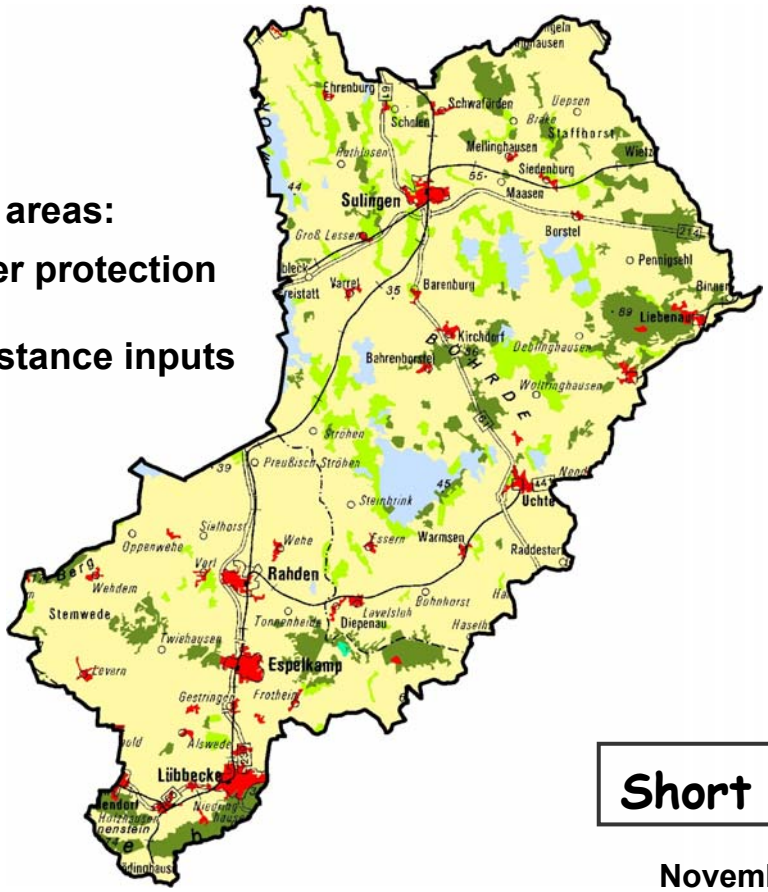
„GROUNDWATER PROTECTION FOR LARGE AREAS“

PILOT PROJEKT FOR IMPLEMENTING THE EC WATER FRAMEWORK DIRECTIVE - MODEL AREA „GROSSE AUE“-

Final Report Projekt II

Key project areas:

Groundwater protection
Agriculture
Diffuse substance inputs



Short Version

November 2003

Commissioned by: District Government Hanover • District Government Detmold

Ingenieurdienst Umweltsteuerung – INGUS • Hubertusstr. 2 • 30163 Hannover

prepared by: Dr. F. Antony & C. Lagemann-Kohnhorst

CONTENTS

1 REASONS, CONTENT AND PROJECT AREA

Reasons for the project

The EC Water Framework Directive (EC-WFD) – or "Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy" – entered into force on 22 December 2000. The objectives of the EC-WFD [COUNCIL OF THE EUROPEAN UNION, 2000] are to ensure "good status" in all surface waters (ecological and chemical status) and in groundwater (chemical and quantitative status) by 2015. The EC-WFD obliges the Member States to draw up management plans (inventory, monitoring programmes and programmes of measures) for river basin districts and to update them regularly. A tight and binding timetable is laid down for the management plans and the implementation of measures.

Compared with activities to date in drinking water extraction areas, the directive gives greater weight to groundwater protection, and now does so on a full-coverage basis. Against this background, the district governments of Hanover for Lower Saxony (NI) and Detmold for North-Rhine/Westphalia (NRW) made a start in 2000 on a inter-state "model" implementation of the EC-WFD in the "Grosse Aue" sub-basin of the Weser river basin. First results were yielded by Project I on model inventory taking, which was completed in March 2001 [F&N Umweltconsult *et al.*, 2001]. This showed that the ecological and chemical status of the surface waters diverged considerably from the target specifications, and the chemical status of the groundwater was classified almost without exception as poor.

Since the end of the 1970s, the agricultural sector has been regarded as a major contributor to diffuse substance inputs into the groundwater. Today these inputs, which have had an impact over large areas for decades, are reflected in many bodies of groundwater. Even today, the concentrations reaching the groundwater via the path "soil → seepage water" are still too high. The EC-WFD therefore specifies comparatively stringent environmental targets for groundwater, in order to bring about a reduction in diffuse substance inputs in the future.

For the "Grosse Aue II" project described here, this results in the project's thesis that the meeting the environmental targets for diffuse substances, and hence the success or failure of the EC-WFD in the groundwater sector, will to a very large extent depend on the creation, implementation and effectiveness of "programmes of agricultural measures". In other words, it will depend specifically on reductions in substance pollution resulting directly from fertilisers, plant protection agents etc., and also indirectly from drainage-induced release of substances from geogenic sources (e.g. low-lying areas). Early cooperation between the agricultural sector and water resource management will therefore have a central role to play.

Project content

The *Länder* NI and NRW have a great deal of experience in "cooperative protection of drinking water" (cf. also Anwender-Handbuch Wasserschutz, ANTONY et al. 2001). The workflow practised in drinking water extraction areas since the mid 1990s, namely "registration of areas (actual situation) → geographical priorities → formulation of objectives → development of measures → implementation of measures → review of results", corresponds in large measure to the workflow specified via the EC-WFD "inventory → environmental objectives → programmes of measures → implementation of measures → monitoring".

In view of these parallels, the inter-state pilot project "Groundwater protection for large areas" using the example of the "Grosse Aue" sub-basin tested a joint approach by the agricultural and water resource management sectors for a year. Before the end of the inventory lasting

until 2004, and in good time before the programmes of measures to be drawn up by 2009, socially acceptable and practically feasible approaches (scenarios) have been jointly developed.

A project support working group of representatives from the agricultural and water resource management sectors has ensured adequate practicability and acceptance of the project results. In line with Article 14 of the EC-WFD "Public information and consultation" and the recommendations in the "Guidance on participation" of "CIS Subcommittee 2.9", the establishment of the project support working group has thus made a major contribution to regional public participation at a very early stage.

The project was moderated and its content designed by the engineering consultants INGUS (Hanover), who can draw on many years experience in agricultural groundwater protection consulting under the Lower Saxony cooperation model.

The following key items of project content were dealt with:

1. Recommendations on the **inventory in relation to programmes of agricultural measures** (cf. Chapter 2).
2. The derivation of **environmental objectives for the groundwater**, differentiated by emission (pollution) and immission (environmental effect) (cf. Chapter 3).
3. **Programmes of measures for reducing nitrogen emission/immission levels from the agricultural sector** making use of the individual instruments of regulatory laws, market economy, cooperation, contract-based water conservation and counselling (cf. Chapter 4).
4. **Monitoring programmes** to describe the actual status with regard to substances and the effects of the measures implemented (cf. Chapter 5).

Steps 1 to 3 were first dealt with in general terms and subsequently applied on a model basis to a "selected body of groundwater" in the project area.

The project also put forward proposals for a corresponding addition to the LAWA working aid. This working aid was drawn up by the Joint Water Commission of the Federal States (LAWA), an alliance of the highest state authorities responsible for water resource management and water legislation, with a view to uniform implementation of the legal and technical requirements of the EC-WFD. Full details of the proposals for additions to the LAWA working aid are set out in the long version of the project report.

The full German version of this expertise "Final Report Project II" can be downloaded from www.bezirksregierung-hannover.de

The project area

The "Grosse Aue" project area is a sub-basin (working area) of the Weser river basin. However, the frame of reference for groundwater protection is the body of groundwater, which as defined in the EC-WFD as a distinct volume of groundwater within an aquifer or aquifers. The "Grosse Aue" working area encompasses a total of 5 bodies of groundwater.

In the context of this pilot project, the body of groundwater known as **"Grosse Aue unconsolidated porous aquifer, left"** was selected for model implementation of inventory taking, objective formulation and programmes of agricultural measures, and the key area "nitrate-related groundwater protection". The choice was made on the basis of its size (704 km^2), varied use structure (76% arable, 10% woodland, 7% grassland, 4% bog and wetlands, 3% settlement) and high groundwater concentration level (76 mg nitrate/l as average of all groundwater measuring sites) (Fig. 1).

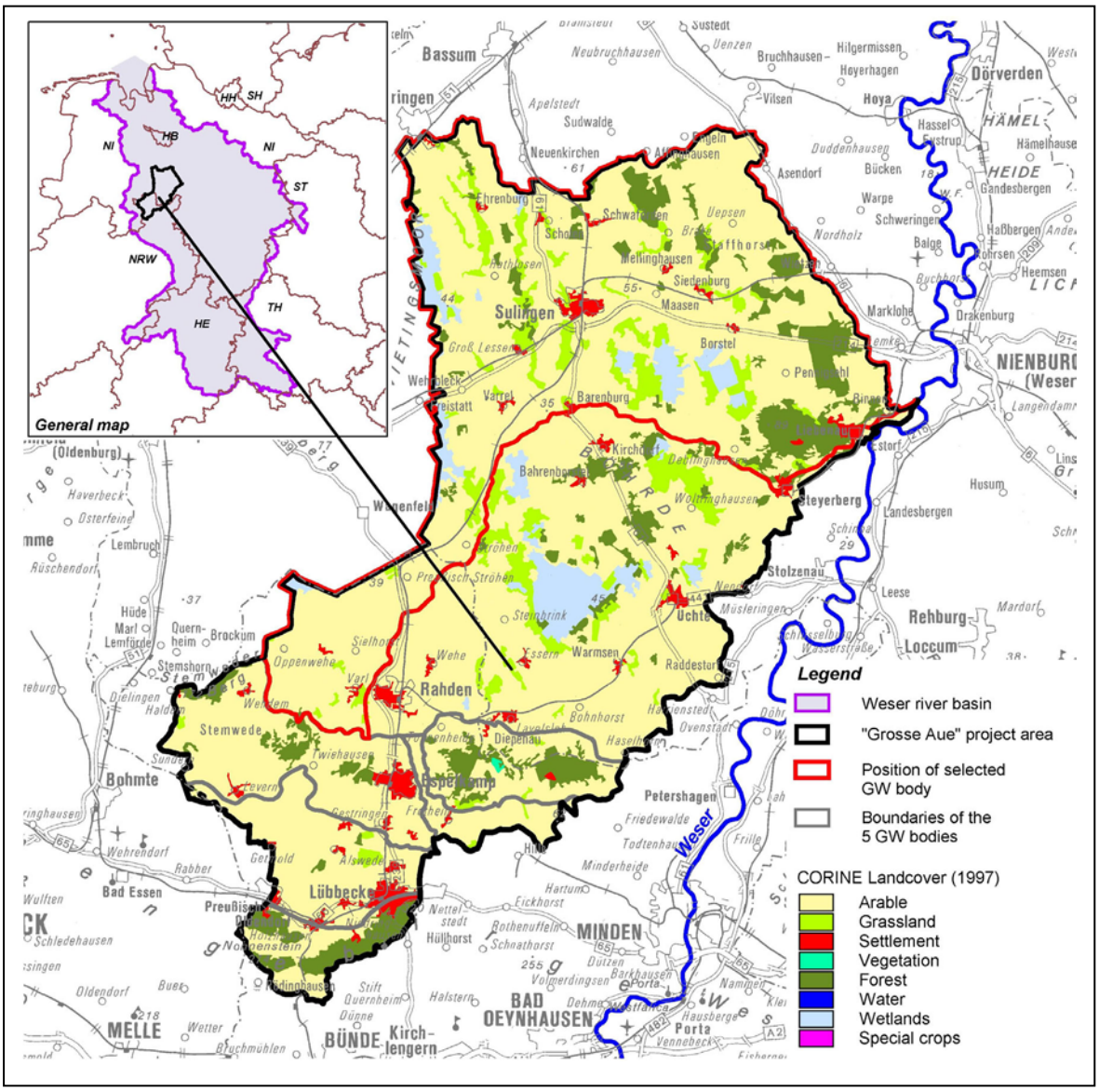


Fig. 1: Location of project area

2 Inventory in relation to Programmes of Agricultural Measures

The inventory is more than a compilation of data to identify “endangered bodies of groundwater”. It forms the basis for the subsequent working steps: formulation of objectives, monitoring and development of measures. It should take account of the groundwater protection priority of an entire body of groundwater and of any geographical priorities within a body of groundwater.

The purpose of the inventory of bodies of groundwater is to register emission, immission and site-specific data. The “initial characterisation” leads on to the “identification of endangered bodies of groundwater”. A “detailed analysis” (further characterisation and review of the impact of human activity on the groundwater) is made only for bodies of groundwater where the initial work indicates there is a risk that they will not meet the environmental targets. The discussion in the project support working group resulted in the following procedural recommendations (Fig. 2).

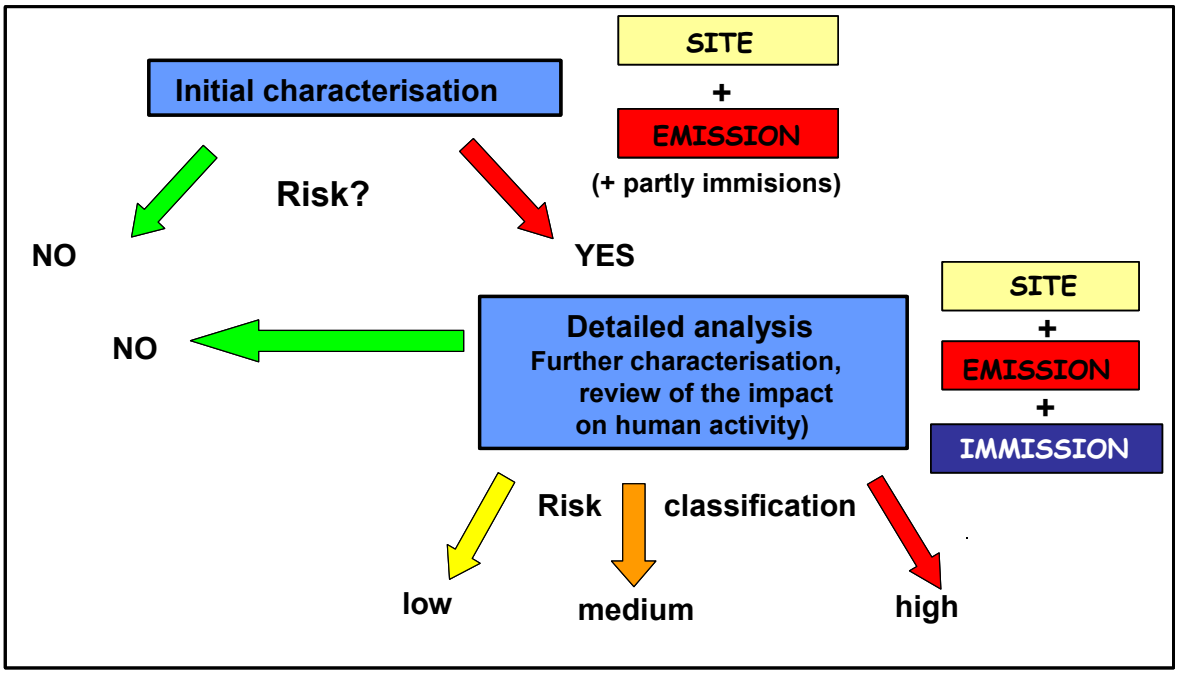


Fig. 2: Risk assessment and possible risk classification for bodies of groundwater at the inventory stage (proposal)

2.1 Initial characterisation

Description of pollution resulting from diffuse sources, and descriptive summary of land use

As a rule, the description of the land use situation is prepared with the aid of a digital geo-information system. When selecting such a system, care should be taken that it represents the proportion of farmland as accurately as possible, since the arable portion in particular is used in many procedural approaches to the identification of endangered bodies of groundwater. Although CORINE Landcover is an inexpensive data model with the merit of EU-wide harmonisation, it suffers from sizeable errors with regard to areas and from a lack of positional accuracy [BACH 2002]. It should therefore be used at most for the initial characterisation, but not for the further characterisation and subsequent planning of measures.

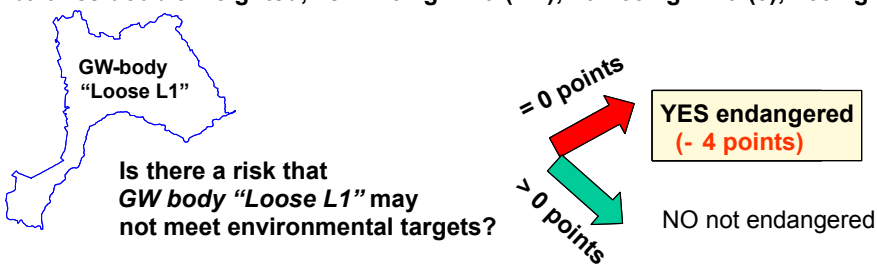
The net nutrient balance [e.g. after BACH *et al.*, 1999], as a direct parameter, is more suitable for a description of pollution due to diffuse sources (emission) in the agricultural sector than indirect parameters such as livestock numbers or the quantity of N due to organic manure.

Identification of endangered bodies of groundwater

On the basis of the initial characterisation it is necessary to decide whether there is a risk of its failing to meet the environmental targets and hence a need for a “detailed analysis”. During the project a proposal was drawn up for a risk assessment procedure for nitrate-related groundwater quality (Fig. 3).

In addition to agricultural emissions or immissions, adequate account is also taken of drainage-induced release of substances from “geogenic substance reservoirs” in groundwater dependent land ecosystems (e.g. nitrate or sulphate released from lowland bogs). This is a source of pollution that is frequently underrated.

Criteria	Risk of not meeting environmental targets			Assess-ment scores
	Low (+ 1)	Medium (0)	High (- 1)	
1. Aquifer type	*Pore aquifer*	Joint aquifer	Karst aquifer	*+ 1*
2. Character of confining strata [1)]	favourable	moderate	*unfavourable*	*- 1*
3. Groundwater dependent land as % of ecosystem area	< 5%	5 – 15%	*> 15%*	*- 1*
4. Diffuse sources and land use				
4.1 Arable as % of total area	< 25%	25 – 50%	*> 50%*	*- 1*
4.2 Mean N balance for area	< 20 kg N/ha	20 – 50 kg N/ha	*> 50 kg N/ha*	*- 2*
* N balance double weighted, i.e. < 20 kg N/ha (+ 2); 20 - 50 kg N/ha (0); >50 kg N/ha (-2)				*? - 4*



1) Most classifications in Lower Saxony and North-Rhine/Westphalia are unfavourable!

Fig. 3: Method for identifying endangered bodies of groundwater (risk assessment) in terms of groundwater quality on the basis of the "initial characterisation" and its implementation (proposal)

Result for the selected body of groundwater in the "Grosse Aue" project area:

Applying the proposed method (cf. right-hand column of Fig. 3) to risk assessment leads to the following result for the selected body of groundwater: In spite of the fact that the aquifer in question is sandy and porous, there is a risk that the selected body of groundwater will not meet the environmental target (nitrate-oriented groundwater quality) in view of gaps in the overlying strata, approx. 25% by area of groundwater dependent land ecosystems, 76% arable area (according to CORINE Landcover), and an average net nitrogen balance of 92 kg N/ha for all land uses in the area (after BACH *et al.*, 1999, for agricultural areas; estimated values for other uses). This means it must be classified as endangered and must therefore be subjected to a "detailed analysis".

2.2 Detailed analysis

2.2.1 Further characterisation

Registration of more differentiated site-specific data permits better risk assessment and hence targeted proposals for measures. This results in a more regional approach and better geographical determination of priorities.

2.2.2 Review of the impact of human activity on the groundwater

Land use

In the interests of the required data accuracy, a powerful geo-information system that represents agricultural land use as accurately as possible should, as described in Chapter 2.1, be used not later than when reviewing the impact of human activity on the groundwater. ATKIS figures have proved particularly suitable for use in Germany [BACH 2002].

Emissions

To review the impact of human activity – in this case farming – on the groundwater, a representative survey of farm-gate level is proposed on the basis of the bookkeeping figures of an agricultural test farm system. This makes it possible to take account of the important balance input quantity "mineral fertiliser input" on the basis of real figures. This figure is merely estimated in the determination of nutrient surpluses by means of area balances after BACH *et al.*

Agriculture

In addition to the net balances of an agricultural test farm system, a list of direct and indirect balance parameters (cf. Table 1) should also be prepared. It is also recommended that a compilation be made of supplementary information on land management (land use, soil cultivation, fertiliser, farming restrictions). Not only would both be useful for finding the causes of elevated emissions and immissions, but are they also a precondition for separate monitoring of the results of programmes of agricultural measures in the required management plans.

Tab. 1: Parameters in the fields of nutrient balances and agricultural land management for describing nutrient emissions in the agricultural sector

Nutrient Balances		Land Management
Net balances	**Balance parameters**	
▪ Net nitrogen ▪ Net phosphorus ▪ Net potassium (balances on the level of parcels or entire farms)	Direct: ▪ Organic manure input ▪ Mineral fertiliser input ▪ SRM fertiliser input ▪ Yield (development) Indirect: ▪ Livestock numbers	Land uses: ▪ Arable (% of farmland) ▪ Special crops (% of farmland) ▪ Arable crop distribution ▪ Catch cropping ▪ Fallow (% of farmland) Soil cultivation Fertiliser: ▪ Slurry storage capacity ▪ Application machinery for organic manure Farming restrictions: ▪ Areas with contractual restrictions on fertiliser

SRM = secondary raw material

With a view to the development of programmes of measures, a number of additional items of information on farms should also be compiled, e.g. number, size, type, livestock farming etc.

Immissions

Another element in reviewing the impact of human activity on the groundwater is describing the immissions by evaluating groundwater analysis data. However, assessment problems frequently arise from uneven distribution and a lack of systematisation of the measuring sites.

2.2.3 Inventory of protected areas

It is recommended that the choice of protected areas be made not solely on the basis of aquatic protection targets, but also with a view to achieving synergies with other protection goals (e.g. nature conservation, soil protection). As a whole, this step should also form the basis for setting geographical priorities for the programmes of measures.

2.2.4 Determining groundwater protection priority for a body of groundwater

The initial characterisation first leads to a preliminary determination of the endangered bodies of groundwater, i.e. to an examination of whether there is a risk that the environmental targets may not be met (Section 2.1). On the basis of the "detailed analysis" (further characterisation and review of the impact of human activity on the groundwater), this first risk assessment is verified and given a more regional focus. In the interests of developing programmes of measures that are as effective and cost-efficient as possible, it would also seem sensible to undertake on the basis of the "detailed analysis" a **graduated risk classification regarding the achievement of targets**, or conversely a determination of groundwater protection priority (graduated in terms of "low – medium – high"). Fig. 4 shows a proposed method from the project.

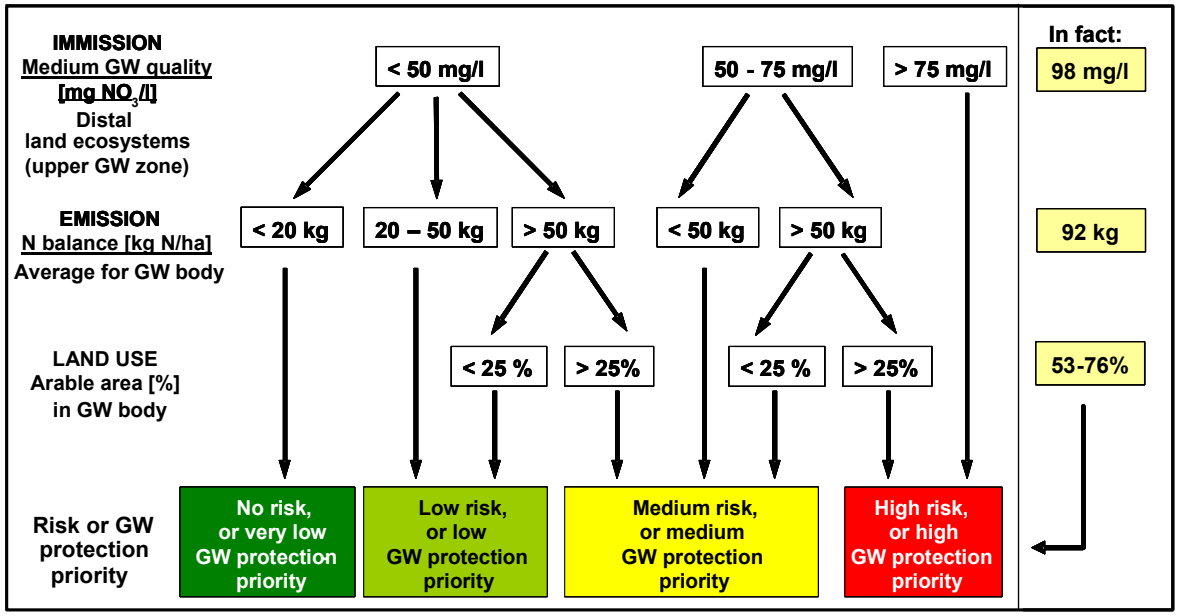


Fig. 4: Method for graduated risk classification and derivation of the groundwater protection priority of a body of groundwater for the example of nitrate, and its use (proposal)

Result for the selected body of groundwater in the "Grosse Aue" project area

Using the proposed method (cf. right-hand column of Fig. 4) to arrive at the groundwater protection priority on the basis of the "detailed analysis" reveals a **high groundwater protection priority** for the selected body of groundwater, with > 75 mg NO_3/l in the groundwater (exactly 97 mg/l as the mean of 95 measuring sites in the distal sandy pore aquifer), a mean net nitrogen balance of > 50 kg N/ha for all land uses (exactly 92 kg N/ha calculated after BACH *et al.*, 1999) and > 25% arable land use (52 % after ATKIS or 76 % after CORINE Landcover) in the area.

2.2.5 Setting geographical priorities within a body of groundwater

In addition to assessing the groundwater protection priority of a body of groundwater, there is often a need for geographically differentiated prioritisation within a body of groundwater to ensure optimum effectiveness and efficiency in subsequent programmes of measures. This applies particularly to bodies of groundwater with medium to high protection priority.

A decisive factor regarding the suitability of the criteria to be used here is in the first instance a corresponding basis of data covering the whole area. The criteria should result in adequate, but not excessive, geographical differentiation. One frame of reference that suggests itself for practical purposes is the geographical classification of natural landscapes. These landscape units can then be described with the aid of further information on the principal site conditions, emission and immission etc.

2.2.6 Suitability of inventory data

There are considerable variations in the suitability of the inventory data for the subsequent steps in preparing programmes of measures.

The **site data** (geological and hydrogeological characterisation, groundwater protection potential of overlying strata, pedological description, potential nitrate discharge risk, groundwater dependent land ecosystems, protected, priority and precautionary areas, physical classification of natural areas) are particularly suitable for **"determining groundwater protection priority"** and **"setting geographical priorities"**.

Land use data (land use distribution, crop ratios for arable land, percentage of special crops, catch crops, fallow land) are particularly suitable for **"planning and designing measures"**.

Emission data (net nitrogen balance, organic and mineral fertilisers, use of SRM fertilisers, organic manure storage capacity, application machinery, livestock numbers, farm type) should also be used primarily for **"planning and designing measures"**.

Existing **immission data** (groundwater quality, seepage water quality) are suitable for **"determining groundwater protection priority"**, but owing to a frequent lack of data density they can hardly be used for "setting geographical priorities" or for "designing measures".

3 ENVIRONMENTAL OBJECTIVES

3.1 Objectives according to EC-WFD

According to Article 4 of the EC-WFD, a good chemical and quantitative status of the groundwater is to be achieved for the area relating to a body of groundwater. The proposal for a "Directive of the European Parliament and of the Council concerning the protection of groundwater from pollution" (directive pursuant to Art. 17 of the EC-WFD) suggests a quality standard of 50 mg/l for nitrate. If this is not exceeded, the groundwater is considered to possess suitably good chemical status.

3.2 Specification of the environmental objectives for bodies of groundwater

3.2.1 Differentiation of emission and immission objectives for agricultural and geogenic nitrogen sources

As early as the inventory stage, a distinction should be made between emission (pollution or risk) and immission (environmental effect). By contrast, the EC-WFD (Art. 4) sets out only

immission-oriented objectives for the status of bodies of water. Particularly in the field of groundwater protection, however, there is a need for the most precise specifications possible for agriculture and other diffuse nitrogen sources, for which emission criteria are much better suited than immission criteria.

For many environmental substance fields it is true to say that little or no quantifiable relationship exists between emission and immission. Thus it is not easy to calculate the resulting seepage water quality or groundwater quality on the basis of the net nitrogen balance and the seepage water rate. As a result, objectives must be formulated separately for emission and immission, and environmental monitoring programmes should always include an emission monitoring and an immission monitoring component (cf. Chapter 5).

3.2.2 Emission criteria and objectives

Agricultural nitrogen sources

In view of the need described above for maximum possible precision of targets for agriculture, the topic of emission criteria and objectives was the subject of thorough discussion in a separate *ad hoc* working group on “Environmental objectives and monitoring for agriculture”. The net nitrogen balance on the basis of farm-gate figures was regarded as particularly suitable. The *ad hoc* working group points out that any definition of agricultural emission objectives should only be undertaken subject to the limiting condition that the agricultural sector continues to exist.

To illustrate the process of arriving at the objectives, the “emission arrow” shown in Fig. 4 was devised. The change of colour from red to green symbolises a decreasing net nitrogen balance. Experience shows that there is currently a great deal of variation in the net nitrogen balance figures for farms, and that they do not always satisfy the level of “Good Agricultural Practice” (GAP). Consequently the agricultural sector first has to ensure the implementation of GAP. Owing to site-specific and farm-specific factors, this does not correspond to a fixed emission value (e.g. nitrogen balance), but a specific range of values.

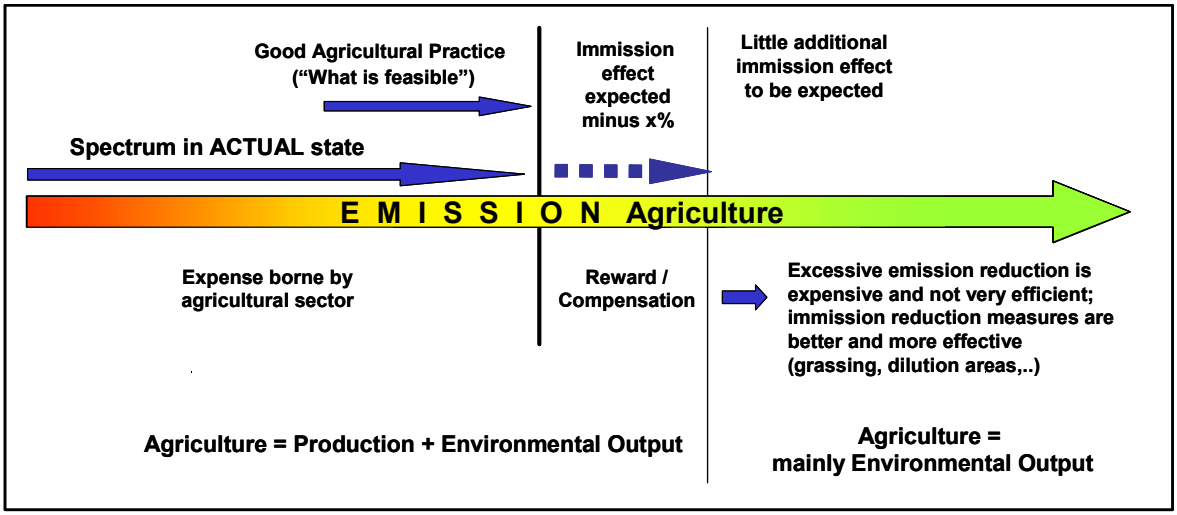


Fig. 5: Average emission objective (e.g. N balance in this case) for agriculture (proposal)

It may be assumed that a further reduction of x% in nitrogen surpluses (into the suboptimal range from a business management point of view) would still result in a certain reduction in immission levels. Such a step, however, certainly calls for a reward or compensation for the farmer, since it goes beyond the requirements of Good Agricultural Practice. After a certain point, merely reducing nitrogen emissions is hardly efficient any more in view of the

uncertainty of the reduction in immission levels. Beyond this point, an extreme reduction in emission levels is expensive, because it is no longer compatible with agricultural production. Instead of excessive emission reductions, therefore, increased use should be made of immission reduction measures (e.g. planting, reduced soil cultivation).

Geogenic nitrogen sources

The initial objective for geogenic nitrogen sources is: conserving nitrogen reservoirs so that as far as possible there is no increase in the release of nitrogen. In addition, however, the nutrient retention and nitrate degradation capacity of low-lying areas that is closely linked with organic matter (denitrification potential) should be maintained or, after weighing up the risks, reactivated.

3.2.3 Immission criteria and objectives

An essential criterion for the formulation of immission objectives for **agricultural nitrogen sources** is groundwater quality. This, however, can only mean the quality of young groundwater close to the surface. Whereas the establishing correspondences between groundwater quality data and individual land uses is often problematical owing to movements and mixing of groundwater, seepage water quality, i.e. nitrate concentration in soil water in the "unsaturated zone", can be clearly assigned to land uses or land areas.

Owing to long seepage water residence times, for example, it will probably not be possible to bring about good chemical status (assumption: < 50 mg NO_3/l) in all bodies of groundwater by 2015. Reasons must be given in the individual case for any extension of deadlines or even for the formulation of "less stringent objectives". Apart from this, however, a first assessment of the probability of timely achievement of the objectives can be made on the basis of the risk classification or groundwater protection priority of a body of groundwater (see Section 2.2.4). A relevant proposal for arriving at the immission objectives for a body of groundwater is shown in Fig. 6.

<table>
<tr><td></td><td colspan="8">Risk of failure to meet environmental target / GW protection priority</td></tr>
<tr><td></td><td>NO</td><td colspan="2">YES - low</td><td colspan="3">YES - medium</td><td colspan="2">YES - high</td></tr>
<tr><td><u>ACTUAL situation</u>
Mean for GW body
1. Immission:
GW quality [mg NO_3/l]
2. Emission:
N balance [kg N/ha]
3. Arable area [%]</td><td rowspan="3">Safeguard</td><td>Case 1
< 50 mg/l
+
20-50 kg</td><td>Case 2
< 50 mg/l
+
>50 kg
+
< 25%</td><td>Case 1
< 50 mg/l
+
>50 kg
+
> 25%</td><td>Case 2
50-75 mg/l
+
< 50 kg</td><td>Case 3
50-75 mg/l
+
>50 kg
+
< 25%</td><td>Case 1
50-75 mg/l
+
>50 kg
+
> 25%</td><td>Case 2
>75 mg/l
-</td></tr>
<tr><td><u>GOAL immission</u>
2015</td><td colspan="2">Maintain < 50 mg/l</td><td>Maintain <50 mg/l</td><td colspan="2">Reversal of trend (extension of deadline)</td><td colspan="2">Reversal of trend</td></tr>
<tr><td>2027</td><td colspan="3">Safeguard</td><td colspan="2">< 50 mg/l</td><td colspan="2">Less stringent targets achieved</td></tr>
<tr><td>> 2027</td><td colspan="3">Safeguard</td><td colspan="2">Safeguard</td><td colspan="2">< 50 mg/l?</td></tr>
</table>

Fig. 6: Derivation and use of the immission target for a body of groundwater in the light of the risk assessment and/or the groundwater protection priority (proposal)

Result for the selected body of groundwater in the "Grosse Aue" project area

The use of the proposed method of arriving at the immission target shows that for the selected body of groundwater, with its high risk of non-achievement of the environmental objectives or conversely with its high groundwater protection priority (> 75 mg NO_3/l in the groundwater), a reversal of the trend can probably be achieved by 2015, "less stringent targets" can be met by 2027, and the environmental objective of 50 mg NO_3/l laid down by the nitrate directive cannot be achieved before 2027.

4 PROGRAMMES OF MEASURES FOR REDUCING NITROGEN EMISSION AND IMMISSION LEVELS IN THE AGRICULTURAL SECTOR

4.1 Basic agricultural policy conditions (Common Agricultural Policy – CAP)

4.1.1 Current situation

The economic framework conditions for agriculture in Germany and the entire European Union are currently strongly influenced by the Common Agricultural Policy (CAP) of the European Union. A major element of the CAP is the market organisation with its range of instruments: intervention prices, monetary compensation amounts, quotas and set-aside schemes. In addition to this first pillar of "market organisation", a "regulation for rural areas" was enacted and is regarded as a second pillar. As well as promoting agricultural structure, it also serves to fund environmental measures in the agricultural sector. However, the second pillar is less important than the market organisation. In the EU as a whole it accounts for only about 10% of EU agricultural expenditure, and in Germany about 18% [OSTERBURG, 2002], though the trend will be rising in the future.

4.1.2 Optimisation of framework conditions ("mid-term review")

Agricultural market policy is made at national and international level, so region-specific modifications aimed at water conservation are out of the question. The mid-term review presented by the EU Commission in July 2002 is keyed to achieving a sustainable, i.e. competitive and environmentally sound, agricultural sector. The goal of ecological sustainability is to be achieved by means of

- reallocation of funds from the first to the second pillar of the CAP,
- increased integration of environmental aspects into the first pillar of the CAP.

Assessment / recommendation of the working group and the project contractor

It has to be said that the existing design of the first pillar of the CAP has had a decisive influence on the economic framework conditions in the agricultural sector, and that it gives rise, on a fairly random basis, to both negative and positive environmental effects of agricultural production. By means of increased future integration of environmental aspects in the organisation of the market, the intention is to largely avoid existing negative environmental effects and to maintain and develop positive effects. However, for various reasons the first pillar of the CAP is not suitable as a targeted control instrument for water conservation.

- The design of the market organisation within the CAP is uniform throughout the EU and does not permit any modifications geared to national, let alone regional, conditions with regard to water conservation.

- Not all areas of agricultural production are subject to the market organisation of the CAP, which means that no influence, or at best indirect influence, is possible for the fields not covered (e.g. pig and poultry production).
- The goal of Agenda 2000 is to bring European agriculture closer to world market conditions. Consequently one can expect to see a decline in use of the instruments of market organisation, which means that in the long term the importance of increased environmental integration in the first pillar must not be over-estimated.

Thus targeted environmental services by the agricultural sector can only be implemented and financed via the second pillar of the CAP (cf. also Working Document ENV.B1: "The Water Framework Directive (WFD) and tools within the Common Agricultural Policy (CAP) to support its implementation").

4.2 Instruments for reducing nitrogen due to agriculture

A wide range of instruments are available for programmes of measures designed to reduce agricultural emissions and/or immissions of nitrogen. These instruments can be divided into the following five groups: regulatory law, market economy instruments, cooperation models, contract-based water conservation, and counselling and education.

4.2.1 Regulatory law

The instruments of regulatory law consist largely of approval regulations (e.g. licensing, registration or notification procedures), prohibitions (e.g. ban on ploughing up grassland), and restrictions (e.g. restrictions on the use of organic farmyard manure). As a rule, control and monitoring measures are used to improve implementation of the regulatory requirements. In practice, regulatory requirements are imposed largely through the Fertiliser Ordinance enacted to implement the Nitrate Directive, through more stringent requirements and/or improved implementation of Good Agricultural Practice, and through the designation of protected areas with corresponding conditions for farming.

Article 11 of the EC-WFD lays down "basic" measures (minimum requirements) and possible "supplementary" measures for the programmes of measures. **Basic measures** open up the possibility of legal restriction (prohibition, approval, registration) of emissions with regard to pollution from diffuse sources, except as otherwise provided by Community law. In certain circumstances **supplementary measures** may be necessary to achieve the environmental objectives of the EC-WFD. The non-exhaustive list of supplementary measures (Annex VI) includes legislative instruments, emission controls and codes for Good Agricultural Practice, but does not go on to explain these at all. The Member States evidently enjoy great freedom of action in this respect.

Assessment / recommendation of the working group and the project contractor

Regulatory provisions are only suitable for specifying nationwide minimum standards for GAP. As a rule, however, failure to take account of farm-specific and site-specific conditions results in failure to achieve more far-reaching environmental effects. Regulatory provisions continue to meet with little acceptance from the agricultural sector, which in turn has an adverse impact on their implementation. It would seem to be more important to ensure improved implementation of regulatory minimum standards by stepping up counselling and, where appropriate, more checks on GAP.

Ordinances designating bodies of groundwater as protected areas (groundwater body regulations) should basically only be considered for bodies of groundwater that are regarded

as high priority (high risk, or non-achievement of environmental objective) on the basis of the "detailed analysis", and whose groundwater resources are already being used for drinking water purposes (water conservation areas) or will be in the future (water extraction areas).

4.2.2 Market economy instruments

In Section 4.1 we have already drawn attention to the market organisation of the CAP (Common Agricultural Policy) as an important economic factor with both negative and positive effects. However, the market organisation is not an instrument for targeted control of the environment. On the other hand there are numerous market economy instruments that can be used to integrate the costs of using the environment into the deliberations of the actors on the market. Market solutions include allocating rights of disposition, imposing public charges that influence the actions of individual businesses, or granting material benefits for environmentally friendly products and processes.

Market economy solutions are often closely connected with regulatory instruments, since they depend on certain legal provisions or are designed to bring about better implementation of regulatory requirements.

Assessment / recommendation of the working group and the project contractor

Certain market economy instruments, such as the mineral N quota or the charge for excess nitrogen balance, can be credited with comparatively high ecological efficiency on the emissions side, but there is no evidence of any immission-reducing effect. Their implementation usually involves considerable administrative and control input. Other instruments, by contrast, such as the tax on mineral nitrogen, can be introduced more easily. As a rule, however, their ecological effect is not very targeted. Frequently there are no rewards for environmentally friendly production of products, because the resulting additional cost prevents them from finding favour with the consumer. It must also be borne in mind that the use of market economy instruments cannot be restricted to individual fields, as this could give rise to distortion of competition.

4.2.3 Cooperation models

Unlike regulatory instruments, models involving cooperation between the agricultural and water resource management sectors are based on the principle of voluntary arrangements. There are various objectives behind the establishment of such alliances:

- Reconciliation of conflicting interests.
- Creation of a basis for trust, individual responsibility and participation. This is very much in line with the participation requirements of the EC-WFD.
- Making use of local knowledge in identifying causes and developing and modifying measures (regionalisation).
- Identification of the agricultural sector with environmental problems and objectives.

Geographical frame of reference

On a model basis and as a proposal, the cooperation concept shown in Fig. 7 was drawn up under the project with two geographical frames of reference: "Groundwater region" ("framework cooperation") and "Individual bodies of groundwater or groups of groundwater bodies" ("regional alliances"). As a rule, "groundwater regions" cover two or more management areas for surface waters, which means that a common frame of reference for groundwater and surface waters is ensured at this level.

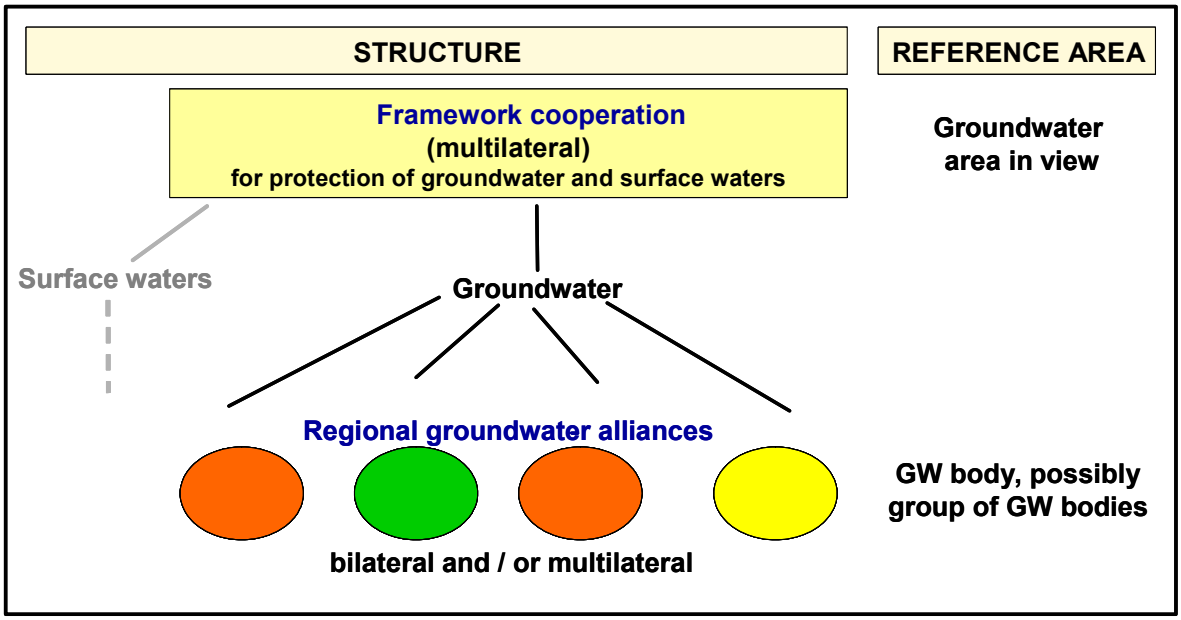


Fig. 7: Structure and geographical frame of reference of groundwater protection alliances (proposal)

Functions

The work of **framework cooperation** comprises:

1. Preparing funding concepts
2. Coordination and practical support for regional alliances
3. Exchange of information between regional alliances
4. Interdisciplinary (multilateral) cooperation between the relevant actors
5. Interdisciplinary area management of all individual measures in the region
6. Public relations work

The activities of **bilateral regional alliances** (water management and agriculture) are:

7. Discussing and recommending area-specific groundwater protection measures
8. Participation in water protection counselling concepts
9. Discussion and recommendation of results monitoring methods

If such arrangements are expanded to **multilateral regional alliances**, the range of activities at regional level is joined by items 3 to 6 from framework cooperation.

Members

In addition to representatives of the agricultural and water resource management sectors in the bilateral alliances, multilateral alliances also include other – local – actors (e.g. nature conservation, flood control, forestry). Framework alliances may be expanded to include environmental associations, regional marketing groups etc. Their business coordination could be handled on the lines of a **regional management** by the district governments or by comparable regional and intermediate bodies. These would then have the function of a focusing and coordinating authority and of a mediator between state (*Land*) policy and regional interests. The technical handling and coordination of a framework alliance, on the other hand, should be undertaken by external service providers.

Assessment / recommendation of the working group and the project contractor

The project contractor and the working group in particular attach great importance to the establishment of alliances as an instrument of full-coverage groundwater protection. It effectively implements the process of public participation that is called for in the EC-WFD. Alliances are dynamic and flexible, i.e. capable of taking direct action in the face of new problems. This has been demonstrated by many years' experience of working in water conservation areas. It must however be noted that strict regulatory provisions are not compatible with a cooperative approach, i.e. the principle of voluntary cooperation. By contrast, the regional alliance model is particularly well suited to the implementation of contract-based water conservation.

4.2.4 Contract-based water conservation for parcels and entire farms

Apart from the production of foodstuffs or renewable raw materials, society demands numerous environmental services from the agricultural sector which go beyond the minimum standard required by regulatory law, and which are in some cases characterised by a lack of marketability or a non-existent market. These include a number of water protection measures, the implementation of which consequently depends on suitable (state) promotion. One suitable instrument is "contract-based water conservation", i.e. voluntary contractual agreements with the farmer on a defined environmental service and corresponding financial rewards.

In Germany, practical experience regarding contract-based water conservation exists primarily in water extraction areas. Here water supply companies and farmers sign "voluntary agreements", e.g. for the growing of non-leguminous overwintering catch crops. The agro-environmental programme measures offered by the individual *Länder* under Regulation (EC) 1257/1999 concerning the promotion and development of rural areas (second pillar of the CAP), and more recently by means of modulation measures as well, may also be regarded as a form of contract-based water conservation provided they serve the ends of water conservation.

Table 2 shows examples of tried and tested measures for reducing nitrate inputs into the groundwater. The list is a selection of measures specific to individual areas for groundwater-conserving management of arable land and grassland. Other measures, such as conversion to organic farming or investment assistance for increasing slurry storage capacity or for precise application of organic manure, relate to the farm as a whole.

Amount of reward or compensation

Under Art. 24 of Regulation (EC) 1257/1999 on rural development, subsidies for agro-environmental programmes are intended not only to cover the loss of income and the additional costs resulting from the obligation, but also to provide the necessary incentive. Such an **incentive component** would appear to be necessary to increase the acceptance of measures that involve serious interference with production workflows. Examples of this include groundwater-conserving crop systems and the conversion of arable land into grassland. Consideration should also be given to an appropriate **regional differentiation** of the amounts of reward or compensation, e.g. keyed to groundwater protection priority, with a view to improving acceptance and achieving targeted steering into specific areas.

Tab. 2: Ecological effect, costs and economic efficiency of water conservation measures for reducing nitrogen emissions/immissions (examples)

	Measure	Groundwater protection effect / Ecological effectiveness [1]					
			Emission		Immission		Envir. scores [2]
			N balance field balance [kg N/ha]	Autumn Nmin [kg N/ha]		SW quality [mg NO_3/l]	+1 bis +5
	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*
Individual area (field)	**1. Fertiliser**						
	Use of special fertilisers (e.g. N-stabilised) on light soils	X	by 0 to 20	-	X	by 10 to 30	+1
	2 Soil cultivation (reduced and avoided)						
	Mulch sowing of winter cereal (single shallow tillage)	X	-	by 10 to 15	X	by 15 to 30	+1
	No stubble cultivation in autumn before summering	X	-	by 20 to 40	X	? (by 35 to 70)	+2
	3. Production system						
	Special groundwater conserving crop systems (crop rotation, fertiliser, soil cultivation)	X	by 20 to 40	down to < 40	X	down to < 80	+3
	4. Planting (non-leguminous)						
	Catch crops (overwintering)	X	by 0 to -40	by 20 to 60	X	by 30 to 100	+3
	Conversion of arable land into grassland without extensification	X	-	down to < 50	X	down to < 50	+4

[1] **Ecological effectiveness:** X = Can be expected to have effect on emission or immission

[2] **Environmental scores:** +1 very slight to +5 very strong improvement compared with Good Agricultural Practice

Assessment / recommendation of the working group and the project contractor

The instrument of contract-based water conservation permits the regionalisation called for in the EC-WFD ("regional and local programmes of measures"). The clearly defined and binding content of such contracts guarantees the changes in behaviour necessary to achieve the environmental objectives. For the majority of measures there is a possibility of monitoring compliance and environmental effects (results monitoring). Contract-based water conservation measures may be modified at any time without any great administrative input, if needed and in the light of new findings. They are thus highly flexible.

4.2.5 Counselling and education

General agricultural counselling – agro-environmental counselling

Over the years the environmental protection demands on agriculture as Germany's biggest land user, with a wide variety of impacts on diverse environmental assets, have grown steadily. First, there is a need to cater for this situation by suitable inclusion of environmental topics in vocational training and upgrading in the agricultural sector. There is also a need for agro-environmental counselling with a standing similar to that of production counselling, with functions and tasks going beyond those of general agricultural counselling.

Unlike general agricultural counselling, demand from farmers for agro-environmental counselling is confined to certain specific topics. In order to achieve positive environmental effects, however, there is also a need for active advice on the availability of other items of environmental counselling content. However, active agro-environmental counselling of this kind can only be established with the aid of financial assistance.

Counselling content / education content

The functions and tasks of "agro-environmental counselling for groundwater conservation" result in the following list of content items:

- Raising awareness of water conservation by providing information on ecological impacts of agricultural production methods
- Implementation of regulatory requirements going beyond GAP

- Introduction of and support for farm audit systems
- Optimisation of farm-level nutrient management (fertiliser, feeding)
- Use and interpretation of analyses accompanying counselling
- Establishment of production methods for the individual farm that conserve surface waters
- Transfer and testing of research findings (including feedback to scientific circles)
- Negotiation of and advice on contract-based water conservation measures
- Development of area-specific and farm-specific groundwater conservation measures

Counselling instruments

The instruments of agro-environmental counselling and education essentially correspond to those of general agricultural counselling. Depending on the number of recipients and the depth of detail for the individual farm, they can be differentiated into “Sectoral counselling and education”, “Group counselling” and “Farm-level counselling and supplementary analysis”.

Institution responsible for agro-environment counselling on water conservation

There are various fundamentally different models for institutions responsible for agro-environmental counselling in the field of groundwater protection, regardless of the question of public or private operation:

- Separate bodies for general agricultural counselling and agro-environmental counselling.
- Agro-environmental counselling as a function of the existing official agricultural counselling
- Office-sharing with specialist advisors for existing key aspects of general agricultural counselling, plus additional specialist agro-environmental counsellors

Assessment / recommendation of the working group and the project contractor

It is recommended that a system of “active agro-environmental counselling” keyed to the medium of water (and possibly other environmental media) be established in the form of competing independent counselling bodies. For example, technical back-up counselling could achieve a considerable improvement in the effectiveness of agricultural environment programmes.

4.3 Suitability, use and design of the individual instruments

On the basis of the description of the instruments of nitrate-related groundwater protection and their effectiveness and encroachment intensity in Sections 4.2.1 to 4.2.5, and practical experience in various EU countries (primarily use of individual instruments such as regulatory law, usually in conjunction with market economy instruments), we can draw the conclusion that the suitability of the individual instruments also depends on the individual risk of failure to meet the environmental targets or on the groundwater protection priority of a body of groundwater. It becomes clear that despite certain differences in suitability, the individual instruments on their own are generally only suitable for achieving environmental objectives if the groundwater protection priority is low. Given medium groundwater protection priority the individual instruments are only of limited suitability. Where groundwater protection priority is high, they cannot by any means be classified as sufficiently suitable. Thus if groundwater protection priority is medium to high, there is a need to **optimise the effect of the individual instruments by using them in combination**. The combination of measures depending on groundwater protection priority in Table 3 is only one of many possibilities, and is to be seen as a suggestion.

Tab. 3: Combination of instruments for reduction of agricultural nitrogen inputs as a function of the groundwater protection priority of a body of groundwater (proposal)

GW protection priority	Instruments for reducing agricultural nitrogen				
	Agro-political framework conditions	Regulatory law	Cooperation	Contract-based water conservation	Counselling / Education
No; safeguard	1. Integration of environmental aspects in first pillar of CAP 2. Cross-compliance 3. Promotion of quality assurance systems 4. Consumer information / PR work	Possibly modify legal basis for Good Agricultural Practice; improve implementation of GAP	-	-	Official counselling
low			Framework cooperation	-	+ Sectoral counselling and education on water counservation
medium			+ Regional alliances for GW bodies	Measures with high expenditure efficiency for GW protection	+ Group counselling, establishment of demonstration areas and farms
high		+ If necessary, ordinance on GW bodies	+ Possibly local alliances for sub-areas	+ Measures with lower expenditure efficiency but high effectiveness	+ Individual farm counselling; moderation and coordination

4.4 Planning instruments

Due to the amendment/revision of the German Water Resources Management Act *(Wasserhaushaltsgesetz – WHG)* that was necessary to transpose the EC-WFD into national law, the management plan will in future be the principal planning instrument for water resource management.

In certain circumstances, regional plans for water resource management in general, and specifically for the implementation of the EC-WFD, may conflict with the plans of other use interests such as nature conservation or agriculture. Against this background, suitable planning instruments should be used to resolve conflicting uses and to take advantage of any synergies. Aspects of particular relevance here are development plans for agricultural structure, and land consolidation. Like all planning instruments, these too require a certain lead time and should therefore be considered at the earliest possible stage in the implementation of the EC-WFD.

4.5 Funding recommendations

Qualified and at the same time attractively financed agro-environmental programmes that are largely implemented and co-financed through the second pillar of the Common Agricultural

Policy (CAP) can be particularly important for full-coverage groundwater protection. They are based on the following programmes:

1. Programmes for the development of rural areas on the basis of Regulation (EC) 1257/1999

On the basis of this regulation, agro-environmental measures are largely designed by the states *(Länder)*. A financial contribution at national level comes from the "Joint Task of Improving Agricultural Structures and Coastal Protection". Other financial measures possible under Regulation (EC) 1257/1999 include compensation for lack of income in areas with environment-specific restrictions under EU law, and assistance for farm counselling. For some years state-specific programmes relating to agro-environmental measures (e.g. PROLAND in Lower Saxony) have been drawn up and implemented through the rural development plans required under the regulation.

2. Programmes based on the Act concerning the Modulation of Direct Payments under the Common Agricultural Policy (Modulation Act)

The shift of funds away from market support (first pillar of CAP) towards the promotion of rural areas (second pillar of CAP) opens up the possibility of developing and implementing state-specific agro-environmental measures. These may be an effective instrument for influencing large-scale groundwater protection. At present, however, there is frequently a lack of the necessary binding character for groundwater protection and targeted direction towards the priority areas. More targeted design of the measures is needed with regard to improving groundwater quality (cf. also Section 4.6).

Assessment / recommendation of the working group and the project contractor

The following proposal is made regarding the funding of groundwater protection measures under the EC-WFD: For bodies of groundwater with "low" to "medium" groundwater protection priority, funding should come from the second pillar of the CAP for full-coverage measures in the field of contract-based water conservation and qualified agro-environmental counselling. In the case of bodies of groundwater with "high" groundwater protection priority, this should be supplemented by state *(Land)* assistance programmes with or without EU co-financing for contract-based water conservation measures with the maximum possible regionalisation.

4.6 Proposals for further development of agro-environmental programmes

According to the proposals of the AGENDA 2000, the second pillar of the CAP is to be strengthened in the years ahead, and greater importance will be attached to environmental services by the agricultural sector, partly in view of the requirements of the EC-WFD. The agro-environmental measures must therefore be keyed even more efficiently to the objectives of the EC-WFD. Such optimisation should take account of the following aspects:

a) **Stronger regionalisation**, in order to permit better targeted direction of the measures to areas with corresponding needs (e.g. high-priority bodies of groundwater" or parts thereof) and to adapt them better to farm structures.

b) Ensuring a **more binding character** for groundwater protection interests, by designing the individual measure more efficiently. Example: the earliest possible date should be laid down for "winter planting with catch crops" in order to ensure adequate growth and give the nitrogen timely and full protection from winter leaching. The catch crops should also be non-leguminous. There is scope here for considerable optimisation of the present practice regarding the design of the measure.

c) **Stepping up monitoring**, in order to assess the effectiveness of agro-environmental measures on an increasingly results-oriented basis. This can bring about greater efficiency in the use of resources, and further optimisation of measures with regard to meeting the environmental target.

d) **Financial expansion** through further strengthening of the second pillar of CAP, as currently practised through co-financed programmes (e.g. modulation measures). The funds reallocated in this way should remain in the respective regions and should be used by the farmers operating there as far as possible for the purpose of groundwater protection.

e) Practising the **cooperative approach** as envisaged in the multilateral alliances described. With additional partners in the fields of nature conservation, flood control, forestry etc. it is possible to achieve synergies that not only increase efficiency but also reduce administrative input.

f) **Streamlining the administration and budgeting financial resources** by means of regional budgeting (in relation to a physical area or a body of groundwater), thereby permitting targeted local use of the funds. The use of funds could be steered by a responsible agro-environmental counselling body, with control through a regional management as an official task.

4.7 Model application to the selected body of groundwater

Sections 4.1 to 4.3 first described the extensive range of instruments for programmes of measures to reduce agricultural emissions and immissions of nitrogen, including the design options for such instruments. This section goes on to apply the instruments on a model basis to the selected body of groundwater.

Programmes of measures for individual bodies of groundwater are to be seen in close connection with the environmental objective in question. The basic rule is: the shorter the time axis chosen for achieving the environmental objectives, the more stringent the environmental objective itself and the greater the initial load (groundwater protection priority) of a body of groundwater, the more difficult it will be to achieve the environmental objective. Art. 4 of the EC-WFD permits the following environmental objective variants, provided suitable justification is given:

1. Achievement of environmental objective by 2015
2. Reversal of trend by 2015 $\Rightarrow$ achievement of environmental objective by 2027
3. Reversal of trend by 2015 $\Rightarrow$ less stringent environmental objectives until 2027 $\Rightarrow$ achievement of environmental objectives after 2027

The variants with regard to objectives (environmental objective), measures (instruments) and regions/areas (with or without geographical prioritisation) result in a large number of possible combinations. In the following diagram, a total of **six scenarios** have been chosen for the selected body of groundwater with “high groundwater protection priority” (Fig. 8).

For the “high-priority” groundwater body in question (“Grosse Aue unconsolidated porous aquifer, left”), the suitability check on six model scenarios reveals the following:

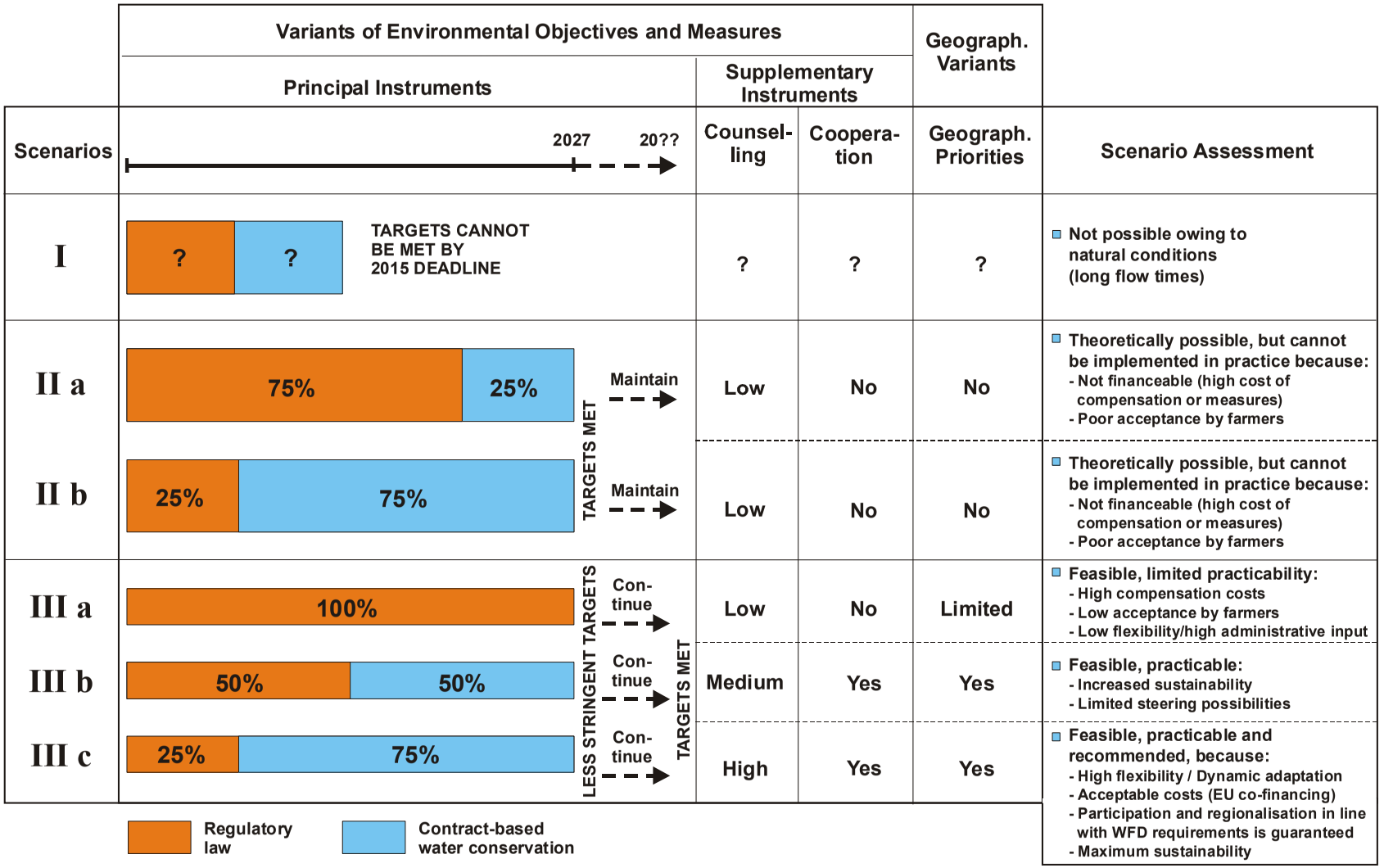


Fig. 8: Investigation of suitability of selected scenarios for implementing measures for a selected body of groundwater with high groundwater protection priority in the "Grosse Aue" project area

Scenario I: "Environmental objective achieved by 2015"

Such scenarios can be eliminated, since the possibility of achieving the environmental objective by 2015 is ruled out from the outset by natural conditions (long flow times in the formation of new groundwater).

Scenarios II a and II b: "Reversal of trend by 2015 and achievement of environmental objective by 2027"

Despite the extension of the time scale to 2027, these scenarios for the "highly polluted groundwater body" can only be implemented by means of stringent regulatory laws and/or by contract-based water conservation involving a large measure of encroachment.

In view of its focus on regulatory law (GAP and groundwater body regulation), Scenario II a would result in "extreme impacts" on the agricultural sector. These would arise, for example, from fertiliser restrictions going beyond the requirements of GAP, or an obligation to engage in active creation of grassland. This would give rise to high compensation costs, and would involve a great deal of administrative input. Its geographical flexibility, however, is limited.

Even Scenario II b, with its focus on a large measure of contract-based water conservation to create "dilution areas", would give rise to "extreme costs". In view of the interference with farm management structures, there is little likelihood that this scenario would be accepted. The following example illustrates the massive scale of the changes to the land use situation that would be necessary to achieve the environmental objective by 2027: Currently the average groundwater quality for the distal part of the selected groundwater body is around 97 mg NO_3/l. In order to achieve the environmental objective of 50 mg/l NO_3/l, it would be necessary to reduce the concentration in the groundwater under arable land from the present 138 mg NO_3/l to 65 mg NO_3/l. Alternatively, if the nitrate concentration below the arable land stayed the same, the percentage of arable land would have to be reduced from 57% to 15% and the percentage of grassland raised from 14% to 56%.

Although both scenarios for achieving the objective are theoretically conceivable, they cannot be implemented in practice since their impacts would be socially and economically unacceptable.

Scenarios III a to III c: "Probable reversal of trend in the upper groundwater zone by 2015, and less stringent environmental objectives by 2027"

Starting from a "moderately to highly endangered body of groundwater", these scenarios initially seek to achieve partial achievement of the environmental objectives (in this case a "step-by-step" but binding reversal of the trend above the level of the environmental objective). They differ from scenarios II a and II b in the longer time scale for achieving the environmental objective and an increasing inclusion of active agro-environmental counselling. Even in this case, however, substantial programmes of measures and expenditure on such measures will be necessary in the agricultural sector for this partial achievement of the objectives, though farming will be maintained as a economic sector on the area concerned.

Scenario III a relies entirely on regulatory law (GAP, regulation on bodies of groundwater, with restrictions on net nitrogen balance that go beyond GAP). For this reason it is classified as being still comparatively expensive for the states (high compensation costs) and as generally of limited practicability. The main reason is that this scenario is primarily geared to emission reduction measures. There is a lack of immission reduction approaches, and only limited success is therefore forecast for the distal groundwater zones.

Scenarios III b (GAP and groundwater body regulation with mainly immission reduction measures, e.g. grassing) and especially III c (GAP without groundwater body regulation) rely on decreasing regulatory law and increasing contract-based water conservation and on the inclusion of the instruments of cooperation, counselling and geographical prioritisation. These instruments permit a high degree of flexibility. Against the background of less pressure on the time axis and a less stringent, but still sufficiently binding situation with regard to achieving the environmental objectives, scenarios III b and III c are classified as not only feasible, but also capable of practical implementation. The probability of success is increased by the participation involved. The scenarios are regarded as socially and economically acceptable.

Scenario III c in particular is suitable for bringing about a clear reversal of the trend for the selected body of groundwater by 2027 and permitting achievement of the environmental objective in the long term, i.e. after 2027.

In the working group's opinion the scenario is acceptable for both the agricultural and water resource management sectors. It is seen as especially suitable for the following reasons:

- Achieves higher documentation standards (verifiability), especially with regard to farmland production, hence satisfying certain minimum standards aimed at better production audit.
- Additional incentives for environmentally relevant farm investments (in this case water conservation).
- Probability of greater acceptance by farmers. Thanks to the reward principle, contract-based water conservation has a favourable impact on farmers' incomes. Provided this impact on income is of a long-term nature, this automatically ensures adequate sustainability on a *quid pro quo* basis.
- Reduced expenditure on administration and monitoring of regulatory law, but increased demands with regard to human and financial resources for agro-environmental counselling and contract-based water conservation. The cost of contract-based water conservation can be flexibly adjusted to the resources available by means of appropriate design.
- Contract-based water conservation can to a large extent be co-financed through federal or EU assistance programmes, so it is possible to make relatively large resources available despite comparatively low burdens on state budgets.
- Accompanying water conservation counselling makes for improved implementation of GAP and increased effectives/sustainability of the measures implemented.
- Diverse ways and means of steering measures through geographical prioritisation, i.e. particularly good channelling of "measure areas" into target areas (in the sense of compensation land) is possible, as are meaningful concepts for subsequent use.
- Broad scope for planning and networking with a view to achieving synergies with other protection targets ("multilateral approach"). Targeted development for gradual adaptation of area situation in the light of the environmental objectives of the EC-WFD.
- Scenario caters best for the regionalisation and participation requirements of the EC-WFD.
- Highly sustainable scenario, as the focus is on raising farmers' awareness of water conservation issues rather than using regulatory legislation as a "deterrent".
- Highly flexible and dynamic scenario that permits an extremely rapid response to changes in the political, social and technical fields.

In view of the known emission and immission data for bodies of groundwater subject to intensive agricultural use, and also the scenario results set out in this project, there is a need to extend the deadline and to assume "less stringent environmental objectives" in order to prevent "extreme impacts" on farmers and ensure practicability. It is essential to take account of these facts in the management plans which are to be drawn up by 2009.

5 SUBSTANCE MONITORING

5.1 Requirements of the EC-WFD

Article 8 of the EC-WFD calls for the “monitoring of surface water status, groundwater status and protected areas”. Operational monitoring programmes are to be ready for use by the end of 2006. In the case of groundwater bodies, the chemical and quantitative status are to be monitored. To describe chemical status, groundwater monitoring networks for “surveillance monitoring” and “operational monitoring” are to be created in accordance with Annex V to the EC-WFD.

Programmes for **surveillance monitoring** are to provide an overview of groundwater chemical status in each body of groundwater and to ensure early identification of adverse changes in chemical status and detection of long-term quality trends and their causes.

Operational monitoring is required for endangered or transboundary bodies of groundwater. This is primarily to be based on surveillance monitoring sites that have already revealed elevated pollutant concentrations or long-term anthropogenic trends.

5.2 Project recommendations for monitoring diffuse substance inputs in the agricultural sector

The EC-WFD relates substance monitoring solely to groundwater quality (immission), whereas for the inventory it requires a description of both the emission (cause/load) and the immission (environmental impact). In line with the approach used for the inventory, the project contractor has also suggested a separation of emission and immission objectives (see Section 3.2.1) for the “environmental objectives” with regard to diffuse substance inputs in the agricultural sector.

Agricultural **immission monitoring** may relate either to the groundwater or to the seepage water (as a precursor stage of groundwater). Groundwater monitoring generally registers the groundwater quality of an area in the sense of surveillance monitoring. Certain requirements have to be met here (density and distribution of measuring sites in the area, measuring site development, sampling intervals, delimitation of approach flow area etc.).

Assuming a detailed knowledge of land use and measures in the approach flow to the groundwater quality measuring sites, groundwater quality monitoring is also suitable for registering the environmental impact of a set of measures in the sense of operational monitoring. Additional figures for seepage water quality have the advantage that they can be clearly assigned to individual land uses.

To “review the impact of human activity“ of the groundwater (cf. Table 1, Section 2.22.), the *ad hoc* working group on “Environmental objectives and monitoring in agriculture” has proposed a list of parameters in the fields of nutrient balances and area management that should be put to similar use for monitoring purposes.

Agricultural **emission monitoring** should primarily concentrate on representative processes for selected farms, i.e. the registration of nutrient balances at farm-gate level. Attention is once again drawn to the possibility of establishing a “representative test farm system” (cf. Section 2.2.2).

6 OUTLOOK AND LONG TERM PROSPECTS

In Northern Germany there continues to be a heavy burden of pollution on bodies of groundwater due to diffuse inputs from the agricultural sector. The risk assessment process following completion of the inventory will probably reveal a large proportion of endangered bodies of groundwater. The selected case study “Grosse Aue II” is one of these. There was found to be a high risk that this body of groundwater would not meet the environmental targets by 2015. In general the results show that, even with the utmost efforts by the agricultural sector, no more than a “reversal of the trend” (in the upper groundwater zone) can realistically be expected in bodies of groundwater currently displaying “moderate” to “high” concentrations, and that concentrations will remain above the environmental target of “good chemical status” until after 2015 or even 2027.

All this supports the project thesis that meeting the environmental targets for diffuse substances, and hence the success or failure of the EC-WFD in the groundwater sector, will depend largely on the preparation and implementation of “effective” programmes of measures in cooperation with the agricultural sector. Conversely, this means that “programmes of agricultural measures” must play a key role in the management plans that are to be drawn up.

This results in a direct need for action. In this context the “Grosse Aue II” project has identified practicable numerous instruments on which consensus is possible. Reversing trends and meeting environmental targets calls for suitably qualified (effective) and at the same time regionalised programmes of measures that can be implemented in day-to-day farm operations. The project group recommends that all services going beyond the requirements of GAP be put on a fee-paying basis.

The second pillar of the Common Agricultural Policy (CAP) already offers openings for supporting the objectives of the WFD via “Rural Development Policy” – especially the programmes of Regulation (EC) 1257/1999 and of modulation. In water extraction areas these possibilities have been in use for years. By the end of the current development plans (2006), area-specific agro-environmental measures in particular should be further optimised in the interests of groundwater protection, differentiated on the basis of geographical priorities and provided with adequate financial resources.

Many new opportunities for implementing the objectives of the WFD in the CAP are offered by the update of the Rural Development Plans for 2007 - 2013. It is essential to seek an amendment to Article 16 of Regulation 1257/1999, so that in future bodies of groundwater can also be designated as “less-favoured areas” on the grounds of increased demands on agricultural production. Furthermore, new agro-environmental measures, including those arising from modulation, must be keyed much more closely to the environmental objective of groundwater protection and their immission reduction effects must be suitably verified. The project has drawn up suitable proposals for the example of nitrate.

The introduction of a counselling system designed to ensure environmental standards via GAP and cross compliance should implement aspects of the WFD as far as possible. In addition, the second pillar of the CAP must basically guarantee qualified agro-environmental counselling (in this case water conservation) in order to ensure targeted steering and effectiveness of measures in the area.

In view of the high administrative input involved, existing financing and control models in the second pillar of the CAP must be called into question. Alternatively, consideration should be

given to new forms of regional budgeting under official management. For example, programmes of measures drawn up on the basis of WFD management plans could be given targeted publicity and provided with priority funds under official administration.

7 BIBLIOGRAPHY

ANTONY, F., von BUTLAR, C., FIEDLER, L., GÖDECKE, B., HÖLSCHER, J., LÖLOFF, A., SCHÜLTKEN, H. & H. WACKER (2001): Anwenderhandbuch für die Zusatzberatung Wasserschutz. Published by Niedersächsisches Landesamt für Ökologie, Hildesheim

BACH, M., FREDE, H.-G., SCHEIKHART & HUBER (1999): Regional differenzierte Bilanzierung der Stickstoff- und Phosphorüberschüsse der Landwirtschaft in den Gemeinden und Kreisen in Deutschland. Institut für Landeskultur, Universität Gießen, Published in: „Nährstoffbilanzierung der Flussgebiete Deutschlands“, UBA-texte 5/99, Umweltbundesamt Berlin, Appendix II

BACH, M. (2002): Informationsgrundlage zur Flächennutzung. Paper delivered at a session on „Diffuse Substance Inputs“ held in Hanover on 13 an 14 August 2002 by the Lower Saxony regional association of the BWK (Federation of Water Resource Management, Waste Management and Environmental Landscape Engineers)

COUNCIL OF THE EUROPEAN COMMUNITY (1991): Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (EG Nitrate Directive), OJ L 375 of 31/12/1991, p. 0001 – 0008

COUNCIL OF THE EUROPEAN UNION (1999): Council Regulation (EC) No. 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations, OJ L 160/80 of 26/06/1999

COUNCIL OF THE EUROPEAN UNION (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (EG Framework Water Directive), OJ L 327/1 of 22/12/2000

F&N Umweltconsult u. P. Neumann (2001): Modellhafte Erstellung eines Bewirtschaftungsplanes am Beispiel des Teileinzugsgebietes Große Aue im Flussgebiet Weser; Pilotprojekt zur Umsetzung der EG-Wasserrahmenrichtlinie. Commissioned by the states of Lower Saxony (District Government Hanover) and North-Rhine/Westphalia (District Government Detmold)

LÄNDERARBEITSGEMEINSCHAFT WASSER (2002): Arbeitshilfe zur Umsetzung der EG-Wasserrahmenrichtlinie. Version dated 16.06.02. Internet: www.lawa.de

OSTERBURG, B. (2002): Integration von Agrar- und Umweltpolitik im Rahmen der Reform der Gemeinsamen Agrarpolitik (GAP); in: 10 Jahre Trinkwasserschutz in Niedersachsen – Modell der Kooperation zwischen Landwirtschaft und Wasserwirtschaft. Published by: Niedersächsisches Umweltministerium & Niedersächsisches Landesamt für Ökologie