Texte

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25/06
ISSN 1862-4804

Evaluation of policy measures and methods to reduce diffuse water pollution

(Evaluierung von Politikansätzen und Maßnahmen zur Reduzierung diffuser Gewässerbelastungen)

Umwelt Bundes Amt
Für Mensch und Umwelt

UMWELTFORSCHUNGSPLAN DES
BUNDESMINISTERIUMS FÜR UMWELT,
NATURSCHUTZ UND REAKTORSICHERHEIT

Forschungsbericht 201 24 222/01 - /04
UBA-FB 000727

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Evaluation of policy measures and methods to reduce diffuse water pollution

(Evaluierung von Politikansätzen und Maßnahmen zur Reduzierung diffuser Gewässerbelastungen)

von

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Im Auftrag des Umweltbundesamtes

This Publication is only available as Download under
http://www.umweltbundesamt.de

Publisher: Federal Environmental Agency (Umweltbundesamt)
P.O.B. 14 06
06813 Dessau
Tel.: +49-340-2103-0
Telefax: +49-340-2103 2285
Internet: http://www.umweltbundesamt.de

Edited by: Section II 2.4
Dr. Volker Mohaupt

Dessau, November 2006

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		9. Publication Date
6. Performing Organisations (Name, Adress) Wuppertal Institute for Climate, Environment and Energy; Research Association for Agricultural Policy and Agricultural Sociology (FAA), Bonn; Association for Technology and Structures in Agriculture (KTBL), Darmstadt; Engineers Association for Urban Hydrology (IFS), Hanover		10. UFOPLAN-Ref. No. 201 24 222/01 - /04
		11. No. of pages 156
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16. Abstract

After considerable improvements of wastewater treatment, the loads of nutrients and plant protection agents, deriving from agriculture and heavy metals from urban drainages effluents as well as from erosion of agricultural soils are the main sources of nutrients and harmful substances in the loads of water bodies. The targets of the project were on the one hand the analysis of the political and legislative framework of both policy fields and on the other hand the evaluation of several, selected water protection measures with regard to their contribution to reduce water pollution, their economical effects as well as their political enforceability. The focus was laid on diffuse water pollution caused by agriculture.

As main reasons for the diffuse water pollution stagnating at high level, the analysis of the political framework identified a lack of implementation discipline of water law, followed by the fragmented and insufficient water protection legislation itself and the previous design of the common agricultural policy slanted towards increasing productivity. For the future co-operation of agricultural and water authorities in implementation of their reforms and better definition of “Good Farming Practice” are recommended.

The second investigation level focuses on the analysis and assessment of selected measures to reduce the input of nutrients and plant protection agents. This part was done with help of calculation models focussing on the specific cost/benefit ratios for water protection. In detail the following measures have been analysed: decoupling of direct payments, coupling of livestock farming to areas, tax on mineral nitrogen, pesticide levy, buffer stripes alongside of watercourses, all season crop cover on arable land, soil cultivation procedures, changing the use of arable land, optimisation of animal nutrition, optimisation of manure storage and application, co-operative agreements, education and training. Co-operations and water protection related education and training can be highly recommended, since they improve knowledge and freedom of action.

As the results on county level show, the measure "Decoupling of direct payments" would not lead to appreciable changes as far as the nutrient surpluses on farmland is concerned. "Coupling livestock farming to areas" would decrease the surpluses substantially. For this measure and Tax on mineral nitrogen", varying adaptation reactions could be expected depending on the regional specialisation in cropping or livestock farming areas. On single farm level the measures, protein adapted feeding, optimisation of manure storage and application showed the best cost-efficiency to reduce nutrient surpluses. All season crop cover on arable land and conservation tillage are highly efficient, too, and should be included in farming practice. A stronger limitation of livestock density could mean a reduction of manure, but the implementation of this measure would lead to high losses of income for farmers specialised in animal production. For reduction of diffuse water pollution caused by urban drainage political approaches as well as detailed technical measures are examined. In the area of urban drainage storm water management (especially infiltration and constructed wetlands), unsealing of paved areas and small wastewater treatment structures (for phosphorus reduction) showed best cost-effectiveness.

17. Keywords		
18. Price	19.	20.

Berichts - Kennblatt

1. Berichtsnummer UBA-FB 000 727	2.	3.
4. Titel des Berichts Evaluation of policy measures and methods to reduce diffuse water pollution		
5. Autor(en), Name(n), Vorname(n) Lange, Uta; Döhler, Helmut; Eurich-Menden, Dr. Brigitte; Gömann, Dr. Horst; Jäger, Peter; Kreins, Peter; Möller, Christine; Prigge, Achim; Ristenpart, Dr. Erik; Schultheiß, Dr. Ute		8. Abschlußdatum 07.07.2004
		9. Veröffentlichungsdatum
6. Durchführende Institution (Name, Anschrift) Wuppertal Institut für Klima, Umwelt, Energie GmbH; Forschungsgesellschaft für Agrarpolitik und Agrarsoziologie e.V. (FAA), Bonn; Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL), Darmstadt; Ingenieurgesellschaft für Stadthydrologie (IFS), Hannover		10. UFOPLAN-Nr. 201 24 222/01 - /04
		11. Seitenzahl 156
7. Fördernde Institution (Name, Anschrift) Umweltbundesamt		12. Literaturangaben 95
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16. Kurzfassung

Nach dem weitgehenden Ausbau der Abwasserreinigung sind diffuse Gewässerbelastungen mit Nährstoffen und Pflanzenschutzmitteln aus der Landwirtschaft sowie Schwermetallen aus der städtischen Regenentwässerung und der Erosion landwirtschaftlicher Böden mittlerweile die bedeutendsten Quellen von Nähr- und Schadstoffen und haben einen hohen Anteil an der stofflichen Belastung der Gewässer. Aufgabe des Projektes war einerseits die Analyse der politischen Rahmenbedingungen und anderseits die Beurteilung verschiedener, ausgewählter Maßnahmen hinsichtlich ihres Beitrages zum Gewässerschutz sowie ihrer ökonomischen Auswirkungen und politischen Durchsetzbarkeit. Der Schwerpunkt des Projektes lag auf der Untersuchung des Teilbereichs Landwirtschaft. Als Gründe für die weiterhin hohen diffusen Einträge durch die Landwirtschaft wurden bei der Analyse des rechtlichen Rahmens die mangelnde Umsetzungsdisziplin der Mitgliedsstaaten bezüglich des Gewässerschutzrechts, gefolgt von der fragmentierten und unzureichenden Gewässerschutzgesetzgebung an sich sowie die früher einseitig auf die Produktion ausgerichteten Agrarsubventionen herausgearbeitet. Für die Zukunft wird Kooperation der Agrar- und Wasserverwaltungen bei ihren Reformprozessen und eine bessere Definition der „Guten landwirtschaftlichen Praxis" empfohlen. Im Rahmen der zweiten Untersuchungsebene wurden die Auswirkungen verschiedener Maßnahmen zur Reduzierung von Nährstoff- und Pflanzenschutzmitteleinträgen anhand von Modellrechnungen analysiert und bewertet. Im Mittelpunkt standen die spezifischen Kosten/Nutzenverhältnisse für den Gewässerschutz. Folgende Maßnahmen wurden analysiert: Entkopplung der Direktzahlung, stärkere Flächenbindung der Tierhaltung, Abgabe auf mineralische Stickstoffdünger, Abgabe auf Pflanzenschutzmittel, Anlage von Gewässerrandstreifen, Begrünung von Ackerflächen, Bodenbearbeitungsverfahren, Nutzungsänderungen landwirtschaftlicher Flächen, Optimierung der Tierernährung, Optimierung der Wirtschaftsdüngerlagerung und –ausbringung, kooperativer Gewässerschutz, Ausbildung/Beratung. Kooperationen und gewässerschutzbezogene Ausbildung und Beratung sind zu empfehlen, da sie Wissenstand und Handlungskompetenz steigern. Die Berechnungen auf Landkreisebene zeigen, dass die Entkopplung der Direktzahlungen nicht zu nennenswerten Veränderungen der Nährstoffbilanzüberschüsse auf der landwirtschaftlich genutzten Fläche führen, während eine stärkere Flächenbindung der Tierhaltung die Überschüsse deutlich reduzieren würde. Durch die Flächenbindung sowie durch eine Abgabe auf mineralische Stickstoffdünger käme es in veredelungs- und ackerbaubetonten Regionen zu unterschiedlichen Anpassungen. Auf der einzelbetrieblichen Ebene wurden die nährstoffangepasste Fütterung, die Erweiterung der Lagerkapazität und die Optimierung der Ausbringung für Wirtschaftsdünger als die bedeutendsten und kosteneffektivsten Maßnahmen identifiziert um Nährstoffverluste zu verringern. Möglichst ganzjährige Begrünungsmaßnahmen und konservierende Bodenbearbeitung sind ebenso effektiv und es ist zu empfehlen, diese Maßnahmen stärker in der landwirtschaftlichen Praxis zu etablieren. Zur Verringerung der diffusen Gewässerbelastung aus der Siedlungsentwässerung wurden sowohl politische Ansätze als auch detaillierte technische Maßnahmen untersucht. In diesem Bereich werden vorläufig die Regenwasserbewirtschaftung, die Flächenentsiegelung und Kleinkläranlagen als besonders kostenwirksam herausgestellt. .

17. Schlagwörter		
18. Preis	19.	20.

List of abbreviations

BMU	Federal Ministry for the environment, nature conservation and nuclear safety
BRD	Federal Republic of Germany
CAP	Common Agricultural police
COM	European Commission
DDR	Federal Republic of East-Germany, before 1990
DFP	Duly Farming Practice
DVGW	The German Technical and Scientific Association for Gas and Water
EC	European Community
EMAS	Environmental Management and Audit Scheme
EU	European Union
FAA	Research Association for Agricultural Policy and Rural Sociology, Forschungsgesellschaft für Agrarpolitik und Agrarsoziologie e.V.
GAP	Gemeinsame Agrarpolitik
GWD	Groundwater Daughter Directive
GFP	Good Farming Practice
HELCOM	Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992, Helsinki Commission
IFS	engineering office for urban hydrology, Ingenieurgesellschaft für Stadthydrologie mbH
IVU	Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control
KTBL	Association for Technology and Structures in Agriculture, Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V.
NEC	National emissions ceilings
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic, Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992
RAUMIS	Regional Agricultural and Environmental Information System
UBA	Environmental Agency
UN/ECE	United Nations Economic Commission for Europe

WFD	Water Framework Directive
WI	Wuppertal Institute for Climate, Environment and Energy, Wuppertal Institut für Klima, Umwelt und Energie
WRRL	Wasserrahmenrichtlinie

Summary

After considerable improvements of wastewater treatment, the loads of nutrients and plant protection agents, deriving from agriculture and heavy metals from urban drainages effluents as well as from erosion of agricultural soils are the main sources of nutrients and harmful substances in the loads of water bodies.

On account of this, the Environmental Agency has initiated the project "Evaluation of policy measures and methods to reduce diffuse water pollution", focussing on agriculture and urban drainage. The targets of the project were on the one hand the analysis of the political and legislative framework of both policy fields and on the other hand the evaluation of several, selected water protection measures with regard to their contribution to reduce water pollution, their economical effects as well as their political enforceability.

With regards to the various problems and political consignees, both policy fields have been analysed with different methods. The focus was laid on agricultural policy and water protection measures. In doing so the project report is subdivided: Part A concentrates on the compressed presentation of the recommendations for the agricultural sector. Part B comprises details on methodology, calculation and recommendations of the modelbased exploratory focuses and the report for the policy field urban drainage.

Agriculture

The agricultural part, is subdivided into the analysis of the legislative framework and the examination of impacts of selected measures on farm management. The latter has been done with help of model calculation.

The analysis of the political framework and the prognosis of the potential effects of the reform process within the common policy fields agriculture and water protection was worked out by the Wuppertal Institute for Climate, Environment and Energy (WI), Wuppertal. In a first step the historical development of common instruments und measures to protect water courses were analysed. As main reason for the water pollution impacts stagnating at a high level, a lack of implementation discipline was identified. In the second instance the fragmented and insufficient water protection legislation itself can be deemed to be a driving force for water pollution. Another reason for the high loads of nutrients and harmful substances loads deriving for farmlands is the previous design of the common agricultural policy slanted towards increasing productivity and the extensively indeterminate term of "Good Farming Practice".

In the context of the present Implementation of the reform of the Agenda 2000, important steps have been taken to implement and reward environmental services by farmers, which also will serve water protection targets. Especially the combination of the entitlement of grants and the duty to legal compliance (Cross Compliance) can be deemed as paradigm shift within the Common Agricultural policy (CAP) – turning away form increasing productivity.

So far, there is no consensual definition of production standards (GFP) defining a common level of environmentally orientated management practices for the European agriculture. In addition to that, the national options to implement the reform are so manifold, that a re-nationalisation of Agricultural Policy not only concerns the environmental standards. De facto the EU shifts the weighting – on the one hand to push the global market orientation, but on the other hand to reward the socio-ecological importance of rural areas – to the Member States.

The Water Framework Directive (WFD) forms a framework for the implementation of a Common European Water Policy, which for the first time includes all farmland. At that moment, the success of the WFD to contribute water protection aims is difficult to assess. Beside opportunities to improve water protection there are some causes for concern, mainly the possibility to extend deadlines, the large number of opt-out clauses, and the opportunity to define national or river basin district related quality objectives for harmful substances (except the priority substances).

The best opportunities to improve water protection of water bodies affected by agriculture, are

- to achieve a synergetic implementation of both reforms: the Water Framework Directive and the Common Agricultural Policy,
- to concretise the GFP and
- to implement a permanent co-operation of competent authorities of both policy fields which secure, on the one hand, a viable and competitive agriculture and, on the other hand, improve water quality.

The second investigation level focuses on the analysis and assessment of selected measures to reduce the input of nutrients and plant protection agents. This part was done with help of calculation models. The specific costs for water protection stand at the centre of attention (that means, the relationship of costs compared to the impact of the measures, e.g. reduced amount of nutrient inputs into watercourses). Additional criteria: target accuracy, political enforceability, administrative implementation and control as well as other potential side effects were taken into account. The following measures have been analysed:

- Decoupling of direct payments

- Coupling of livestock farming to areas
- Tax on mineral nitrogen
- Pesticide levy
- Buffer stripes alongside of watercourses
- All season crop cover on arable land (catch crops, underseeding or interrow greening)
- Soil cultivation procedures (mulching, direct seeding)
- Changing the use of arable land
- Optimisation of animal nutrition
- Optimisation of manure storage and application
- Co-operative agreements
- Education and training

The evaluation of the measures "Co-operative Agreements" and "Education and Training" were assessed according to supporting literature. Both measures can be highly recommended because of their longtime efficiency. Both measures improve the knowledge and the freedom of action of farmers for environmental needs permanently.

All other measures were calculated model based, but with differing points of view. The impacts of the measures "Decoupling", "Coupling livestock farming to areas", and "Tax on mineral nitrogen" have been calculated with help of the Agricultural Sector Model RAUMIS by the Research Association for Agricultural Policy and Rural Sociology (FAA), Bonn. The model projects the results on county level for the target year 2010 and compares them with the reference situation under "Status-Quo-Policy".

As the results show, the measure "Decoupling of direct payments" would not lead to appreciable changes as far as the nutrient surpluses on farmland are concerned. But for the measures "Coupling livestock farming to areas" and "Tax on mineral nitrogen", a regional adaptation, depending on the regional specialisation - cropping or livestock farming - could be expected. As far as the specific cost of the measures are concerned, it can be summarised that the measures "Coupling livestock farming to area" on the one hand is the most expensive way to reduce nitrogen inputs into water bodies, but on the other hand it is the only one that would lead to a substantial reduction of nutrient surpluses in regions with high nitrate surpluses.

With regards to the use of this part of the study for consulting services, it has to be pointed out, that due to missing information about specific location conditions as well as differing preferences, the use of the results only has limited validity. In these regional aspects the integration of Agricultural and Water Protection Policy needs further research work.

Beside the model based calculation on county level, the Association for Technology and Structures in Agriculture (KTBL), Darmstadt, has evaluated the impacts of the above mentioned measures (except the measure "Decoupling") on the profitability of farms and water protection targets. For the consideration at farm level four general farm types (reference farms), which are representative of typical farming conditions in Germany, were selected.

- Extensive crop production
- Intensive crop production
- Mixed farming – pig fattening/crop production
- Mixed farming – dairy cows/crop production

On single farm level the measures, protein adapted feeding, optimisation of manure storage and application showed the best cost-efficiency to reduce nutrient surpluses. All season crop cover on arable land and conservation tillage are highly efficient, too, and should be included in farming practice. A stronger limitation of livestock density could mean a reduction of manure, but the implementation of this measure would lead to high losses of income for farmers specialised in animal production.

The range of costs incurred when converting arable land into extensively managed grassland depends on the subsequent use of the land and farm equipment. While specific costs for permanent fallow are low, measures like changes in land use (turning arable land into extensive grassland) combined with low economic livestock farming (e.g. suckler cows) causes high cost on single farm level. Introducing water margin buffer strips are comparatively expensive. A levy on mineral nitrogen and plant protection agents means financial disadvantages, especially for farm types specialised in crop production.

In general measures, which have a high potential to reduce nutrient losses and at the same time only a marginal influence on farm incomes, have a higher acceptance. These measures should obtain priority.

Urban drainage

The investigation area ’urban drainage’ is subdivided into two thematic parts. For reduction of diffuse water pollution caused by urban drainage political approaches as well as detailed technical measures are examined. The political approaches follow four different principles:

- State authority principle: Environmental standards have to be appropriately further developed by legal regulations for storm water management (discharges, treatment) and surveillance of sewage systems.

- Market principle: Economic / market incentives include funding of measures for reduction of water pollution and on the other hand waste water charges for pollutant discharges into receiving waters according to the 'polluter pays' principle.

- Co-operation principle: The application of instruments using co-operative approaches has to be extended. This consequently requires an integrated view on all areas of action (urban drainage, agriculture, industry, river development etc.) like foreseen by the WFD. Especially voluntary self commitments in industry and business for abstaining from ecologically questionable substances have to be emphasized.

- Public participation and environmental education: Information and training or education as an instrument has to be used for modifying the behaviour of individuals, social groups and business. This includes public participation (e.g. obligatorily required by WFD or voluntarily applied to progressive drainage planning) as well as storm water experience for the public through attractively designed drainage structures (infiltration swales, open channels, cascades, ponds and waterworks).

The spreading of the following detailed technical measures has to be extended:

- Storm water management including treatment

- Road runoff treatment

- Sewage systems surveillance and renovation

- Alternative integrated urban water concepts

- Replacement of hazardous substances (in construction industry)

Cost-effectiveness-analyse are suitable for priority setting and selection of final recommendations among the different measures, but there are still large uncertainties in quantifying the input parameters. In the area of urban drainage storm water management (especially infiltration and constructed wetlands), unsealing of paved areas and small wastewater treatment structures (for phosphorus reduction) showed best cost-effectiveness. In general source control measures have to be preferred to achieve sustainable water resources management because they prevent emissions prior to emerging.

In the sense of integrated solutions the analysis' has to include all pollutant sources and all areas of action (urban drainage, agriculture, industry, traffic, river development, landscape planning etc.) respectively. By this means the setup of cost-effective measures and management plans for river catchment management required by the WFD will be enabled. The inclusion of the different areas of society and politics like households, municipalities, states and countries according to the mentioned principles of action is indispensable.

The results of this study have been presented on the "7th International Conference on Diffuse Pollution and Basin Management (DIPCON)" in August 2003 in Dublin. Furthermore, the agricultural part forms the scientific base for a resolution, which has been adopted at the conference. This resolution is addressed to the EU-Commission as common recommendation of the IWA- section "Diffuse Pollution".

Recommendations of instruments and measures

Resolution

from the
IWA Congress on Diffuse Water Pollution[1]
on
Water Pollution Control in European Agricultural Policy

Agriculture puts pressure on water resources by diffuse pollution, extensive water use in arid regions and destruction of water habitats (e.g. by brook maintenance). Water bodies are contaminated by various agricultural inputs or their by-products or metabolites, leading to eutrophication and side effects on non-target organisms. The 7th IWA Diffuse Pollution and Basin Management Congress participants recommend there has to be a co-ordinated sustainable policy for agriculture and water pollution control. This requires a better co-ordination between these policies at EU, Member States and river basin district levels.

At present Europe has a unique opportunity to achieve progress in reducing diffuse water pollution from agricultural sources in a sustainable and socially compatible manner. With the Mid-term Review of Agenda 2000 the current agricultural policy has been reviewed and profound changes have been brought about. In parallel, the Water Framework Directive (WFD) is being implemented across Member States.

In the view of the Congress participants the required reduction of water pollution by agriculture may be only achieved by implementing a package of measures. A combination of area-wide instruments (cross-compliance with legal minimum standards and modulation) and of regionally adapted area-oriented measures (e.g. training, agri-environmental measures, river management plans) is recommended.

Measures in the EU Policy Field

Controls to improve water quality must be included in agricultural policy without compromising agriculture. The following measures are recommended towards achieving this objective:

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[1] 7th International Conference on Diffuse Pollution and Basin Management (DIPCON), International Water Association (IWA), Dublin, 17th – 22nd August 2003

1. Further develop and specify ”Good Farming Practice” (GFP) in environmental and agricultural legislation according to the guidelines indicated in measure 8 (below) as minimum standard of a common policy in the water pollution control field;

2. Immediate and full implementation of cross-compliance and the adoption and implementation of a farm audit system based on the Environmental Management and Audit Scheme (EMAS) for agriculture;

3. Implementation of obligatory modulation with higher rates strongly rerouted to the benefit of selected measures within the rural development programs. These include the practices outlined in Measure 8 if they exceed GFP and measures necessary to fulfil the aims of the WFD;

4. Ensure that decoupling does not result in increased water pollution (e.g. ploughing of grassland);

5. Co-operation and integration in the preparation of river basin management plans and rural development programs aimed at using all possibilities of the draft CAP agreement including Art.69;

6. Development and promotion of co-operative agreements in and outside water protection areas;

Measures to reduce local and regional water quality problems

7. Greater integration of environmental awareness and understanding in agricultural practice through training and advisory programs;

8. Greater protection of water resources from contaminants arising from agriculture by the adoption of a range measures for animal and plant production systems including:

    - Nutrient Management Plans supported by certified experts based on soil tests, crop requirements with due recognition to site vulnerability
    - Establishment of appropriate livestock density limits
    - Livestock diets adapted to reduce animal nutrient intake
    - Improved manure management systems on farms (application and storage)
    - Ensure winter cover on arable land
    - Erosion control measures

- Integrated water management strategies to reduce emissions to water (e.g. buffer zones, wetlands, ponds)
- Correct pesticide application rates and methods
- Disposal of spray mixture residues on arable land and the return of empty containers to the pesticide supplier
- collection of a fee on pesticides to finance training and advice programs
- Development of plant protection agents with due regard to a faster degradability and a lower transportability/mobility

Kurzfassung

Nach dem weitgehenden Ausbau der Abwasserreinigung sind diffuse Gewässerbelastungen mit Nährstoffen und Pflanzenschutzmitteln aus der Landwirtschaft sowie Schwermetallen aus der städtischen Regenentwässerung und der Erosion landwirtschaftlicher Böden mittlerweile die bedeutendsten Quellen von Nähr- und Schadstoffen und haben somit einen hohen Anteil an der stofflichen Belastung der Gewässer.

Vor diesem Hintergrund hat das Umweltbundesamt das Forschungsprojekt "Evaluierung von Politikansätzen, Maßnahmen und Wegen zur Bekämpfung diffuser Gewässerbelastungen" initiiert. Aufgabe des Projektes war einerseits die Analyse der politischen Rahmenbedingungen und anderseits die Beurteilung verschiedener, ausgewählter Maßnahmen hinsichtlich ihres Beitrages zum Gewässerschutz sowie ihrer ökonomischen Auswirkungen und politischen Durchsetzbarkeit.

Unter Berücksichtungen der unterschiedlichen Problemstellungen und involvierten Handlungsebenen wurden die beiden Untersuchungsbereiche Landwirtschaft und Siedlungsentwässerung mit verschiedenen methodischen Ansätzen untersucht. Der Schwerpunkt des Projektes lag auf der Untersuchung des Teilbereichs Landwirtschaft. Der Forschungsbericht ist dabei zweigeteilt: Teil A konzentriert sich auf die komprimierte Darstellung der Forschungsergebnisse für den Bereich Landwirtschaft. Teil B beinhaltet Detailinformationen zur Methodik, Berechung und den Ergebnissen der modellbasierten Untersuchungsbereiche, und den Untersuchungsbericht zum Schwerpunkt Siedlungsentwässerung.

Landwirtschaft

Im Rahmen des Untersuchungsbereichs Landwirtschaft wurden neben der Analyse der politischen Rahmenbedingungen die Auswirkungen von produktionstechnischen Maßnahmen anhand von Modellrechnungen untersucht.

Die Analyse des rechtlichen Rahmens und eine Prognose der möglichen Auswirkungen der Reformprozesse innerhalb der Landwirtschafts- und Gewässerschutzpolitik wurde durch das Wuppertal Institut erarbeitet. In einem ersten Schritt wurden die politischen Instrumente analysiert. Auf der Gemeinschaftsebene wurde vor allem die in der Vergangenheit mangelnde Umsetzungsdisziplin aller Mitgliedsstaaten bezüglich der auf den Gewässerschutz ausgerichteten Rechtsakte, und erst in zweiter Linie die fragmentierte und unzureichende Gewässerschutzgesetzgebung an sich, als Gründe für die hohen diffusen Gewässerbelastungen identifiziert. Als weitere wichtige Gründe werden die bisher zu einseitig an der Produktionsmaximierung und später an der Marktregulierung ausgerichtete

Gestaltung der Subventionspolitik und der weitgehend unbestimmte Rechtsbegriff der "Guten Fachlichen Praxis" angesehen.

Im Rahmen der derzeitigen Umsetzung der Reform der Agenda 2000 hat die Integration und Honorierung von Umweltleistungen in der Landwirtschaft an Bedeutung gewonnen, was auch dem Gewässerschutz dient. Insbesondere die Verbindung von Beihilfeberechnung und der Pflicht zur Einhaltung von relevanten Umweltstandards (Cross-Compliance) kann als Paradigmenwechsel in der bisher vor allem auf Produktion ausgerichteten Gemeinsamen Agrarpolitik (GAP) gewertet werden.

Bisher fehlt es aber vor allem an abgestimmten allgemeingültigen Produktionsstandards (der sogenannten "Guten Fachlichen Praxis"), die ein einheitliches Umwelt- und Naturschutzniveau für die europäische Landwirtschaft definieren. Zusätzlich ist der nationale Gestaltungsspielraum zur Umsetzung der Reform so weitreichend, dass nicht nur in Bezug auf die Umweltstandards von einer Renationalisierung der Agrarpolitik gesprochen werden kann. De facto verschiebt die EU die Gewichtung - einerseits die Weltmarktausrichtung in der Landwirtschaft zu forcieren, aber andererseits die sozio-ökologische Bedeutung der ländlichen Gebiete zu honorieren – auf die einzelnen Mitgliedsstaaten.

Mit der Wasserrahmenrichtlinie (WRRL) ist zum ersten Mal ein umfassender Rahmen für den europäischen Gewässerschutz vereinbart worden, der alle landwirtschaftlich genutzten Flächen in seinen Geltungsbereich einschließt. Der Nutzen für den Gewässerschutz lässt sich zum derzeitigen Stand des Umsetzungsprozesses nur schwer abschätzen. Neben positiven Ansätzen sind es vor allem die Möglichkeit, die Umsetzungszeiträume zu verlängern, zahlreiche Ausnahmeregelungen und die auf die Nationalstaaten bzw. Flussgebietseinheiten zurück delegierte Festschreibung von Umweltstandards (Mit Ausnahme der prioritären Stoffe), die eine qualitative Verbesserung im europäischen Gewässerschutz gefährden können.

Insgesamt werden die Chancen eine Verbesserung im landwirtschaftlich beeinflussten Gewässerschutz Europas zu erreichen, vor allem darin gesehen,

- die beiden Reformprozesse „Wasserrahmenrichtlinie“ und „gemeinsame Agrarpolitik“ miteinander zu verbinden,
- die „Guten Fachliche Praxis“ zu konkretisieren und
- die Kooperation von Landwirtschafts- und Gewässerschutzakteuren mit dem Ziel zu etablieren, sowohl die Gewässerqualität zu verbessern als auch eine wettbewerbsfähige Landwirtschaft zu erhalten.

Im Rahmen der zweiten Untersuchungsebene wurden die Auswirkungen verschiedener Maßnahmen zur Reduzierung von Nährstoff- und Pflanzenschutzmitteleinträgen anhand von

Modellrechnungen analysiert und bewertet. Im Mittelpunkt standen die spezifischen Kosten für den Gewässerschutz (d.h. Verhältnis der Kosten zur erreichten Wirkung für den Gewässerschutz, z.B. Minderung des Nährstoffaustrags). Als weitere Bewertungskriterien wurden die Zielgenauigkeit und das Potential der Maßnahmen, die politische Durchsetzbarkeit, die administrative Umsetzbarkeit und Kontrolle sowie mögliche Nebeneffekte herangezogen. Folgende Maßnahmen wurden analysiert:

- Entkopplung der Direktzahlung,
- stärkere Flächenbindung der Tierhaltung
- Abgabe auf mineralische Stickstoffdünger
- Abgabe auf Pflanzenschutzmittel
- Anlage von Gewässerrandstreifen
- Begrünung von Ackerflächen (Zwischenfrüchte/Untersaaten, Zwischenreihenbegrünung)
- Bodenbearbeitungsverfahren (Mulchverfahren, Direktsaat)
- Nutzungsänderungen landwirtschaftlicher Flächen (Umwandlung von Ackerland in Grünland, Erhöhung des Anteils von Dauerbrachen)
- Optimierung der Tierernährung
- Optimierung der Wirtschaftsdüngerlagerung und -ausbringung
- Kooperativer Gewässerschutz
- Ausbildung/Beratung

Die Maßnahmen "Kooperativer Gewässerschutz" und "Ausbildung/Beratung" wurden mit Hilfe einer Literaturrecherche in ihren Wirkungen abgeschätzt. Beide Maßnahmen sind zu empfehlen und zu unterstützen, da diese den Wissensstand und die Handlungskompetenz der Landwirte in Bezug auf die Umweltwirkung landwirtschaftlicher Produktionsverfahren erhöhen.

Für die übrigen Maßnahmen wurden Modellrechnungen auf unterschiedlichen Betrachtungsebenen durchgeführt. Die Auswirkungen der Maßnahmen "Entkopplung", "stärkere Flächenbindung der Tierhaltung" und "Abgabe auf mineralische Stickstoffdünger" wurden von der Forschungsgesellschaft für Agrarpolitik und Agrarsoziologie e.V. (FAA),

Bonn, mit Hilfe des Agrarsektormodells RAUMIS auf Landkreisebene für das Zieljahr 2010 abgeschätzt und mit der Referenzsituation „Status-Quo-Politik“ im gleichen Jahr verglichen.

Wie die Berechnungsergebnisse gezeigt haben, würde eine Entkopplung der Direktzahlungen nicht zu nennenswerten Veränderungen bezüglich der Nährstoffbilanzüberschüsse auf der landwirtschaftlich genutzten Fläche führen, während für die beiden anderen oben genannten Maßnahmen regional unterschiedliche Anpassungen – je nachdem, ob es sich um eine veredelungs- oder eine ackerbaubetonte Region handelt – eintreten würden. Hinsichtlich der Maßnahmenkosten lässt sich zusammenfassen, dass die „stärkere Flächenbindung der Viehhaltung“ einerseits die vergleichsweise teuerste Nährstoffreduzierungsvariante wäre, andererseits die Einzige unter den untersuchen Maßnahmen darstellt, die auch in Gebieten mit hohen Nährstoffüberschüssen zu einer deutlichen Reduzierung der Nährstoffüberschüsse führen würde.

Im Hinblick auf die Verwendung der Modellergebnisse zur Politikberatung muss darauf hingewiesen werden, dass wissenschaftlich ausreichend abgesicherte Maßnahmenempfehlungen aufgrund fehlender regionalspezifischer Zusatzinformationen bezüglich natürlicher Standortbedingungen sowie gesellschaftlicher Präferenzstrukturen nicht vorgenommen werden können. Hinsichtlich dieser regionalen Aspekte erfordert die Integration des Gewässerschutzes in die Agrarpolitik weitergehende Forschungsaktivitäten.

Neben den Modellrechnungen auf regionaler Ebene wurden vom Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V. (KTBL), Darmstadt, die Auswirkungen der o.g. Maßnahmen (ausgenommen "Entkopplung") auf die Wirtschaftlichkeit von landwirtschaftlichen Betrieben und den Gewässerschutz bewertet. Für die Modellrechnungen wurden vier typische landwirtschaftliche Betriebe (Referenzbetriebe) herangezogen:

- Marktfruchtbetrieb mit extensiver Arbeitswirtschaft
- Marktfruchtbetrieb mit intensiver Arbeitswirtschaft
- Tierhaltungsbetrieb mit Schweinemast
- Tierhaltungsbetrieb mit Milchproduktion

Eine nährstoffangepasste Fütterung, die Erweiterung der Lagerkapazität und Optimierung der Ausbringung (Applikationstechnik, -zeiträume) für Wirtschaftsdünger zeigten sich auf einzelbetrieblicher Ebene als die bedeutendsten und kosteneffektivsten Maßnahmen um Nährstoffverluste zu verringern. Möglichst ganzjährige Begrünungsmaßnahmen und konservierende Bodenbearbeitung sind ebenso effektiv und es ist zu empfehlen, diese Maßnahmen stärker in die landwirtschaftliche Praxis zu etablieren. Eine stärkere

Flächenbindung der Tierhaltung hat einen geringeren Anfall von Wirtschaftsdüngern zur Folge; die Umsetzung dieser Maßnahme führt allerdings zu hohen Einkommensverlusten von tierhaltenden Betrieben. Die Kosten für eine Umwandlung von Ackerland in Grünland sind in hohem Maße von der Folgenutzung und betrieblichen Ausstattung abhängig. Während die Kosten für Dauerbrachen gering sind, fallen bei der Umwandlung von Ackerland in extensiv genutztes Grünland, insbesondere bei Tierhaltungsverfahren mit geringer Wirtschaftlichkeit (z.B. Mutterkuhhaltung), hohe Kosten auf einzelbetrieblicher Ebene an. Die Anlage von Gewässerrandstreifen ist mit vergleichsweise hohen, negativen Einkommenswirkungen verbunden. Eine Abgabe auf mineralische Stickstoffdünger und Pflanzenschutzmittel hat insbesondere wirtschaftliche Nachteile für Marktfruchtbetriebe zur Folge.

Ganz generell haben Maßnahmen, die ein hohes Potential zur Reduzierung von Nährstoffverlusten aufweisen und sich gleichzeitig gering auf das Einkommen landwirtschaftlicher Betriebe auswirken, eine höhere Akzeptanz und sollten im Rahmen des Gewässerschutzes vorrangig gefördert werden.

Siedlungsentwässerung

Zur Verringerung der diffusen Gewässerbelastung aus der Siedlungsentwässerung wurden sowohl politische Ansätze als auch detaillierte technische Maßnahmen untersucht. Die politischen Handlungsansätze sind nach vier unterschiedlichen Prinzipien zu unterscheiden:

- Hoheitliches Prinzip: Umweltstandards sind durch gesetzliche Regelungen und technische Richtlinien für die Regenwasserbewirtschaftung (Niederschlagswassereinleitungen, Regenwasserbehandlung) und die Kanalisation (Überwachung) maßvoll weiter zu entwickeln.

- Marktwirtschaftliches Prinzip: Die ökonomischen Anreize umfassen einerseits die Förderung von Maßnahmen zur Verminderung von Gewässerbelastungen und andererseits die Erhebung von Gebühren und Abgaben für belastende Abwassereinleitungen in die Gewässer gemäß dem Verursacherprinzip.

- Kooperationsprinzip: Kooperative Ansätze sind zu nutzen. In letzter Konsequenz erfordern diese eine integrierte Betrachtung aller Handlungsfelder (Siedlungsentwässerung, Landwirtschaft, Industrie, Wasserbau etc.), wie es z.B. auch von der WRRL vorgesehen ist. Besonders hervorzuheben sind außerdem freiwillige Vereinbarungen mit Industrie und Wirtschaft zum Verzicht auf ökologisch bedenkliche Stoffe.

- Öffentlichkeitsbeteiligung und Umweltbildung: Information und (Aus-, Fort-, Weiter-) Bildung sind zur Änderung des Verhaltens beim Einzelnen, bei gesellschaftlichen

Gruppierungen und in der Wirtschaft einzusetzen. Das Spektrum umfasst neben der Öffentlichkeitsbeteiligung (z.B. obligatorisch gefordert von der WRRL oder freiwillig im Rahmen fortschrittlicher Entwässerungsplanung) auch das "Erfahrbarmachen" von Regenwasser für die Bevölkerung mittels attraktiv gestalteter Entwässerungsanlagen.

Zu den detaillierten technischen Maßnahmen, deren weitere Verbreitung zu forcieren ist, zählen:

- Regenwasserbewirtschaftung einschließlich Niederschlagswasserbehandlung
- Behandlung von Straßenabflüssen
- Kanalnetzüberwachung und –sanierung
- Alternative integrierte urbane Wasserkonzepte
- Ersatz schädlicher Substanzen (z.B. Bauindustrie)

Zur Priorisierung und Auswahl der Instrumente und Maßnahmen bieten sich Kosten-Wirksamkeits-Analysen an, die bisher jedoch noch mit Unsicherheiten behaftet sind. Im Bereich der Siedlungsentwässerung werden vorläufig die Regenwasserbewirtschaftung (insbesondere Niederschlagswasserversickerung und Bodenfilter), die Flächenentsiegelung und Kleinkläranlagen (zur Phosphorreduktion) als besonders kostenwirksam herausgestellt. Grundsätzlich sind im Sinne einer nachhaltigen Wasserwirtschaft Maßnahmen an der Quelle zu favorisieren, um bereits die Entstehung von Emissionen zu verhindern.

Analysen zur Erarbeitung integrierter Lösungen müssen alle Belastungsquellen und alle möglichen Maßnahmenbereiche (Stadtentwässerung, Landwirtschaft, Industrie, Verkehr, Wasserbau, Landschaftsplanung usw.) berücksichtigen. Nur so kann die von der Wasserrahmenrichtlinie geforderte Auswahl kosteneffizienter Maßnahmen für die Maßnahmenpläne innerhalb der Flussgebietsmanagementplanung gelingen. Die Einbeziehung der verschiedenen gesellschaftlichen Gruppen und Politikbereiche, wie z.B. Haushalte, Kommunen, Regionen bzw. Bundesländer und Staaten gemäß o.g. Prinzipien ist unentbehrlich.

Die Ergebnisse des gesamten Forschungsprojektes wurden im August 2003 auf der "7th International Conference on Diffuse Pollution and Basin Management (DIPCON)" in Dublin präsentiert. Das Teilprojekt Landwirtschaft bildet zudem die wissenschaftliche Grundlage für eine im Rahmen der Konferenz verabschiedete Resolution zu diffusen Gewässereinträgen, die an die EU-Kommission als gemeinsame Empfehlungen der IWA-Fachgruppe "Diffuse Pollution" adressiert ist.

Empfehlung geeigneter Maßnahmen und Instrumente

Resolution

des
IWA Kongresses „Diffuse Gewässerbelastung“ [2]
zu
Maßnahmen gegen Gewässerbelastung
in der Europäischen Landwirtschaftspolitik

Die Landwirtschaft bedroht die Wasserressourcen durch diffuse Gewässerbelastung, Entnahmen für Bewässerungszwecke in trockenen Gebieten aber auch durch die Zerstörung aquatischer Habitate (z.B. durch Gewässerunterhaltung). Wasserkörper werden kontaminiert durch landwirtschaftliche Nähr- und Schadstoffeinträge, ihre Nebenprodukte und Metaboliten, die zur Gewässereutrophierung und einer negativen Beeinflussung vieler Lebensformen führen. Im Rahmen der 7. IWA Konferenz "Diffuse Gewässerverschmutzung und Flussgebietsmanagement" wurde daher eine abgestimmte und nachhaltige Politik für die Aktionsfelder Landwirtschaft und Gewässerschutz empfohlen. Hierzu bedarf es einer besseren Koordination zwischen diesen beiden Politikfeldern auf europäischer, nationaler und Flussgebietsebene.

Derzeit bietet sich in Europa die einmalige Gelegenheit deutliche Fortschritte in der Reduzierung der Gewässerkontamination aus landwirtschaftlichen Quellen in nachhaltiger und sozialverträglicher Weise zu erreichen. Im Zuge der Halbzeitbewertung der Agenda 2000 wurde die bisher gültige Agrarpolitik überprüft und tiefgreifende Veränderungen mit Relevanz für den Gewässerschutz beschlossen. Parallel dazu wird die Wasserrahmenrichtlinie (WRRL) in allen Mitgliedstaaten sukzessive umgesetzt.

Im Konsens der Kongressteilnehmer kann die notwendige Reduktion der Gewässerverschmutzung durch den landwirtschaftlichen Sektor nur durch die Implementierung eines Maßnahmenbündels erreicht werden. Vorgeschlagen wird eine Kombination aus europaweit wirksamen Instrumenten (Cross-Compliance mit europaweit gültigen Mindeststandards und die aktive Nutzung des Instruments Modulation) und regional angepassten Maßnahmen (z.B. Aus- und Weiterbildungsangebote, Agrar-Umweltprogramme, Flussgebietsmanagementpläne).

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[2] 7. Internationale Konferenz über Diffuse Gewässerbelastung and Flussgebietsmanagement (DIPCON), International Water Association (IWA), Dublin, 17. – 22.8.2003.

Maßnahmen im Bereich der Gemeinschaftspolitik

Die Anstrengungen zur Verbesserung der Gewässerqualität müssen auch in die Agrarpolitik Einzug halten ohne jedoch die Landwirtschaft in ihrer Existenz zu gefährden. Die folgenden Maßnahmen werden zur Erreichung dieses Ziels empfohlen:

1. Weiterentwicklung und Spezifizierung der „Guten landwirtschaftlichen Praxis“ im Umweltrecht und landwirtschaftlichem Fachrecht gemäß vorab genannter Leitlinien als Mindeststandard der gemeinsamen Gewässerschutzpolitik unter besonderer Berücksichtigung der in Aufzählungspunkt 8 (siehe unten) formulierten Anforderungen.

2. Sofortige und vollständige Implementierung des Instruments „Cross-Compliance“ und Verabschiedung sowie Einführung eines auf die Landwirtschaft abgestimmten Umweltmanagementsystems in Anlehnung an das EG-Öko-Audit System (EMAS);

3. Einführung der obligatorischen Modulation mit größeren Anteilen, die strikt Maßnahmen innerhalb der Agrar-Umweltprogramme zu Gute kommen sollen. Solche Maßnahmen umfassen Verfahren, wie sie unter Aufzählungspunkt 8 dargestellt sind, wenn sie über die „Gute Fachliche Praxis“ hinausgehen und Maßnahmen, die geeignet sind die Ziele der WRRL zu erfüllen.

4. Sicherstellung, dass die Entkopplung nicht zu einer steigenden Gewässerverschmutzung führt (z.B. durch Grünlandumbruch);

5. Kooperation und Integration bei der Entwicklung der Flussgebietsmanagementpläne und der Agrar-Umweltprogramme unter Nutzung aller Möglichkeiten der Vereinbarung über die GAP, inkl. Art. 69

6. Entwicklung und Förderung von Kooperativen Gewässerschutzvereinbarungen innerhalb und außerhalb von Gewässerschutzgebieten;

Maßnahmen zur Reduzierung von lokalen und regionalen Qualitätsproblemen in Gewässern.

7. Bessere Integration von Umweltbewusstsein und Umweltwissen in die landwirtschaftliche Praxis durch Aus- und Weiterbildung;

8. Erhöhung des Gewässerschutzes in Bezug auf Kontamination durch landwirtschaftliche Produktion durch Anwendung einer Reihe von Verfahren in der Tierhaltung und Pflanzenproduktion; hierzu gehören:

- Nährstoffmanagement-Pläne, unterstützt durch zertifizierte Experten, basierend auf Bodenuntersuchungen und Kulturerfordernissen unter Berücksichtigung der Standortempfindlichkeit gegenüber Gewässerverschmutzungen.
- Einführung angemessener Obergrenzen für den Tierbesatz
- angepasste Fütterung zur Verminderung der Nährstoffaufnahme und –abgabe
- verbessertes Güllemanagement (Ausbringung und Lagerung)
- ganzjährige Begrünung von Ackerland
- Maßnahmen zur Erosionsvermeidung
- integriertes Wassermanagement zur Reduktion der Gewässerbelastungen (einschließlich Randstreifen, Feuchtgebiete und Teiche)
- korrekte Pestizidanwendung hinsichtlich Menge und Ausbringung
- Ausbringung von Pestizidresten auf der landwirtschaftlichen Nutzfläche und Rückgabe der Behälter an den Produzenten
- Einführung einer Pestizidabgabe zur Förderung von Ausbildungs- und Beratungsprogrammen
- Entwicklung von PSM mit besserer Abbaubarkeit und geringerer Transportierbarkeit/Mobilität

Part A

Final report agriculture

1. General project description

1.1 Description of issues

Despite the achieved progress in water pollution control over the last 20 years, there is still a call for action, to reduce diffuse water pollution. Based on a publication of the German Federal Environmental Ministry, the total input of nitrogen into the river catchment areas accounted approx. 820 kt N/a during the period from 1993-1997. Compared to the past decade this means a reduction of 266 kt N/a respectively 25 % (BMU 2001). Mainly the inputs of the point sources have been reduce, e.g. by improvements of wastewater treatment, while the loads of diffuse origin still remain on high level. That means the proportion of water pollution loads have been shifted relatively form the point to the diffuse sources.

The main fraction of diffuse pollution originates from agricultural farmland. In Germany, approximately 60% of all nitrogen entry into surface waters is directly derived from farmland. Until the 1980`s, intensification of agricultural production led to an increase in regional livestock density and manure accumulation as well as enhanced application of pesticides for crop production. As a consequence, eutrophication of surface and ground waters became a major environmental problem. Following that period of time, application of pesticides and the problem of eutrophication in general were slightly reduced. In particular, agricultural nitrogen and phosphorus emissions were diminished by 1/3 and 2/3 respectively since 1987 (figure 1).

Despite the cut of agricultural emissions, the political goal e.g. to reduce nitrogen loads by 50% (North Sea Protection Conference) and to reach water quality level II at all LAWA-control points has not yet been reached (BMU 2001). Therefore, further emission reductions are required.

Recently, the Water Framework Directive (WFD) expanded the number of water polluting activities. Maintenance activities, like cutting water plants and un-silting surface waters, do also refer to aquatic pollution due to the WFD. Those activities often contribute to the degradation of ecological functions and loss of valuable habitats.

Determined measures, which differ a lot in design, effectivity (with regards for example to water protection aims and farm income) show multifold options to improve water quality. The overall objective of this project was to evaluate selected measures with respect to their contribution to reduce water pollution, their economical effects as well as their political enforceability.

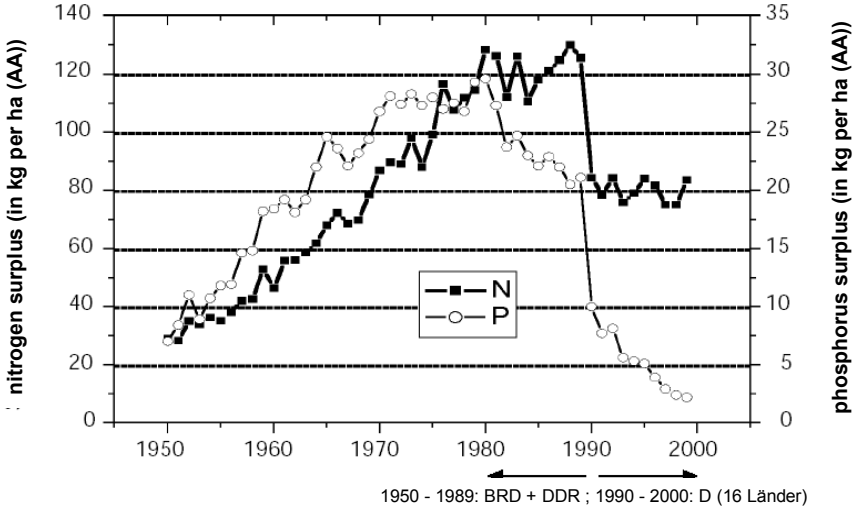

figure 1: Development of nutrient surpluses of the farmland in Germany from 1950 to 1999 (Bach in Behrendt et al. (1999))

1.2 Definition of the term: „diffuse pollution“

Currently three definitions exist to distinguish diffuse from point sources:

There is a practical definition[3]: Sources are diffuse if their inputs come from the surface or are small, immeasurable amounts.

And there is a scientific definition[4]: Sources are diffuse if they are tied directly to precipitation or the flow of lotic water bodies. The definition makes it possible to distinguish diffuse from point sources according to their dependency on river flow. Point sources have a constant load, while diffuse sources vary according to the behaviour of water systems.

Water lawyers add a third one. Sources are diffuse, if they are not controlled by water law, but are subject of other sectors of law.

The difference between the definitions means, that the same source might be defined as point source or diffuse source, depending on the definition used. For example, storm water from urban surfaces is a point source according to the practical definition - measurable, discharged through a pipe - but diffuse pollution according to the scientific definition - dependent on precipitation.

There are various kinds of diffuse sources, which can be categorised as follows:

[3] LAWA A O / UBA Draft 1.3.01 for the 6. LAWA/EA-Workshop in Belfast

[4] LAWA A O / UBA aaO

- anthropogenic inputs from sparsely distributed small point sources, e.g. drainpipes, road drains, etc.
- anthropogenic inputs from soil, especially agricultural and managed forest land, via eroded soil, eluviation or substance seepage
- anthropogenic inputs from paved areas and other impervious areas in cities and business areas
- anthropogenic inputs from atmospheric deposition
- anthropogenic and geodetic inputs from soil, loose stone and rock, generally from a wide area, e.g. as a consequence of rising ground water in mining areas

In contrast, individual point sources for substance inputs into ground and surface water can be easily identified, for example discharges from waste water treatment plants for local authorities, industries and mining, or fish farms.

1.3 Targets for the agriculture sector

Beside the analysis of the legal framework concerning diffuse pollution in the political spheres – common water and agriculture policy - the assessment of the reduction measures on base of concrete, additional requirements or omissions were evaluated on regional as well as on single farm level. The relationships of expected environmental benefits and the measurable/predictable costs have been in the focus of this assessment. As a result, recommendations for a subsequent improvement of the legislation frameworks as well as a range of practical, obligate or incentive instruments on single farm level have been suggested, especially for those regional problem areas where area-wide measures are not sufficient.

1.4 Schedule and methods

To investigate measures and instruments to reduce diffuse water pollution for the agricultural sector, a multistage procedure was used. In the first step the general framework for European water policy and the influence of the Common Agriculture Policy (CAP) was analysed. The main focus laid on the demonstration of risks of diffuse water pollution. Within this context those regulations and support mechanisms of the Common Policy Spheres – environment and agriculture - which negatively affect water quality are identified. Special attention was given to the innovations, which result from of the WFD. The examination of the legislation framework was done on basis of a literature study.

Among various instruments that potentially reduce diffuse water pollution, a set of 12 measures regarded as most suitable has been assessed in this investigation (table 1-1). Again, this operation was subdivided into two parts. On the national level (macro level) the impacts of current nation-wide or Europe-wide changes of agricultural transfer payments, production costs, the legal framework and voluntary measures are either simulated using the agricultural

sector model RAUMIS (Henrichsmeyer et al. 1996) or assessed according to supporting literature. As a parallel operation the national Agenda of water pollution control with regards to agriculture was analysed for selected European neighbour countries (France and the Netherlands). This method can determine those instruments that are highly effective in reducing the total diffuse nutrient inputs.

Besides the investigation on district level the effects of implementing water protection measures on the profitability at the single farm level are evaluated (see report "Effects of water protection measures on the profitability of farms"). The following farm types were taken into account:

- crop production (intensive and extensive),
- animal production (pigs and dairy cows).

For the calculation on district and on farm level, a standardised evaluation sheet was used (compare Döhler et al. 2002). The sheets include a detailed description of the different measures as well as an evaluation according to key parameters. As a result a combination of selected instruments and measures is recommended, which should be consistent to most of the agricultural and environmental objectives.

Table 1-1: Overview of the investigated measures

Strategies to reduce diffuse emission from agricultural origin	Method of analysis
obligatory measures	
Decoupling of direct payments	Calculation RAUMIS (FAA)
Coupling livestock farming to areas 1,5 respectively 1,0 livestock unit per hectare	Calculation RAUMIS (FAA) and KTBL
Tax on mineral nitrogen Simulations of 100 respectively 200 % extra charge	Calculation RAUMIS (FAA) and KTBL
Pesticide levy	Calculation (KTBL)
Buffer stripes alongside watercourses	Calculation (KTBL)
Voluntary measures	
Co-operative agreements between agriculture and water suppliers	Estimation on base of bibliographical research (WI/KTBL)
Education and training	Estimation on base of bibliographical research (WI/KTBL)
Crop cover on arable land	Calculation (KTBL)
Soil cultivation procedures	Calculation (KTBL)
Changing the use of arable land	Calculation (KTBL)
Optimisation of animal nutrition	Calculation (KTBL)
Optimisation of manure storage and application	Calculation (KTBL)

Additionally, the problem of environmentally effective pharmaceutics used in livestock farming was analysed. Due to the small data base; only a description of the standard of knowledge could be elaborated (see excursion 3.13 “Residues of pharmacologically effective substances in farm manure”).

1.5 Basis for the assessment of recommendations

The methodical approach for concluding recommendations uses qualitative assessment (inference) concerning the legal analytical part. The evaluation of the 12 investigated measures on district and on single farm level is based on computer simulation models.

In addition a standardised estimation scheme including five criteria of assessment that are considered as most important i.e. target accuracy, economic effects, political enforceability and administrative implementation/control, as well as possible side effects, was used (Döhler et al. 2002). These criteria are defined as follows:

Target accuracy

Under this criterion it should be assessed how effectively the measure contributes to changes in production patters, technologies and/or management reducing diffuse water pollution respectively to what extent diffuse water pollution is directly reduced.

Economic effects

The recommended measures were assessed on district as well as on single farm level. If a measure is cost-neutral or has a slightly positive effect on income the acceptance in agriculture is given and facilitates its enforceability.

Political enforceability

The political enforceability depends, apart from the financial effect[5] on the operations level, on how the instrument conforms to other political and intrasectoral (e.g. social) targets of the European and National Agricultural Policy, the state's financial scopes (compensation payments, etc.), possible conflicting interests and the activities of existing interest groups.

Administrative implementation and control

Whether a measure can be implemented depends on the required level of administration costs and the existing administrative structures, knowledge and experience. Thus measures, which are based on measures already currently in force, are easier to implement than new political approaches, which cannot fall back on existing experience. Further important indicators to determine implementation could be problems expected during control, sanction possibilities or legally binding requirements. Thus technical measures, e.g. investments in slurry storage capacity, are as a rule, easier to control, than pure management measures, such as optimising the application of manure.

Side-effects

Additionally desired and undesired side effects were taken into account. To name a few: effect on other production branches, fairness of distribution, changed framework conditions (e.g. in the form of rising lease prices as a result of agri-environmental measures, etc.) or disproportional high economic effects.

[5] With measures having a negative effect on income, political enforceability is less and the necessary degree of control higher.

Whereas the first two criteria, “target accuracy” and “economic effects”, can be derived largely from simulation or calculation, the criteria “political enforceability”, “administrative implementation and control” and “side-effects” have been derived qualitatively.

2. Analysis of the political framework

The required reduction of diffuse water pollution by agriculture may only be achieved by overcoming of gaps and contradictions within the legal frameworks, by enforcing of current protection provisions and by implementing a package of suitable measures. Beside a stronger cross linking of the common policy fields – agriculture and water pollution prevention - a combination of area-wide instruments (e.g. cross-compliance in combination with enforcing and further specifying of the GFP, modulation, improvement of regulatory and specific agricultural provisions) to reduce the general intensity of management and of regionally adapted up to area-oriented measures (e.g., training, agri-environmental measures, river management plans) aimed at a location-specific management of especially polluted or sensitive areas is recommended.

2.1 Recommendations for the Common Policy Fields – agriculture and water pollution prevention

To improve water quality, water pollution control aspects have to be more strongly included in the agricultural policy. On the other hand, there has to be considered that agriculture will have to be able to exist. The following measures are recommended as central requirements:

As a basis for creating a consistent legal framework the principles of the European environmental and water pollution control policy have to be enforced. This means with regard to the field of tension between water pollution control and agriculture that the deficiency in implementing the common policy in water pollution control has to be overcome and the principle of precaution and the polluter pays principle have to be defined for agriculture and applied to it.

At present, essential regulation options for more specific measures result from the detailed implementation of the WFD and the CAP reform just concluded.

2.1.1 Historical reflection on the Common Water Policy

The development of the Common Water policy is marked by three waves[6]. The first wave started with the initiation of the first Environmental Action Programs in 1973. Since the end of the 1970s, several measures for the reduction and prevention of water pollution have been introduced, based primarily on a regulatory approach. These directives subdivided the aquatic

[6] Federal Ministry for Agriculture and Forestry, Environment and Water Management (2000): EU launches new water policy, in: Aqua press international 5/2000, p. 10f

eco-systems into individual protected commodities and named environmental quality standards for each specific type of water like:

- Surface water directive (75/440/EWG)
- Bathing water directive (76/160/EWG)
- Fish water directive (78/659/EWG)
- Shellfish water directive (79/923/EWG)

Other directives established values for emission limits that would regulate the permissible level of discharges of dangerous pollutants in the future:

- Dangerous Substances Directive (76/464/EWG) and
- Groundwater Directive (80/68/EWG)

In practice however the dual approach of the first wave did not only lead to highly fragmented water legislation, but also to huge implementation problems.

Within the following development water protection is bounded to the generally upvaluation of environmental protection. With the coming into force of the Single European Act in 1987, environmental protection was established as an independent area of responsibility in the EC Treaty. Thus further possibilities to create secondary Community legislation for water protection opened up. Even stricter environmental protection rules were established in the Treaty of the European Union (1992)[7]. Along with this the link between two policies, one of the oldest (agriculture) and one of the newest ones (environment) at European level, had become legally bound by e.g. Article 6 of TEC that states:

"Environmental protection requirements must be integrated into the definition and the implementation of all the Community policies and activities… in particular with a view to promoting sustainable development"

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[7] The following regulations form the legal basis for creating legal acts with the aim of protecting water.

According to Art. 2 of the EC Treaty the realisation of environmentally sound growth is a task of the Community.

According to Art. 3 of the EC Treaty environmental protection is a joint field of action of the Community. According to Art. 130 r, paragraph 2 of the EC Treaty environmental policy aims at a high level of protection. Essentially it is based on the precautionary principle, the principle of prevention, the polluter-pays-principle and the principle of combating damage at the source. (see Holtmeier; E.-L., (1997) a.a.o)

Although there are gaps and inconsistencies in the water protection legislation, the biggest problem of the past was not the insufficient legislation, but the fact that basically no directive has been completely implemented and applied by the Member States. On the top of the list of judgements concerning water protection are the **Dangerous Substances Directive 76/464/EEC** and **Groundwater Directive 80/86/EEC.** In case of the **Nitrate Directive 91/676/EEC** enquiries have been ordered against 13 out of 15 Member States.

2.1.2 Water Framework Directive - reform of the common water protection policy

Adopted in December of 2000 the WFD introduces a remarkable change in Community water legislation. Water protection regulations moved form protection of particular waters of special interest to protection and use based on overall appreciation of the hydrology and ecology of the entire natural cycle of each river basin. From a legal point of view, the WFD forms an umbrella for the implementation of various instruments of European Water Policy, as well as an introduction of new standards and tools for the protection of the ecological quality of waters. Even the territorial validity has expanded strongly. The WFD sets common approaches and goals for the management of water in 27 countries (15 Member States and 12 Pre-accession Countries). The directive should also contributes to achieve the objectives of relevant international agreements (e.g. OSPAR and HELCOM).

At that moment, the success of the WFD to contribute water protection aims is difficult to assess and depends on future decisions. It will strongly depend on the concrete design and implementation of the **Groundwater Daughter Directive (GWD),** as well as on the exploitation of synergies between the various legislative instruments provided for under the directive. One important question is, if the enforceability of the directives, which will be repealed by the WFD (in 6 and 12 years) will lose its current momentum. In general there are mainly the long deadlines, the ambiguous provisions, the unclear level of protection, the large number of opt-out clauses, the underestimate of the issue diffuse water pollution and last but not least the wide national ranges for limit values and trends of harmful substances (e.g. within GWD), which are the main causes for concern.

Currently the third proposal of the GWD is in circulation. Contrary to the prior proposal the third proposals of the GWD presents a clear detoriation for the aim of groundwater protection, which partly can not be brought in line with the targeted quality standards of the WFD.

As far as diffuse pollution from agricultural sources is concern the main criticism on the so far implementation process of the new Common Water Protection Policy are:

Relationship of WFD and Annex III (1782/2003/EC)

First of all the WFD itself is not included in the list of European regulations farmers have to apply to (1782/2003/EC, Annex III). That means offences will not be sanctionable with regards to cross-compliance (s. chapter 2.2.2).

Delay of the Non-deterioration clause

The WFD indicates specific dates for all objectives to be achieved, except the "non-deterioration clauses"[8]. It can be implied that this provision entered into force immediately upon the publication of the WFD.[9] However the absence of a date in this clause reflects that the Parliament's opinion prevailed.[10] The third proposal of the GWD indeed delays the target of non-deterioration for ground waters for years, because measurements to calculate significant and continuous pollutant trends will start not before 2006 and could continue till 2021. That means till then, it would be impossible to impose a sanction for detectable deteriorations and not until 2011 first steps to reverse pollutant trends have to be attempted. From what point of approximation to the threshold value the pollutant trend has to be reversed, is shifted to the responsibility of each Member State.

Regulations for Non-deterioration within a category

Additional Article 4 WFD contains a further weakness. The non-deterioration in status objectives only prohibits ground waters with "good status" deteriorating to "bad status". Deterioration within the wide good status class is still possible under this objective (see below). Effectively, the requirement to prevent or limit the input of pollutants and the obligation to reverse any negative trend in groundwater pollution (Art. 4 (1) b iii) should provide a more stringent control on quality deterioration than the non-deterioration objective itself.

Insufficient protection of unpolluted groundwater

Especially the protection of "pristine ground waters" should be secured by a category of its own, as it was originally provided by the Commission: "These requirements are not explicitly

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[8] WFD Article 4 I a) i

[9] Epiney, A.; Felder, A. (2002) Examination of international transboundary river conventions with regard to the implementation of the WFD, UBA-Forschungsbericht Nr. 17/02, p. 30 and www. Umweltbundesamt/wasser.de

[10] Barreira, A. (2002): The Water Framework Directive and its Non-Deterioration Clause: Practical Implications for the Spanish Hydrological Plan in: Environmental Law Network international, p.36ff

specified in the should hence be covered by the GWD as additional requirements"[11]. This regulation will concern in particular conservation areas.

Potential different mandatory limit values for ground waters on level of the Member States

For nitrate and pesticides only the third proposal of the GWD defines a Europe-wide limit value. For pesticides the limit value of the Drinking Water Directive (0,1 µg/l) will be adopted, but not the limit value of 0,5 µg/l for the sum of all proved pesticides. Another list of harmful substances is in fact specified but here the Member States are requested to define national "Threshold values" till the end of 2005.[12] For the determination of the threshold values, only rough criteria have been defined (Annex II). But without precise guidelines there is no possibility to avenge Member States for insufficient water protection targets.

Furthermore the proposal of the GWD permits to define varying threshold values for different types of ground waters and therefore to consider anthropogenic strains as well as economical and social cost of reconstruction measures.

Prevention and restriction of indirect discharge of substances according to annex VIII

As far as substances of annex VIII are concerned a Europe-wide consistent procedure is needed. The regulations of the GWD proposal to prevent diffuse water pollution by a program of measures seems to be a suboptimal procedure. A prohibition of dangerous products would be a more practical and environmental measurement. This is especially important for priority hazardous substances**.**

At stake is whether the 14 priority substances under investigation remain as priority substances or are classified as more dangerous priority hazardous substances (PHSs). The former will face tough restrictions under the directive but will remain in circulation. The latter are to be phased out entirely within 20 years.

Legal action by pesticide manufacturers is currently pending at the European Court of Justice against the listing of seven pesticides as PH Ss. The aim is to delete the pesticide substances: Atrazin, Chlorpyrifos, Diuron, Endosulfan, Isoproturon, Simazin and Trifluralin. All seven pesticides can be detected in European rivers and in ground waters in concentrations above

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[11]COM (2002): Proposed framework structure of the Directive establishing strategies to prevent and control the pollution of groundwater, draft 2, 06.12.2002, Brussels

[12] A list of those substances are: Ammonium, Arsenic, Cadmium, Chloride, Lead, Mercurial, Sulfate, Trichlorethyle and Tetrachlorethyle.

the permitted EC threshold value of 0,1 µg/l. Furthermore, these pesticides also show properties, which identify them as being particularly dangerous. This situation can be seen as a reason for the announcement of the Commission, that they failed to propose a classification of the 14 priority substances, whether they are hazardous or not, within the given deadline. The Commission also fails to fully apply the WFD hazard approach, as defined in Article 2(29) WFD, but instead waits for full risk assessments being available or decisions are taken under the Directive 91/414/EEC pesticides authorisation process.[13]

At the same time the list of priority substances presents a legally binding implementation of the commitment, which the European Commission and 12 of the 15 Member States entered into under the Convention for the Protection of the North-East Atlantic (OSPAR). With signing this contract, all involved parties agreed on banning all hazardous substances out of the sea until 2020.

Preference of the agrarian sector

Within the WFD and the GWD the agrarian sector is still privileged in using natural resources, e.g.:

Biocides and Pesticides are characterised in Art. 6 GWD and listed in Annex VIII WFD as substances, whose indirect discharge into ground waters can be approbated, if the target to achieve a good ecological status of the ground water is not endangered by the discharge. For this reason agriculture is conceded a deterioration right till the limit value of 0,1 µg/l is reached. But original the limit value of 0,1 µg/l was defined as detection limit because a zero value was not enforceable by law. So that regulation can be seen as a clear degradation of water protection level, too.

The draining of farm land is protected as an infrastructural intention (Art. 4 (3) iv WFD and could be used as justification for the classification “heavy modified” or for reduced purposes concerning ground water protection. Through this for the aim of water pollution prevention very important areas will be excluded form more significant protection targets.

[13] The final judgment is expected after the summer recess.

2.2 Common Agriculture Policy (CAP)

The CAP is one of the oldest common policy fields and was formulated in the Treaty of Rome (1957) already. Since than, it has developed into the most complex and most expensive policy of the Community.

2.2.1 Historical reflection on the CAP

The dominating guidelines of the CAP derive from a period of time when Europe was far away from a complete self-supply with food. The CAP's main objectives were to increase agricultural productivity and to ensure a proper standard of living for farmers. Environmental objectives were not listed. In order to achieve the main objectives, the EC pursued an income-oriented price support policy, which has stimulated the intensification and concentration of agricultural production and has contributed to rising environmental problems.

This situation chanced from the mid-60es onwards and the agricultural production became a surplus production, with growing financial requirements for storage, discreation and export refund. Due to increasing financial burdens on the EC budget and the international pressure on the EC within the GATT negotiations to liberalise the CAP, the EC introduced programs for extensive agricultural production and for setting aside arable land. The goal of these programs was primarily to reduce the production surplus and only secondary to reduce the negative environmental effects of agriculture. Because these policy did not show the effect expected and due to the ongoing negotiations in the Uruguay Round, the EU passed the strongest change in course until then in the CAP was carried out. At the centre of the reform of 92 was a cut in price support for major commodities like cereals and oilseeds. Farmers' income losses were compensated by acreage premiums for these crops, coupled with land set-aside requirements. Support for livestock husbandry by per-head payments was limited to a defined livestock density. Within the framework of the so-called "accompanying measures" of the CAP reform the EEC ordinance No. 2078/92 created for the first time an independent, EU-wide agri-environmental program to support environmentally acceptable production methods. The environmental goods produced by the farmers received through state intervention the character of public goods, whose availability in sufficient quantity could not be guaranteed only by the market. Especially those "horizontal" extensification measures aimed at the protection of abiotic resources serve the target of water protection through a reduction in the use of fertiliser and pesticides.

The main characteristics of the agri-environmental program is its voluntary nature, the time limitations as well as the payment of a premium as compensation and incentive to farmers

taking part.[14] Environmental achievement here must go beyond the legal standards, so that the principle of burden sharing can be applied.[15] For the necessary programs, the EU provided its Member States – in contrast to the former market regulating measures – co-financing of 50 (respectively 75%) from the funds of the EAGFL (alignment) – so-called 2nd pillar.

Assessing the reform of 1992, it can be summarised, that it could neither clearly reduce the high burden on the budget nor the serious environmental problems. Although at the same time a slight decrease in the intensity of fertilisers and pesticides could be identified[16], considerable changes in intensity in, for example, cereal cropping were hardly achieved. With only a 10% share of the agricultural budget (agri-environmental measures 5%), the provision of funds for accompanying measures remained low. Also the effect on distribution through the conversion to direct transfer of payments did not change substantially. Consequently a further reform became necessary long before expected.

2.2.2 Changes in the Common Agriculture Policy due to the Agenda 2000

Agenda 2000 is, after the reform of 1992, the second largest attempt by the European Union to fundamentally reform agricultural policy.

The main points of Agenda 2000 are:

- Limiting the expenditure in agriculture to EURO 41.66 bill. (in the middle of the years 2000-2006),
- The further reduction in intervention prices for arable land cultivation and beef,
- The further increase in compensatory payments,

With the regulation to support the development of rural areas (1257/99/EEC), the European Commission set down its policy for rural regions. The regulation covers a broad scope of

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[14] Bromley, D.W. (1997): Environmental Benefits of Agriculture: Concepts. OECD Proceedings: Environmental Benefits from Agriculture: Issues and Policies. The Helsinki Seminar, p. 35-53.

[15] In contrast to measures in water and nature conservation areas in which rights of disposal are limited without compensation within the framework of social bondage of property or against payment of compensation by sovereign requirements and prohibitions, agri-environmental measures differ because participants agree voluntarily and are able to withdraw unconditionally.

[16] Stoyke; C. and Waibel, H. (1997): The development of land use and resource use in crop farming under the influence of the EU agricultural reform – Effects on the environment and the need for ecopolitical action. The Magazine for Environmental Policy and Environmental Legislation 3/97, p. 289-316.

measures to support structural adjustment and the development of rural areas, a stronger integration of agriculture and forestry into regional production cycles and to promote new sources of income to preserve and maintain cultivated land. The most important points for water protection within the context of Agenda 2000 are*:*

- Commitment to carry on agri-environmental programs. The environmental targets of the agri-environmental measures in Art. 22 of regulation 1257/99/EEC are described more precisely than in the previous regulation, and targets relating to income and markets are no longer named.[17]

- Conversion of compensatory payments for disadvantaged areas to a pure land premium, and linked to the carrying out of GAP.

For the first time there was the possibility of support obligatory requirements in accordance with Art. 16 of legislation 1257/99/EEC. Compensation can be awarded in areas with specific environmental limitations (Flora and Fauna Habitat Directive and the Bird Protection Directive). New are also measures to protect the environment in accordance with Art. 33 of regulation 1257/99/EEC, which make projects and investments in nature conservation and environmental protection possible.

Of greatest importance for the ecological alignment of European agricultural policy and therefore also for water protection is the so-called **"Horizontal Regulation"** establishing Community rules for direct payments (1259/99 EEC). Here Member States are authorised to cut or delete direct payments to agricultural operations under certain conditions. The main points of the regulation are:

- Direct payments (e.g. premiums for land and animals) can depend on whether specific environmental regulations (GAP) are respected (cross-compliance);

- Direct payments can be cut by up to 20% depending on the workforce, the economic situation or on the total amount of support to the agricultural operation (modulation);

- Cuts in funds, which result from applying the horizontal ordinance can be used for rural development measures.

The application of these measures has until now been optional for Member States. Furthermore the Agenda 2000 was not able to solve the main conflicts: a just allocation of

[17] With the regulation 1750/99/ECC the EC makes increased demands on the programming, accompanying and assessment of measures (see Bergschmidt, A.; Plankl, R. (1999): Evaluation of the agri-environmental program according to the resolutions of Agenda 2000. Reports on agriculture.

support and to reduce the negative environmental effects of the agricultural sector. With regard to environmental and especially water protection aims the abandonment of the Member States to make use of the instruments cross-compliance and modulation was hindering the initiation of a real change towards the improvement of water quality.

2.2.3 Mid-term review of the Agenda 2000 and its potential contribution to supporting of the objectives of water pollution prevention

In Contrast to its intention the mid-term review of the Agenda marks a new and radical chance for the CAP and starts an new reform process. The reform framework includes, apart from the obligation to decouple the compensatory payments, primarily a transition from the so far voluntary to the obligatory use of the instruments cross-compliance and modulation. Both instruments have a high synergetic potential for the objectives of water pollution control.

Cross-Compliance

By implementing Cross-Compliance, for the first time in the history of the CAP, an instrument for sanctioning offences on GFP has been introduced into this policy field. Support from the CAP will be conditional on respect of statutory management requirements directly linked to farming, covering environmental, animal welfare and food safety aspects. [18] Agricultural production will have to be carried out according to these statutory management requirements, and land will have to be maintained in good agricultural condition. [19] This bounding seems legitimated because there is no legal right to the payment of subsidies and therefore the subsidy changes to a payment, which is connected with a real consideration. However, the respective requirements for a common GFP have not yet been specified in greater detail, thus the span reaches from an unchanged status quo up to wide-ranging obligations.

Because of the partly different implementation of EU Directives within the Member States (e.g. Nitrate Directive 91/676/EEC[20]) and because of the space for decision making as far as

[18] Farmers have to maintain 18 EU-wide valid regulations, which are listed in Annex III (Ordinance of the CAP reform EC No. 1782/2003).The proposal of the Commission covered the opportunity to add additional standards to the list. But the council die not made use of it. For the next planning horizon and within the revision of cross-compliance there is still the opportunity to enlarge the list.

[19] For that purpose annex IV (Ordinance of the CAP reform 1782/2003/EEC) lists universally valid criteria, which have to be concretized by public authorities.

[20] in Germany the Directive is valid Area-wide, in Spain e.g. it is restricted to defined areas.

annex IV (1782/2003/EEC) is concerned, there is the danger to cement different kinds of standards, which can cause distortion of competition (q.v. agri-environmental measures). Furthermore there is still dissension if the GFP is based on legal compliance or if this standard goes at least partly beyond the legal requirements.

The control of the legal compliance requires political agreement in the Member States and to build up suitable structures and administrations. The EU commission entrusted with controlling the National States has to exert the required pressure here and to use its forces to reduce or delay payments to Member States in the case of an insufficient implementation and control.

The fact that the farm advisory audit[21] mandatory for farms receiving more than EURO 15.000 of direct payment per year, that was still envisaged in the last concept, was replaced by a voluntary participation of farms, has to be regarded as a clear deterioration.[22] Though the recommendation to support only preferably farms receiving high direct payments in implementing a management system, farms specialized in pig and poultry keeping, which are highly relevant to water pollution prevention and which receive, as a rule, only insignificant direct payments, will not be affected by this measure. In future an improvement of water pollution control possibly may be reached by enforcement and improvement of regulatory and specific agricultural provisions only.

Further the chosen environmental manage system can not control essential problems such as intention, insufficient training and advanced training. For this reason it should be obligatory to adopt a practicable version of an Environmental Management and Audit Scheme for agriculture (EMAS)[23]. In case of a successful certification, the responsible authorities for validation may decide to relax control, in order to reduce unduly expenses for the authorities and farmers.

For the environment performances, which go out of the legal framework stable markets, must be created. These are established in form of agri-environmental measures, but in modest masses: Only about 5% of the last EC-agrarian budget (1993-2000) was spend on these measures. In this connection it is of significance to formulate up to what point services

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[21] COM 23 (2003)

[22] Reasons were primarily that practicable systems considering environmental standards, food standards and consumer and animal protection jointly do not exist. Moreover, the development of such systems was assigned to the private sector.

[23] System as Umweltsicherungssystem Landwirtschaft (USL environment securing system agriculture)[23], Agra-Öko-Audit[23] or REPRO[23] are still in the trial phase.

prescribed by the GFP have to be performed by the agricultural sector without payment and which tolerations, omissions or expenditures for achieving best environmental practice should be compensated. Because the standard of GFP is designed as an area-wide standard, which is not adapted to specific geo-climatically distinctions, additional regional standard in the meaning of "Duly Farming Practice" (DFP) have to be defined and implemented. A temporary monetary compensation for all requirements beyond GFP within identified problem areas is recommended.

Generally it is of main importance to improve the financial significance of environmental services and good in the awareness of farmers

Modulation and degressiveness

The application of modulation is an essential step towards a further re-allocation of funds from agricultural commodities market regimes (1st pillar) to rural development programs (2nd pillar) of the CAP. The Commission will reduce direct payments progressively over the period from 2006 to 2013 for all producers who receive a support of more than EURO 5000 annually[24]. It will be introduced with 3 % in the whole community, increased to 4 % in the year to follow and maintained at 5 % between 2007 and 2013. Thereby it is envisaged to keep at least 80 % of the modulated funds in the Member State where they were obtained. But comparing the agreement with the initial concept (communications COM (2002) 394 and COM (2003) 23) a significant deterioration for environmental protection is to be detected because the shifting of money from the 1st to the 2nd pillar has been clearly reduced. For that reason the percentage for the reallocation between the first and the second pillar should be increased from 2008 significantly. In the meantime the instrument "National envelope" (Art. 69) should be use to pay for additional programs, which would be theoretically eligible by the second pillar (see below).

National Envelope

Due to Art. 69 Member States have the opportunity to withhold 10% of the direct payments in order to support special forms of agricultural production/cultivation. Supportable are e.g. environmental friendly production methods, production of premium products and marketing activities to promote agricultural products.

Supportable measures, which can serve the target of water protection are e.g.:

- A pasturing premium (for suckler cows, oxes, shep)

[24] Producers in ultraperipheral areas and the Aegadian Islands make an exception in this case.

- A premium for extensive cattle keeping

As a major difference to the instrument modulation, its application is voluntary to the Member States and there is no need to co-finance the measures. Until now no Member State made use of this program and in particular the relationship of this instrument and measures of the Rural Development Program as well as Agri-Environmental Measures is still open.

Decoupling

Decoupling means the establishment of a single income payment per farm decoupled from the production.[25] That means farmers are flexible on the pattern of crops they grow. The actual compromise[26] defines a single payment scheme based on a period of reference (2000-2002) to be the standard and provides various possibilities of using this measure and starting it between 2005 and 2007. Depending on the product, various variants from a complete decoupling to a partial decoupling may be chosen on national level. That includes, an animal and area bonus will be maintained to a reduced extent, the rest will be included in the farm bonus. Examples of market regime with the possibility of partial decoupling are grain, cattle, starch potatoes and sheep. As an alternative, it is also possible to convert the decoupled bonus into a regional area bonus (Art 58). In contrast to the single payment scheme a re-allocation of funds could be made here between farms with e.g. arable farming and intensive cultivation and extensive grassland farms.

As shown above the conclusions of Luxembourg imply a multiplicity of options and will - de facto - lead to various national concepts for the agrarian sector. For the target of water protection consecutively the potential effects of both payment systems will be discussed.

Single payment sheme (Art. 33)

The Commission has designed the single payment based on a period of reference (2000-2002) to be the standard scheme. If Member States do not determine to apply Art. 58 (1782/2003/EEC) until may 2004 the latest, the single payment scheme is considered to be chosen automatically. Within this system not all the farmland is entitled to a premium. Seeing that, the duty to control legal compliance on single farm level is not guaranteed area-wide. It is imaginable, that farmers who receive, as a rule, only a marginal amount of direct payments, could get ride of the duty of legal compliance by selling their farmland entitled to a premium and buying farmland that is not supported. That can be regarded as potential negative for the

[25] Proposal based on the average payment of the years 2000-2002.

[26] Conclusions by the EU ministers for agriculture in Luxembourg, June 2003

target of water protection, especially because offences of Art. 5 (Protection of grassland in 1782/2003/EEC) would not be sanctionable.

Regionalisation of the single payment sheme (Art. 58 ff 1782/2003/EEC)

According to Art. 58 Member States have the opportunity to introduce an area-wide acreage premium, with equal amounts for arable land and grassland and which also include "non-productive" acreages.[27] Advantages for the target of water protection arise form the fact that that the obligation to apply to Cross-Compliance is valid for all the farmland. That means the entirety of all farmland has to be kept according to Annex III and IV.

But the main effects of the instrument decoupling with regards to prevent diffuse water pollution will essentially depend on the on the specific national interpretation and implementation of Cross-Compliance (see chapter 3.2.1).

Rural Development Programs and Integration of Common Agricultural Policy (CAP) and WFD

Rural Development Programs provide for several measures to support farmers and the rural community. Some of these, in particular agri-environmental measures, could directly contribute to the implementation of the WFD. Due to their main targets – extensification of agricultural production – agri-environmental measures have strongly supported water protection targets in the past. Therefore the agreement that the EU increased its co-financing portion by 10 % and thus only 40 respectively 15 % have to be financed by the States themselves is of advantage to water pollution prevention. Thus, also financially weak regions/states may maintain or improve their agri-environmental measures offered.

However, the increasing spectrum of measures has to be seen critically due to the clearly reduced financial funds of the 2nd pillar as compared with former concepts. Additionally the rural development programs are restricted to 10% of the countries area and allow to fund voluntary measures by farmers only. Measures obliged to fulfil particular objectives of the WFD possibly cannot be supported, because the WFD was not included into a list of EU-directives whose implementation measures can be funded.

Within the running budget period the share of the instruments support of investigations, support of less favoured areas as well as education and training to provide water protection targets can be expected to be very limited.[28] Principally with the beginning of the next budget

[27] like hedges, groves a.s.o.

[28] till now only measures for manure storage are supportable

period the above mentioned instruments could make a substantial contribution e.g. by opting Art. 16 (EC No. 1257/99) to compensated restrictions for water related targets or to fulfil new standards like the extension of manure storage capacities.

Interaction of Rural Development Programs and River Management Plans

Owing to water pollution control being area-wide extended by the WFD river management plans have to be adjusted to the rural development programs and vice-versa. This requires an appropriate participation of authorities responsible for agriculture in the process of river basin planning and water protection aims in the process of rural development program design as well as a close co-operation between the authorities responsible for rural development programs and water. Representatives of rural development authorities have to be represented in the river basin authorities and vice versa. Thus, measures of the rural development programs may be included in the program of measures under the WFD regardless their voluntary nature.[29]

The co-operation of the competent authorities is particularly important because the framework of the Member States´ Rural Development Programs have to define common codes of DFP[30]. Only a consensual formulation of these standards which secure, on the one hand, a viable and competitive agriculture and, on the other hand, improve water pollution prevention will be a satisfactory solution for both fields of policy. For a synergetic implementation it is indispensable to create sufficient "freedom of movement" within the WFD and the CAP so that improved water protection aims, including regional differences in natural conditions and susceptibilities as well as a stabilisation of farm incomes for environmental services can be gained.

Complications can be expected of the fact, that a strict enforcement of the WFD (in combination with an ambitious implementation of annex EC No. 1782/2003) will probably support the trend of tightening the legal framework and therewith the use of compensations is largely reduced. On account of the rising demand, the agri-environmental measures, which until now were supportable, would no longer be so. Here it has to be weigh up, if increasing requirements of the agri-environmental programs will lead to obvious acceptances problems of if more elaborated programs with at the same time raising acreage premiums open up

[29] COM (2003) The Water Framework Directive (WFD) and tools within the Common Agricultural Policy (CAP) to support its implementation, Working document, DG Env.

[30] Farmers receiving support under programs like less favoured areas, agri-environmental measures have to comply with GFP

acceptable financial perspectives for the participating farmers. Looking at the last development of the paticipation numbers, the former seems to approve.

Hence to the next budget period definded restrictions of the code of condutct of each river catchment areas could be compensated by applying Art. 16 EC No. 1257/99.

3. Description and assessment of the measures

In the following - summarised descriptions and assessments of the selected measures in the face of preventing diffuse water pollution is given (compare chapter 1.5). An unrestricted recommendation for most of the discribed measures are impossible because there are nearly always conflicts with other important targets for the agrarian sector. E.g. significant prospects of success for the target of reducing diffuse water pollution are as a rule linked with high business costs or in the face of empty treasury unrealisable without distortion of competition for the German/European agriculture.

Area-wide the cost-value ratio of the measures co-operative agreements and training and education seems to be generelly advicable. As far as all the other measures are concerned compromises on a regional level have to be fund between legal compliance and incentive measures depending on the specific water pollution problem of this area.

3.1 Decoupling of direct payments

Deviant from the decision of the Luxembourg agricultural council, a complete decoupling of direct payments was examined within the project (cp. Part B, final report FAA). The level of individual farm premium of the reference period is also granted in the future, independently of production structure. Premiums are bound to the farm areas and will be assigned to another farm in combination with the area, e.g. by a new lease. In order to obtain the premiums the farm has to prove the extent of the area which was necessary in order to get premiums in the reference situation.

Target accuracy

A decoupling of direct payments does not significantly reduce nutrient surpluses on agricultural land (Bertelsmeier et al. 2002). In present, the agrarian basic conditions approximate to decoupling in the range of the Grand Cultures (cereals, oilseeds, and pulses) where it is possible to receive premiums for land set-aside. It is expected that an assignment of this regulation to the remaining vegetable production methods will only have small effects to the plant production and the management intensity because they only have a small stake of the field-structural land use (approx. 10 %). Larger effects are expected in the range of animal production (Cypris et al. 1997; Kreins et al. 1999). A Decoupling of product specific premiums for suckler cows, bulls and sheep significantly turns down the relative competitiveness of their production. Hence beef and sheep production will be adjusted accordingly. However, a positive effect on diffuse nutrient entries into water bodies will be small because raising of suckler cows is an extensive production method and predominatly taken place in regions which show smal nutrient surpluses so far. Furthermore, raising of

suckler cows as well as fattening of bulls only has a small stake in the total cattle stock (5 % and 16 %).

Potential

For these reasons this measure only has a small potential.

Economic effects

Positive economic effects are expected due to improved allocation efficiencies (Bertelsmeier et al. 2002).

Political enforceability

EU subsidies for the agricultural sector were partially decoupled for the first time by the introduction of the GAP reform 1992. Price support systems for major crops (e.g. Grand Cultures) and beef production were replaced by a system of area payments and animal premiums. This removed the output price component from production decisions. The direct payment system was continued and further developed within "Agenda 2000". However, in the context of the mid term review of "Agenda 2000" a consensus about a complete decoupling of transfer payments - proposed by the European Commission – could not be reached in all areas. This fact has been acknowledged by the Luxembourg council decision, which introduces a partial and deferred decoupling.

Administrative implementation and control

A decoupling of direct payments provided by Agenda 2000 will reduce administration and control of these measures substantially.

Side effects

- WTO-compatible
- distortions of competition are diminished between the agricultural production procedures
- relationship to former authentication of transfer payments (reduction of intervention prices) is broken

3.2 Coupling of livestock farming to areas

Introduction of an upper limit of livestock numbers on individual farm level. The proof of areas of neighbouring farms is possible. At the upper limit of livestock numbers all productive livestock is seized and refered to the agricultural area in use.

Target accuracy

There is a close relationship between surplus of nutrient budget and stocking rate. For this reason a restriction of the stocking rate is effective.

Potential

The potential of this measure depends on the maximally permitted stocking rate. For example: By fixation of livestock numbers at 1 or 1.5 livestock units per hectare agricultural area the surplus will decrease around 7 and 3 kilograms per hectare agricultural area in Germany.

Economic effects

High income losses are to be expected in the regions and farms that are characterized by a high stocking rate in the starting situation (Möller et al. 2003, Schultheiß et al. 2003).

Political enforceability

There are restrictions respecting to the stocking rate in some development measures and in grant of animal premiums. Moreover, the demand of a stronger connection of livestock farming to the area is brought into the public discussion by different side, so it can be expected a political feasibility.

Administrative implementation and control

Conversion and control of these measures are easy because without large expenditure present report obligations of farms can be extended to the acquisition of not premium-entitled animals.

Side effects

- strong effect on structure
- loss of jobs
- disused livestock buildings
- lower smelling nuisance
- the problem is shifted into other ranges

3.3 Tax on mineral nitrogen

Introduction of a tax on mineral nitrogen (100 and 200 %), whereby the amount of this tax is repaid independently of production, e.g. depending on the agricultural area.

Target accuracy

Regions with a high surplus of N-budget can even be favoured by this measure. Nevertheless, if the price of nitrogen increases this measure will cause a high reduction of the sectoral surplus of nutrient budget (Weingarten 1996).

Potential

Depending on the amount of N-tax, a high potential can be assigned to this measure (Strotmann 1992), whereby in particular the intensive arable farm regions are concerned, which however are not problem regions.

Economic effects

In comparison to the other measures the income decreases hardly, whereby the income effect is very different between the individual regions and types of farms (Möller et al. 2003, Schultheiß et al. 2003).

Political enforceability

A political feasibility is not rather given, although this measure is dicussed in public consistently.

Administrative implementation and control

The administration and control of this measure is manageable because it is realized at wholesale level ("bottleneck-effect"). Reimbursement of the tax can be realised by existing instruments, e.g. cheapening of Diesel oil or premium grants.

Side effects

- reduction of management intensity (reduction of nitrogen fertilizing)
- revaluation of organic fertiliser

3.4 Pesticide levy

The run-off of pesticides into surface waters happens because of improper practices, e.g. not keeping required distances. Predominantly it arises from the cleaning of equipment, whereby the contamination occurs in the effluents from the farm yard (e. g. cleaning of sprayers; Fischer 1996, Bach et al. 1999, 2000).

A pesticide levy or tax on pesticides could make a contribution to the reduction of these run-offs, and a reduction in the intensity of use of pesticides generally. For the pesticide application level to be governed by economics a significant price rise of 50 to 100 % would be necessary according to literature. It has also been suggested that the levy is used for training and providing consultation for the farmers. If this were the case, price rises of about 20 % would be sufficient. The basis of the levy should be formulated on eco-toxicological grounds. For this it has been suggested that the price for a standard application is increased by a standard rate.

The aim of the consultancy is to create more awareness, to ensure that required distances are kept, that left over spraying liquids and cleaning effluents are used on the field in a way such that they do not pollute the water as well as the environmentally sound disposal of the pesticide packaging.

Target accuracy

As with a levy for mineral fertiliser, a levy for pesticides hits cash crop farms especially and farmers who farm according to the code of good practice. However, the price rise of pesticides and the use of the proceeds for training and consultancy should lead to more appropriate handling of pesticides and therefore to lower run offs.

Potential

Because of the relatively low proportion of pesticide emissions during the application of pesticides (e.g. in Germany about 0.1 %) and the low translocation rates, the question of the appropriate handling of pesticides presents the biggest potential for reduction.

Economic effects

The anticipated reduction in income with this measure, depending on the extent of the pesticide use, can be between 5 and 10 % for cash crop farms (Schultheiß et al. 2003).

Political enforceability

Although the introduction of a pesticide levy to finance consultancies in water protection measures is currently being discussed and some European states already have such levies (Denmark, Sweden), the political enforceability of this measure is low.

Administrative implementation and control

This measure, like the levy on mineral N fertiliser, would be easy to administer and control because it can be applied at the wholesale level.

Side effects

The levy could result in a reduced production intensity because of the decreased use of pesticides and, where applicable, in a stronger consideration of economic thresholds.

3.5 Buffer stripes alongside watercourses

The keeping of watercourses clean is promoted by establishing watercourse margins with prescribed restrictions and requirements of use. Buffer stripes reduce the run-off from soil into the watercourses. This is especially significant for the reduction of phosphorus pollution, because phosphorus, contrary to nitrogen, is mostly leached into surface water via soil erosion and run-off (DVWK 1995). However buffer stripes do not provide enough protection against extreme erosion incidents. Buffer stripes, especially when they include woody species, serve as buffer zones against agricultural activities, e.g. fertilisation and pesticides applications. Furthermore direct spraying into watercourses should be prevented by obligatory distance requirements. Buffer stripes alongside watercourses therefore have an effect against run off, erosion and pesticide effluents and moreover contribute to the bringing together of biotopes. In many areas buffer stripes are important to reach the minimum ecological requirement, which should be achieved along all surface waters before 2015 as stipulated by the EU's water regulation. Only with the additional space, which the buffer stripes provide, can the watercourses re-establish the natural biotopes, which are required by this regulation. How wide these margins have to be and the restrictions on use are different in the different federal states of Germany (UBA 2003).

Target accuracy

The reduction of contamination arising from sedimentation of suspended particles, sorption of dissolved substances, infiltration of the surface run-off and distance requirements for pesticide applications leads to a remission for surface waters. Hence the measure is efficient.

Potential

The potential of this measure is dependent on the establishment of buffer stripes along watercourses and the corresponding distance requirement and use restrictions by the executive of the state or within the framework of agri-environmental programs. The filtering effect with respect to nutrient flows into the surface waters is expected to be low and therefore the contribution of this measure to reduce pollution is not expected to be high. This is because the structure and width of the margins are usually insufficient for effective filtering and because the topography alongside only a few surface waters allows for a filtering function by the vegetation on the bank anyway (DVWK 1995). However if the protection against pesticides and the impact on the ecology is considered, the effect of buffer strips alongside watercourses is judged to be very positive. A quantitative assessment of this reduction measure is not possible.

Economic effects

With this measure income losses are, compared to the other examined measures, quite high and amount from 95 up to 651 €/ha a (Schultheiß et al. 2003). The higher costs are generated mainly by the crowding-out of cash crops and the associated loss of revenues and by costs for planting.

Political enforceability

In some German states and in cooperative agreements restrictions on the use of buffer strips alongside watercourses are financially compensated for. Distance requirements and application restriction for pesticides are regulated in the water laws of the individual states. The political enforceability is therefore given.

Administrative implementation and control

The measure is controllable through the application of funding within agri-environmental programs and by on site visits.

Side effects

- buffer stripes form structural element in the landscape and maintain the crosslinking of biotopes
- increased biodiversity

3.6 Co-operative agreements

In the framework of the German water legislation appropriate compensation payments have to be made for restrictions of agricultural production in water protection zones. On this basis concepts were adopted in the German Federal laender, which differ as to their legal, technical, organizational and financial basic conditions. Whereas individual Federal laender adopted a uniform approach in water protection zones in other laender arrangements and contractual agreements were made in co-operations between farmers and water works. In many cases this resulted in positive joint actions of agriculture and water management with the aim to reduce water pollution. In the framework of co-operative agreements management requirements and compensation payments were fixed. The largest number of co-operative agreements addresses nitrate pollution, followed by pesticides.

The total Number of CAs in the EU in 2002 is about 530 (Heinz et al. 2002). By far the largest number (435) has been established in Germany representing more than 80 % of the total numbers of CAs observed in the EU.

Definition of co-operative agreements

"Co-operative agreement" will be defined according to DVGW/LAWA (1999) as voluntary agreements as a result of negotiations between farmers and water supply companies. According to Heinz et al. (2002) optionally also other actors (e.g. authorities) may be involved in co-operations.

Such agreements have to meet three key requirements. They must be:

1. established on a voluntary basis between farmers and at least one water supplier and relying on self–interest of the parties involved,

2. based on self-regulation among the key actors,

3. targeted to a specific area (e.g. water catchment area, groundwater protection zone).

The CAs is generally directly negotiated between farmers and water suppliers although in most of the German laender the regulatory authorities need to approve the CAs before implementation.

Target accuracy

Whereas in some co-operations reductions of nitrate concentrations are already measurable (DVGW/LAWA 1999, Heinz et al. 2002), in a number of cases the nitrate concentrations are still rising. This can be interpreted that CAs not being in operation long enough but also that the restrictions in farming practices are inadequate to achieve a better water quality.

Altogether an improvement of the water quality (e.g. in terms of meeting drinking water standards or trend reversal) may only be seen after many years owing to the activities or the co-operations being of a short duration and the flowing time in the draining zone being long. In other cases insufficient monitoring data are available to assess the results

Co-operations minimise the potential confrontation as, as a rule, farmers willing to co-operate or users participate who are only insignificantly or not affected by protection measures, which represent a heavy interference in the process of operation. As a drawback of a co-operation there should be mentioned that farmers ”not willing to co-operate” may not participate in co-operative agreements without lodging an appeal.

This is also a reason why by coupling of subsidies (e.g. for equipment for applying farm manure, creation of storage capacity, installation of washing bays for plant protection sprayers) to the membership of a co-operation raises the readiness of the farmers in some Federal laender to participate in it. In general, however, involving farmers in the implementation of management requirements or protection measures has an acceptance promoting effect.

The real prospects of success of the co-operative agreements depend on the target-oriented co-operation of the co-operation partners and on a possibly high quota of participants. This refers primarily to problematic areas where management-connected or location-dependent collateral circumstances and a high groundwater pollution occur, thus requiring to make especially high demands for measures reducing groundwater pollution.

Economic effects

Co-operative agreements are multiform, as they have to be orientated according to the respective location conditions. Thus, the assessment of cost-efficiency is difficult. Calculations made by Heinz et al. (2002) point to the fact that as regards alternative water treatment methods the conclusion of CAs is the more cost-efficient solution for national economy. Notably against the background that the WFD requires that the most cost-effective measure should be applied for achieving the environmental objective CAs are gaining increasing importance presumably also beyond the catchment areas.

Related to the farm the high acceptance and participation speak for the fact that efficiency and reward are in a balanced relationship. In individual cases also free rider effects may be assumed.

Political enforceability

The already high number of existing CAs with and without the competent local authorities points to the high political enforceability.

Administrative implementation and control

Related to the comparison with taxes on nutrients and pesticides the administration expenses have to be assessed as being higher. Alternatives are mandatory regulations such as statutory standards. There are many cases, especially in Germany, where authorities promote the establishment of CAs in favour of the command and control approach in order of facilitate the implementation of environmental standards as the compulsory measures are difficult to enforce and the degree of state intervention is high. Nevertheless compulsory rules as a legal framework are indispensable for co-operative agreements (e.g. statutory protection zones, code of good agricultural practice).

Clear advantages result for the CAs from the fact that modifications or adaptation reactions to the conditions existing locally are possible without causing long-term administration costs.

Side effects

- Farmers participating in co-operations will practise water-protecting ways of management to a higher degree also beyond the borders of water protection zones.
- Co-operations may ease the pressure on public households as in addition to the obligatory consultation also the financial compensation for the restriction of the agricultural production will be implemented via the consumer price or directly via the water supplier.

3.7 Education and training

To consider water pollution control aspects in the framework of production-technological measures in agriculture the promotion of an interdisciplinary agricultural consulting and training and advanced training is of high significance in the field of environmental policy. Deficits in water pollution control are seen notably in the implementation of measures to eliminate environmental impacts discussed over many years. It is the task of education and training related to water pollution control to sensibilise farmers for the problems of water pollution control and to impart knowledge or to indicate measures of management to avoid impacts on water-bodies.

Education involves study in vocational schools and colleges and institutions of advanced training whereas training comprises training on specific priority subjects offered to the farmer by various institutions supporting consulting.

3.7.1 Education

In particular training and advanced training is regarded as an instrument, which has area-wide effects on the application of water-protecting methods in agriculture. Imparting of qualified knowledge on environment-protecting management systems through training and advanced training is the prerequisite for their implementation in practice. Agricultural training is integrated in the dual system of training farm and vocational school in Germany and is to impart basic knowledge and skills, which may be subsequently deepened and extended in colleges (e.g. foreman courses).

Environmental protection and water pollution control have been considered in training regulations and basic curricula of agricultural vocational schools and colleges. Thereby, water pollution control has been included as an interdisciplinary subject.

Target accuracy

The quality of imparting knowledge is different depending to a high degree on the quality of imparting knowledge and the compatibility of the information offered with the personal problems and interests. There applies notably to the vocational school that the higher the technical specialization of the trainees and the more heterogeneous the composition of the group is the more difficult it is to achieve specific options of solutions during the instruction.

The trend is to consider the subject water pollution control to a greater extent in colleges and to offer it methodically in a more attractive way to reach here a higher efficiency.

Potential

The control of success is difficult as, on the one hand, after completion of the training no further contact is maintained to the school-lever and, on the other hand, other influences, e.g. practical work in the training or the parental farms, counteract the knowledge theoretically imparted.

Thus, it may happen that innovations also in water pollution control are shifted to the succession of generations and thus, a high percentage of farmers, notably part-time farmers, is not reached with the aid of this instrument as they frequently have not completed a vocational training as a farmer[31] and also less frequently make use of offers/possibilities of consultation.

Economic effects

[31] In 1991 only 60 % of the farmers in the old Federal laender and still 73 % of the farmers in the new Federal laender completed a vocational training in agriculture.

Imparting of knowledge by multiplicators is a low-cost possibility to achieve the targets of water pollution control agreed upon politically. Changes in the content of training are, as a rule, connected with low costs as teaching materials have to be continuously updated.

Political enforceability

Environmental protection and water pollution control are considered in the training regulations and basic curriculum so that their political enforceability may be assessed as high.

Administrative implementation and control

Vocational training in agriculture and advanced training to become a foreman or engineering worker is carried out in governmental training institutions. Other events of advanced training and additional qualification are offered in farms, vocational schools and training centres so that a demand for an intensified training and advanced training is connected with a high enforceability.

Side effects

Making water pollution control aspects a subject results also in a sensibilisation for further environmental subjects.

3.7.2 Training

The term training summarizes a multitude of various proposals of advanced training reaching from written information materials, via papers and demonstration projects, group consultation up to problem-related consultation of individual farms. In this connection, a distinction should be made between cost-free consultation, e.g. in the case of founding of businesses or firm restructuring, and consultation with costs on individual problems of production technology (e.g. plant spray warning system, weather fax) or consultation immediately locally.

The explicit water pollution control offered is, as a rule, spatially restricted and concentrated on areas where problems occurred or are expected (e.g. water protection zones). Here, the consultation in water pollution control is concentrated on production technology, i.e. manuring, organisation of crop rotation, soil tillage and plant protection.

Consultation is differently organized in the individual Federal laender, reaching from area-wide governmental consultation via mixed forms of governmental and private consultation up to purely private consultation, partly by order of the government (Thomas 1999, Stommel 2001, Hoffmann 2002). Consultation supporting institutions are industry, consultation combines, water suppliers and private consultation offices apart from governmental institutions.

Target accuracy

The concurrence of the following factors is decisive to the acceptance and the success of the consultation (Schultheiß and Doehler 1998, LAWA 2000).

- The more specifically the consultation offered is adapted to the farm and the respective problems the better are the prospects for success.
- Highly qualified consultants may only reach success in consultation. They have to be in a position to combine the consultation as to legal targets, optimised production technology, economic targets and water pollution control.
- The acceptance of the consulting recommendations is, as a rule, ensured if the measures recommended require no or only insignificant changes in the farm and do not impede its future development.
- Consulting has to be separated from control and sanctions.

Potential

To consider environment-protecting methods the level of knowledge of the farmers has to be improved as an important factor of success. However, consultation measures leave to the farmer plenty of scope in implementing recommendations. Possibilities of reducing emissions by an intensified consultation are only limited, in particular, if the operational aspects speak against environment-protecting management methods. An intensified consultation is prospective notably in farms especially contributing to pollution, i.e. the consultation should be intensified for specific target groups (Böhm et al. 2002). A profitable reduction potential may be expected in farms, which do not work according to the rules of the good farming practice.

Owing to various measures and influences concurring a general quantification of the measure potential is difficult. According to Böhm et al. (2002) the potential of reducing the nitrogen input into flowing waters in Germany totals about 15 kt per year.

Economic effects

Owing to the high costs of the consultation the German Federal laender transferred to a differing degree individual consultation contents from the official consultation to private consultation offices in the last years. As opposed to this and accompanying regulatory and co-operative measures implemented in water protection zones in some German Federal laender essential additional consultation was offered; this is an essential cost factor (DVGW/LAWA 1999). Economic advantages of consultation in water pollution control may be detected in

water protection zones where owing to co-operative agreements existing it was no longer necessary to apply technological elimination methods of aftercare. An extension of the consultation offered would be connected with high costs.

Political enforceability

The demand for an intensified consultation – also area-wide - has been raised for a long time. Owing to high staff costs it is difficult to create additional consultant jobs. Individual German Federal laender have stopped every governmental financing for consulting in agriculture, others offer still an area-wide governmental consultation in agriculture according to the requirements (Stommel 2001, Hoffmann 2002). In contrast to this consulting in water pollution control (water protection zones) is in the public interest and is, as a rule, organized or financed by the laender.

Administrative implementation and control

For the time being, there exists still a governmental consultation in most of the German Federal laender (with a strong variation in organization and financing). However, for an area-wide consultation a transfer to private institutions on an intensified scale, partly by order of the government or with subsidies, is to be noticed in individual laender.

As against this in most of the Federal laender cost-free consultation in the framework of regulative approaches as well as in co-operations has been additionally provided for water protection zones.

Linking to existing consultation systems is of advantage to the demand for intensified consultation; this would speak for a high enforceability.

Side effects

Consultation with costs, staff shortages and reductions in the experimental field result in a reduction of consultation and have counterproductive effects on water pollution control. On the other hand, offering official consultation free of charge prevents efficient private consulting from developing. In addition to the effects on environment innovations and increase in productivity could be implemented by improving the level of information.

3.8 Crop cover on arable land

Within this measure different reduction possibilities are summarised: catch crops/under sown crops and intercropping.

Water protecting agricultural management practices should not be based only on optimised fertiliser and pesticide management - crop rotation that is adapted to the site specific conditions which possibly includes growing a crop throughout the year is of central importance. The inclusion of catch crops, established as a single crop, sown under the previous main crop or intercropped in rows, contributes fundamentally to the use of the residual nitrogen in the soil after a main crop and therefore to the minimisation of leaching of nitrates over winter. The aim is a year-round, closed cover of green plants and therefore a high uptake of nitrogen. By achieving this, erosion and surface run-off can effectively be reduced. If possible, winter hardy catch crops should be used in order to avoid losses from spontaneous mineralisation and the N being mobile over winter.

The working in of the catch crop should be preferably carried out in spring with an immediate cultivation of the following crop to prevent the mineralised nitrogen from leaching (DVGW/LAWA 1999, Berendonk 2002). In order to avoid batches of materialisation and to reduce P losses via erosion and surface run off, as well as for economic reasons the traditional form of working-in catch crops by ploughing should be abandoned and the subsequent main crop should be sown using a mulch-seed procedure (Schultheiß et al. 2003).

The nutrient supply from the catch crop should taken into account for when planning the fertilisation of the following crop, because, with concurrent cover crops, and especially when additional fertilisation is applied, the nitrogen supply in the soil can be increased.

Target accuracy

Cultivation of catch crops reduces demonstrably the level of residual mineral nitrogen (Nmin) before and after winter (DVGW/LAWA 1999). Furthermore, in comparison with a bare fallow (ploughed), growing a green cover crop reduces soil erosion. The extension of catch crop growing therefore is an efficient measure for water protection.

Potential

The potential of this measure depends on the area grown with a catch crop. With respect to the local potential of reduction (high N uptake, soil erosion protection), the selection of proper plant species (high potential when seeded late, winter hardy), the time of sowing as well as the time of working in, i.e. in line with the crop rotation, is of great importance. Generally brassica species effectuate a good reduction of nitrate leaching, on average the reduction amounts to 25 kg NO_3/ha (European Commission 1998). The reduction of losses through erosion and avulsion is estimated to be about 50 % by DVWK (1995).

Economic effects

When growing catch crops, depending on the procedure of implementation, a reduction in income is anticipated because of additional costs for seed bed preparation, sowing, seeds as well as mulching and, where required, working-in of the crop (Schultheiß et al. 2003).

Political enforceability

The cultivation of catch crops is promoted within agri-environmental schemes and also in co-operative management agreements in water protection areas and is now more widely accepted. The German Fertiliser Ordinance (Düngeverordnung 1993), which is the German implementation of the European Nitrate Directive, includes the recommendation to cultivate catch crops. Within the EU there are no legal requirements to grow catch crops.

Administrative implementation and control

The control of this measure is possible by local checks or with the use of satellite sensors. The current obligations in the German Fertiliser Ordinance do not require that crop planning information for specific plots (crop rotation) on farms are made available.

Side effects

- reduction of diffuse P inputs via erosion and surface run off
- improvement of soil structure by increasing the organic matter of the soil, establishment of humus and increase in the biological activity
- improvement of the infiltration rate
- a possibly higher use of herbicides with winter-hard catch crops

3.9 Soil cultivation procedures (mulching, direct drilling)

According to the German Ordinance for the protection of soil, the cultivation of soil should be carried out with consideration of the weather and adapted to the site-specific conditions in a way which influences the soil structure positively, conserves and promotes life in the soil and avoids harmful soil compaction. Erosion of the soil is to be avoided by using it appropriately in line with the site specific conditions, especially by taking into consideration slope, water and wind conditions and the soil cover (KTBL 1998). The time and the intensity of cultivation in autumn and early winter have a big impact on the level of nitrogen mineralisation. The change from conventional soil cultivation by ploughing to more conserving, minimum tillage procedures without working of the soil can lead to less mineralisation and therefore to less mineral-available nitrogen in the soil before winter. Especially in combination with the cultivation of a catch crop and mulch seeding of the following main crop, a lower level of mineralised nitrogen has been recorded over winter (Wolf 2001). The mulch layer additionally serves as a protection against erosion and puddling. On the other hand, with direct drilling there is a danger that, via macro pores from fertiliser, which has not been worked in, a translocation of dissolved nutrients from the soil surface into deeper soil layers takes place. This risk, however, only arises for a limited time and depends mainly on the intensity of precipitation and how saturated with water the soil is.

Target accuracy

While it is possible to reduce soil erosion by using minimum tillage procedures (mulch drilling), it is not possible to give a general statement of the effects of individual cultivation practices in respect of the minimisation of nitrate leaching. It is however necessary to adapt all cultivation measures to the site-specific conditions (DVGW/LAWA 1999).

Potential

The potential of the measure depends on the size of the area where the more conserving soil tillage or direct drilling is carried out. The reduction of the tillage of soil in order to reduce nitrate leaching is dependent on favourable weather conditions. Furthermore conservation procedures and direct drilling are not equally suited to all sites (Feldwisch und Schultheiß 1998). Assessments in Saxony, which were carried out within the framework of agri-environmental programs showed that direct drilling and the growing of catch crops, led to an overall reduction of soil erosion by 20 %. Experimental research in Baden-Württemberg showed that erosion was reduced by direct mulching by up to 54 % (European Commission 1998).

Economic effects

The costs for working time, capital for machinery and energy decrease from: conventional tillage procedures to soil-conserving tillage procedures without ploughing to direct drilling (Brunotte and Wagner 2001, Schultheiß et al. 2003). On the other hand pesticide costs can increase for systems with minimum tillage and direct drilling. With respect to the yields of mulching systems compared to ploughing systems both higher yields and lower yields are reported in literature. Although lower yields during the conversion period have been reported, in the long term equally high yields are to be expected. Altogether it should be taken into consideration that soil-conserving systems pose higher demands on the management of the farm and crop.

Political enforceability

Soil-conserving tillage and direct drilling procedures are especially promoted within the framework of integrated farming. Although reduced soil tillage procedures were mainly applied within co-operative agreements (Wolf 2001), an obligatory implementation of these measures is unlikely to be enforced politically.

Administrative implementation and control

Soil-conserving tillage and direct drilling measures are controllable, to some extent, with on site visits.

Side effects

- more stable soil structure, higher resilience (load capacity) and a better trafficability
- higher proportion and greater consistency of large water and air pores and therefore a higher level of infiltration of precipitation
- altered mineralisation (temporally delayed)
- changed pest and weed infestation and therefore some higher inputs of pesticides

3.10 Changing the use of arable land

In order to minimise nutrient losses from agricultural fields and to rehabilitate polluted surface waters land is reclassified or its use is changed. To change the use of land such that it still remains agricultural land is possible, for example, the conversion from arable land to grassland or the inclusion of a temporal perennial fallow.

3.10.1 Changing the use of arable land

This measure is the temporary establishment of grassland on arable land. The implementation rules in the agri-environmental programs state that the farm land, which is converted, into grassland is to be used extensively with a maximum stocking rate of 1.4 SLU/ha.

Target accuracy

There is a close relationship between nutrient surpluses and the residual amount of mineral nitrogen before winter and the type of land use (arable crops or grasslands). A conversion from arable land into grassland is therefore efficient.

Potential

The potential of this measure is dependent on the amount of land, which has its use changed and the management restrictions imposed.

Economic effects

The change of use from arable land to grassland, in comparison to other measures, which establish a catch crop, leads to a significant loss of income for farms because of the reduction in the gross margin and the concurrent costs for managing the grassland (Schultheiß et al. 2003). Altogether it can be assumed that the change of arable land into grassland has an effect on the balance of the market because land is taken out of production and replaced with extensive grassland (European Commission 1998).

Political enforceability

The conversion from arable land to grassland is promoted within agri-environmental programs (European Commission 1998, Hartmann et al. 2003) and also in co-operative agreements in water protection areas (DVGW/LAWA 1999). However it has not found any noticeable acceptance.

Administrative implementation and control

The measure is controllable through the application of funding via agri-environmental programs and by on site visits.

Side Effects

- an increase in the biodiversity on extensively managed grassland is possible
- reduction of run-off and erosion

3.10.2 Increase of the proportion of long-term set asides compared to rotational fallows

On set-aside arable land it is expected that, in total, a reduction of nitrogen leaching takes place as usually the set asides are not fertilised with fertilisers containing nitrogen. Furthermore the land is not, or significantly less, treated with pesticides. However, when the cover is insufficient or the crop stand is loose and there are high amounts of residual nitrogen from the previous crop, then there is an increased danger of soil erosion as well as increased nitrate leaching. The working of the soil before set aside and the kind and way of establishing the cover crop have a strong influence on the nitrate accumulation of set aside arable fields (Schultheiß et al. 1993). When arable fields are permanently set aside then over time the danger of leaching compared to rotational fallows reduces and is relatively low. A critical point in time, for long-term set asides as well as for rotational fallows, is the period of actually setting aside, i.e. the transition period from arable field to fallow. High levels of residual nitrogen from the previous crop should be effectively prevented from leaching. A systematic establishment of cover crop with a high potential to take up nitrogen, if possible with non-leguminous plants, can be effective against nitrogen leaching. Also under sowing with grasses is suitable for longer-term set-asides. The field should not be worked on in the autumn before setting aside as cultivation intensifies the mineralisation of nitrogen in autumn (Frede and Dabbert 1998). The set aside would be useful with respect to leaching if cutting without fertilisation and a taking off of the biomass was allowed.

Target accuracy

Long-term set asides show, compared to rotational fallows, lower mineral nitrogen content in the soil before winter (Schultheiß et al. 1993, Frede and Dabbert 1998). An increase of their proportion compared to rotational fallows efficiently decreases the risk of nitrogen leaching.

Potential

The potential of this measure is dependent on the proportion of set aside to cultivated land on a farm, the management restrictions imposed and the site-specific conditions and can therefore not be exactly quantified. With long-term set asides the annual cultivation is not carried out, consequently the mineralisation of nitrogen in total is reduced.

Economic effects

A 10-year set aside has, compared to the one-year rotational fallow, economic advantages because of the single cultivation of the soil and once-off sowing. Higher costs can occur through the replacement of the cash crop and the lost revenue. In this case, compared to other measures examined, the income losses are relatively high (Schultheiß et al. 2003).

Political enforceability

Long-term set asides are promoted in agri-environmental programs although they have not reached a high level of acceptance.

Administrative implementation and control

The measure is controllable with funding via agri-environmental programs and by on site visits.

Side effects

- increase of biodiversity
- reduction of run-off and erosion

3.11 Optimisation of animal nutrition

The most important measure to reduce nitrogen content in animal manure is the adjustment, in terms of N, of the protein supply to the nutritional demand of cattle, pigs and poultry. With a consistent N-adjusted feeding regime for pig fattening, sow keeping and poultry fattening nitrogen excretion is reduced and the nitrogen content in the manure is limited. As well as reducing ammonia emissions, this measure also reduces nutrient losses via leaching and denitrification.

The excretion of phosphorus can also be significantly reduced by using phytases, phased feeding regimes and feed compositions, which are in line with nutritional requirements. The addition of phytase, which is a microbially produced enzyme, can increase the utilisation of phytin-phosphorus, which is abundantly available in plant-based feeds. Without phytase,

phytin-phosphorus is digested by pigs and poultry to only a limited degree. Consequently the use of mineral phosphor compounds is reduced.

Target accuracy

Implementing an N-adjusted feeding regime can reduce nitrogen in animal manure. In combination with the timely application of the manure to coincide with the highest demand of the plants, the risk of nitrogen losses can also be minimised. The same applies for phosphorus. The measure, therefore, is very efficient.

Potential

The potential for reducing nutrient excretion with an N-adjusted feeding regime varies between 5 and 40 %, depending on animal species, performance and the initial situation (aid 2003, Gronauer 2002, Hartung 2002, van den Weghe 2002). The effects of reduction are determined by how frequently the N is adjusted during the fattening period (two, three or multi-phase feeding), or in sow keeping (two phase feeding: lactation and pregnancy) and by the proportion of the amino acids added.

According to the results of the Ammonia Emissions Inventory in Agriculture (Döhler et al. 2002a), the potential of the N-adjusted feeding cannot be conclusively determined. Experts assume that currently N-adjusted feeding regimes are implemented in 70 % of cases. However, there are different interpretations of the term "N-adjusted". As, currently, N-adjusted feeding is mainly practised on big farms, the introduction of this feeding management practice on smaller farms would allow for further reduction.

The resulting reduction of P excreted during pig and poultry production from the above-mentioned measures can reach up to 40 %.

Economic effects

The implementation of phased feeding requires the appropriate technical equipment on the farm. Costs arise for this additional feeding technology, although costs for the raw protein in feed can be reduced. Depending on the implementation of the phased feeding (two or multi-phase feeding) and the size of the farm, these costs could be balanced for a farm with many animals.

Political enforceability

The requirement to implement phased-feeding practices is stipulated in the technical regulation for the protection of air which currently only applies to animal production

enterprises which need to be licensed (EG 1996, IVU-Directive). For smaller farms there are no legal requirements.

Administrative implementation and control

The administrative practicability is assumed to be moderate as the measure "N-adjusted feeding" is often difficult to control. On farms where ready-mixed feeds are bought in, the proportions for the different feeding phases can be determined. On farms where own feed mixtures are used the measure is very difficult to control.

Side effects

The reduction of nitrogen in animal manure leads to a reduction in the emission of ammonia.

3.12 Optimisation of manure storage and application

When applying animal manure, losses to the air and ground water should be reduced as much as possible. When nitrogen losses to the air are reduced by the use of appropriate measures (e. g. covering the storage pits) the nitrogen content in the manure increases. This nitrogen should be applied in a well-directed and targeted fashion so that the crop can use the nitrogen most efficiently. To achieve this the application period as well as the technology used are of utmost importance (aid 2003). Ideal application periods are in spring, mainly from the middle of February until the end of April. By transferring the application periods from summer/autumn to the whole of spring the application is made when the crop can best use the nitrogen. Consequently, the translocation of nitrogen to deeper soil layers in late summer/autumn is impeded. These different application periods increase the necessary storage period on animal production farms to about 8 months (Schultheiß et al. 2003).

Trailing hose technology is recommended for applying liquid animal manure at a later point in time to a growing crop (on grasslands: trailing shoe technology, Döhler et al. 2002a). With this equipment the slurry is applied directly on the soil's surface and is hence protected from radiation and wind, which decreases emissions and therefore leads to a higher use-efficiency of the nitrogen by the crop. If the liquid manure is nevertheless applied during summer on bare arable land then this should be immediately worked into the soil in order to reduce ammonia emissions (German regulation of Fertilisation, Düngeverordnung 2003). With this procedure emissions can be reduced by up to 90 % (Döhler et al. 2002a). This reduction, however, is only achievable if the slurry is worked-in within an hour after application (with a second vehicle or in a combined operation). The later the working-in is done, the less the emissions are reduced.

Target accuracy

The use of appropriate technology for the application of animal manure when the crop has the highest demand for it in combination with an extension of the storage capacity are assumed to be measures of very high efficiency.

Potential

The potential for reducing the translocation of nitrogen by choosing the best time for application is highly rated. Also the potential of using low emission technology is generally rated as high (Böhm et al. 1999). In pig production the potential is generally judged slightly lower than in cattle production because higher storage capacities are already in place and also higher amounts of slurry are already applied during spring (Döhler et al. 2002b).

Economic effects

The increase of the storage capacity and the use of better application technology have higher associated costs. However as the more efficient use of the nitrogen in the manure allows savings of mineral nitrogen, some costs are reduced.

Political enforceability

Although according to international conventions (Multi-Component-Protocol, UN/ECE 1999, EU-Regulation, National emission ceilings, NEC 2001) reductions of ammonia emissions should be achieved, the political enforceability can be expected to be only moderate because of the high costs for increasing storage capacities and the low emission application technologies.

Administrative implementation and control

Currently the application of animal manure (timing and amounts) and their storage is regulated by the German of fertiliser ordinance (Düngeverordnung). The included regulations should be more clearly defined - especially the “immediate working-in of the liquid manure” needs a concrete definition. A minimum storage time of only six months is required by the German Technical Regulation for the Protection of Air for animal production enterprises, which need to be licensed. According to IVU-Directive (EG 1996), animal production enterprises need to be licensed if they have the capacity for more than 2000 fattening pigs, 750 breeding sows, or 40,000 domestic fowls.

The control of the prevailing storage capacity is possible, although there is a high level of administration associated with this. The available application technology could be checked at the same time. Whether or not this application technology is used to bring out the slurry when

the demand of the crop for nutrients is highest and whether its use in practice is the best available to reduce ammonia emissions, is, however, difficult to determine. Whether or not the animal manure is immediately worked-in is also hard to establish.

Side effects

- Ammonia emissions are also reduced by the better utilisation of the nitrogen in the slurry by the plants and with that a contribution is made to reduce the acidification and eutrophication of natural and semi-natural ecosystems (e.g. forests, moors, lakes and watercourses).

3.13 Excursion: Residues of pharmacologically effective substances in farm manure

In farm manure veterinary pharmaceuticals, in particular antibiotics may be detected in various concentrations; they may have effects on soil and water-bodies. The present level of knowledge relating to the use and occurrence of pharmacologically effective substances in animal husbandry is incomplete (KTBL 2004). Pharmaceutical products as well as their related metabolites may end up in the aquatic environment after use. Recent investigations show that low concentrations of pharmaceuticals are detectable in surface water and groundwater (Jongbloed et al. 2001, Knecht et al. 2001, Derksen et al. 2002). Little is known about the effects, and with that the risk, of long-term exposure to concentrations of pharmaceuticals for terrestric and aquatic ecosystems (Kunst et al. 2002).

Use of antibiotics – quantities used and agent groups

In 1999 EU-wide 4700 t of antibiotics (agents) were used in animal husbandry 3800 t thereof for therapy and 900 t for promoting efficiency (FEDESA 2001). In the field of therapy notably the agent group of tetracycline is used. From the quantity of agents altogether used in Europe for antibiotics 35 % come to veterinary medicine, the remaining 65 % to human medicine. For the time being, no data relating to the scope of use of antibiotics in animal husbandry in Germany are accessible to the public. According to investigations made by Winckler and Grafe (2000) in 1997 approx. 150 to 200 t of animal pharmaceuticals were used in 6 rural districts in Lower Saxony with intensive animal husbandry. With 52 % the agent group of tetracycline had the biggest share in it, followed by sulfonamides with 17 % (both of them used in pig fattening) and neomycin with 9 % (preferably used in poultry fattening).

Concentrations of antibiotics and behaviour in soil

As big parts of the agents leave the animal organism completely or insignificantly changed 50 to 80 % of the quantities given may appear in animal excrements (Zullei-Seibert and Skark 2002). In particular, tetracycline is metabolised only insignificantly in the animal getting in big portions into farm manure (Römbke and Knacker 1996); in 44 of 181 liquid pig manure samples from intensive livestock farms in Lower Saxony tetracycline was detected in concentrations between 0.6 g/m³ and 66 g/m³ (Winckler and Grafe 2000). The storage conditions of farm manure (e.g. aerobic/anaerobic conditions, temperature) have a strong influence on the degradation of the agents. In the topsoil of areas regularly manured with liquid pig manure tetracycline was detected in concentrations partly distinctly above 100 mg/kg soil. In contrast to this only insignificant concentrations of sulfonamides were detected in liquid manure and soil samples (Winckler and Grafe 2000).

Tetracycline and chlorotetracycline show a high persistence in sandy soil (within 6 months no significant degradation was detected), thus accumulating in the case of farm manure being repeatedly supplied (Hamscher et al. 2002). As according to investigations made so far the substances may be strongly adsorbed in the topsoil their bioavailability and potential effects on soil microorganisms may at present not be assessed. Thus investigations will have to be made, in particular with regard to their transferability in soil or large-area distribution, e.g. by erosion.

Spreading of germs resistant to antibiotics or resistant genes by farm manure and inducing of resistance of germs to antibiotics in soil by applying farm manure containing antibiotics is of importance; here additional investigations will have to be made.

Measures to reduce the use of antibiotics in animal husbandry

In Germany the Federal Medical Society and the Team of Senior Veterinary Officers composed ”Guidelines of the careful handling of antimicrobially acting animal pharmaceuticals” (”Leitlinien für den sorgfältigen Umgang mit antimikrobiell wirksamen Tierarzneimitteln”) involving i. a. avoiding of the preventive use of antibiotics for healthy, not infected animals. In addition criteria for the selection of the proper antibiotic are fixed and recommendations for the correct dosage and duration of therapy are given (Deutsches Tierärzteblatt 1999).

As a further measure the prohibition of antibiotically acting food supplements in 1999 should be mentioned. In addition, the antibiotic food supplements still permitted for the time being are to be prohibited before 2005. And the improvement of the hygiene in animal houses and the introduction of closed production cycles (e.g. production of piglets, fattening of pigs) could result in a reduction of the use of antibiotics.

In the area of animal feeding the optimisation of food quality and the dimensioning of a ration resulting in strengthening of the endogenic immune defence may have use-reducing effects. For the time being, giving of alternative supplements such as pro- and prebiotics (Simon 2001), organic acids, herb extracts and ethereal oils and specific enzymes are under discussion. So far few information has been available on these alternative supplements

Sufficient areas for keeping animals, possibilities of creating functional areas by the animals themselves (resting, walking, feeding and excrement areas), optimum climatic conditions and avoiding of high harmful gas concentrations (e.g. ammonia) are proposed. Constructional measures for improving hygiene are i.e. a quarantine house, a sick and treatment department and carcass containers as they have been already prescribed according to the pig keeping regulations (Schweinehaltungsverordnung 2000).

Results

As regards the assessment of the behaviour towards environment or the environmental relevance of pharmaceuticals, in particular antibiotics, the requirements for research to be made are altogether very big. This refers notably to the determination of quantities of use and reliable substance characteristics such as water solubility or inclination to sorption and degradation. Equally the measures to reduce pharmacological residues of farm manure have to be investigated as to the accuracy of their target and efficiency.

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Part B

Detailed reports sub projects

Impact and Cost-Efficiency of Alternative Policy Measures to Reduce Diffuse Pollution Caused by Agriculture (FAA, Bonn)

Umweltforschungsplan
des Bundesministeriums für Umwelt,
Naturschutz und Reaktorsicherheit

Förderkennzeichen 201 24 222

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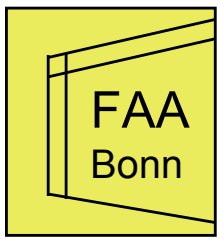
Research Association for Agricultural Policy and Agricultural Sociology



Mai 2004

Preface

The Research and Development Project "Evaluation of policy measures and methods to reduce diffuse water pollution" funded by the Federal Environmental Agency, Berlin, over the period from 01.09.2001 till 31.12.2003 is composed of four sub-projects (a-d). The report on hand concerns subproject b – belaboured by the Research Association for Agricultural Policy and Agricultural Sociology, Bonn (FAA). Within the sub-project b, the FAA allocated form-harmonised research assignments as follows (executive summaries of the respective final reports of these assignments please find in Annex):

Institute for Agricultural Policy, Market Research and Economic Sociology of Bonn University (IAP); handling by Ignacio Perez and Dr. Wolfgang Britz

Theme: Calculation of nutrient balances on EU Nuts II level applying the model system CAPRI

Agricultural Economics Research Institute (LEI), Den Haag; handling by John Helming and Kees Jan Wolswinkel

Theme: Agrarian determined nutrimental water pollution in the Netherlands – analysis and evaluation of reduction measures

Institut Agronomique Méditerranéen de Montpellier (IAMM), Montpellier ; handling by Dr. Guillermo Flichman

Theme: The French Agenda against water pollution caused by agriculture

Within the framework of the joint research project the FAA held paper and poster presentations at conferences of the International Water Association (IWA) – Specialists Group Diffuse Pollution - in Amsterdam 2002 and Dublin 2003:

Poster Presentation:

"Evaluation of policy measures and methods to reduce diffuse water pollution",
Amsterdam 2002

Paper Presentations:

"Impact of nitrogen reduction measures on nitrogen surplus, income and production of German agriculture", Amsterdam 2002"

"Impact and cost-efficiency of alternative policy measures to reduce diffuse pollution caused by agriculture", Dublin 2003

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1 Introduction

1.1 Problem

In economically developed countries, nutrient loading of water bodies today is primarily attributed to excessive mineral and organic fertilizing of agricultural area by farmers. The intensive use of fertilizer results in high nutrient field balance surpluses, that are considered to be appropriate "pressure indicators" for water quality. In order to further reduce nutrient concentration in watercourses various groups demand a firm integration of water pollution control into the Common Agricultural Policy of the EU (CAP). However, to make this entitlement operational on a scientific bases cost benefit analyses of alternative policy measures have to be available. Indeed, there is a lack of suchlike analyses tracing back to the fact that neither costs nor – exceptionally - benefits of alternative measures have been quantified adequately.

1.2 Objective

The objective of the study on hand is to quantify the impacts of alternative measures in particular with respect to nutrient reductions and costs incurred by agriculture applying the Regional Agricultural and Environmental Information System for the Federal Republic of Germany (RAUMIS). For that purpose the following questions shall be processed:

1. What is the methodical design of RAUMIS*?*

Besides a general presentation of the model system mainly the applied method of nutrient balancing on county level shall be described.

2. How did the nutrient surpluses on agricultural area evolve during the past two decades in Germany?

On the basis of ex-post data calculated with RAUMIS the regional change of nitrogen and phosphorus balances on district level between the years 1979 till 1987 and 1987 till 1999, respectively, will be shown and explained. Even though the status quo situation in 1999 reflects lower balance values than in the beginning of the investigation period, surpluses – in particular in regions where livestock density is high – still remain on exalted levels.

3. What would be the impacts of alternative policy measures on nutrient surpluses in the target year 2010 in comparison to a scenario of reference which bases on Agenda 2000 policies?

On the basis of the Agenda 2000 policy agricultural nutrient surpluses projected by RAUMIS for the target year 2010 do not change significantly in comparison to the status quo situation in 1999. The same holds after an introduction of modulation and decoupling-practice that are core elements of the reform proposals of the EU Commission (COM) within the framework of

the Agenda 2000 Midterm Review (MTR)[1]. Hence, further nutrient reduction measures will be analysed, namely a federal wide consistently reimbursed tax on mineral fertilizer of 100 respectively 200 per cent, a constraint on livestock density of 1.5 respectively 1.0 livestock units (LU) per hectare agricultural area (AA), and nutrient surplus restrictions that take regional livestock densities into account. Calculated reduction potentials will be compared with agricultural income losses that are associated with the implementation of a specific measure. In a final step the nutrient reduction costs in terms of agricultural income loss can be computed in EURO per kilogramme nutrient.

4. How do the modelling results have to be disposed?

In this section the results shall be discussed against the background of their usability in policy advice whereas considerations mentioned in chapter 1.1 will be taken up again. Closing, conclusions shall be drawn.

[1] Bertelsmeier, M., Gömann, H., Kleinhanß, W., Kreins, P., Manegold, D. und F. Offermann: Modellanalysen zu den Auswirkungen der KOM-Vorschläge im Rahmen der Halbzeitbewertung der Agenda 2000. Schriftenreihe der FAA Bd. 320, Bonn 12/2002, S. 61

2 Methodological design of the Regional Agricultural and Environmental Information System for the Federal Republic of Germany (RAUMIS)

The Regional Agricultural and Environmental Information System RAUMIS is designed for a continuous usage in the scope of long-term agricultural and environmental policy impact analyses and aims to support policy-makers in policy decision processes. During the last years the model has been extensively used for policy impact analyses carried out for the German Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL). Figure 1 gives an overview over RAUMIS' modular design. Impacts of alternative policies being analysed are in particular changes of agricultural production, inputs, and net agricultural value added as well as resulting changes in environmental risk factors such as nitrogen and phosphorus surpluses.

The model consolidates various agricultural data sources and generates base model data with the national agricultural accounts as a framework of consistency. The most relevant information being processed in RAUMIS are activity specific data about production and yields on national and on regional level from the official agricultural statistics, technical input-output coefficients, cost estimates, data from a network of representative farms[2] and various other calculation data. The model comprises more than 50 agricultural products and used inputs with exogenously determined prices. RAUMIS completely reflects the German agricultural sector with its sector linkages. Due to the four year interval of the official agricultural statistic survey base model data for six base years are currently available ranging from 1979 to 1999.

According to the data availability the spatial differentiation of RAUMIS presently bases on administrative criteria. The continuous spatial distribution of agricultural production is approximated by some 326 regions basically on a county level ("Landkreis"). These Regions are treated as single "region enterprises" that autonomously reach their production decisions i.e. adjustments of production on national level base on the aggregated responses of the "region farms".

Adjustments caused by changes in general conditions such as agricultural policies are determined using a mathematical programming approach with a non-linear objective function. This method is an algorithm that models responses of producers to changes in the relative profitability of production activities subject to technical, political and economic constraints. The basic assumption of this approach as formulated in the non linear objective function is maximising farm income. The derived optimal production plan yielding the highest farm income does not necessarily match exactly the observed amounts of production because of

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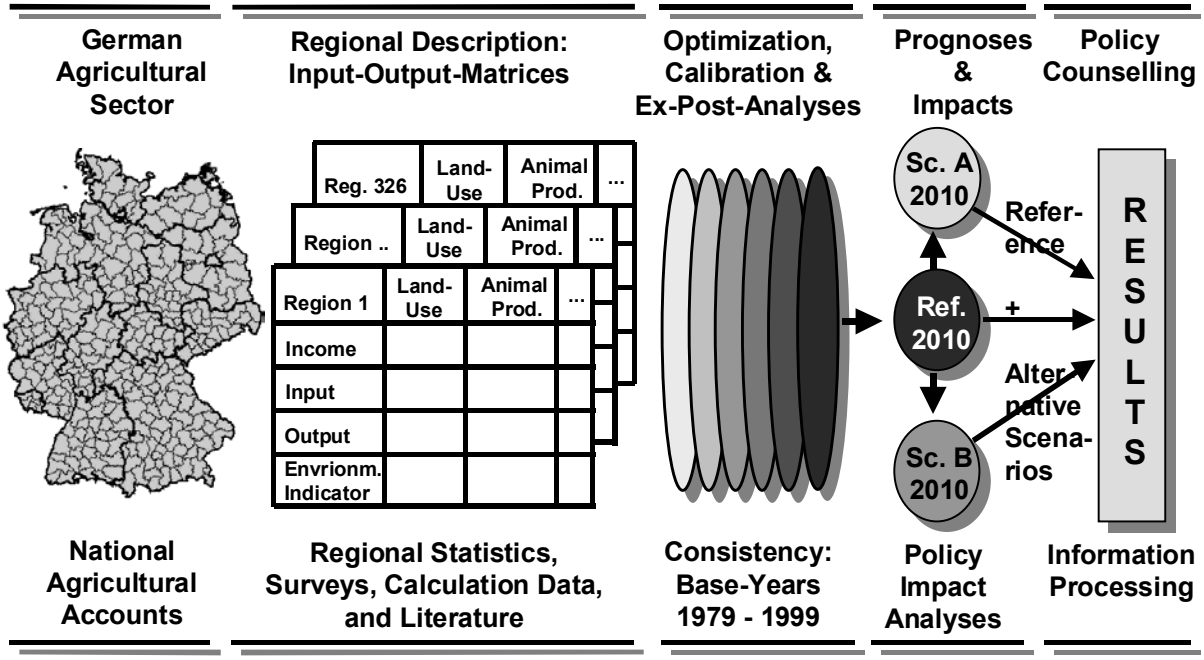
[2] Farm Accountancy Data Network (**FADN**) is an instrument for evaluating the income of agricultural holdings.

imperfect information about the true coefficients. This problem is overcome by applying the technique of positive mathematical programming (HOWITT, 1995). The positive mathematical programming approach provides substantial advantages with respect to the long-term forecasting behaviour of the model. In the projection phase a variety of exogenous variables such as implicit costs resulting from positive mathematical programming, input-output coefficients, yields, capacities, and prices are forecast. Updates partially base on trend and yield dependent regression analyses as well as on estimations of experts particularly regarding prices and the development of farm structures.

Figure 1: System of the modular design of RAUMIS



Source: FAA – Description & Layout.

Because various parameters are changing in the long-run in addition to the investigated policy measures comparative static policy impact analyses for a future target year require a scenario of reference. Deviating from the scenario of reference alternative policy measures and environmental regulations are imposed on the model leaving all other parameters and variables constant. This procedure separates the policy impacts on agricultural production and hence indirectly on the environment e.g. nitrogen and phosphorus surpluses as deviations from the scenario of reference.

In RAUMIS a set of agri-environmental indicators is implemented to analyze the direct and indirect environmental impacts of the agricultural production at the regional level. Regarding diffuse water pollution the indicator "Fertilizer Surplus" is of particular importance. In the following the methodological rules applied in RAUMIS to calculate a nitrogen balance are illustrated.

The concept of balancing nitrogen as shown in Figure 2 follows the field principle (BACH, 1987) where the soil surface represents the system border. The primary demand for nitrogen

bases on the nutrient uptake of plants that are removed from the soil during the harvest. A further reduction of nitrogen occurs as a loss of ammonia (NH_4) during storage and application. Important inputs of nitrogen are organic and mineral fertilizer. Other sources are symbiotic and asymbiotic nitrogen-fixation, as well as atmospheric deposition. A nitrogen surplus results from the comparison of demand and supply and is displayed as quantity unit per acreage (kg per ha) on the regional level. This spill-over is regarded as a risk indicator because this amount is potentially available for de-nitrification and leaching into water bodies.

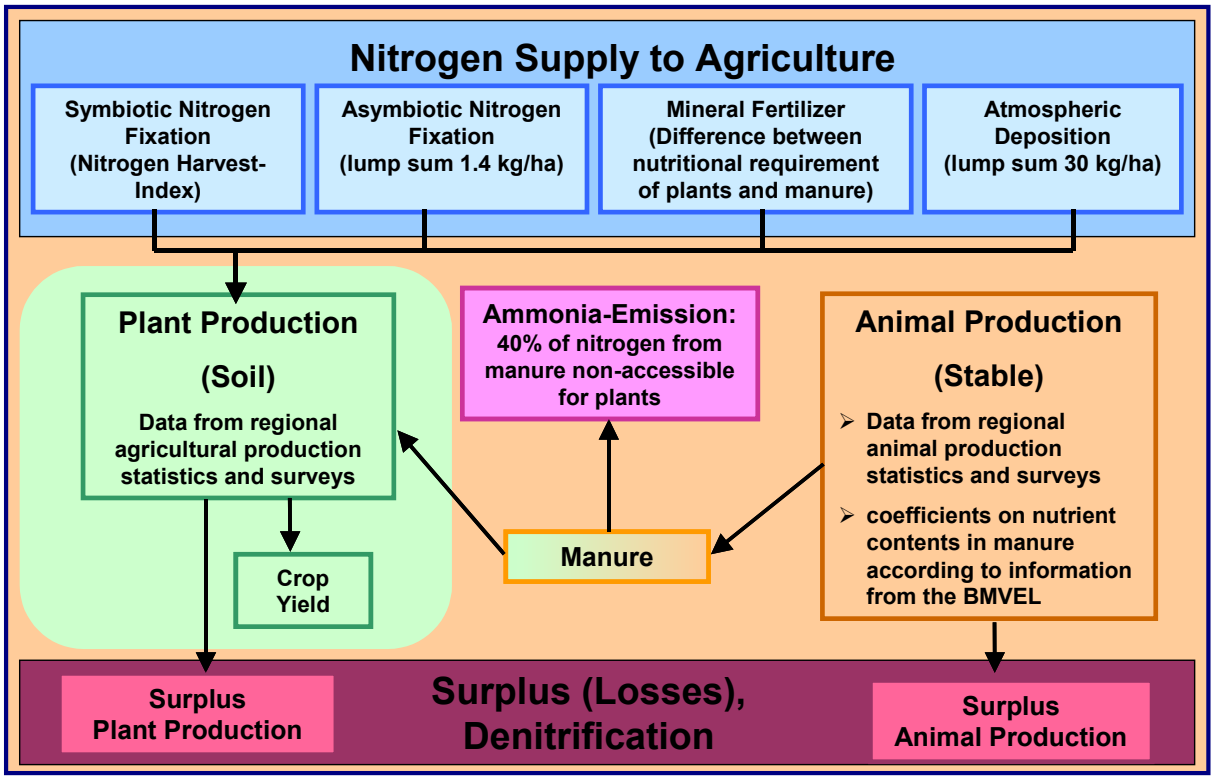


Figure 2: Structure and Elements of the Nitrogen Balance

Source: FAA – Description & Layout.

The listed positions of the nitrogen balance are calculated by the activity-based framework in RAUMIS. In order to obtain regional input and output positions, activity-specific coefficients are multiplied with the level of each activity e.g. area harvested or livestock.

Nutritional requirements for each crop production activity and region are based on expected crop-specific yields as well as soil and climate conditions. Nitrogen use of individual crop production activities is calculated by linear yield-dependent requirement functions. The loss of ammonia during storage and application is adapted from the assumption that 40% of the nitrogen in manure inaccessible to plants is converted into ammonia during storage and application.

The nitrogen supply from manure is derived from nitrogen contents in the excrements of farm animals. RAUMIS differentiates between four processes of manure and its application i.e.

dung and liquid manure from cattle, hogs and poultry. Coefficients about the nutrient content in manure as well as the utilization factors of plants are taken from the literature and are provided by experts of the BMVEL, also. Presumably, these coefficients are neither static over time nor identical between regions especially regarding (bio)-technological progress and regional differences in feeding practices. However, due to missing information average sectoral parameters are assumed temporally and spatially constant in RAUMIS except for cows. The regional nitrogen content in cowshed manure is calculated subject to the share of green fodder. Following the concept that nitrogen from manure can replace nitrogen from mineral fertilizer, mineral fertilizer equivalents for manure are calculated based on different plant nitrogen utilization factors of dung and liquid manure from cattle, hogs and poultry. The application of organic manure in plant production is associated with unavoidable nutrient losses. These losses are being accounted for in the mineral fertilizer equivalent for organic fertiliser assumed in RAUMIS. The mineral fertilizer equivalent for dung is constantly 25% which implies that four kg of nitrogen from dung substitute one kg of nitrogen from mineral fertilizer. The coefficients for liquid manure regionally vary between 16 to 25% for cattle, 20 to 30% for hogs, and 26 to 39% for poultry.

Because of high transport costs it is assumed that organic fertilizer remains in the region and substitutes mineral fertilizer in crop production subject to regional rates and thresholds of substitution. A regional excess demand for nitrogen in plant cultivation is equalized by using mineral fertilizer in a way that the derived aggregated mineral fertilizer demand matches the amount of national fertilizer sales from the national agricultural accounts for the base years.

The positions asymbiotic nitrogen fixation and nitrogen entry from the atmosphere are included as lump sum amounts, namely 30 kg per hectare for atmospheric entry and 1.4 kg per hectare for a symbiotic nitrogen fixation. Calculations for symbiotic nitrogen fixation are based on expert information and depend on the levels of pulses, clover and alfalfa.

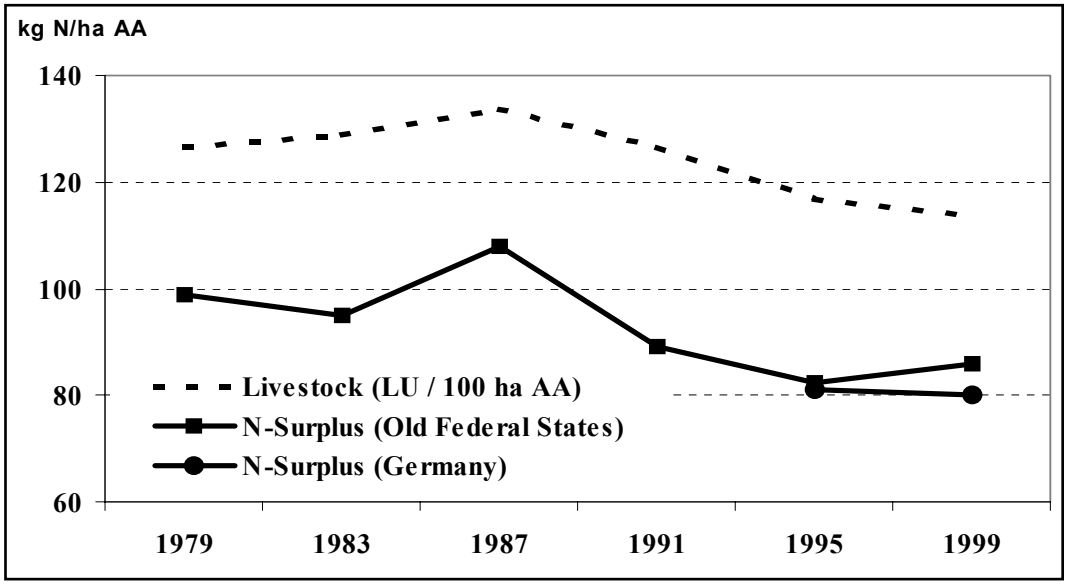
Regarding the phosphor balance, which bases on the same principles as its nitrogen counterpart only the nutrient uptake of plants that are removed from the soil during the harvest and the input of organic and mineral fertilizer are taken into consideration as “Demand” respectively “Supply”.

3 Development of nutrient surpluses on agricultural area during the past two decades in Germany

3.1 Nitrogen

Regarding the development of nitrogen balances on agricultural area during the last two decades it becomes apparent that the surpluses increased until the end of the eighties and decreased as of the nineties. This trend is identifiable in Figure 3 that displays the development of nitrogen balances on agricultural area in Germany from 1979 till 1999. The development and regional differentiation of N-Surpluses are strongly correlated to the development and regional livestock allocation because of the associated manure supply. In the Old Federal States total N-Surplus increased up to 108 kg N per ha AA until the end of the eighties and dropped to 86 ka N per ha AA in 1999. In Germany total N-Surplus was approx. 80 ka N per ha AA due to a lower livestock density in comparison to the Old Federal States.

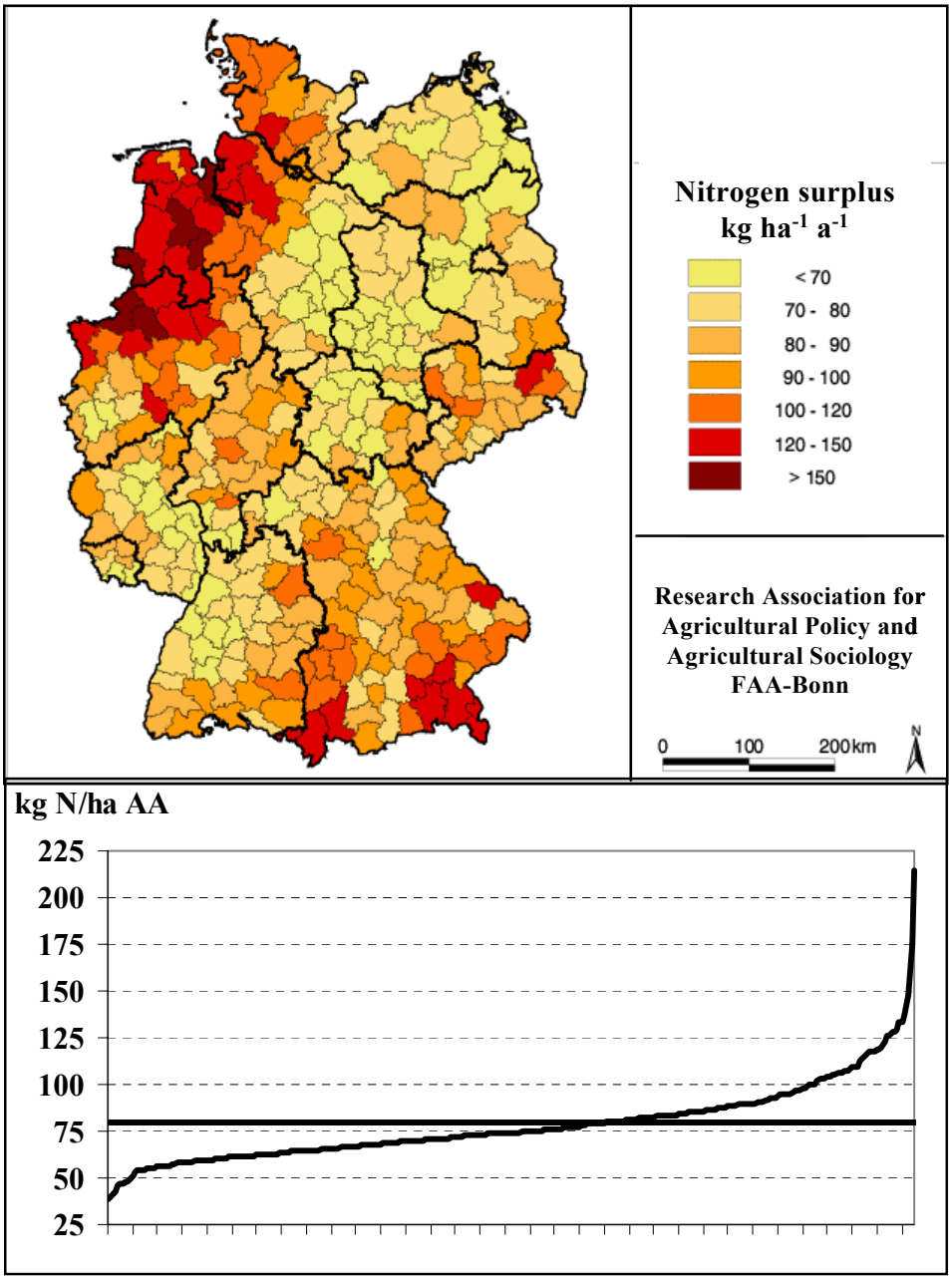
Figure 3 Development of nitrogen balance on AA in Germany from 1979 till 1999 (in kg N per ha)



Source: RAUMIS calculation, FAA-Bonn.

Livestock densities predominate the regional distribution of N-Surplus that is displayed in Figure 4 for Germany in 1999. The nitrogen surplus can be specified in 45 less than 60 kg N per ha AA. Federal States with comparatively low N-balance are Brandenburg, Hesse, Mecklenburg – Western Pomerania, Rhineland - Palatinate and Saarland. Areas with surpassing high N-balance (more than 110 kg N per ha agricultural area) lie above all in the western part of Lower Saxony, in northwest North Rhine - Westphalia as well as in wide districts of southern and south-eastern Bavaria. Referring to this context in the new Federal States there are only Saxon regions around Kamenz flashly.

Figure 4 **Surplus of nitrogen on agricultural area on district level in 1999 (in kg N per ha)**

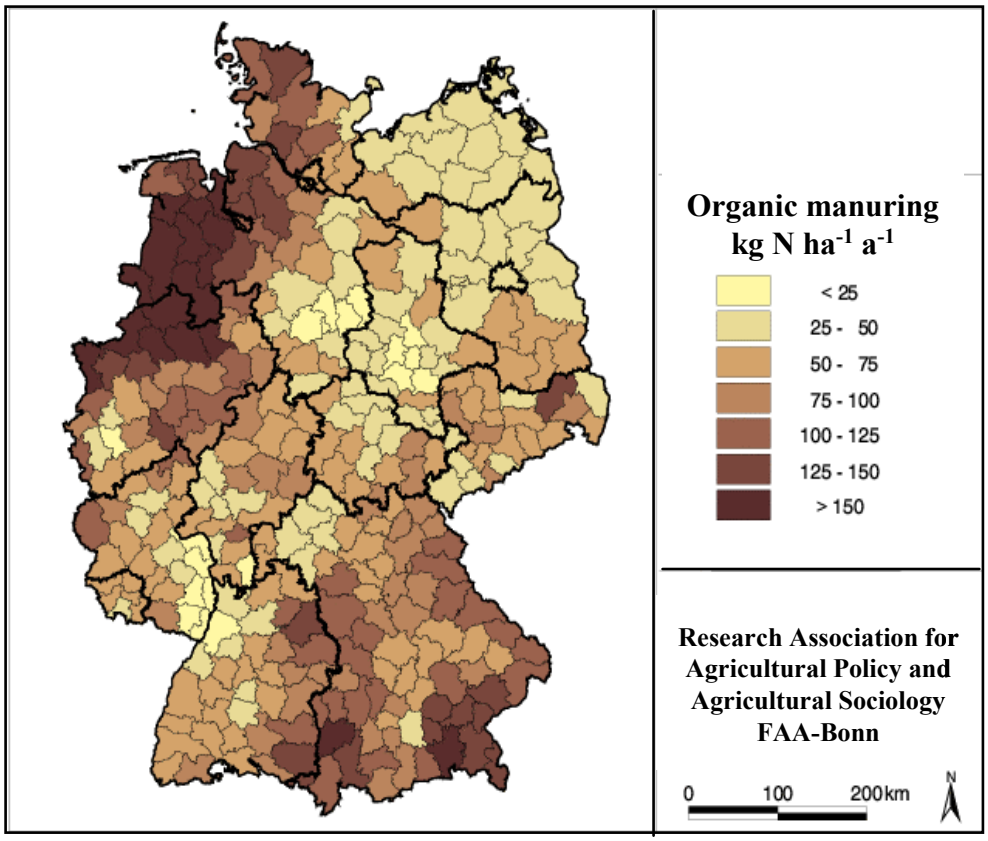


Source: RAUMIS calculation, FAA-Bonn.

The by far highest N-surplus was ascertained in the district of Vechta with 208 kg N, Borken with 165 kg N, Grafschaft Bentheim with 164 kg N and the district of Coesfeld with 157 kg N per ha AA. Notably is the relative geographical vicinity of these regions to each other.

In many cases a high N-surplus is linked with a high exertion of organic fertilizer (Nicklis 1991, Köster 1992, Brouwer et al. 1995, Weingarten 1996). To illustrate this correlation Figure 5 shows the amount of nitrogen in kg per ha agricultural land being spread out in terms of organic fertilizer.

Figure 5 **Organic manuring on AA on district level in 1999 (kg N per ha)**

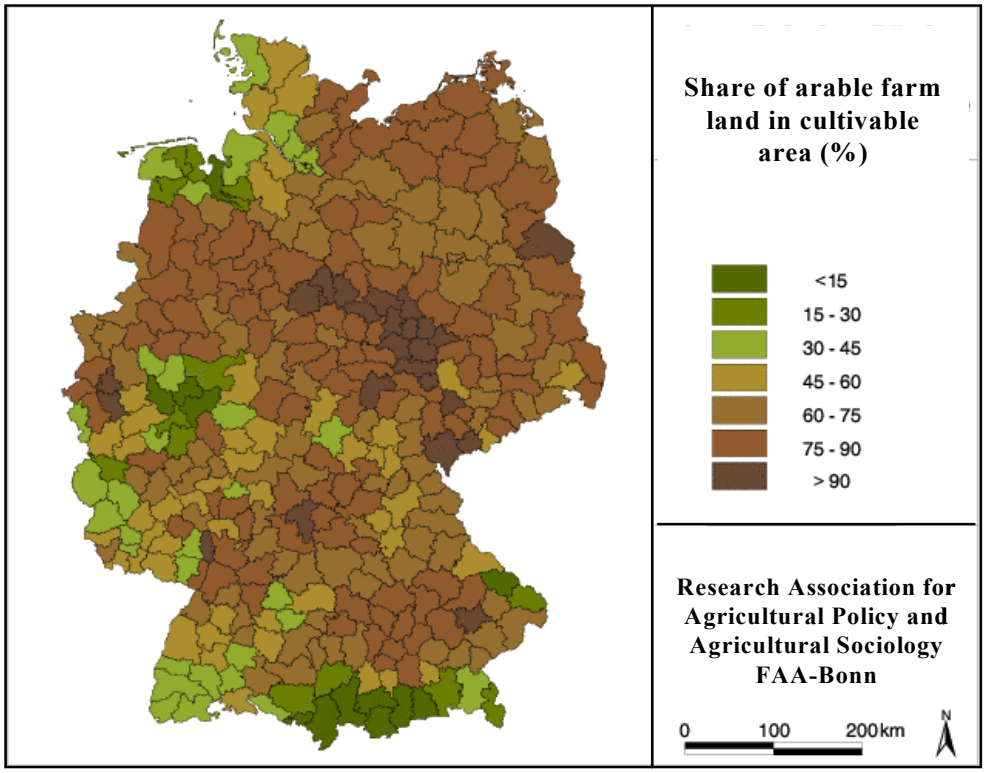


Source: RAUMIS calculation, FAA-Bonn.

At this it becomes clear that in wide regions of Schleswig-Holstein, Lower Saxony, North Rhine - Westphalia and Bavaria more than 120 kg organic nitrogen per ha agricultural area have been spread out. Regions with an extremely high N-balance (Vechta, Cloppenburg, Borken, Grafschaft Bentheim, Coesfeld) show a share of more than 170 kg organic nitrogen per ha agriculture area throughout.

Against the background of present law the above mentioned circumstance has to be assessed as problematic because in the German regulation of fertilizers the spreading out of organic nitrogen on arable farm land is limited to 170 kg N per ha and on meadow or pasture to 210 kg N per ha and year. The above identified regions evince a share of more than 60 per cent respectively more than 80 per cent of arable farm land in total agricultural land (cp. Figure 6) which aggravates the problem.

Figure 6 Share of arable farm land in AA on district level in 1999 (in %)



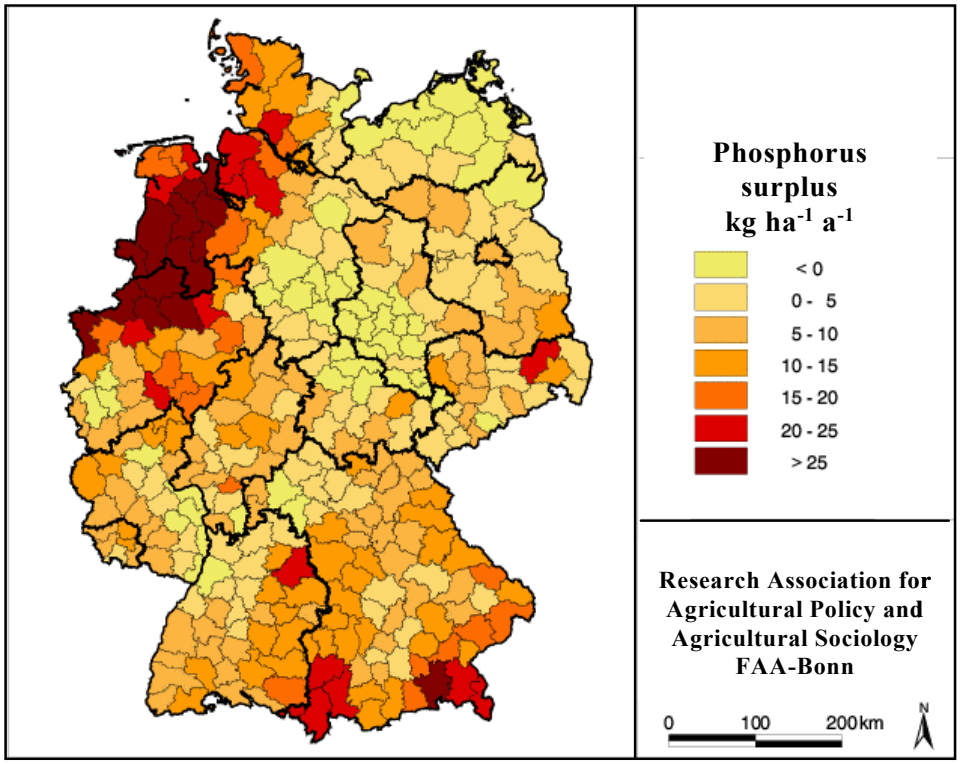
Source: RAUMIS calculation, FAA-Bonn.

3.2 Phosphorus

According to Bach et al. (1997) the surplus of phosphorus on agricultural area in Germany has increased till 1980 and then has constantly decreased till 1995. In 1999 almost 14 per cent of the 326 investigated districts show a negative balance (cp. Figure 7). Most conspicuously becomes this fact in the area Wolfenbüttel with about – 8 kg P per ha. Phosphorus surplus of more than 20 kg P per ha agricultural area is identified above all in wide regions of Lower Saxony, North Rhine - Westphalia and Bavaria. Regarding regions with maximum balance there can be listed parallels with previous nitrogen data; the districts Vechta (70 kg P per ha), Cloppenburg (51 kg P per ha), Grafschaft Bentheim and Borken (both 37 kg P per ha) and in addition Coesfeld (31 kg P per ha) have to be pointed out.

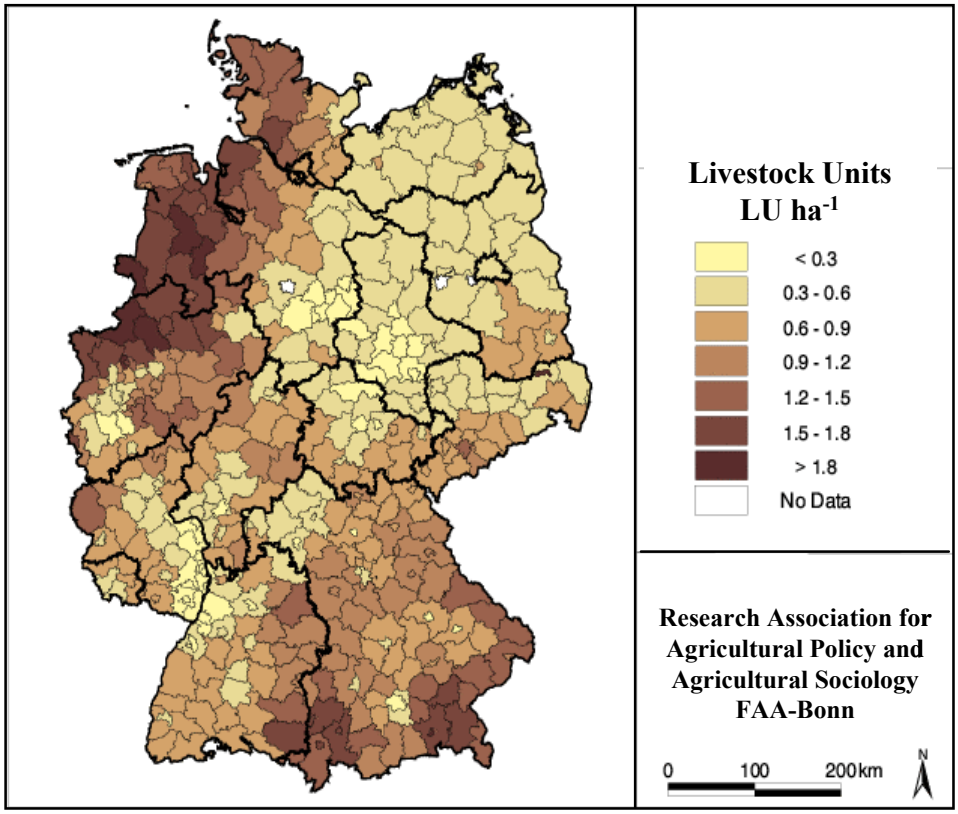
Referring to data of the BMVEL (BML 1996) land belonging to farms with intensive animal production shows a very high supply of phosphorus. Additive fertilizing – as a rule - doesn't induce yields to rise. To maintain a closed internal nutrient circuit the German fertilizer regulation recommends to supply the phosphorus demand measured as uptake by plants and removal during crop by organic fertilizer but to avoid a further accumulation of P in soil (BML 1996).

Figure 7 Surplus of phosphorus on district level in 1999 (in kg P per ha AA)



Source: RAUMIS calculation, FAA-Bonn.

Figure 8 Livestock units on district level in 1999 (in LU per ha AA)



Source: RAUMIS calculation, FAA-Bonn.

Against this background for estimation of environmental effects caused by agriculture it seems to be interesting to compare the balance of phosphorus with the number of livestock units on district level (Figure 7 and Figure 8) which reveals the close relationships. In this respect the districts Vechta, Cloppenburg, Grafschaft Bentheim, Borken and Unterallgäu attract special attention.

4 Impacts of alternative agricultural policy measures on nutrient surplus reductions and corresponding costs of reduction

In order to reduce the actual nutrient surpluses on agricultural area (cp. Figure 4) various measures that directly or indirectly influence balance surplus level are conceivable and are discussed currently. Thereby it has to be taken into account, that specific measures have specific reduction potentials and are connected with specific costs. In the following, effects of alternative policy measures in comparison to a reference scenario will be analysed whereas the focus lies upon the nutrient nitrogen.

4.1 Scenarios

4.1.1 Scenario of reference - Agenda 2000

The scenario of reference - calculated for the target year 2010 - bases on the Common Agricultural Policy (CAP) of the European Union till 2006 determined within the Agenda 2000 and on trend extrapolations of the database of the model system RAUMIS which goes back to the year 1979 for the old federal states of Germany. The coming reduction of milk prices at 15 per cent and the introduction of milk bounties are as taken into account as the expansion of milk quota of 1.5 per cent. The compensatory payments for less favoured areas of 300 Million € annual are kept constantly, flanking measures of 600 Million € annual are neglected. It is assumed that current environmental regulations are enforced as in 1999, the most actual base year of RAUMIS.

Within this study it is necessary to select a bunch of measures subject to a feasible implementation. Against this background and in order to generate comparable results, the project partners agreed to examine the following scenarios for the target year 2010:

4.1.2 Reform proposals of the European Commission within the framework of the Agenda 2000 Midterm Review

The investigated MTR scenario bases on amended reform proposals of the European Commission as of January 2003 and includes changes of market regulations as well as modulation and decoupling of direct payments. Hence, the scenario deviates from the MTR regulations adopted by the council of ministers in June 2003 and is specified as follows: The cereal intervention price is reduced by 5% to 95.35 EUR/t, and intervention for rye is abolished. Direct payments for cereal, oilseed and set-aside area are increased by 3 EUR/t to 66 EUR/t of reference yield. The set aside system is replaced by an obligatory 10-year permanent pasture of 10% of the concerned agricultural area. Cropping energy crops on this area is not permitted. Pulses and energy crops on non-set-aside area receive an integrative additional bonus of 55.57 EUR/ha respectively 45 EUR/ha. The amount of hectare premiums

and animal bounties that were paid within a reference period are pooled into an uniform direct payment per hectare eligible agricultural area and are thus decoupled from production. In this context it has to be annotated that a designated “cross compliance” – arrangement has not been taken into consideration due uncertainties with regard to concrete modalities of implementation and control in the future.

4.1.3 Constraint of livestock density

Livestock density on farms will be reduced to 1.5 respectively 1.0 livestock units LU per hectare AA. It has to be pointed out that RAUMIS models this restriction on district level only, because the district is its smallest spatial unit differentiable. All kind of livestock is taken into consideration.

4.1.4 Tax on mineral nitrogen

In this scenario a tax on the price of mineral fertiliser of 100 respectively 200 per cent will be raise. The tax revenues will be reimbursed to farmers through a federal wide consistent direct payment per hectare agricultural area.

4.1.5 Regional differentiated restriction of nitrogen surplus

Depending on regional livestock density – whereas all kind of livestock will be taken into account - the following restrictions of maximal permitted nitrogen surplus per ha agricultural area will be formulated:

- maximum 40 kg N/ha in regions with 0 - < 0.5 livestock units per ha
- maximum 60 kg N/ha in regions with 0.5 - < 1.5 livestock units per ha
- maximum 80 kg N/ha in regions with 1.5 and more livestock units per ha

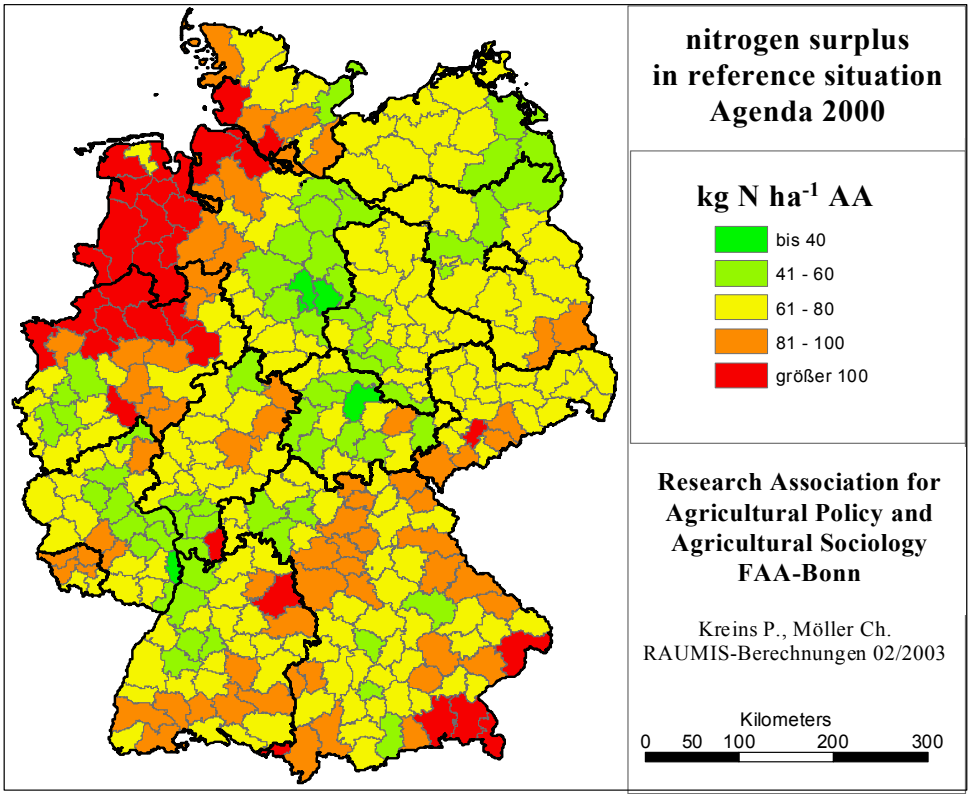
Within this scenario it is assumed that nitrogen balances compiled by farmers have a less substantial structure, i.e. as balance positions only mineral and organic fertilizer (input factors) and N-uptake by plants/N-removed during crop (output factor) appear. For this reason, RAUMIS considers the less complex “farm balance” to accomplish the given restrictions. Anyway, final calculating of balances proceeds as normal.

4.2 Results

4.2.1 Results for nutrient field balance surplus

Under the assumed circumstances of reference scenario till 2010 the average German nitrogen balance will hardly change (Figure 9) and can be calculated at 77 kg N per ha agricultural area (Table 1). An entirely decoupling of direct payments and animal bounties of production within the framework of the MTR proposals does not have any significant effects on N-balances on the whole agricultural area Figure 10.

Figure 9 **Nitrogen balance surplus in reference situation «Agenda 2000 » in target year 2010 in kg N/ha AA**



Source: RAUMIS calculation, FAA-Bonn.

Table 1: Nitrogen balance of the German agricultural sector and three selected regions in 2010 (in kg N per ha agricultural area)

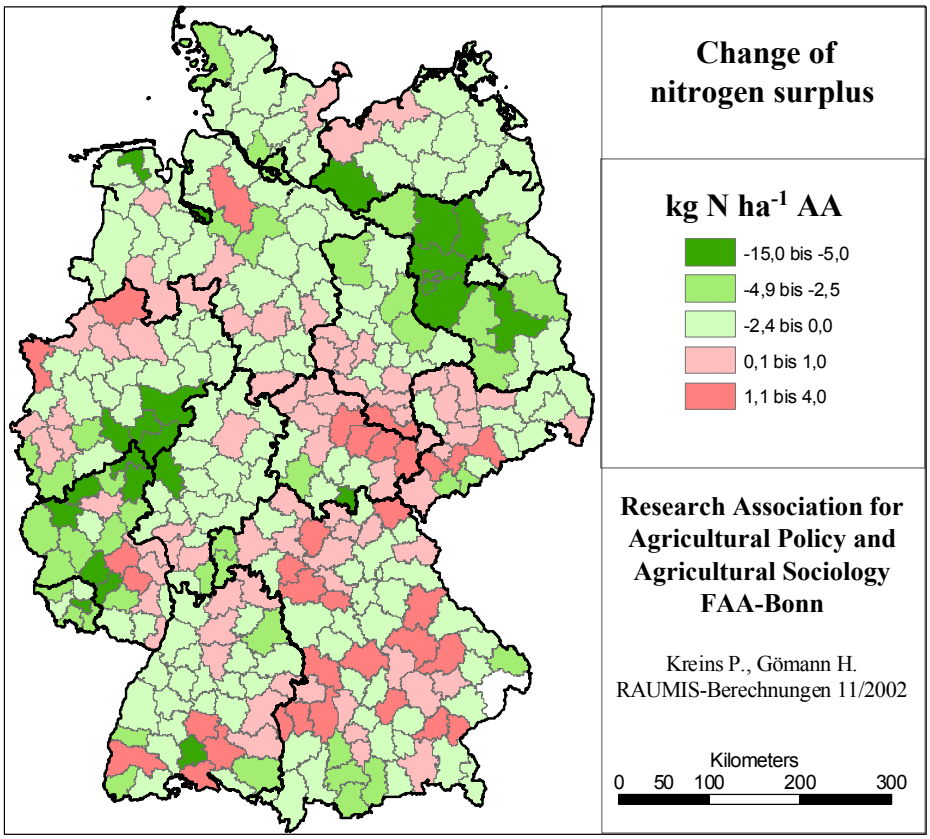
	Refe-rence	MTR	Livestock Restriction		N-Tax		Surplus Reduction
			1.0 LU	1.5 LU	100%	200%	40-60-80
Germany							
Supply of mineral fertilizer	116	112	116	117	91	69	110
Supply of organic fertilizer	79	77	63	73	79	79	64
Other N-Supply	35	37	35	35	36	37	35
Supply overall	230	226	214	225	206	185	209
N-Demand	129	125	126	129	123	114	123
Loss of Ammonia	24	23	18	22	22	24	20
N-Balance	77	78	70	74	61	47	66
N-Surplus in three selected regions							
Vechta (Livestock farming)	219	220	95	112	135	176	81
Bergheim (Crop farming)	43	45	43	43	26	13	43
Daun (Grassland)	68	63	68	68	60	56	66

Source: RAUMIS-Calculations, FAA Bonn, 2003.

Restricting livestock concentration at 1.5 livestock units (LU) per ha agricultural area (1.0 LU per ha) induces little decrease of N – balance to 74 kg N per ha (70 kg N per ha) on national

level, though this instrument – as well as the nitrogen surplus restriction scenario (cp. Figure 13) - takes purposeful effect in regions showing high livestock concentration and N - surpluses in the initial situation Figure 11.

Figure 10 "MTR-Scenario 2010": Change of nitrogen balance surplus compared to "Agenda 2000-Scenario" in kg N/ha AA



Source: RAUMIS calculation, FAA-Bonn.

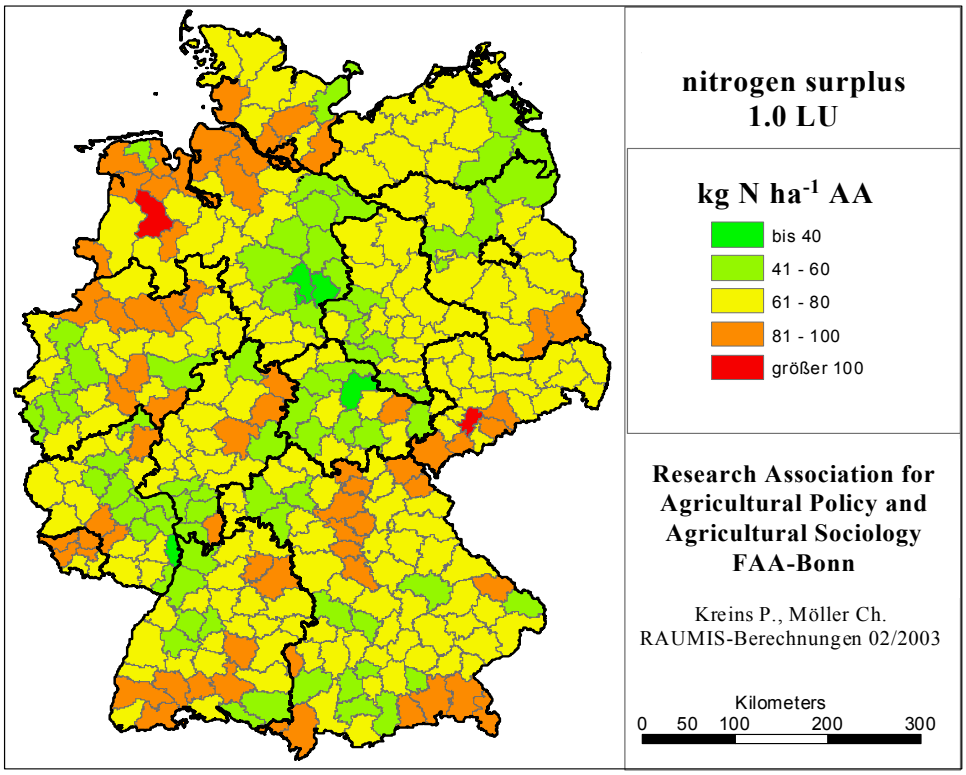
In Vechta, the area with the highest N – balance in reference situation, the N – surplus will decline from 219 to, in fact, 81 kg N per ha agricultural area due to surplus restriction scenario. The examined tax on mineral fertilizer results in a higher reduction of average surplus on sectoral level (cp. Figure 12) though this intervention is only weakly correlated with the environmental problem. Thus, at regional scale this instrument induces only insufficent effects in problematic regions which are characterized by high livestock density. Sure N-balance decreases due to nitrogen tax of 100 per cent for example in Vechta by 24 kg N per ha agricultural land – on the other hand the N-balance drops by 17 kg N per ha in Bergheim which is exemplary for a favourable crop farming region located in the "Köln-Aachener Bucht". The remaining stress potential in Vechta indeed still amounts to more than seven times as much opposed to Bergheim in the reference situation 2010.

Contrary to surpluses in the regions Vechta and Bergheim, nitrogen values in typical grassland region Daun – located in low mountain range Eifel – are affected to a much lesser extent by the examined measures.

4.2.2 Results for costs

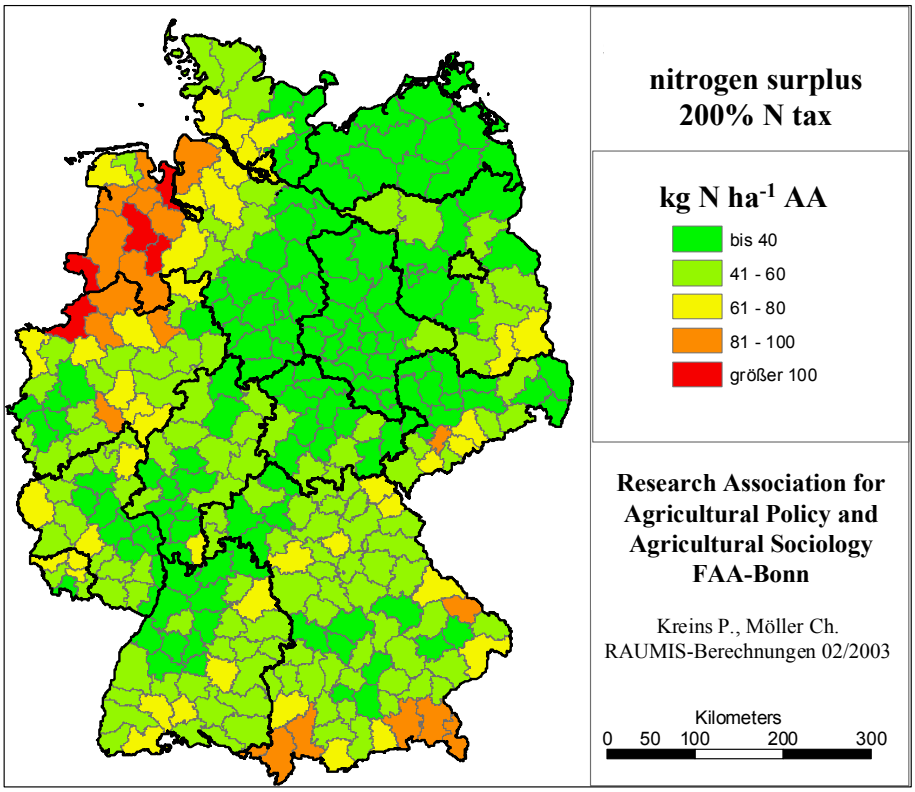
The effects due to different scenarios on agricultural income as measured by changes of Net Agricultural Value Added (NAV) opposed to the reference scenario vary considerably (cp. Table 2). Without direct payments the constraint of livestock density reduces NAV on sectoral level by one per cent. Indeed, the decline of income only affects a part of farms. In the refinement region of Vechta the agricultural income decreases by 46 per cent (LU 1.0) respectively 42 per cent (1.5 LU). However, by far the highest deficit appears in case of the surplus restriction scenario (-55 per cent). The examined nitrogen tax is - without consideration of transaction costs - budget neutral, but results in income losses for German agriculture up to 2 (100 %) respectively 5 per cent (200 %) whereas arable farming regions like Bergheim are mostly concerned.

Figure 11 "Scenario 1.0 LU/ha 2010": Nitrogen balance surplus in kg N/ha AA



Source: RAUMIS calculation, FAA-Bonn.

Figure 12 „Scenario 200 % N-tax 2010“: Nitrogen balance surplus in kg N/ha AA



Source: RAUMIS calculation, FAA-Bonn.

Table 2: Change of agricultural income (NAV) due to the examined measures of water pollution control in Germany and in three selected regions in 2010

	Bill. €	Percentage change vis-a-vis reference				
	Refe-rence	MTR	max. LU		N – tax		Surplus Restriction
			1.0 LU	1.5 LU	100%	200%	40-60-80
Germany	11.481	-3	-1	-1	-2	-5	-2
Vechta (Refinement)	0.13	-	-46	-42	1	1	-55
Bergheim (Arable farming)	0.048	-1	-	-	-7	-13	-
Daun (Grassland)	0.012	4	-1	-1	2	-1	-
Change of agricultural income in €/kg N reduction vis-a-vis reference							
Germany[1)]	-	-	-1.2	-2	-0.8	-1.2	-1.3
Vechta (Livestock farming) [1)]	-	-	-7.7	-8.2	0.9	0.4	-8.3
Bergheim (Arable farming)	-	-	-	-	-2.5	-3.1	-
Daun (Grassland)	-	-	-	-	0.9	-0.4	-

Note: [1)] Several reasons for the fact that the calculated average costs per kg N reduction due to a constraint at one LU per ha are lower than due to a constraint at 1.5 LU per ha can be accounted. One reason is that not the N surplus per ha is restricted but the density of livestock. Another reason is that complex adjustment reactions within one region respectively different adjustments within the regions can lead to a more cost - efficient reduction per kg N surplus.

Source: RAUMIS-Calculations, FAA Bonn, 2003.

Referring to the overall reduction of nitrogen surplus of 48 respectively 126 kt nitrogen on 16.5 Million ha due to the constraint of livestock concentration in sectoral average the decrease of agricultural income – measured by NAV at factor costs – amounts to 2.0 respectively 1.2 € per reduced kg nitrogen. Hereby a long term announced introduction of the constraint is assumed so farmers have the possibility to attune their investment planning adequately. In other respects the average income reduction – measured by Gross Added Value (GAV) at factor costs – is a multiple higher (9.4 respectively 8.0 € per reduced kg nitrogen). In intensive livestock farming regions like Vechta, agricultural income declines at average 8.2 € (NAV) respectively 14.3 € (GAV) per kg nitrogen surplus reduction.
The introduction of a tax on mineral fertilizer (100/200%) results in a 276 respectively 497 kt lower nitrogen surplus in Germany whereas sectoral NAV decreases by 0.8 respectively 1.2 € per kg nitrogen on average. This contemplation does not include transaction costs accumulating for implementation and control.

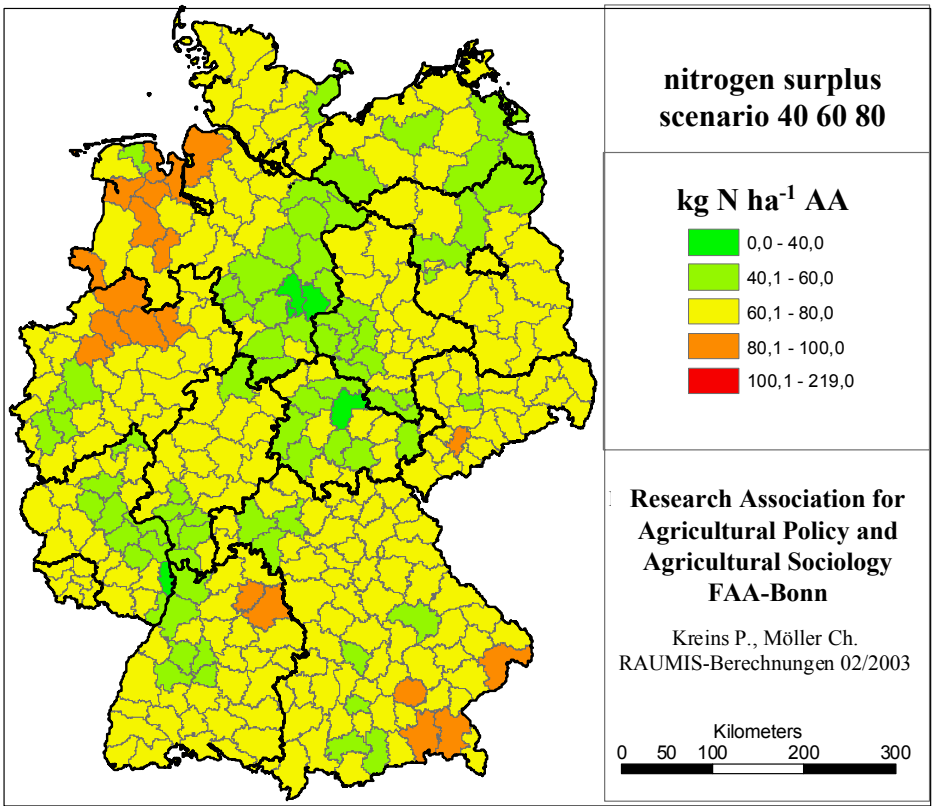


Figure 13 "Scenario 40 60 80 in 2010": Nitrogen balance surplus in kg N/ha AA
Source: RAUMIS calculation, FAA-Bonn.

4.2.3 Results for water leaving soil

How meaningful are the above condensed results with respect to water pollution control?

Considering the concept of designation nitrogen balance as environmental "pressure - indicator"[3] to picture the potential water pollution on basis of the performed data (Figure 9) there can be established a priority list of risk regions. However, it is possible that the rating does not match the real environmental state. In order to illustrate an eventual discrepancy between "pressure-"and "state – indicators" in this report only a raw example shall be given.
Figure 14 displays the regional hypothetical nitrate concentration in water leaving soil as a "state indicator" which takes the groundwater renewal rate into account as well as denitrification rate assumed to be regional constant at 50 per cent of N-surplus which is the measured value in hard rock regions. As a result the new federal states – beneath the Weser–Ems district - appear as problematic regions even though the "pressure - indicator" nitrogen surplus depicted in Figure 9 does not reveal that tendency. Due to low groundwater renewal rates in eastern Germany the hypothetical nitrogen concentration in water leaving soil is higher compared to the Weser-Ems district. However, in eastern Germany the rate of de-nitrification exceeds the federal average. A forthcoming scenario will be calculated with 90%. Further reasons lie in the surpassing long time from accruement of nitrogen surplus till its entry into groundwater[4]. Furthermore it has to be noted that particularly in the northern flat country of Germany an extensive degradation of nitrate in groundwater takes place. Hence, high nitrogen surplus due to agriculture leads to relatively little groundwater borne nitrate entries into surface water[5]. In the context of nutrient entries into North – and Baltic Sea this fact is of importance.
Examined measures of water pollution control show different effects in single problem regions. While a constraint of livestock density is able to reduce the hypothetical nitrate concentration in the Weser–Ems region perceptible, effects in north – eastern districts are negligible. Reverse successions shows the introduction of a nitrogen – tax: hereby the potential nitrate stress in Mecklenburg – Western Pomerania and Brandenburg is perspicuously deactivated. However, for the intensive livestock farming region Weser – Ems the impact is small.
The ascertained hypothetical nitrate concentration in water leaving soil points at the fact that in regions with a little nitrogen surplus per hectare agricultural area environmental pressure can exist, too, if the groundwater renewal rate is low.

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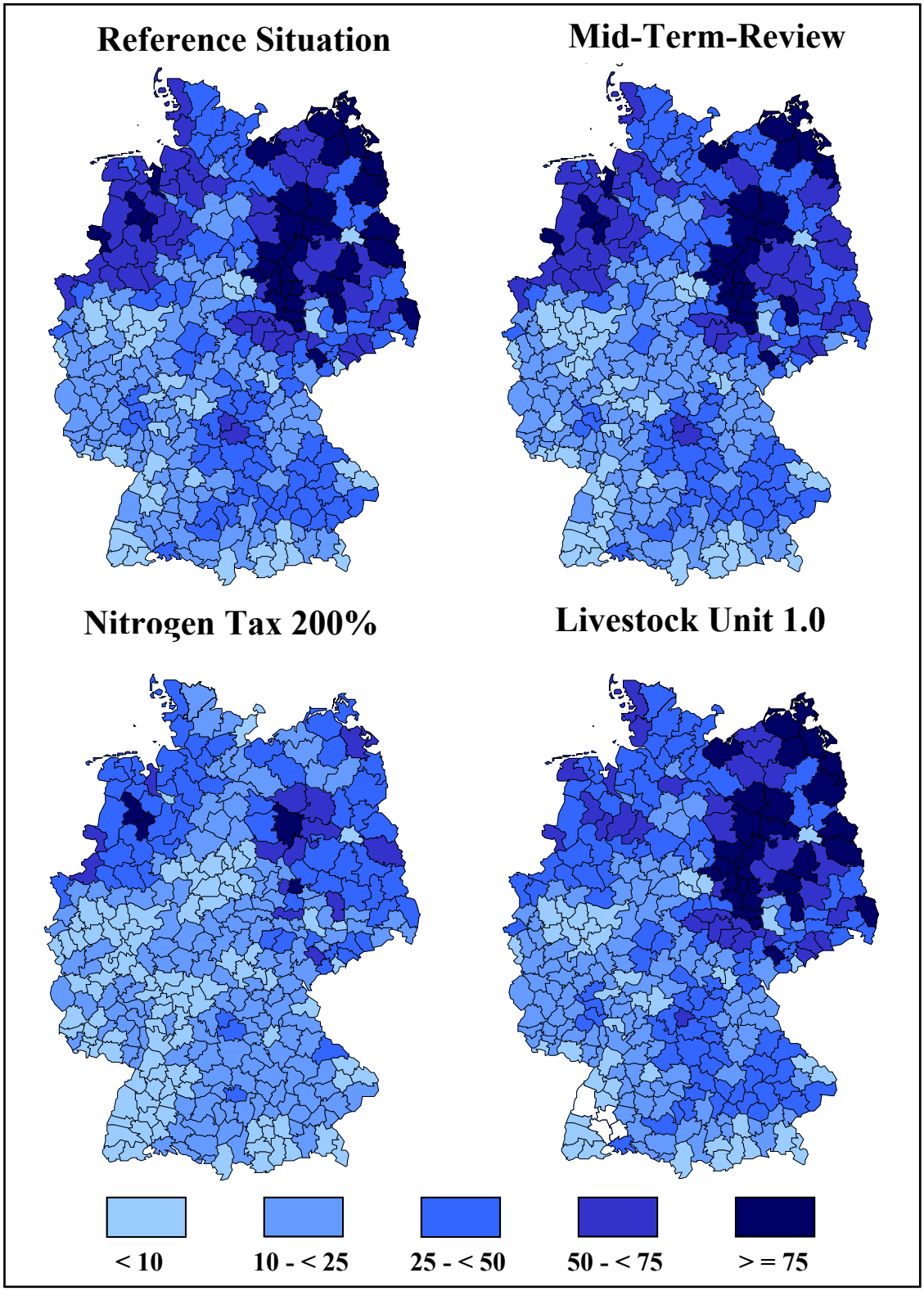
[3] According to the OECD – classification of environmental indicators into "pressure-", "state-" and "response-indicators".

[4] Kunkel, R. / Wendland, F.: Analyse von Wasserhaushalt, Verweilzeiten und Grundwassermilieu im Flußeinzugsgebiet der Elbe. Jülich, 1998.

[5] Kunkel, R. / Bach, M. / Behrend, H. / Wendland, F.: Groundwater – Borne nitrate intakes into surface waters in Germany. – 6th international conference on diffuse pollution. Amsterdam 2002, 30.09. – 04.10. In Press.

Figure 14 **Hypothetical nitrate concentration in new formed groundwater due to examined scenarios (in mg NO3/l); Note: De – nitrification rate 50 %**



Source: RAUMIS calculation, FAA-Bonn.

5 Conclusions

As mentioned above, the model system RAUMIS was developed as an instrument in the field of policy advice. Against this background, the question becomes evident how to achieve a reasonable disposal of modelling results in the range of agri-environmental consulting. Here shall be referred to preceding considerations where it already was suggested additional specific information-bricks – stated as the following questions - are relevant:

Which nitrogen concentrations in single water bodies are exactly desired by society, i.e. which nitrogen concentrations entail the greatest (quantitative) benefits?

By means of which modalities can the desired state indicators "nitrogen concentrations in water bodies" be transformed into the correspondent pressure indicators "nitrogen field balances" according to natural coherences depending on site-related factors?

Answering these questions is necessary in respect of defining adequate policy measures basing on balanced cost-benefit relations.

It becomes clear, that the attained modelling results only attend a fragment of the information requirements. Consequentially, solely on its foundation a scientifically based recommendation cannot approve a bunch of measures but has to strongly allude to the existing deficits in literature in terms of area-wide information concerning quantified benefits of water pollution control as well as the relationship between nitrogen field balances and nitrogen concentration in connected water bodies. A firm integration of water pollution control into agricultural policy demands further research activities.

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6 Annex: Executive summaries of the final reports of allocated research assignments

6.1 Medium Term Changes of Nitrate Balances for EU 15 under different CAP policy options

Institute for Agricultural Policy, Market Research and Economic Sociology of Bonn University (IAP);
Ignacio Perez and Dr. Wolfgang Britz

Nitrate balances at the Medium Term are influenced by the interplay of technological development – yields, machinery, management – with markets and policy, which are in the context of the study analysed with the CAPRI modelling system[6]. A three-year average around 2000 is chosen as the base year, since it is the most recent period for which all necessary statistical data are available. The reference scenario captures the so-called 'Agenda 2000' policy package, whereas the so-called 'CAP Reform scenario' captures the effect of so-called "full-decoupling" option of the Agricultural Council decision from June 2003.

In the *reference scenario* **cereal** production increases by 7.8%, almost exclusively due to yield increases as hectares stay almost stable. A different situation can be observed for **oilseeds** with yield increases around 12%, but a drop in area by -4.6% as the former higher premiums for oilseeds are now lined up with the cereal premium group (63 € per ton of historical yield). For most other crops, there a similar pattern with output increases due to technical progress but little change in areas. Higher crop production increases the export of nitrogen by harvested material (+3.5%, see table below). Assumed continuation of past trends of increased efficiency in anorganic and organic fertilizer use – around +1% per year in most Member States in the period 1985-2001 -, lets anorganic fertilizer input drop by about -4.6% despite higher crop needs. Nitrogen output at tail from all herds increases slightly by around +1.0%, the effect of higher meat production (+5.5%), mostly pork and poultry, and a slight increase in milk production (+2.4%) as quotas are expanded.

Ammonia losses do not change drastically. Reduced anorganic fertilizer input clearly lets ammonia losses drop, whereas shifts in herd composition in combination with somewhat higher manure output increase losses from organic fertilizer by around +1.2%. Overall, the increase fertilizer use efficiency reduces the surplus at soil level (after ammonia losses had been deducted) by around -7.55% at EU level, or from an average 56 kg/ha to around 48.4 kg/ha, in line with past trends.

[6] Heckelei T., Britz, W. (1999): Maximum Entropy Specification of PMP and CAPRI. CAPRI Working Papers 99/08, University of Bonn

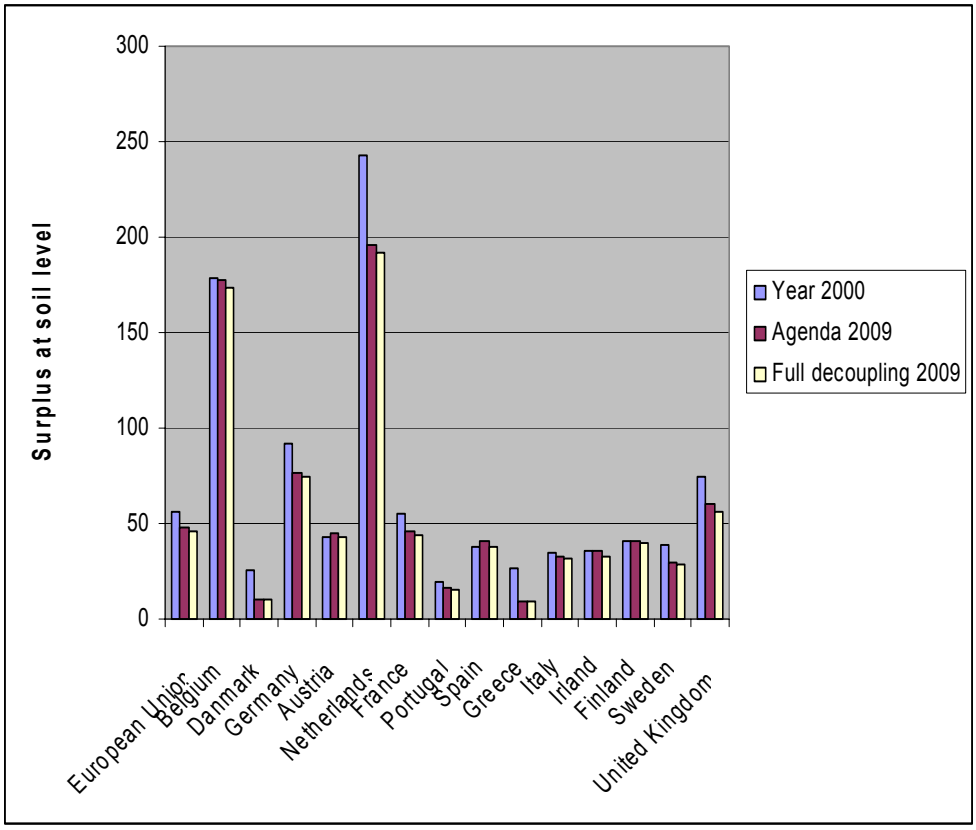
Nutrient Balances for the EU, 'Agenda 2000' and 'CAP Reform 2003' scenarios

Region : European Union	Base year [2000]		Agenda reference run [2009] **difference to : Base year [2000]**		CAP July 2003, full decoupling **difference to : Agenda reference run [2009]**	
	Total	Per ha	Total	Per ha	Total	Per ha
Export with harvest 1000 t or kg/ha N	8515.53	63.07	9020.81 505.28	66.58 3.51	8755.13 -265.68	64.61 -1.97
Import by anorganic fertilizer 1000 t or kg/ha N	9478.24	70.20	8885.03 -593.21	65.57 -4.63	8594.12 -290.91	63.43 -2.14
Import by manure 1000 t or kg/ha N	7844.31	58.10	8005.99 161.68	59.09 0.99	7621.93 -384.06	56.25 -2.84
Biological fixation 1000 t or kg/ha N	241.58	1.79	212.09 -29.49	1.57 -0.22	222.38 19.29	1.64 0.07
Atmospheric deposition 1000 t or kg/ha N	1930.57	14.30	1937.18 6.61	14.30 0.00	1937.18 0.00	14.30 0.00
Ammonia loss organic fertilizer 1000 t or kg/ha N	2033.24	15.06	2086.68 53.44	15.40 0.34	2005.46 -81.22	14.80 -0.60
Ammonia loss anorganic fertilizer 1000 t or kg/ha N	400.50	2.97	380.70 -19.80	2.81 -0.16	368.45 -12.25	2.72 -0.09
Ammonia loss from soil 1000 t or kg/ha N	993.88	7.36	996.58 2.70	7.35 -0.01	978.56 -18.02	7.22 -0.13
Surplus (without ammonia losses) 1000 t or kg/ha N	7551.55	55.93	6555.52 -996.03	48.38 -7.55	6268.01 -287.51	46.26 -2.12

Source: CAPRI Modelling System

As well known, higher nutrient surpluses are located in the BENELUX, with other hot spots in Northern Germany and the Po plane in Italy. The reference run shows a decline in all Member Sates from 2000 to 2009 (See table 2, Agenda 2009), with the Netherlands showing the highest absolute reduction. In Denmark and The Netherlands, the high rates of increased efficiency of fertilizer use are certainly due to rather strict Nitrate policies. It should be mentioned that manure is not tradable in the model beyond NUTS II level and that options as manure pelleting etc. are not modelled, partially overestimating the pressure at least in the Netherlands.

- **Nutrient Surplus in different countries in the reference run**



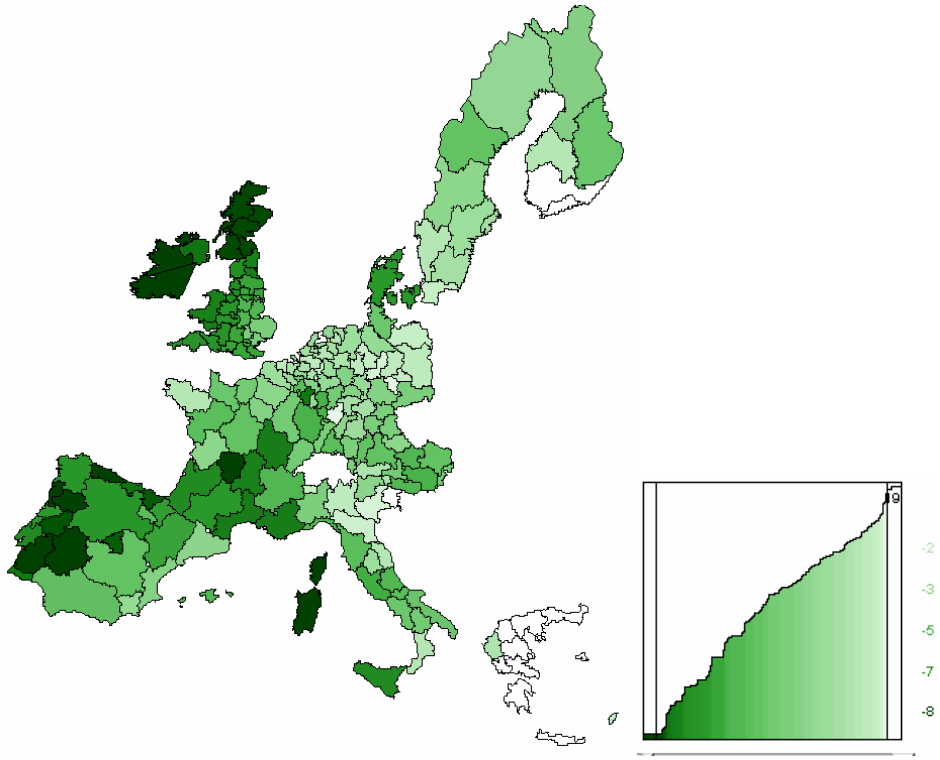
Compared to effect of technical progress, the influence of the decided upon **changes in the Common Agricultural Policy** are far **less important,** as seen already from the table above. The reform package from June 2003 gives Member States some room how the former coupled premium schemes under "Agenda 2000" will be mapped into payments less coupled to production. The policy scenario discussed in the following assumes that Member States will de-couple as far as possible, showing consequently the possibly strongest effect of any implementation option. The actual policy implemented in 2009 will most probably be a mix of the two modes of implementation of payment schemes presented, but little is known currently regarding actual implementation of the June 2003 reform at Member State level.

Full de-coupling in the sense of the new legislation would spread the premiums for certain crops and cattle equally across hectares (with some exemptions as table potatoes, sugar beet, fruits and vegetables), reducing the comparative advantage of cereals, oilseeds and pulses and, in certain Member States, of fodder maize. Accordingly, alternative crops including fallow land (+9.3%) are extended, and the number of cattle reduced (-7.7%). The effect is especially pronounced where part of the premiums had to be used under Agenda 2000 to cover production costs, as in marginal areas for cereals and oilseeds, and more generally, for suckler cows (-17% at EU level).

Crop needs for nitrate (-2%) and manure output (-2.8%) drop slightly, allowing for a reduction of anorganic fertilizer as well (-2.1%). The overall effect on the nitrate surplus at soil level is minor with –2.1% (see map below), but reduces pressure in almost all regions.

Small exemptions are found in Greece in Southern Finland are in regions with a very low surplus to start with. Not surprisingly, the effect in the hot spots as the Netherlands is below average in relative terms. First of all, a higher part of the pressure stems from pig production which is not receiving premiums and is hence only indirectly affected by somewhat higher cereal prices. Secondly, more drastic changes in the crop rotations would occur in marginal areas where the nitrate surplus is generally lower due to low intensity in production.

- **Change in nitrate surplus, June 2003 CAP reform with full decoupling compared to Agenda 2000**



Since the 1992 McSharry reform, payments are formally linked to cross-comply with environmental standards as the Nitrate directive. The new legislation enforces that link, and there is ample room to do so, so that positive effects on nitrate leaching beyond the ones discussed in here cannot be excluded.

6.2 The agrarian determined nutrimental water pollution in the Netherlands – analysis and evaluation of reduction measures

Agricultural Economics Research Institute (LEI), Den Haag; John Helming and Kees Jan Wolswinkel

6.2.1 Introduction

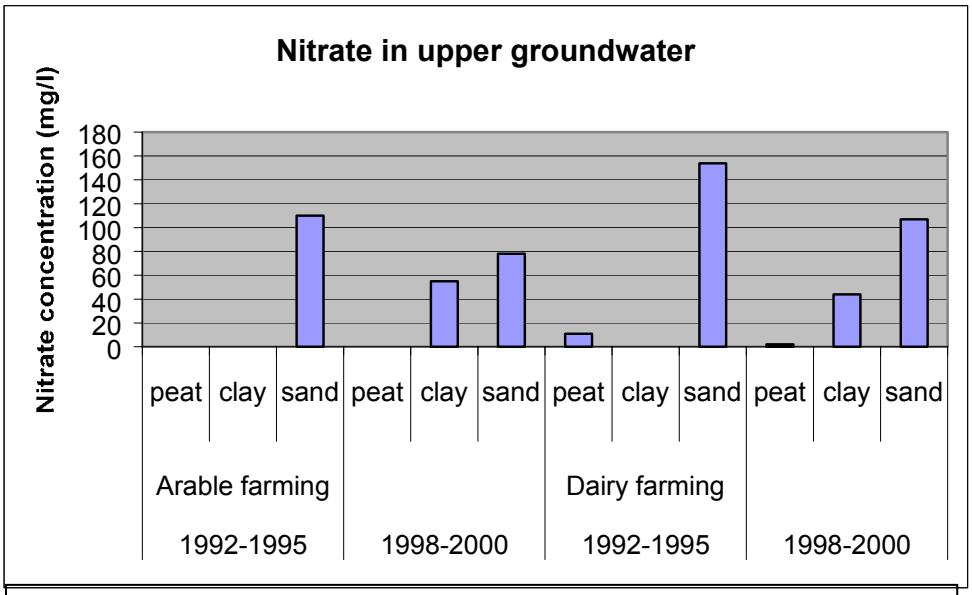
The concentration of nitrate and phosphate in ground and surface waters is a main problem in today's intensive agriculture. Despite considerable efforts, the Dutch Farmers produce more manure than they have land on which to deposit it, according to environmental standards. Since the 1980s the Dutch administration has introduced different policies to combat the

problem of nutrient surpluses. The first measures were aimed at minimizing the negative effects of these surpluses. The paper analyses the most important current Dutch policy plans.

6.2.2 Concentration of nitrate and phosphate in groundwater and surface water

Concentration of nitrate and phosphate is different in ground and surface waters. In ground water, nitrogen that is left in the ground after the production period will leach in autumn and winter, largely in the form of nitrate. In the upper ground, but also during nitrate transport through the ground, nitrate can be decomposed into nitric oxide, nitrous oxide and dinitrogen.
In general, Dutch agriculture regions (soil types) can be divided as follows: Sand regions, Clay regions, Peat regions, and Loess regions (less important than the other types). The average nitrate concentration in the upper groundwater under agriculture cultivation is the highest in sand regions and the lowest in peat regions. In sand regions the nitrate concentration in the upper ground water produced by arable farmers is lower compared to dairy farmers. The nitrate concentration in loess regions are more or less the same as in sand regions. In clay regions the nitrate concentrations are the highest by arable farming.
The nitrate concentrations are strongly dependent on the weather circumstances. In wet years the concentrations are on a lower level than in dry years.
The concentration also depends on the depth, too. You can say the concentration decrease with depth. In peat regions the concentration in groundwater is lower than in clay regions; in clay regions the concentration are lower than in Sand regions. This process is caused by a difference in the dentrification capacity from the different soil types.
The nutrients supply to the Dutch cultivated land has grown rapidly since World War II. This development was closely connected with the expansion of livestock (and a strong increase of feed import) and the increase of the use of fertilizer.

Figure 1: Nitrate in upper groundwater under agriculture (average per soil type, sector and period)



When no value of the nitrate concentration is given in the figure, there are no reliable data available for this item.

6.2.3 Analysis and evaluation of implemented measures to reduce nutrimental water pollution from agriculture

The Dutch nutrients policy mainly consists of the following three parts:

1. MINAS (nutrients accounting system): The Dutch administration has developed a system to reduce the manure surplus, called MINAS. Farmers have to keep an accurate record of nutrients inputs and outputs on their farm. The nutrients accounts for inputs and outputs of nutrients and animal products are based on given (fixed) standards per animal or product unit. The nutrients content of vegetable products and other crop yields are also given by standards per hectare. The levies are so high that it is more economical for a farmer to take measures to reduce the nutrients surplus than paying the levies (each year).

2. System of animal rights: The principle is uncomplicated; a farmer may not have more animals than animal rights. Another policy example is the measure 'Termination livestock farms'. The termination measure started at March 22 in 2000 and consisted of two elements: (1) those farmers who terminate their production can become a compensation for the manure production rights (initially given to farmers under the interim law 'Restriction Pig and Poultry farms') and (2) farmers in the so-called concentration areas of the intensive cattle breeding can become a compensation for the demolition of the vacant livestock stables. The evaluation of the measure will take place at the end of 2003. The reduction of the Dutch livestock clearly contributes to a significant decrease of the nutrients surplus.

3. Manure disposal contracts: Since 2002 a system of manure disposal contracts has started. The idea behind this system is to realize a more efficient distribution of manure: Livestock farms with no land (intensive livestock farms) dispose their manure to farmers who produce no manure (arable farms). In addition there are possibilities for manure export. The

contractual agreement for the disposal of manure is only necessary when the input of nitrogen (according to standard rates) measures more than 250 kg
Nitrogen / ha grassland or 170 kg / hectare arable and maize land. Chemical fertilizer does not account in the latter amounts.

6.2.4 Outlook

The nitrate concentration in groundwater depends not only on human activities but also on soil type, local hydrological conditions and sampling depths. The last decade average nitrate concentrations decreased, but in some areas not enough. Some problems are raised with the European Commission about the EU Nitrate Directive. At present the EuGH is concerned with this theme, a decision is expected for 2003.
The EU Water Framework directive came into force in October 2000.At this moment there are only concrete policies for the monitoring of surface water (not for groundwater). The EU Water Directive includes position- and trend monitoring, Operational monitoring, and Monitoring for further research and protected areas. It must be operational per 22/12/2006.
The Dutch nutrients policy currently consists mainly of three parts, namely the Nutrients accounting system (MINAS), system of animal rights and manure disposal contracts. Some problems are raised with the European Commission about the EU Nitrate Directive.
However, in general it can be said that farmers have a more economical nutrients management. The Dutch MINAS system works and is obligatory for all farmers since 2001.

6.3 The French Agenda against water pollution caused by agriculture

Institut Agronomique Méditerranéen de Montpellier (IAMM), Montpellier ; Dr. Guillermo Flichman

The Water pollution caused by agriculture is regardless a real problem in France. The French water policy derives from the 1964 law which is based on the following principles: integrated management by consultation off all parties concerned and application of the polluter-pays principle. In 1992 the water legislation was reviewed. Water is no longer regarded as a simple resource, but as a part of the nation's common heritage.

The objective of the paper on hand is to present the existing measures taken in France in order to reduce agrarian determined nutrimental water pollution.

The French State policy against water pollution caused by the agriculture can be divided into four categories:

The legal control of farm activities, notably by the Classified Installation Law of 1976 (CIEP).

Since 1976, cattle farms have to respect an anti pollution reglementation: for the small-sized farms, it's the Departmental Sanitary Reglement (DSR). The medium and large farms are subjected to the law relating to Classified Installation for Environment Protection (CIEP). In CIEP law, there are the declaration modality for medium-sized farm and the authorization modality for the largest ones. In fact, the difference between the reglementation is based on the pollution risk. The higher the cattle number is the harsher is the reglementation. The DSR is the minimal level of demanding defined by the Departmental prefect to eliminate at least the health hazard. The prescriptions are more or less intensive in function of the livestock size. The objective of this new reglementation is to have a better control of the human and environmental impact of the spreading by increasing the information's about spreaded matters.

Table 1: Reglementation in function of holding type and size

Animal Type	Departmental Sanitary Reglementation	CIEP Declaration	CIEP Authorization
Dairy cow	≤ 40	41 – 80	> 80
Beef cattle	≤ 50	51 – 200	> 200
Suckling cow	≤ 40	> 40	
Pig (ELU)*	≤ 50	51 – 450	> 450
Poultry (ELU)* (> 30 Days)	≤ 5000	5001 – 20 000	> 20 000
Rabbit (> 30 Days)	≤ 2000	2001 – 6 000	> 6 000
Horse, sheep	All		

* Equivalent Livestock Unit: notion introduced to deal with the diversity of animal types for each specie

In 1993 was the introduction of the Code of Good Agricultural Practices (CGAP). Based on individual and voluntary procedures, it deals with the pollution by the manure storage and spreading, the over-fertilization and the irrigation.

The code of good agricultural practices is based on a voluntary approach at the level of the national territory. Carried out in 1993, some of its prescriptions became obligatory since this date, notably in the most nitrogen sensitive areas. So CGAP and the application of the Nitrate Directive are closely linked.

The CGAP deals with the good management of manure storage and its spreading, with the good management of the land, notably the rational fertilization and with the good management of irrigation.

The third type of measures is the Agricultural Pollution Control Programme (APCP) whereas the first programme was set between 1993 and 2001 in order to apply the EU Nitrate Directive of 1991 with the definition of the vulnerable zones and action programmes. At the same time, France created the cattle farm taxation on the basis of the quality of manure collect, storage and spreading. The cattle farm taxation has been carried out from the first Agricultural Pollution Control Programme (1993) and has been reformed for the second programme (2001) to reinforce its links with the European Nitrate Directive objectives and to correct its financial modalities after an European critic. It is an inclusive taxation based on livestock size, nature and quality of organic pollution (manures, silo juices, liquid waste) collect and storage equipments and the fertilization management.

The actual APCP (2002-2006) reinforced the water pollution prevention of establishing harsher limitations of input quantities and other obligatory measures, notably in the most polluted zones.

The « Schéma Directeur d'Aménagement et de Gestion des Eaux » (a master plan for the planning and management of water – SDAGE), fixes the guidelines of this management. The SDAGE is a new obligatory management tool to control all human activities in the related

field, notably, the agricultural uses of water and its polluting activity. It is an application of the French Law, taking into account the local specificities of the water resources and their vulnerability.

The River Contract is another process to enhance integrated water management by users. It's a programme of actions for five years to answer to specific problems proper to one or several rivers.

The Sustainable Agriculture Contract (SAC)

Farmers, who want to do more than only to respect the environmental legislation, may subscribe SAC and obtain the qualification « reasoned agriculture »

The Natura 2000 Contract

The aim of the Natura 2000[7] network is to preserve the biological diversity of European natural environments, while taking into account the economical, social, cultural and regional demands made upon them. This is the reason why the network will operate on the basis of contracts with its users.

The CORPEN Actions

The CORPEN[8] was created in 1984 through a decision made by Agriculture and Environment Ministers.

The CORPEN is a multi-partner authority that elaborates all technical, scientific or methodological documents related to the orientations defined in thematic action programmes.

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[7] **"Natura 2000"** is a generic name that covers all the areas designated under the "Birds" and "Habitats" Directives

[8] CORPEN : orientation committee for the reduction of the nitrate pollution in the waters

Effects of water protection measures on the profitability of farms

Umweltforschungsplan
des Bundesministeriums für Umwelt,
Naturschutz und Reaktorsicherheit

Förderkennzeichen 201 24 222

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Mai 2004

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1 Abstract

The effect of different management measures on the nutrient losses from crop production and animal husbandry, in particular nitrogen, and on the total income of model farming enterprises was investigated. Such measures are considered as effective options for meeting the requirements of ”cross compliance” within the Agenda 2000 midterm review of the CAP.

Optimisation of the storage and handling of animal manure was shown to be the most important and cost effective measure to reduce nutrient losses on farms. Other measures such as protein and phosphorus adapted feeding, maintaining a year-round cover crop on arable land and conservation tillage were also effective and it is recommended that these are adopted into farming practices. In general, measures which both have a high potential to reduce nutrient losses and are cheap to apply, and therefore have little effect on the overall profitability of farms, should be given priority in water protection policies.

2 Introduction

Diffuse emissions are the main factor responsible for the pollution of surface and ground waters. Diffuse pollution caused by agriculture has become one of the major source of water pollution since extended wastewater treatment in Europe has taken place. Water pollution by agriculture is mainly caused by erosion of soil particles contaminated with phosphates and pesticides in surface waters and by leaching of nitrate in ground waters as a result of arable and grassland farming, in particular of the use of mineral fertilisers and animal manures. Despite the achieved progress in water pollution control over the last 20 years there is still a demand to further reduce diffuse water pollution.

The reduction of the diffuse pollution of water bodies by agricultural activities has become a major target of European environmental policies. Within the scope of the Common Agricultural Policy (CAP) since the reform in 1992 and the decisions of the agenda 2000 the integration of environmental objectives gain more and more in importance (KOMMISSION DER EUROPÄISCHEN GEMEINSCHAFTEN 1999, KILIAN 2000). Already within the market and price policy, i. e. the 1. pillar of the CAP, environmental aspects were considered, e. g. reducing the stocking rates, or by offering subsidies for fattening bulls and suckler cows. A further adoption of measures of cross compliance and modulation will increase the budget available for agri-environmental targets (OSTERBURG 2002). The Agenda 2000 midterm review therefore is expected to encourage farmers to adopt water protection measures. The aim of water protection activities is to improve the quality of the water bodies in agricultural landscapes. As the quality of surface and ground waters is interrelated and interdependent, water protection measures need to focus on both types of water resources.

Water protection measures need to be evaluated in terms of their potential to reduce nutrient losses and the costs incurred when implemented in crop and animal husbandry. The overall objective of the study is to investigate the effects of different management measures on the nitrogen losses from crop and animal husbandry systems and on the total income of model farming enterprises.

3 Methods

The cost benefit analyses of alternative policy measures were considered at two levels of modelling. The effects of current nation-wide or Europe-wide changes to agricultural transfer payments, production costs, the legal framework and voluntary measures, e. g. the maximum density of livestock and a tax on mineral nitrogen, are simulated with the help of the model RAUMIS on a district level (see chapter “Impact and Cost-Efficiency of Alternative Policy Measures to Reduce Diffuse Pollution Caused by Agriculture”, this report). Besides this the effects of implementing water protection measures on profitability at the farm level are evaluated. For the consideration at farm level four general farm types (reference farms), which are representative of typical farming conditions in Germany, were selected (table 1). The reference situation was defined as being compatible with the rules of ”Good Farming Practice”. The farm sizes were chosen to provide an adequate income or wage in comparison to other possibilities under present market and price conditions. A database has been established which includes detailed information on the different farm types, such as production processes, labour and machinery requirements, costs, yields, etc. The data was mainly derived from KTBL sources and supplemented by recent surveys on input factors and product markets (KTBL 2002a-d). A model was developed which calculates the costs and margins on a total cost farm level basis. Calculations were made with the adoption of water protection measures and these were evaluated against the reference situation without such measures.

Total farm income has been chosen to evaluate the effect of implementing protection measures. If only the gross margin was taken into account side effects of protection measures on fixed costs and necessary investments would have been left out of the consideration. However, side effects can markedly affect profitability and acceptance of water protection measures.

table 1: Reference farms

farm type	(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
Production	60 ha winter wheat, 30 ha winter barley, 22.5 ha maize for corn, 22.5 ha winter rape, 15 ha set-aside low labour requirements	35 ha winter wheat, 20 ha winter barley, 15 ha summer barley, 5 ha potatoes, 20 ha sugar beets, 5 ha set-aside labour intensive	40 ha winter wheat, 20 ha winter barley, 15 ha maize for corn, 15 ha winter rape, 10 ha set-aside	25 ha winter wheat, 12 ha winter barley, 8 ha maize for silage, 5 ha set-aside, 50 ha grassland
Livestock	-	-	1,600 places (fattening pigs); 2.4 rotations yr^{-1}	100 dairy cows with next generation, 6500 kg milk yr^{-1}
farm size (ha)	150	100	100	100
labour hours, farm (lh)	1,123	1,153	2,322	5,409
gross margin, farm (€ yr^{-1})	88,939	101,456	236,388	161,382
gross margin (€ ha^{-1})	592.92	1,014.56	2,363.88	1,613.82
gross margin (€ lh^{-1})	79.17	87.97	101.80	29.84
fix special and over-head costs (€ yr^{-1})	36,935	41,053	100,219	66,174
farm income (€ lh^{-1})	46.29	52.37	58.64	17.60
farm income (€ yr^{-1})	**52,004**	**60,403**	**136,169**	**95,208**

In order to reduce the loss of nutrients into the water bodies a broad range of protection measures are discussed and have been adopted in the farming practice, e. g. within the frame of agri-environmental schemes and in water protection areas, respectively. Some of these measures have a specific reduction potential and give rise to particular production costs. The costs of the different protection measures were calculated and the results are given in costs per kg N and ha that was saved from leaching by the introduction of the measure. In the present investigation it was generally assumed that the suggested water protection measures reduce nitrogen losses by between 10 and 20 kg N ha^{-1} y^{-1} compared to the reference situation. Nitrogen was chosen as the key pollutant. The water protection measures were grouped according to their specific target, i. e. plant production including tillage and taxes or animal husbandry (table 2) and their environmental benefit evaluated.

table 2: Water protection measures

plant production
- catch crops/green manures
- inter-row green manuring
- under-seeding (maize)
- conservation tillage (minimum/zero tillage) and direct seeding
- water margin buffer strips
- turning arable land into extensive grassland
- increasing set-aside period (10 years instead of rotational fallow)
taxes
- tax on mineral nitrogen to increase the current price by 100 and 200 %
- tax on pesticides to increase the current price by 20 %
Animal production
- protein and phosphorus adapted feeding
- reducing the stocking rate per ha from 2.24 to 1.5 and further to 1.0 SLUs for fattening pigs, and from 1.5 to 1.0 SLUs for dairy cows
- optimisation of the storage and application of animal manure

4 Results and discussion

4.1 Plant production

The most important measure to reduce nutrient losses from arable land is to adapt the fertiliser strategy to the requirement of the crop and to the availability of nutrients in the soil. The maintenance of a year-round cover crop on arable land is another effective way to reduce nutrient pollution from arable land into the environment (DVGW/LAWA 1999). A cover crop ensures a continuous uptake of the available soil nutrients and thereby prevents the leaching of nutrients with percolating water in late autumn and winter. If annual crops are grown, tillage and the establishment of the new crop should preferably be done in spring rather than in autumn. A living mulch can be established by sowing catch crops/green manures, underseeding or interrow greening in row crops, e. g. maize.

A main source of phosphorus pollution in surface water resources is the water runoff and soil erosion from arable land. Consequently phosphorus pollution from arable land can effectively be reduced by employing methods that control soil erosion and water runoff. An effective measure in this respect is the adoption of conservation tillage techniques, such as zero tillage, minimum tillage and direct seeding. In addition, maintaining a year-round soil cover of living or dead mulch, introducing water margin buffer strips, and shaping the arable fields in a way which reduces surface water runoff are effective measures to control phosphorus losses. Water margin buffer strips have an additional advantage with regard to contamination of surface water with pesticides.

It was estimated that the different techniques for establishing a living mulch (catch crops / green manures, underseeding, interrow greening) have the potential to reduce nitrogen losses from arable land into surface and ground water by, on average, 20 kg ha^{-1} yr^{-1}. The related costs at farm level when adopting such techniques amount to between less than 1 % to about 4 % of the total farm income, depending on the farm type (table 3). In order to calculate specific costs of water protection measures the costs of each measure were set against the potential reduction of nitrogen losses. The costs of plant production measures to reduce nitrogen losses range from 2.20 to 3.88 € kg^{-1} of avoided nitrogen loss or nitrogen saved. On an area basis, the costs range from 44 to 77 € ha^{-1} yr^{-1}.The reason for the increased costs are that additional costs are incurred with the adoption of water protection measures, such as costs for seed, additional labour, and new technical equipment.

A particular advantage of the ten year fallow is the comparatively low costs in contrast to the rotational fallow - almost no management costs arise. Thus, an economic gain of up to 3.80 € kg^{-1} of nitrogen saved can be achieved (table 3). On the other hand, if the land has previously been used to produce cash crops, such as cereals or oil seed, these costs may amount to 1.10 € kg^{-1} nitrogen saved. These costs are similar to those that have been calculated for measures

which maintain a cover of living mulch over the soil. Costs will even exceed this amount if the yields of the cash crops go down as a result of employing water protection measures. For direct drilling of sugar beet in a conservation tillage system it has been calculated that avoiding one kg of nitrogen loss per ha will cost 13 €, i. e. it is an expensive protection measure. The reason for this is that yield losses of 5 % with an average sugar beet yield of 700 dt ha^{-1} may occur with conservation tillage practices. For other cash crops the situation is different as with conservation tillage the yields are not necessarily reduced and the farm income may even be increased as the production costs are lower than those for conventional tillage (see farm type I, table 3). The establishment and maintenance of water margin buffer strips is comparatively expensive (initially 95 € ha^{-1} and then 8.80 € kg^{-1} of nitrogen saved per ha) due to the additional costs for seed and the smaller size of the area to be sown. If a cash crop, e. g. winter barley, is replaced by a buffer strip the costs increase up to 650 € ha^{-1} and 60 € kg^{-1} of saved nitrogen per ha, as no saleable product is produced.

table 3: Effects of employing crop-related water protection measures on farm income for the different farm types in comparison to the reference farm

	(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
catch crops/green manuring				
farm income (%)	-2.7	-4.1	-0.4	-0.6
costs (€ kg N^{-1} ha^{-1})	3.88			
underseeding maize				
farm income (%)	-1.8	-	-0.5	-0.7
costs (€ kg N^{-1} ha^{-1})	2.20	-	2.20	2.20
Interrow greening of maize				
farm income (%)	-1.2	-	-0.3	-0.5
costs (€ kg N^{-1} ha^{-1})	2.20	-	2.20	2.20
direct seeding of sugar beets				
farm income (%)	-	-8.8	-	-
costs (€ kg N^{-1} ha^{-1})	-	12.98	-	-
conservation tillage				
farm income (%)	-25.3 to +2.4	-8.7	-6.9	-5.2
costs (€ kg N^{-1} ha^{-1})	-0.85* to 8.77	5.23	9.38	9.81
water margin buffer strips				
costs (€ ha^{-1} $yr^{-1)}$	95 to 651			
costs (€ kg N^{-1} ha^{-1})	8.80 to 60.28			
set-aside (10 years instead of rotational fallow)				
farm income (%)	+2.2	-0.4	+/- 0	+0.4
costs (€ kg N^{-1} ha^{-1})	-3.80*	1.10	-0.30*	-3.80*

* saving costs

The range of costs incurred when converting arable land into extensively managed grassland depends on the subsequent use of the land (e. g. fattening of bulls on pasture, suckler cow husbandry, fodder production for dairy farms) and the replaced crop. The effects on farm income caused by the turning of arable land into extensive grassland were calculated for a period of five years. The economic effects comprise of (table 4):

- costs to establish grassland, including fencing,
- loss of income because of loss of land for arable farming and
- change of labour costs due to switch from arable to grassland farming.

Additional costs are at least partly covered by additional gross margins from grassland based on fattening of bulls or suckler cows. As the profitability of grassland based on suckler cows is low the losses of total farm income vary between 464 and 780 € ha^{-1} yr^{-1}. The reduction of farm income amounts from 2.9 to 6.7 %. For fattening of bulls losses of income arise between 5 and 321 € ha^{-1} yr^{-1}; the reduction of farm income is between 0.1 and 0.7 %. Assuming that 20 kg N ha^{-1} is saved, the costs for reducing nitrogen leaching by extensive use with fattening of bulls vary between 0.25 to 16 € kg N^{-1} ha^{-1}, while for suckler cows higher costs are to be expected (23 to 39 € kg N^{-1} ha^{-1}, table 4).

table 4: Costs of turning arable land into extensive grassland

Case		(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
A+B	costs of changing, seeding, fences (€ ha^{-1} yr^{-1})	160.58			-
A+B+C	Loss of gross margin by reducing production of saleable field crops (€ ha^{-1} yr^{-1})	475.12	490.00	790.98	348.55
A	reducing costs by gross margin fattening of bulls (€ ha^{-1} yr^{-1})	(-) 874.69			-
A	additional labour costs, fattening of bulls (€ ha^{-1} yr^{-1})	244.03			-
B	reducing costs by gross margin suckler cows (€ ha^{-1} yr^{-1})	(-) 311.25			-
B	additional labour costs, suckler cows (€ ha^{-1} yr^{-1})	139.86			-
C	additional labour costs changing basic ration, reducing winter barley production (€ ha^{-1} yr^{-1})	-	-	-	70.07
A	reduction of farm income a. by extensive use with - fattening of bulls (€ ha^{-1} yr^{-1})	5.05 (0.1 %)	19.92 (0.2 %)	320.90 (0.7 %)	
B	- suckler cows (€ ha^{-1} yr^{-1})	464.32 (6.7 %)	479.19 (4 %)	780.19 (2.9 %)	
C	b. changing basic ration, reducing winter barley production (€ ha^{-1} yr^{-1})				419 (3.2 %)
A+B+C	costs (€ kg^{-1} ha^{-1} saved nitrogen)	0.25 to 23.22	1.0 to 23.96	16.04 to 39.01	20.93

A=fattening of bulls, B=suckler cows, C=used for feeding dairy cows

If dairy farms convert arable land into extensive grassland the area of maize for silage can be reduced. It was calculated that 2.5 ha of extensive grassland replace 0,36 ha of maize for

silage. For the remaining 2.14 ha of extensive grassland the acreage of winter barley is reduced. This causes a loss of gross margin of 349 € ha^{-1}. In addition labour requirements increase and additional costs of 70 € ha^{-1} arise. The reduction of income amounts to 419 € ha^{-1} yr^{-1}, i. e. 3.2 % of this farm type (IV). The costs for reducing nitrogen leaching are 21 € kg N^{-1} ha^{-1} (table 4).

Taxes

Tax on mineral nitrogen

In order to make the use of mineral fertilisers in practical farming more efficient and to reduce the overall application of fertilisers the introduction of a tax on nitrogen fertiliser has been suggested. In the present investigation it was assumed that a tax will raise the current prices for fertiliser nitrogen by 100 or 200 %. The tax revenues will be returned to farmers through a federal wide, direct payment per hectare of agricultural area. Increasing nitrogen prices combined with reimbursements proportional to agricultural area may reduce farm income for farm type I. But may have positive or lower effects to changes of farm income for farm types II, III and IV (table 5).

table 5: Effects of a tax on mineral nitrogen (100 and 200 % on the current price) on the farm income in relation to the reference farm and N-requirement and N-supply from animal manure

	(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
requirement of N (kg ha^{-1} yr^{-1})	147	140.3	147	162.5
covered by farm manure (%)	0	0	43	40
changing farm income (%) by N-tax 100 % (reim-bursement of 55.5 € ha^{-1})	-6.9	+3.0	+1.1	+0.3
changing farm income (%) by N-tax 200 % (reim-bursement 83.4 € ha^{-1})	-21.8	+1.4	+1.1	-2.4

With a tax on mineral nitrogen, cash-crop farms, because of their high proportion of costs for purchased mineral fertilisers, are discriminated against animal husbandry farms which often have high amounts of nutrients from animal manure. The effect of discrimination is reduced through reimbursements, but not totally balanced.

Tax on pesticides

FISCHER (1996) has shown that the discharge of pesticides into surface water takes place primarily via sewage plants with contaminated sewage (e. g. from cleaning sprayers). A tax on pesticides could contribute to a reduction of both point source discharges and to a decrease in the intensity of area-wide applications of pesticides. In this scenario, a 20 % tax on the price of pesticides is levied. The revenue from the tax should be invested into training and consultancy services for farmers in order to further reduce the improper use of pesticides and any related point pollution (keeping proper distances, disposal of surpluses of spraying solutions and cleaning equipment, packing materials in a way to protect the water). Besides an appropriate usage there is a potential for reduction given by further improvement of application technique (e. g. choice of anti-drift nozzles, computer-aided dosing systems).

The calculations show that the tax, especially for farm type I, leads to a decrease in farm income by up to 10 % and that the farms which maintain livestock (farm types III and IV) are only slightly effected by such a tax (1.5 up to 2 %, table 6). The additional costs vary between 27 to 34 € ha^{-1}. Farm type IV with dairy cows and 50 % grassland has additional costs of only 15 € ha^{-1}, because the use of pesticides on grassland is low. As is the case with the tax on mineral fertilisers, the cash-crop farms that manage according to the Code of Good Practice are discriminated with this tax.

table 6: Effects of a tax on pesticides (20 % of the current price) on the farm income in relation to the reference farm

	(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
additional costs for pesticides (€ yr^{-1})	5,039.22	3,153.00	2,699.30	1,467.46
costs (€ ha^{-1} yr^{-1})	33.59	31.53	26.99	14.67
farm income (%)	-9.7	-5.2	-2.0	-1.5

A tax on pesticides has a stronger effect on farms that are specialised on crop production compared to animal husbandry. In particular intensive horticultural production, e. g. vegetables, fruits, wine, where pesticides are widely used, is markedly affected by such a tax. As an example, table 7 shows the costs for pesticides of horticultural farms. On such farms costs for pesticides amount to 20 % of the total variable production costs. A tax on pesticides would therefore considerably increase production costs and decrease income for farms with permanent culture and vegetables.

table 7: Costs for pesticides and proportion of variable costs in specialised cultures

	pesticides	
Culture	variable costs (€ ha^{-1})	proportion of variable costs (%)
Hop	810.40	23.3
vini culture, lower yield [1)]	444.82	18.6
vini culture, higher yield [1)]	710.70	22.6
[1)] no bottled wine		
	pesticides and fertilisers [2)]	
fruits production, lower yield	491.35	30.8
fruits production, higher yield	936.18	30.8
[2)] fertiliser and pesticides not shown separately reference: KTBL (2002b)		

4.2 Animal production

4.2.1 Feeding according to nutrient requirements

The provision of protein which is adapted to the requirements of cattle, pigs and poultry is one of the major measures which reduce the emission of nutrients from animal production. With a consistent implementation of an adapted protein feeding regime, especially in pig and poultry fattening and pig production, the level of nitrogen excreted is decreased and therefore the nitrogen content in manure is reduced. Additionally lower costs for feeding are incurred. The decrease in excreted N by adapting feeding to animal requirements varies according to animal species, development stage and the initial situation between 5 and 20 % on average and reductions up to 40 % are possible (DÖHLER et al. 2002a). The decrease is determined by how frequently the feeding is adapted to the N requirement during the fattening period (two, three, multi-phased feeding) and the proportion of amino acids added. The costs of the necessary equipment, for example computer controlled distribution and mixing technology, can be offset by savings in feed costs through the reduced use of expensive protein compounds. When an amount of nitrogen of 9.4 kg ha^{-1} y^{-1} is saved due to a reduced level of N in the manure, the costs for the nitrogen decrease are 4.97 € kg N^{-1} ha^{-1}. With the reduction of feeding costs an increase in the farm income up to 11.5 % can be achieved (table 8).

table 8: Effects of a protein reduced feeding of fattening pigs on labour requirements, farm income and costs for avoiding nitrogen losses

farm type	(III) mixed farming fattening pigs / field crops	
Changes in labour requirements	small	
	without...	... with saved costs for feeding
additional costs for feed stock and feeding technique (standard value 2,6 € fattening place^{-1} yr^{-1}) (€ yr^{-1})	4,160	4,160
saved feeding costs (-4.39 € dt^{-1}) with low protein feed stuff (€ yr^{-1})		+20,229.12
costs (€ yr^{-1})	-4,160	+16,069
farm income (%)	-3.4	+11.5
N (available) reference farm (kg yr^{-1})	6,263	6,263
N (available) with protein adapted feeding (kg yr^{-1})	5,323	5,323
Δ available N (kg yr^{-1})	-940	-940
saved nitrogen (kg ha^{-1})	9.4	9.4
costs (€ kg avoided N^{-1} ha^{-1})	-4.97	+16.55

- = additional costs; + = saved costs

The phosphorus excreted during pig and poultry production can also be clearly reduced - up to 40 % - by the use of phytase, adapting the composition of the diet to requirements and phased feeding.

4.2.2 Reduction of stocking rates

A reduction in the amount of animal manure used is possible through a stronger binding of animal husbandry to area, i. e. by the introduction of maximum permitted stocking rates for all livestock which is related to the total agricultural area. This measure aims to increase the efficiency of the use of animal manure and reduce surface balance surpluses.

Reducing the stocking rates has a strong effect on the farm income of farm type IV (mixed farming, dairy cows / field crops). If the stocking rate of this farm type was reduced from 1.5 to 1 SLU per ha the number of dairy cows would be decrease from 100 to 70 per farm and farm income would decrease by 30 % (table 9). Money would only be saved regarding the variable costs such as concentrate feed stuff, veterinary costs, a. s. o. Fixed costs such as for housing, milking machine, feeding technique would remain unchanged. Unless further adaptation in the farm management would reduce fixed costs. An advantage would arise from the conversion of 5 ha maize which would no longer be necessary for dairy cow feeding into cash crop growing. In the model calculation the acreage of winter barley would increase accordingly and this would at least partly compensate for the losses due to the reduction of the

stock. Animal manure available on the farm would decrease by 30 % i. e. the demand for mineral fertilisers would increase accordingly. The resulting costs for purchasing additional mineral fertilisers are only partly compensated for by decreased costs for handling and spreading animal manure. In particular, fixed costs for storage and technique for spreading manure would stay the same. Hence, production costs will increase.

Table 9 shows the effects of reduced stocking rates on farm income and the nitrogen supply in manure on animal husbandry farms (farm type III and IV). With a reduction of the N-supply from animal manure, a lower loss of income results for farm type IV (dairy cows – 15.7 € kg N^{-1} ha^{-1}) than for farm type III (fattening pigs - 16.9 and 27.1 € reduced kg N^{-1} ha^{-1}).

The costs for the reduction of stocking rate are similar to those arise if arable land was converted into extensive grassland. Costs per kg saved nitrogen range from 16 to 27 Euro i. e. the costs and the costs benefits relation are comparatively high. As long as the stocking rates are adapted to the farmed land the farms may either rent additional land or sell animals to neighbouring farms in order to meet the reduction in stocking rate. However, this would jeopardise the aim to reduce stocking rates on the regional scale.

table 9: Effects of reduced stocking rates on farm income and the nitrogen content of excrements on mixed farms (fattening pigs and dairy farms)

	stocking rate (SLU ha^{-1} of agricultural area)		
(III) mixed farming fattening pigs / field crops	**2.24 (reference)**	**1.5**	**1**
farm income (€ yr^{-1})	136,169	82,049	41,332
changing farm income (€ ha^{-1})		-541 (-40 %)	-407 (-60 %)
changing farm income (€ reduced SLU^{-1} ha^{-1})		-731	-814
nutrients in animal manure... (kg ha^{-1})			
N (available)	79	53 (-26)	35 (-18)
P_2O_5	56	38 (-18)	25 (-13)
K_2O	56	38 (-18)	25 (-13)
changing farm income (€ reduced kg N^{-1} ha^{-1})		-16,9	-27,1
(IV) mixed farming dairy cows / field crops		**1.5 (reference)**	**1**
farm income (€ yr^{-1})		95,208	63,724
changing farm income (€ ha^{-1})			-315 (-33 %)
(€ reduced SLU^{-1} ha^{-1})			630
nutrients in animal manure... (kg ha^{-1})			
N (available)		84	60 (-24)
P_2O_5		57	40 (-17)
K_2O		172	120 (-52)
changing farm income (€ reduced kg N^{-1} ha^{-1})			-15,7

4.2.3 Optimisation of the storage and application of animal manure

Ammonia emissions from animal production can be reduced by measures which optimise the storage and application of animal manure. Losses during storage can be reduced, for example, by covering the slurry storage tank. Application technology should comply with generally recognised engineering rules, ensure that appropriate amounts are applied with a low level of losses. When applying animal manure, ammonia emissions are to be avoided as much as possible by applying the slurry close to the ground. The state of the vegetation and the weather conditions, especially temperature and solar radiation, should be taken into account. When applying to bare ground, slurry should be immediately incorporated into the soil, i. e. within about 1 hour. Consequently a reduction of ammonia-emissions of up to 90 % is achievable (DÖHLER et al. 2002b). The immediate incorporation can be accomplished either with a second vehicle or in a combined operation when the slurry is applied. For crops on arable land the use of trailing hoses is recommended, and, on grassland, trailing shoes. The advantage of the use of this equipment is that it deposits the slurry directly on the ground and the slurry is better protected from solar radiation and wind - both of which increase emissions. This results in more nitrogen being available to the plants.

Time and amount of slurry application is dependent on the slurry storage capacity of the farm and the available application technique. The reference situation is characterised by a low capacity of 4 months. Thus, the slurry is spread early in spring and again in the summer at an almost similar amount. The nitrogen efficiency therefore is low, in particular of the summer application. By optimising the timing of the application of slurry to better match the N-requirements of the crop during its various stages of growth and by using better application technology (trailing hose and trailing shoe instead of broad casting), the proportion of short term available nitrogen of the total nitrogen increases from 45 % (reference) to 59 % (optimised application). The application period shifts from February/March (reference) to March, April and May (figure 1). On top of this, the application period gets shorter in late summer/early autumn. Such optimisation results in a reduction in farm income of 2 % or 2.85 € kg N^{-1} ha^{-1} yr^{-1} for farm type III (fattening pigs) and 4 % or 1.96 € kg N^{-1} ha^{-1} yr^{-1} for farm type IV (dairy cows, table 10). To reduce ammonia emissions the Code of Good Practice requires a storage period of 6 months for pig producing farms and a minimum of 4 months for grassland farms (dairy farming). With the shift of the application of some slurry from summer/autumn to the following spring the required storage period is increased for both type of farms to about 8 months. In addition, advanced technique for low emission application of manures is required which causes additional costs. As by this the amount of available nitrogen increases, the amount of mineral fertiliser can be reduced, accordingly, and costs for spreading mineral fertilisers also decrease. The number of applications of animal manure is reduced and therewith the labour requirement; for farm type III (fattening pigs) 23 hours and for farm type IV 32 hours of labour are saved (table 10).

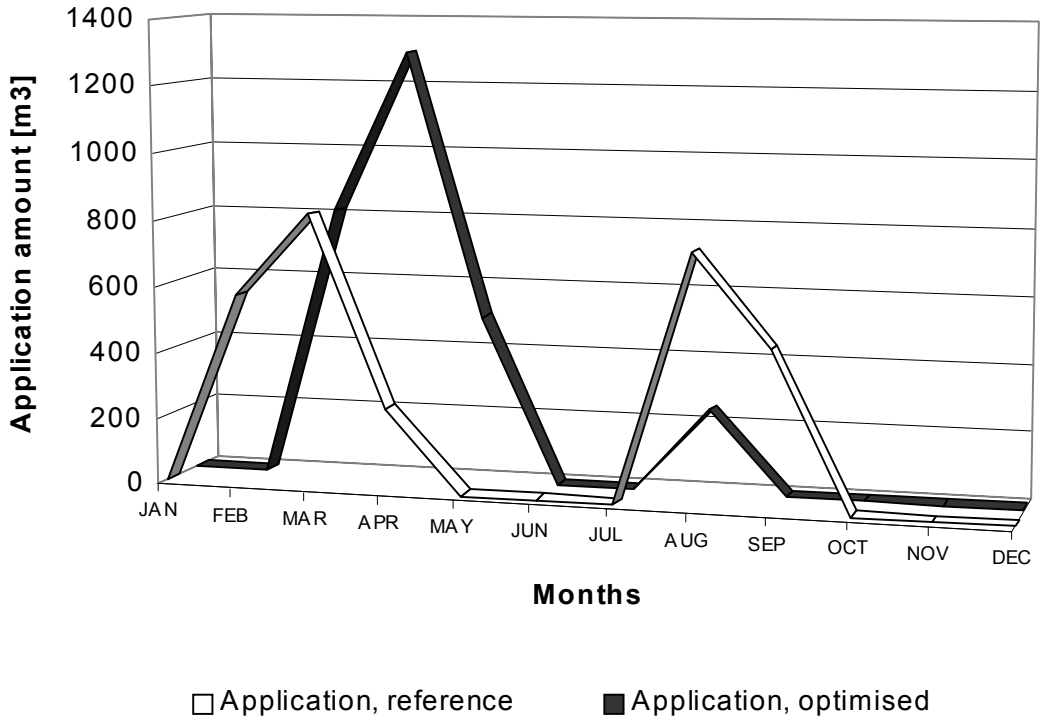

figure 1: Optimisation of the application of slurry - trailing hose and trailing shoe instead of broad casting; farm type IV, mixed farming, dairy cows/field crops

table 10: Consequences and costs of an optimised storing and application of animal manure

	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
additional costs for increasing storing capacity (€ yr^{-1})	1,440	2,240
additional fix costs for application technique (trailing hose/trailing shoe) (€ yr^{-1})	1,300	3,500
increasing of storing capacity	from 6 to 8 months	from 4 to 8 months
lowering of the time span where spreading manure is allowed	4 instead of 5 months	
changes in labour requirements (less labour requirements for animal manure and for spreading mineral fertilisers) - = saved labour hours	-23 lh yr^{-1}	-32 lh yr^{-1}
availability of nitrogen from animal manure	from 45 up to 59 % (= + 14 %)	
... corresponding additional available N (kg yr^{-1})	937	1,918
... saving because of less purchase N-fertiliser (N-fertiliser 0,54 € kg N^{-1}) (€ yr^{-1})	506	1,036
farm income (%)	-2	-4
costs for additionally utilisable N (€ kg N^{-1} ha^{-1} yr^{-1})	2.85	1.96

5 Conclusions

The costs of measures should be evaluated against their efficiency to prevent nitrogen from being leached. Those measures should be given priority that cause low costs but are that highly effective. Such measures

- are highly acknowledged in the farming practice and are therefore readily adopted,
- increase political enforceability,
- enable a reasonable allocation of money where budgets are limited.

Based on this the costs were related to the per kg saved nitrogen and modelled measures were grouped into to five classes (table 11).

The implementation of nitrogen and phosphorus adapted feeding regimes and the optimisation of the storage and handling of animal manure are most cost effective measures on livestock farms. The introduction of living mulch systems (catch crops, interrow greening, under-seeding) in arable farming is an effective and affordable measure in crop production. Within set-aside programs for arable land priority should be given to permanent fallow rather than rotational fallow. Turning arable land into extensively managed grassland and introducing water margin buffer strips are highly effective measures to reduce nutrient and pesticide effluents into the water bodies, however, they are comparatively expensive and therefore difficult to achieve in practical farming. The introduction of taxes on fertilisers and pesticides is not considered suitable as it effects different farm types differently. The efficiency of conservation tillage systems are dependent on the soil and climatic conditions and farm type / farm management practice. On sites where conservation tillage does not result in lower yields the measure is very cost effective as the labour requirements decrease. However, on sites where yield losses occur the costs for reduced tillage can increase considerably. The reduction of stocking rates is grouped in class 4 and 5 i. e. it is accompanied by high costs. The reason for this is that fixed costs in animal husbandry such as costs for housing and technical equipment will not decrease in the same way as the stocking rate is reduced.

table 11: Summary of evaluation of cost-effectiveness of water protection measures

farm type		(I) extensive field crop production	(II) intensive field crop production	(III) mixed farming fattening pigs / field crops	(IV) mixed farming dairy cows / field crops
	class	costs (€ saved kg N^{-1} ha^{-1})			
protein adapted feeding, favourable conditions	favourable up to 1 Euro	-	-	-16.55	-
set-aside, 10 years (instead of rotational fallow)		-3.80	1.10	0.30	-1.00
conservation tillage, favourable conditions		-0.85	-	-	-
arable land into extensive grassland, fattening bulls		0.25	1.00	-	-
interrow greening (maize) or underseeding	up to 5 Euro	2.20			
optimised application of animal manure		-	-	2.85	1.96
catch crops/green manuring (winter period)		3.88			
protein adapted feeding, unfavourable conditions		-	-	4.97	-
conservation tillage, unfavourable conditions	up to 10 Euro	8.77	5.23	9.38	9.81
water margin buffer strips (instead of fallow)		8.80			
arable land into extensive grassland, fattening bulls		-	-	9.12	-
direct seeding of sugar beets	up to 20 Euro	-	12.98	-	-
reduced stocking rates: 1,5 to 1 SLU ha^{-1}, dairy cows		-	-	-	15.70
reduced stocking rates: 2,24 to 1.5 SLU ha^{-1}, fattening pigs		-	-	16.90	-
arable land into extensive grassland, dairy cows	more than 20 Euro	-	-	-	20.93
reduced stocking rates: 1,5 to 1 SLU ha^{-1}, fattening pigs		-	-	27.10	-
arable land into extensive grassland, suckler cows		23.22	23.96	32.09	-
water margin buffer strips, complex conditions		60.28			

- = saving costs

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Approaches against Diffuse Water Pollution caused by Urban Drainage

Umweltforschungsplan
des Bundesministeriums für Umwelt,
Naturschutz und Reaktorsicherheit

Förderkennzeichen 201 24 222/03

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Mai 2004

CONTENTS

1 Introduction

Agriculture as well as urban drainage are recognised as important sources of diffuse water pollution with regard to nutrients and pollutants. According to the scientific definition of diffuse pollution (all sources which are directly associated with rainfall-runoff processes, see part A, section 1.2) the main urban diffuse inputs are:

- storm water effluents from urban areas drained by separate sewerage systems,
- combined sewer overflows (CSO) from urban areas drained by combined sewerage systems,
- effluents from road drains,
- wastewater effluents, which are not connected to a wastewater treatment plant (WWTP).

Böhm et al. (2000) carried out pollutant input balances for waters in Germany and the reference year 1997. The data for diffuse emissions are based on Behrendt et al. (1999) which are overall confirmed by estimations of other authors. The main nutrient input originates more and more from the diffuse sources while the input load from point sources decreases due to the achieved effect of sewage treatment. It was determined that about 67 % of the total phosphorus load (25 kt P/a) is caused by diffuse inputs. The main pathways of this input are erosion of agricultural soils (33 % of diffuse sources), wash out via groundwater (23 %) and urban areas (4 kt P/a, 16 %). About 72 % of the total nitrogen load (586 kt N/a) comes from diffuse sources. The main pathways of this input are wash out via groundwater (2/3 of diffuse sources), agricultural drainage (21 %) and urban areas (34 kt P/a, 5 %). So in total the urban areas provide 11 % of the nutrients diffuse pollution load.

The share of the total load of all heavy metals for diffuse sources is around 77 % in Germany (Böhm et al., 2000). Within the diffuse input pathways, the most important ones are the erosion of agricultural soils (30 % of diffuse sources) and the urban areas (32 %). The inputs by the effluents from separate sewers and CSO during heavy rainfalls are playing the main role. 15-44 % of the diffuse heavy metal load comes from roofs and roads in the cities during heavy rainfalls. After Hullmann and Kraft (2002) the proportional part of heavy metal load in the river Rhine shows for copper 1.3 % and for zinc 5.2 % originating from metal roofs.

A joint working team is commissioned by the German Federal Environment Agency to evaluate political approaches and investigate technical measures for the reduction of diffuse water pollution on both agricultural and urban pathways. The results for the agricultural sector have been presented in the above sections. The urban storm drainage pathway will be presented in this part of the report. Following contributions to the 6th and 7th Conference on Diffuse Pollution (Ristenpart and Prigge, 2002; Ristenpart, 2003) and interim reports to the German Federal Environment Agency (Wuppertal Institut für Klima, Umwelt, Energie et al., 2002a+b) this contribution analyses the approaches throughout Europe in a broader sense and gives recommendations for integrated water protection management.

2 Methodology

The assessment of broader political approaches (legislative, economic, co-operative and participatory instruments) as well as detailed technical measures described in this study is based on different methods using several sources of information:

- literature review with main focus on Germany but taking into account also other European countries
- questionnaire addressing several European research experts working in the field of urban drainage - but return of answers was sparse, so that only a limited number of countries is covered
- leading edge knowledge of directors of contractor gained by authoritative collaboration in technical and strategic working groups of national and international professional associations for drainage and water resources (ATV-DVWK, BWK, IWA etc.) dealing with storm water treatment and waters protection
- know how of contractor as research institution and consulting office in the urban drainage area, especially working on storm water treatment and storm water management (SUDS)

In a second step a cost-effectiveness-analysis carried out in Germany by Böhm et al. (2002) is critically evaluated. The results are used for priority setting and selection of final recommendations among the different measures. In this step solutions in the main fields of agriculture and morphology of waters are also considered in an integrated view. In relation with the water framework directive (WFD) of the European Union the results will be helpful to establish cost-effective action plans in river basin management.

3 Prevailing Policy Conditions

The Water Framework Directive (WFD) was drawn up to concentrate, rationalise and standardise as well as improve the efficiency of European water protection legislation. Enacted in December 2000 the WFD introduces a remarkable change in Community water legislation by moving from protection of particular waters of special interest (fish waters, shellfish waters etc.) to protection and use based on overall appreciation of the hydrology and ecology of the entire natural cycle of each river basin. A further key point of the directive is the management of water resources across national boundaries choosing a co-ordinated approach within river catchment areas. In the meantime a competent authority had to be designated for each of the river basin districts identified by the Member State. River basins covering the territory of more than one Member State will be assigned to an international river basin district.

As laid down in reason 16 of the WFD the further integration of protection and sustainable management of water into other Community policy fields (e.g. energy, transport, agriculture, fisheries, regional policy, tourism) is necessary. This means that implementing this directive will have effects on all business sectors.

The WFD aims firstly at achieving a good ecological and chemical status of all water bodies. The increased requirements to the state of waters and the influence of anthropologically caused loads demand the involvement of the waters themselves. Secondly water has to meet the standards established in existing water directives. So deterioration of the current status of waters must be avoided. The noxious substance and nutrient discharges from urban drainage should not excessively affect the state of waters. The diminution of the disposal of priority substances plays an important role in this context. Thus the philosophy of the WFD is based on a combined approach of quality standards for waters with supplemental consideration of limit values for emissions.

4 Recommendations

In general a diffuse pollution reduction plan will consist of multiple single measures which have to be balanced and co-ordinated. To reach significant emission reductions and to shift to sustainable water resources management different areas of society and policy have to be taken into account. It is necessary to realise an integrated view of households, municipalities and industry as well as of urban drainage, agriculture, traffic, landscape planning and the morphology of waters. The complexity of the problem requires a subdivision of recommendations on different levels beginning with the broader basic instruments and ending with detailed technical measures.

The basic instruments for realisation of diffuse water pollution reduction were compiled in a joint paper by the Working group of the federal states of Germany on water problems and the German Federal Environment Agency (LAWA and UBA, 2001). They are listed in the following together with three exemplary approaches for each instrument:

1. state authority principle

   Appropriate further development of the authority of the state (a proven instrument of prevention and precaution in the past) as the guarantor of high environmental standards.

   - Extend and implement legal regulation where necessary (e.g. Industrial Plant Ordinance).
   - determine uniform minimum standards (e.g. Best Environmental Practice),
   - guarantee compliance with measures and standards through state inspection.

2. market principle

   Use of targeted economic / market incentives to reduce water pollution (pass on environmental costs in prices) and assessing the efficiency of water protection measures in environmental and economic terms.

   - Base taxation on pollution loads,
   - take account of costs and benefits, decide on a case-by-case basis between measures to reduce point source discharges (e.g. expanding waste water treatment) or diffuse inputs (e.g. storm water runoff treatment, more extensive agricultural practice),
   - support research and development of new green productions.

3. co-operation principle

   Build on co-operative approaches, demand responsible action from those whose activities can impact on water quality (achieve sustainable development at a minimum cost and with a maximum of creativity).

   - Voluntary agreements with business to abandon the use of substances which give cause for concern; monitor and document success stories (e.g. heavy metals),

- co-operation with consumers and consumers' groups,
- promote a harmonisation of the goals of agriculture and environmental policy.

4. public participation, rising public awareness, environmental education
   Information and training or education as an instrument for modifying the behaviour of individuals, social groups and business
   - Accompany regulatory and fiscal measures with information and convincing (building consensus and acceptance),
   - co-operation with consumers and consumers' groups,
   - address specific polluter groups.

4.1 Approaches

The concrete approaches which are described in this section can all be related to the above basic catalogue of instruments which is used here as structure. On the other hand it is most effective to promote single (technical) measures like e.g. storm water management with several of the approaches and instruments.

4.1.1 Legal Regulations

Federal and state standards for wet weather urban drainage discharges. In a project funded by the German Federal Environment Agency new emission requirements for storm water discharges are set up for their later implementation in a law or ordinance. The discharge into receiving waters is to be limited by quantity as well as by solids load. Ground waters have to be protected according to the soil conservation act (Grottker, 2003). On the federal states level for separate storm systems requirements only exist in a few German states although its effluents pollution load is comparable (or even higher) to those of the overflows in combined systems. Discharge of polluted storm water should be permitted only after its treatment. Advanced requirements has to be defined according to the state of surface waters quality (see section '*Guidelines*...').

Requirements for storm water management in state acts. In some German states (e.g. North Rhine-Westphalia, Baden-Württemberg) storm water infiltration as an important source control measure in new built properties has to be preferred in comparison to conventional drainage systems. In Switzerland also the infiltration is obligatory. In North Rhine-Westphalia even in permitted drainage master plans for existing urban areas storm water infiltration has to be taken into account belatedly.

State ordinances for self surveillance of sewerage systems. In nine German states such ordinances are already realised (N.N., 1998). The municipalities which are responsible for the operation have to self-supervise their sewerage system and have to report on this to the water

authorities. Main aspects of surveillance are the structural state of sewers (e.g. leakage) and accurate operation of overflow structures.

Guidelines for wet weather urban drainage discharges. The philosophy of the WFD is based on a combined approach of quality standards for waters with supplemental consideration of limit values for emissions. Two recently enacted German guidelines are following this approach. The guideline BWK M 3 (BWK, 2001) was developed for the State of North Rhine-Westphalia for "Derivation of state of waters-orientated requirements to combined sewage and storm water discharge under consideration of local conditions". It enables assessments of the state of receiving waters with adequate efforts. It determines limit values for hydraulic stress and pollution and it additionally defines sections of waters which must be totally kept clear from urban drainage effluents. The guideline ATV-DVWK M 153 (ATV-DVWK, 2000) formulates the objective to minimise the hydraulic and pollution impact of storm water from separate drainage systems. Field of application is the storm water treatment in the context of storm water management. Discharges into surface waters on the one hand and storm water infiltration into groundwaters on the other hand are considered.

Design guidelines for storm water treatment structures. For constructed wetlands (technical references see below) as presently strongly favoured type of treatment structures new design guidelines were developed by some German states (e.g. North Rhine-Westphalia) or are just in preparation by technical associations (ATV-DVWK) respectively.

4.1.2 Economic Instruments

Funding. For some technical measures funding programmes were set up in Germany. For instance storm water management measures (e.g. infiltration structures) are funded by some German states (e.g. in Hesse and North Rhine-Westphalia), municipalities or water associations (e.g. Emschergenossenschaft). Funding rates for the property owners are ranging from 5 to 30 € per square meter runoff producing area disconnected from the sewer system. Some storm water treatment structures like constructed wetlands are also funded by German states to a significant amount (e.g. in North Rhine-Westphalia).

The state funding policies have to be optimised in terms of their efficiency to deliver the greatest possible relief for water bodies. The different fund receiving sectors (agriculture, industry, urban drainage, etc.) have to be evaluated in an integrated approach by cost-benefit analysis. Only those sectors should be further funded where the most effective relief is to be expected.

Wastewater charges. According to the German wastewater charges act direct sewage effluents into receiving waters are charged in relation to their quantity and concentration of several pollutants (COD, P, N, AOX, Hg, Cd, Cr, Ni, Pb, Cu and fish toxicity). Different pollutants are taken into account by specific pollution units. In general charging rates has to be increased and negotiation possibilities should be restricted. Compared to the German

federal act additional pollutant parameters should be taken into account (zinc, bio test parameters, endocrine constituents). For polluted storm water discharges only special lump regulations are valid. By increasing the pollution units for storm water a charging equivalent to the point source effluents has to be reached. By this means incentives to reduce pollutants at source are established and reductions of emissions are expected The increased revenues should be used for better funding of storm water management (Böhm et al., 1999).

For the indirect storm water runoff discharges from urban areas into the sewer systems the property users (private, industrial and municipal) have to pay a wastewater fee. This fee has to depend on the quantity of the discharges. Therefore the introduction of split sewage rates is necessary. The foul flow fee is calculated with the help of the amount of fresh water consumed. The storm water fee is depending on the paved area connected to the sewer system. By this means an incentive to disconnect runoff producing areas is given.

In Norway, Switzerland and Germany (as mentioned) the wastewater fee must cover the calculated costs as required by the WFD - the polluter pays principle. In Austria and Portugal exists a subsidy-system, in the first case the costs are covered by the community budget and in the second case other fees within the water sector cover them. Only in Austria, Switzerland and Germany (44 % of the municipalities) a separate storm water fees exist.

4.1.3 Co-operative Instruments

EU water framework directive. The WFD aims at achieving a good ecological and chemical status of all water bodies. This implies an integrated approach considering all the different sources of pollution (agriculture, urban drainage, industry, river development, etc.). An effective pollution control without serious efforts of the agricultural sector will be unsuccessful. In the sense of the above mentioned combined approach the state of waters-orientated requirements have also to lead to strengthened efforts of ecologically developing rivers and streams instead of expensive technical treatment structures. Cost-benefit analysis (see economic instruments) will help to support this integrated approach.

Voluntary self commitments in industry and business. In terms of a more sustainable source control approach and integrated environmental protection commitments of the industry to reduce emissions should be proposed. The companies are asked to voluntarily abandon the use of toxic substances and to substitute hazardous constituents with ones less hazardous to water (e.g. heavy metals in construction industry).

4.1.4 Public Participation

Urban water planning. Integrated municipal water plans including optimised pollution control strategies are more effective in the implementation and operation phase when public participation is guaranteed. This information and involvement of the public is required at an early stage in an ‘open’ planning process. Geldorf (2002) furthermore reported about a

‘parallel’ planning ‘approach where goals, measures and support emerge together out of a process with a lot of interactions between the actors and where planning and implementation are not strictly separated in time’.

Storm water experience. An important principle of decentralised storm water management (see below) is to make the storm water visible for the public. Attractively designed structures like infiltration swales, open channels, cascades, ponds and waterworks bring back the storm water within the peoples experience. By this means a better understanding of the water system is gained and it is much easier for the public to take responsibility also for water pollution control.

4.2 Technical Measures

After the above review of the broader approaches this section closer describes the single technical measures for reduction of diffuse water pollution.

4.2.1 Storm Water Management

Storm water management concepts are combining unsealing of paved areas, infiltration of runoff from disconnected areas, storm water re-use, distributed retention, delayed transport and treatment (the latter to be described in the following sub-section). The pressure to rethink conventional drainage systems and realise such modern concepts is due to mainly water quantity problems (insufficient hydraulic capacity of sewer systems as well as of streams and rivers) but also quality requirements. In the sense of sustainable development, ecological criteria are taken into account in these drainage concepts which are potentially much closer to nature than the traditional approach has been. The decentralised solutions (e.g. infiltration structures as main element) are used as best management practices (BMP) and are recently named ‘sustainable urban drainage system’ (SUDS). Practical planning experience shows the necessity to involve drainage planners into town and traffic planning at an early stage because boundary conditions are fixed then which are very important for feasibility and efficiency of the local storm water management concept.

SUDS are a very popular topic in urban drainage in Germany. Beginning with first exemplary projects in the late 1980s which already include investigations of impacts on groundwater quality SUDS are now widely used in drainage planning. The approach is also beginning to be used more extensively in other European countries, e.g. in the UK, France and Switzerland as well as in the US and in Australia.

The first mentioned two elements of SUDS (unsealing and infiltration) as source control measures have a reduction effect on the runoff volume, the others an attenuation effect on the peak flows. Both effects are reducing the hydraulic stress for the receiving waters (disturbance of benthic fauna). Infiltration closes the natural water cycle by increasing the ground water feeding. Böhm et al. (1999) stated an efficient decrease of emissions of hazardous substances into receiving waters (especially heavy metals, nutrients only to a minor

extent), but partly these loads are transferred to soils and wastes. Therefore measures at source are necessary in parallel (see sub-section 'Replacement of hazardous substances'). Additionally it is expected that the elimination efficiency of the existing treatment structures improves by 10-15 % in terms of pollutant load emissions due to the reduced inflow rates.

4.2.2 Urban Storm Water Treatment

Storm water treatment is one of the elements of the above described urban storm water management concepts. First aim is to treat only that part of storm water which is really polluted. Therefore a consistent separation of storm water fluxes with regard to their pollution degree is a pre-condition which has already to be guaranteed in the storm water management concept (e.g. infiltration of roof runoff, further treatment of road runoff with heavier traffic load). Infiltration structures itself also show a good treatment efficiency (for less polluted runoff) due to the treatment processes occurring in the top soil layer.

Basins for storm water treatment do exist in Germany only to a small extent. Böhm et al. (1999) therefore expected a significant load reduction by increased construction of efficient settling basins. Due to the controversial efficiency of the basins constructed wetlands (called 'soil filters') are at present strongly favoured in Germany for (advanced) treatment of storm water discharge from combined and separate drainage systems and from roads (Ristenpart and Prigge, 2002). Recent research work showed that the different types of constructed wetlands fulfil their purpose of elimination of noxious substances from sewerage with high performance as well as their water retention function. The suitability of other technical measures for limiting pollutant pressure on waters is evaluated by BWK (2001) and Geiger et al. (2001) and summarised in tables by Ristenpart and Prigge (2002). Böhm et al. (1999) additionally mentioned that in 30-50 % of the cases treatment is due to the poor state of the receiving waters. Efforts to ecologically develop rivers and streams for reducing their pollution sensitivity is an alternative to expensive technical treatment.

Combined sewage treatment has to be improved in Germany by consistent overall realisation of states requirements in terms of construction of retention and settling basins. Böhm et al. (1999) expected an overflow load reduction by around 50 % for SS, PAH and some heavy metals. Reduction rates for pollutants which have a higher soluble share will be significantly lower (e.g. by 20-30 % for COD). These load reduction expectations are based on relatively high controversial cleaning efficiencies.

The treatment of CSO is quite different in Europe. In Germany (as mentioned) and Switzerland a lot of treatment measures for the discharged wastewater are used like storm water sedimentation tanks, retention tanks, screens and brushes. In Austria and Portugal special treatment structures for spilled combined sewage do not exist, only a few storm water retention tanks and sand filtration structure are known in Portugal. In Norway some large cities have retention tanks and screens at exposed places.

4.2.3 Road Runoff Treatment

Car traffic is a diffuse source of pollution of water, soil and atmosphere. Road runoff is polluted by heavy metals and oils due to abrasion of tyres, brakes and road surfaces, leakage of lubricants and corrosion of crash barriers. This occurs from narrow village streets, city roads and highways with no strict correlation to traffic intensity. According to a Dutch general policy guideline on traffic emissions (Berbee et al., 2002) highways are generally made of porous asphalt. It consists of an upper layer of 5 cm of porous asphalt on impervious asphalt. The runoff contains far lower concentrations of pollutants which is probably a result of solids filtration in the top layer. These solids are transported to the unused hard shoulders by a typ of pumping effect by the tyres. To avoid plugging, the shoulders have to be cleaned periodically. But porous asphalt has a few disadvantages: its lifetime is less than traditional asphalt and it requires more salt for de-icing in winter. Runoff then mostly infiltrates in the verges. Infiltration is controlled by periodical inspection of chemical quality of soil and groundwater. Only in sensitive areas there is an option to route the runoff outside by a sewage system.
In France, Germany and the UK settling basins are more or less used for treating pollutants. But efficiency of removing heavy metals was disappointingly low at 20-40 % and costs are more than a factor ten higher compared to wastewater treatment (Berbee et al., 2002). Investigations at German highways by Lange et al. (2003) confirm the low efficiencies of concrete settling basins but determined much better ones for earth basins planted with reed (67-84 % for SS, COD and metals, 96 % for PAH).

4.2.4 Sewer System Inspection and Renovation

By sewer inspections leakage leading to sewage exfiltration into groundwater and groundwater infiltration into sewers is detected and has to be rehabilitated. Avoiding exfiltration reduces raw sewage emissions into groundwater. Reduction of infiltrating water allows to use a higher capacity of the continuation flow for the foul flow to the WWTP which reduces overflows into surface waters. Böhm et al. (1999) estimated a reduction of overflow volume by 10 % in case the extraneous water decreases by 50 %. Additionally an increase of the treatment efficiency at the WWTP is to be expected due to reduced dilution of raw sewage.

The performance of CSO structures has to be hydraulically checked. The throttle devices have to prove the accurate limitation of the continuation flow to the WWTP. This assures that the CSO are performing like they are designed and that the amount of overflow into surface water is restricted to the permitted values.

4.2.5 Alternative Integrated Urban Water Concepts

In contrast to traditional flushing sewer systems the main principles of alternative sustainable drainage concepts are the consistent separation of wastewater fluxes and their subsequent split

flow treatment with adapted technologies. Pilot projects are realised in some countries for new housing development sites (e.g. Germany, Austria, Sweden), but there are also approaches for existing urban areas. The water and material fluxes are as follows:

- Storm water is re-used for toilet flushing, washing-machines and garden irrigation. Surplus storm water is infiltrated into the ground by swales, trenches etc..
- Grey water (from washing, bathing, cooking) is treated in sand filters or constructed wetlands and afterwards re-used like storm water as far as possible.
- Faeces and urine are treated in an anaerobic reactor together with the biodegradable waste. The treated sludge is re-used as agricultural fertiliser. In further advanced concepts the separated urine is directly used as fertiliser substitute without pre-treatment.

Hillenbrand and Böhm (2001) analysed the pollutant fluxes and showed an efficient decrease of emissions into receiving waters (by 60-90% for nutrients, by 45 % for copper and AOX), but partly these loads are transferred to agricultural soils. Additionally the water consumption decreases significantly.

4.2.6 Replacement of Hazardous Substances

As mentioned earlier measures at source to abandon the use of hazardous substances and to substitute their noxious constituents are needed because they prevent emissions prior to their emerging. This most sustainable approach has to receive unanimous support. In this sense real no-emission substitutes have to have priority over only slightly changed conventional substances with still low emissions. As an example the reduction of heavy metals in construction industry is described in the following. For other pollutants like herbicides (urban weed control strategies) and phtalates (replacement of PVC) similar strategies are known. In general all measures against air pollution take effect at source and reduce rainfall pollution and thus indirectly runoff emissions also.

Runoff from building roofs is a main source of zinc (and copper) emissions due to corrosion and abrasion of roof surfaces and gutters. In 2001 the Dutch government and the zinc industry have agreed that if product innovation and the actual application of the new materials (supported by a promotion campaign) is successful the government will not take action to reduce zinc applications. However, the Dutch government acknowledges the local government's responsibility for solving their local environmental problems and for executing the environmental regulations (Gouman, 2002). To improve zinc as a building material another alloy of zinc which causes less emissions and the possibilities for coating are investigated. The covering of gutters (and other construction elements) with an impermeable EPDM rubber foil reduces emissions by 90 %. To reduce zinc loads on the local scale in Amsterdam for instance zinc roofs on new and renovated buildings are not permitted. Runoff from roofs of existing buildings is allowed to contain a maximum zinc concentration of 200 µg/l. In Germany and Switzerland substitution of zinc by aluminium or stainless steel for roof

and façade covering is promoted but worse corrosion behaviour has to be taken into account (Böhm et al., 1999).

For a substantial part the copper load to surface waters is due to the wash out from copper drinking water tubes. The Dutch industry has developed a special copper alloy which reduces copper losses by 30-70 %. Further development is necessary to improve price, safety of production and workability (van Tilborg et al., 2002). In Germany substitution of copper by polyethylene (PEX), polypropylene (PP) and stainless steel is promoted (Böhm et al., 1999).

Dutch environmental policy promotes the substitution of primary building materials (e.g. sand, gravel) by secondary building materials (e.g. bulky wastes like mine stone, steel and phosphorus slag, demolition waste). The latter materials contain various harmful substances (heavy metals), which may leach into ground and surface water. Leuven and Willems (2002) determined the contribution of secondary building materials in river engineering to total heavy metals pollution of Dutch surface waters to be relatively low (<< 1 %). Nevertheless the authors recommended the application of these materials in constructions that are not or to a lesser extent exposed to water flows.

4.3 Priorities

Böhm et al. (2002) have examined in Germany costs of measures in the three fields of urban drainage, agriculture and morphology of waters and assessed their effectiveness on water pollution. They are considered in an integrated way to find the most cost-effective combinations of measures. The cost-effectiveness-analysis is then used for priority setting among the different measures. The most important results in the field of urban drainage are:

The cost-effectiveness of measures is showing a wide spread but per pollution unit avoided the costs of the single measures differ significantly over orders of magnitude. This is the case especially for the urban drainage measures storm water infiltration, unsealing of paved areas and reduction of extraneous water. The wide spread of the results is very much influenced by a similar spread of the boundary conditions of each measure but also by the uncertainty related to the effects of the measures. Böhm et al. (2002) therefore proposed more detailed investigations which has to be supported. The assumptions for the favourable conditions of storm water infiltration and unsealing seems to be too optimistic and to less secured. Especially the estimations for the cost savings due to saved sewer system upgrading were only deducted from the split wastewater fee. Thus the priority of measures mentioned below has to be carefully interpreted and the results cannot be simply transferred to single cases without going deeper into local details.

In general the cost-effectiveness of measures with low priority under favourable conditions is better than that of the best measures under only mean boundary conditions. Over all storm water infiltration shows under favourable conditions the best cost-effectiveness due to cost savings for the drainage system. However under unfavourable conditions reduction of

emissions is very expensive, but on the other hand important ‘side’ effects like reduction of hydraulic stress and solids load of surface waters and groundwater recharge has not been taken into account here. With regard to nitrogen reduction agricultural measures are more cost-effective than further advanced wastewater treatment. With regard to phosphorous reduction storm water infiltration and small wastewater treatment plants are the most effective measures under favourable conditions. A significantly worse cost-effectiveness showed the P-elimination on large WWTP and even agricultural measures. With regard to heavy metals reduction again storm water infiltration is the most effective measure under favourable conditions.

5 Conclusions

Storm water run-off from urban areas has a significant impact on diffuse water pollution. In general a diffuse pollution reduction plan will consist of multiple single measures which have to be balanced and co-ordinated. Cost-effectiveness-analysis is an essential element of setting the priority of effective measures, but there are still large uncertainties in quantifying and comparing costs, effects and benefits. Source control measures are to be preferred because they prevent emissions prior to their emerging. To reach significant emission reductions and to shift to sustainable water resources management different areas of society and policy have to be taken into account (households, municipalities, industry, agriculture, traffic, landscape planning). It is necessary to realise an integrated view of sewer systems, treatment plants, surface and ground waters, agriculture and the morphology of waters. Such coordinated approaches are required anyway in the near future by the EU Water Framework Directive (WFD) for the obligatory setup of river catchment management plans.

The chosen approaches will have to cover the whole set of legislative, economic, co-operative and participatory instruments. The degree of realisation of measures will be highly affected by the comprehensive application of all kinds of approaches as complete as possible. Such a support in different areas of action and actors will best promote single measures. Most of the measures are of a mid term character. Realisation will not be a task to solve in the near future, but needs to be a continually operated, strategically directed political process for many years.

The main technical package of measures which has to be supported even stronger in the future are the sustainable urban drainage systems (SUDS). Storm water management with respect to quantity and quality like decentralised infiltration structures and constructed wetlands for biological treatment and retention are favoured measures not only for new building areas. But for existing drainage systems realisation will be a middle to long term task. So in the short term only minor reductions of emissions are expected from these measures. Instruments to further prefer storm water infiltration in new built properties in comparison to conventional drainage systems are legal regulations, funding programmes and decentralized open storm drainage structures itselves as visible examples of attractively well designed and ecologically sound developments.

Another important measure is the further development of wastewater charges which follows the ‘polluter pays principle’. Compared to the German federal act additional pollutant parameters should be taken into account. For storm water effluents it is demanded that the charging has to be made equivalent to the point source discharges. In general charging rates has to be increased and negotiation possibilities should be restricted. By this means incentives to reduce pollutants at source are established and reductions of emissions are expected.

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