How to provide a fair and realistic mandatory baseline through the basic measure DüV (causing conflicts for cooperative approaches) while reaching maximum levels of acceptance for supplementary, voluntary measures (based on cooperative water protection) will be the main challenge to be explored in the WagriCo project in Lower Saxony.

References

Osterburg, B., Rühling, I., Runge, T., Schmidt, T. G., Seidel, K., Antony, F., Gödecke, B. and Witt-Altfelder, P. (2007): Kosteneffiziente Maßnahmenkombinationen nach Wasserrahmenrichtlinie zur Nitratreduktion in der Landwirtschaft. In: Osterburg, B. and Runge, T. (Hrsg.): Maßnahmen zur Reduzierung von Stickstoffeinträgen in Gewässer - eine wasserschutzorientierte Landwirtschaft zur Umsetzung der Wasserrahmenrichtlinie. Landbauforschung Völkerode, Sonderheft 307, S. 3-156.

Schmidt, T. G., Osterburg, B. and Laggner, A. (2007): Datenauswertung zur Quantifizierung diffuser Stickstoffemissionen aus der Landwirtschaft im Rahmen des Projekts „Integriertes Monitoring des chemischen Zustandes des Grundwassers" in Niedersachsen. Top-Down-Ansatz mit Daten der Agrarstrukturerhebungen 1999 und 2003 und Analyse des Landnutzungswandels. Arbeitsberichte des Bereichs Agrarökonomie 02/2007 der FAL. Braunschweig.

WATECO (Ed.) (2003): Common implementation strategie for implementation of the Water Framework Directive (2000/60/EC). In: European Commission (Hrsg.): Economics and the environment - The implementation challenge of the Water Framework Directive. Guidance n.o 1.