MANAGEMENT OF REGIONAL GERMAN RIVER CATCHMENTS (REGFLUD) - ANALYSIS OF THE EFFICIENCY OF INSTITUTIONAL ARRANGEMENTS -

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ABSTRACT:

The REGFLUD-project addresses the problem of the pollution of water resources through agricultural production. Within the REGFLUD-Project it is the task of the RWI to develop suggestions for an economically efficient river-basin-management with respect to the reduction of nonpoint source pollution in the research areas of Rhein and Ems. The economic theory of environmental federalism is used as the theoretical foundation for this analysis. This theory offers several categories, which help to define regions which are appropriate to address the problem of agricultural nonpoint source pollution efficiently. In this paper a method to define homogenous regions as a basis for joint implementation of measures to reduce this kind of pollution is presented. This method comprises of an modified cluster analysis, which allows the demarcation of regions that are more homogenous than the present administrative structure with respect to the variables made available by the project partners.

Keywords: diffuse pollution, environmental federalism, institutional efficiency, river basin management

INTRODUCTION

The REGFLUD-project addresses the problem of the pollution of water resources through agricultural production. The overall objective is the development and application of multicriteria scientific methods to set up a Decision Support System (DSS) aimed at reducing nonpoint source pollution in river catchments subject to economic feasibility and social acceptability. The project is funded by the Federal Ministry of Education and Research. It has a duration of three years and will end by summer 2004.

The project structure includes the following subtasks:

1. Linking an agri-environmental sector model to hydrological models
2. Cost-benefit analysis of alternative policy measures
3. Analysis of the efficiency of institutional arrangements
4. Development of an online Decision Support System

Within the REGFLUD-project it is the task of the RWI to develop suggestions for an economically efficient river-basin-management. Efficiency in the context of the management of river-basins means that one the one hand property rights should be available for purposes, which comprise the greatest appreciation by society. On the other hand the management of a river-basin should be as cost-efficient as possible.

The RWI focuses on the establishment of homogenous regions in the research area which allow the implementation of joint measures to reduce nonpoint source pollution through nitrate and phosphorus in a more efficient way then in the traditional spatial structure. One major weakness of the present administrative structure with regard to the management of river catchments and especially the reduction of nonpoint source pollution is the fact that river catchments are managed by a multitude of administrative units of different federal levels and have no central planning authority for each watershed. Even the implementation of the EU Water Framework directive (WFD) will not lead to structures comparable to the situation e.g. in France, but only to an rather informal cooperation within the existing administrative structure.

Therefore positive or negative external effects may occur within a river basin. These external effects might either lead to spillovers, if the administrative area is only a part of the catchment area, or to internalities, if the catchment area fits into the administrative area that finances and implements a certain measure with effects on the catchment area.

In Spillover cases (Figure 1) positive external effects might occur, if one administrative unit implements a measure to reduce nonpoint source pollution (e.g. a tax to finance measures to ameliorate the water quality). In this case the inhabitants outside the respective administrative unit but within the same catchment area would profit from an amelioration without paying for it (free rider effect), which is economically not desirable. On the other hand negative external effects might arise, if an administrative unit doesn't implement measures to reduce nonpoint source pollution and thereby negatively effects the water quality in adjacent administrative units of the same catchment area.

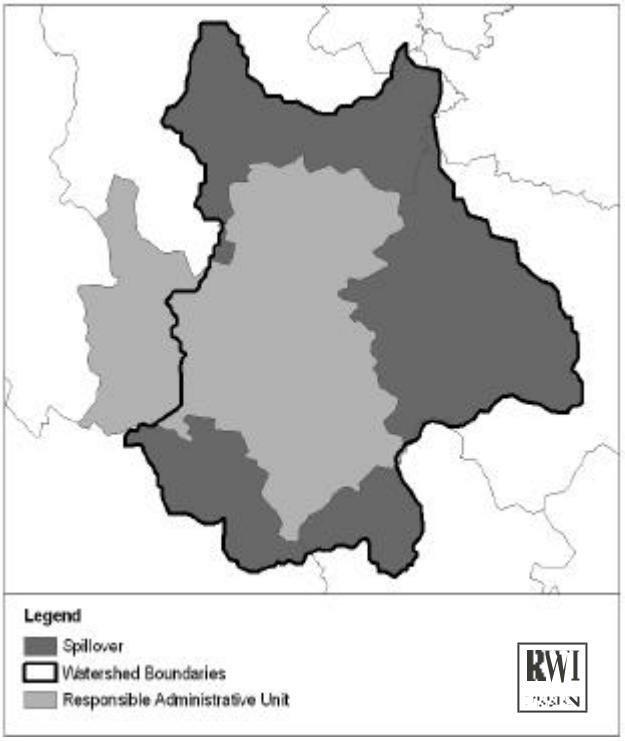

Figure 1: Spillovers

The second group of effects that averts an efficient river basin management are internalities. They occur, if the competent administrative unit is bigger than the catchment area, as shown in Figure 2. In this case measures to reduce nonpoint source pollution tend not to take into account the different natural boundaries but lump together all catchment areas which are part of the administrative unit. This approach leads either to an under- or an over-performance of the implemented measures and therefore causes external effects.

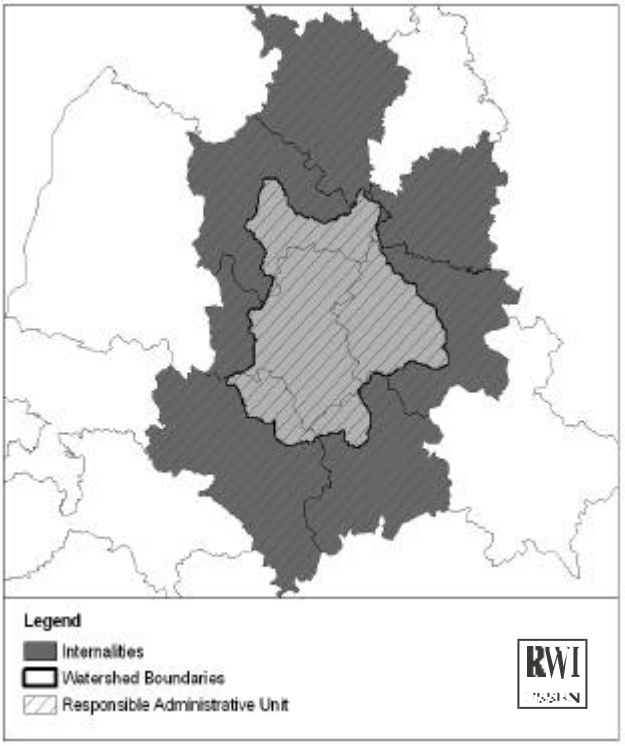

Figure 2: Internalities

Due to the fact that the suggested solutions should have high political relevance and constitute an input in the Decision Support System, it is nevertheless important to define regions which have a connection to the present administrative structure. Therefore “Gemeinden”, which form the smallest administrative unit in Germany, will be the building blocks of the developed regions. Another reason for the choice of “Gemeinden” as building blocks was the availability of data, since essential data is not available area-wide below this level.

The theory of environmental federalism forms the theoretical background of this analysis. It aims at arranging competences among different federal levels in a way that public duties can be fulfilled efficiently and offers categories, which help to define regions which are appropriate to address the problem of agricultural nonpoint source pollution. In case of regional external effects like they occur in catchment areas the theory suggests decentralised solutions. Following the subsidiarity principle the competences have to be allocated on the lowest administrative level that is still able to fulfil the tasks associated with certain competences. Klemmer (1988) argues that decentralised solutions have to be preferred, if there are distinct emission-immission connections in a restricted area, serious differences in the natural situation and diverging preferences towards a desirable quality of the environment.

Another constitutional principle of the theory of environmental federalism is the fiscal equivalence or perfect mapping[1] of institutional arrangements. According to this principle allocative efficiency in the provision of public goods requires the matching of the goods boundaries and the territory of the government that provides it as well as the level on which these goods are financed. If these conditions are not complied with by an institutional arrangement, it can be characterized as non-efficient due to the fact that it causes positive or negative external effects (imperfect mapping).

Taking this theoretical considerations into account, the regions developed in this project should represent a gain in homogeneity with respect to the following variables:

Level of nutrient-entry into water systems (nitrate and phosphorous)
Marginal costs of avoiding these external effects
Marginal willingness to pay for a reduction of nonpoint source pollution

In this regions the implementation of joint measures to decrease the amount of diffuse pollution should be more effective, since the degree of imperfect mapping is decreased. Which exact measures are suitable for an efficient management in the developed regions has to be discussed in the course of the project.

METHODS

The main goal of every regionalisation is to develop a zoning system in which the homogeneity inside of each region and the homogeneity between different regions are maximised[2]. In addition to this task regions developed within this project have to be more homogenous than the demarcation that results from the present administrative structure. Therefore two methodological problems have to be solved.

1. to find an ideal regional structure, and
2. to measure the level of homogeneity.

The first methodological problem can be solved by using a cluster analysis. This statistical method enables the user to take into account several variables simultaneously. As it is important only to join only adjacent spatial units, variables that represent the location of the spatial units have to be considered in addition to the four core variables[3]. A matrix consisting of variables with the parameter value "0" for non-adjacent units and the value "1" for adjacent spatial units enables the clustering algorithm to join only spatial units into one cluster that have conjoint borderlines. If you also take the affiliation to certain watersheds into account, you have to add another matrix, which provides the percentages of the area of the respective administrative unit in a certain watershed.

Certainly the consideration of such a great amount of additional data in a cluster analysis will lead to regions which are less homogenous with respect to the core-variables as a solution which doesn't take the location into account. But as it is important for the joint implementation of measures to reduce nonpoint source pollution that adjacent administrative units of one watershed cooperate, this limitation has to be accepted. To estimate the loss in homogeneity an additional cluster analysis without the location-based variables will be carried out. This analysis will combine spatial units without taking the location into account and therefore lead to types of spatial units. These spatial units may only have adjacent boundaries by chance. Therefore the results may only be used to simplify the exchange of information between spatial units of one type. Possible contents of this exchange may be the discussion of how to handle a certain amount of pollution or which measures may be considered regarding the specific costs of avoiding nonpoint source pollution. Figure 2 illustrates in a schematic way the two possibilities to find homogenous clusters within a watershed.

The second methodological task is to compare the solutions provided by the cluster analysis with the present spatial structure. Former research at the RWI[4] proved that f- and t-values are adequate means to interpret and compare the developed regions.

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1 Breton 1965, Buchanan 1965
2 Bacher 1994
3 Level of nutrient-entry into water systems (N and P), marginal costs of avoiding these externalities and marginal willingness to pay for a reduction of nonpoint source pollution
4 Urfei 1999

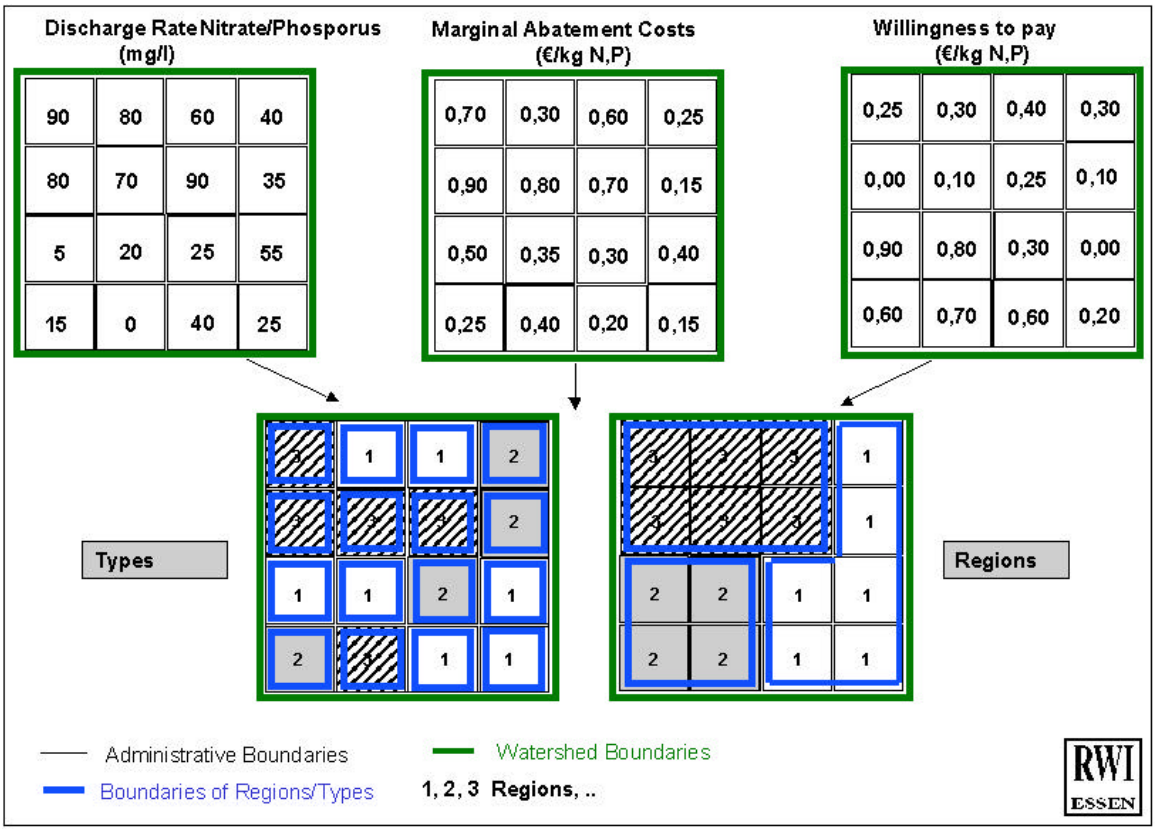

Figure 3: Demarcation of Regions and Spatial Types within a watershed

The f-value is defined as the between-group variance of one variable divided by the within-group variance. A cluster can be regarded as totally homogenous, if all f-values are smaller than 1. The t-value is defined as the difference of the means of a certain variable in one cluster and the means of this variable in the population divided by the standard deviation of the population. The t-value can be interpreted as the relative deviance of a cluster from the means of the population. High t-values indicate that the respective cluster differs strongly from the population with respect to a certain variable.

To compare the developed regions with the present administrative structure, f- and t-values will be calculated for all clusters and all administrative levels. The interpretation of the results should prove whether the developed regions are more homogenous and therefore can be used as a foundation for the implementation of joint measures to reduce nonpoint source pollution.

RESULTS AND DISCUSSIONS

As the project of the RWI is dependent on the data delivered by the other project partners, it is not possible to present final results here yet, since the essential data is not completely available from all project partners. A test of the described method with data on a higher administrative level in a small area led to promising results. It is possible to build regions which are more homogenous with respect to the used variables. These regions can be used as an input into the Decision Support System and might help to adjust measures to reduce nonpoint source pollution more efficiently.

Further research will focus on the one hand on the methodological approach by varying distance measures and linkage rules within the cluster analysis. Another task is to find an optimal standardisation formula to maximise the weight of the core variables in the analysis.

On the other hand the boundaries of the developed regions have to be discussed with experts inside and outside of the project team to ensure a high political relevance. One possible outcome from this discussions might be that the developed regions shouldn't consist of administrative units of two federal states (Bundesländer), since the implementation of joint measures across these borderlines might evoke problems.

CONCLUSIONS

To increase the efficiency of the watershed management in Germany, the strength and the kind of measures have to be adjusted to the specific environmental problems and the situation in each watershed. By taking into account the level of nutrient-entry into water systems (N and P), marginal abatement costs and marginal willingness to pay for a reduction of nonpoint source pollution to define homogenous regions within a watershed, it is possible to implement joint measures to reduce diffuse pollution more effectively than in the present administrative structure.

A means to define these regions is the cluster analysis. This multivariate statistical method can be modified in a way that only contiguous administrative units are bundled to homogenous regions. For this a matrix consisting of binary variables hast to be constructed and added in the cluster analysis.

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