International Journal of Rural Management

http://irm.sagepub.com

Evaluation of Agri-environmental Measures: Analytic Hierarchy Process and Cost-effectiveness Analysis for Political Decision-making Support

Jadwiga Ziolkowska

International Journal of Rural Management 2008; 4; 1
DOI: 10.1177/097300520900400201

The online version of this article can be found at:
http://irm.sagepub.com/cgi/content/abstract/4/1-2/1

Published by:
SAGE
http://www.sagepublications.com

International Journal of Rural Management, 4(1&2), 2008: 1–24
SAGE Publications • Los Angeles/London/New Delhi/Singapore/Washington DC
DOI: 10.1177/097300520900400201

Evaluation of Agri-environmental Measures: Analytic Hierarchy Process and Cost-effectiveness Analysis for Political Decision-making Support

Jadwiga Ziolkowska

In this article, we discuss the implementation of two evaluation approaches—the Analytic Hierarchy Process and the cost-effectiveness analysis for political decision-making support in agri-environmental policy. The approaches represent two different ways of evaluation: hierarchical weighting for estimation of immeasurable environmental benefits and effectiveness analysis focused on economic aspects. These methods can be used separately; however, the combination of the approaches in one evaluation system can help to consider different economic and ecological aspects of environmental protection to a wider extent. The main objective of the article is to investigate which agri-environmental measures would be recommended for political strategies to maximize environmental benefits or else to minimize the realization costs of the measures. The investigation is based on results of a case study conducted in voivodship Subcarpathia in Poland including interviews with agricultural experts, agri-environmental advisors and farmers. The results show that the measures 'Extensive meadow farming' and 'Organic farming' denote the highest environmental benefits with regard to the envisaged environmental objectives defined in the National Agri-environmental Programme 2004–2006. The cost-effectiveness of agri-environmental measures is differentiated depending on the stakeholder group. The results can be helpful to support political decision-making processes considering simultaneously regional priorities of the environmental protection in rural areas.

INTRODUCTION

Agri-environmental measures are realized in Poland since the accession to the European Union (EU) in May 2004. The agri-environmental measures are co-financed by 80 per cent from the European Agricultural Guidance and Guarantee Fund (EAGGF) and by 20 per cent from the Polish state budget (MRiRW 2004a). As the agri-environmental policy is new in Poland, there is little experience in the evaluation of the agri-environmental measures. The first evaluation of the National Agri-environmental Programme 2004–2006, delivered by the Ministry of Agriculture and Development of Rural Areas, is based on statistical data regarding the number of participating farmers and the budget amount spent on financing the respective agri-environmental measures. Apart from this statistical evaluation, no other empirical evaluation has been undertaken in Poland until now. In order to extend the research and to state the effectiveness of agri-environmental measures in Poland after the accession to the EU on the basis of empirical data, we conducted an explorative case study in the region of Subcarpathia in South-eastern Poland (Ziolkowska 2007a). Within this case study, three stakeholder groups were interviewed: agricultural experts, agri-environmental advisors and farmers. The stakeholders assessed the importance of the agri-environmental measures with regard to environmental objectives defined in the National Agri-environmental Programme 2004–2006 using the Analytic Hierarchy Process (AHP) according to Saaty (1990). On this basis, objective coefficients were estimated and used further to investigate the effectiveness of agri-environmental measures in Poland.

AHP was used in the study due to its several advantages in analyzing immeasurable (intangible) variables like environmental protection in rural areas. It is a proven method which has found wide implementation in several branches until now such as the finance sector, education, engineering, government, industry, management, manufacturing and sports (Steuer and Na 2003; Vaidya and Kumar 2006) for the following problems: priority setting, resource allocation, risk assessment, performance measurement, system design and assurance of system stability, optimization, planning and conflict solution (Saaty and Vargas 1991: 13). The approach was also used in combination with other approaches such as mathematical programming techniques, including linear programming (LP), integer linear programming (ILP), mixed integer linear programming (MILP) and goal programming (GP) (Ho 2008). Thereby, qualitative and quantitative methods were integrated to comprehensively solve the analyzed problems. According to Ho (2008: 223), the AHP was used only twice in the time period 1997–2006 to investigate agricultural problems (Guo and He 1999; Shrestha et al. 2004) and three times for the analysis of environmental issues (Kurttila et al. 2000; Malczewski et al. 1997; Masozera et al. 2006).

Investigating agricultural problems, Guo and He (1999) use the AHP to analyze the flexibility needed to allocate resources by considering both quantitative and

qualitative decision criteria. Using the AHP and a large-scale linear goal programming model, the authors deliver solutions for optimal allocation of facilities for a grain harvesting and post-harvest system within one province in China. Shrestha et al. (2004) analyze the prospects and challenges for silvopasture adoption in south-central Florida using the strengths, weaknesses, opportunities and threats approach (SWOT) in combination with the AHP. In his article, Malczewski et al. (1997) integrate the AHP for structuring the decision problem and determining land suitability for different socio-economic activities (the uses of land), and an integer mathematical programming method for identifying the land-use pattern that maximizes consensus among interest groups in the Cape Region of Mexico. Kurttila et al. (2000) examine a new hybrid method for improving the usability of the SWOT analysis and its common implementation with Decision Analysis Method—the AHP in application to a forest-certification case. The same method combination was used by Masozera et al. (2006) to estimate the perceptions of stakeholders with regard to the suitability of community-based management (CBM) approach to the Nyungwe Forest Reserve (NFR) in Rwanda.

In this article, the AHP and the cost-effectiveness analysis are combined to investigate both qualitative and quantitative issues for agri-environmental policy in Poland. The combination of AHP and Linear Programming for this question in Poland can be found in the study by Ziolkowska (2007a).

Cost-effectiveness analysis is often used for economic evaluation of political and scientific projects and programmes in order to reflect relations between benefit and cost values resulting from the implementation of the programmes. Indeed, the cost-effectiveness analysis is more limited compared to the cost-benefit analysis as it quantifies costs in monetary units and effects in units of functions or services (Poister 1978; Portney 2000). However, for the investigation of immeasurable issues, the cost-effectiveness analysis is recommendable. It can also be used as a prestage for designing political strategies and programmes (Kirschke et al. 2004, 2007; Kirschke and Jechlitschka 2002; Ziolkowska 2007a, 2007b).

In the current analysis, we express the environmental benefit of agri-environmental measures in intangible (immeasurable), non-monetary units (environmental units). Thus, the analysis should be understood in an extended way compared to the standardized cost-benefit analysis. The article delivers new findings on agri-environmental measures in Poland after the accession to the EU which can be used to design agri-environmental policy in Poland more effectively in the next financing periods.

This article is structured as follows: first, the agri-environmental measures in Poland, after its accession to the EU, are presented. Next, the research methodology and case study in Poland are introduced. Following this, the AHP for agri-environmental measures in Poland is structured. The results are then discussed for maximal possible environmental benefit. In the next section, the results of the cost-effectiveness analysis for agri-environmental measures in Poland are

discussed and possible decision strategies with regard to maximal effectiveness or minimal realization costs are analyzed. Finally, the advantages and restrictions of the cost-effectiveness analysis in the evaluation of agri-environmental measures in Poland are assessed. Conclusions are then drawn to show how to evaluate agri-environmental measures to make them more effective in terms of environmental and economic aspects.

AGRI-ENVIRONMENTAL MEASURES IN POLAND AFTER THE ACCESSION TO THE EUROPEAN UNION

Since the accession of Poland to the EU, the agri-environmental policy and measures are obligatory for the policy of rural areas, according to the EU regulation 1257/99 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) (Europäische Kommission 1999). According to the EU regulation, farmers realizing agri-environmental measures are supported with compensation payments for their services for the environment. The support is granted to farmers who are owners or tenants of farm land of more than 1 ha and who oblige to meet all agri-environmental commitments exceeding the requirements of the 'good agricultural practice' for at least five years.

In the negotiation process, seven agri-environmental measures ('Sustainable agriculture', 'Organic farming', 'Extensive meadow farming', 'Extensive pasture farming', 'Ground and water protection', 'Buffer zones' and 'Domestic farm animal species') were proposed by the Polish Ministry of Agriculture and Development of Rural Areas and approved afterwards by the European Commission for its realization in Poland. The agri-environmental measures were divided in 40 realization options and can be realized both horizontally (in all regions in Poland) and regionally (in specific priority zones). While the measures 'Organic farming', 'Ground and water protection', 'Buffer zones' and 'Domestic farm animal species' are realized in all regions of the country, 'Sustainable agriculture', 'Extensive meadow farming' and 'Extensive pasture farming' can be realized only in the 69 priority zones.

The agri-environmental measures are realized within the National Agri-environmental Programme which is an integral part of the Plan for Development of Rural Areas (PROW). The available budget for agri-environmental measures amounted to € 348.9 million for the first membership period in the EU in 2004–2006 (MRiRW 2004a: 129). According to the first evaluation of the usage of available budget for agri-environmental measures, the Committee for Monitoring of the Plan for Development of Rural Areas decided to shorten the budget for the National Agri-environmental Programme by 37 per cent down to € 218.9 million (MRiRW 2007).

The National Agri-environmental Programme is defined, planned and coordinated by the Polish Ministry of Agriculture and Development of Rural Areas. The competences regarding the preparation, realization and control processes rest on the national and regional offices of the Agency for Restructuring and Modernization of Agriculture. Regional experts or farmers have no impact on political decision-making processes in agri-environmental policy. In order to stress the importance of regional stakeholders for an effective planning of agri-environmental measures, we use the results of an explorative case study in the region Subcarpathia in Poland.

Methodology of the Case Study

As agri-environmental measures are recent political instruments since the accession to the EU, there is little experience with the evaluation of the measures and no empirical studies have been undertaken until now to investigate the importance of agri-environmental policy from the regional perspective. In order to fill this existing research gap, a case study in the region of Subcarpathia in Southeastern Poland was conducted in September 2005. The voivodship was chosen due to its specific economic and ecological aspects, and conditions, compared to other regions in Poland (a large number of natural resources on the one hand and difficult existence conditions for several semi-subsistence family farms on the other). In the case study, the following stakeholders were interviewed:

- Eight agricultural experts in the Marshall Office in Rzeszów (the capital city of the voivodship—regional administrative unit),
- Twenty-six agri-environmental advisors in regional agricultural advisory centres, and
- Hundred farmers from all the 21 circles in the voivodship realizing agri-environmental measures. The farmers were chosen according to the principle to consider each form of the agri-environmental measures. The farmers were then interviewed by agri-environmental advisors as due to legal regulation of data protection, a direct survey was not possible.

The named stakeholders were chosen with the aim to consider both persons with political background as representatives of national political decision makers (agricultural experts) and practitioners (agri-environmental advisors and farmers). The interviewed stakeholders assessed the importance of agri-environmental measures with regard to environmental objectives defined in the National Agri-environmental Programme 2004–2006 by means of the AHP according to Saaty and Kearns (1985). The AHP approach is an approved practice-oriented Hierarchical Additive Weighting Method (Weber 1993: 73) which is particularly

recommended to be used in the estimation of intangible environmental aspects, thus, also for environmental benefit of agri-environmental measures.

AHP FOR ASSESSMENT OF ENVIRONMENTAL PRIORITIES

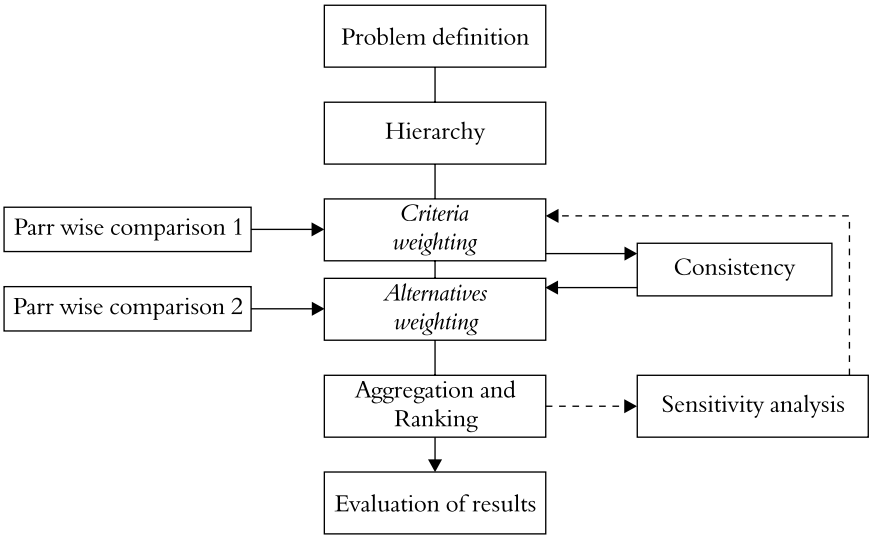
The AHP is classified as a multi-criteria decision support and evaluation approach. The idea of this approach is to find out optimal measures on the basis of hierarchical problem structure—measures which fulfil defined criteria to the highest extent. Therefore, the method is often called as an approach for structuring, measurement and synthesis of multi-criteria problems (Forman and Gass 2001). The background for the assessment of optimal alternative (alternatives) creates an evaluation done by stakeholders by means of AHP-scale according to Saaty (Saaty et al. 2003).

In the process of political-decision support, the assessments of stakeholders are, in many cases, decisive for the design of political strategies or programmes. Several studies confirm that considering estimations of different stakeholders as well as of regional conditions can support political decision-making processes (Pohl 2001; Prager 2006; Rathwell and Bruns 1985; Van De Ven and Delbecq 1974). On the other hand, the fact should be pointed out that the estimations of farmers can bias the results as they assess personal interests and benefits. However, the farmers are the only persons who can estimate the actual ecological, economic and social problems in rural areas. Thus, practitioners in decision-making processes can improve the process of finding the appropriate solution. Therefore, we discuss the question of environmental priorities and environmental benefit from the point of view of different stakeholders.

Using the AHP approach, we estimate the objective coefficients which reflect the importance of the respective agri-environmental measures in terms of environmental objectives 'Protection of natural resources' (Objective 1), 'Protection and conservation of biodiversity' (Objective 2), and 'Conservation of cultural landscape' (Objective 3). Thus, we evaluate the environmental benefit of agri-environmental measures. The evaluation was conducted in several steps, which are displayed in Figure 1.

In the first step, the problem was defined. The problem hierarchy for agri-environmental measures in Poland consists of three levels: (*i*) Main objective (protection of agri-environment)—Level 1, (*ii*) sub-objectives as criteria ('Protection of natural resources', 'Protection and conservation of biodiversity' and 'Conservation of cultural landscape')—Level 2 and (*iii*) alternatives (all agri-environmental measures in the National Agri-environmental Programme

Figure 1
Evaluation of Environmental Benefit of Agri-environmental Measures in Poland Using the AHP Approach



Source: Author's performance according to Rohr (2004: 54).

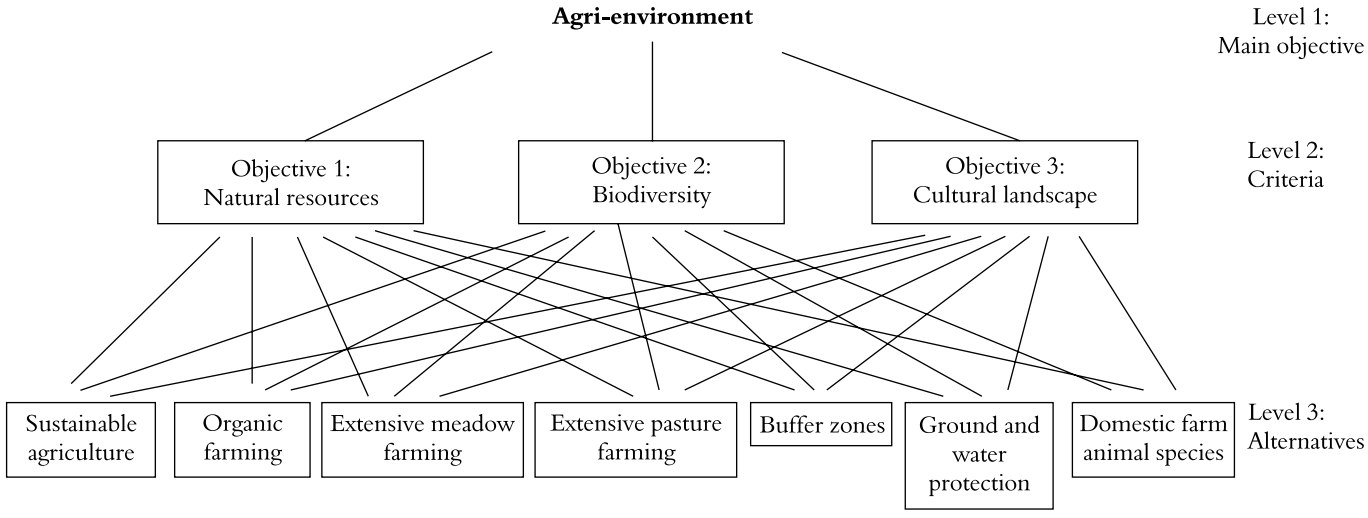
2004–2006)—Level 3. The structure of the AHP approach for the agri-environmental measures in Poland is displayed in Figure 2.

The model structure reflects, thus, relations between the agri-environmental measures and environmental objectives. The objectives were derived from the National Agri-environmental Programme 2004–2006 and reflect all aspects of the sustainable development in rural areas such as biotical, abiotical and aesthetic elements.

Basing on the model structure, the criteria and alternatives were evaluated in pair-wise comparisons using the AHP scale (Table 1). The stakeholders in the voivodship Subcarpathia assessed, thus, the importance of the respective agri-environmental measure with regard to each environmental objective (upper criteria in the hierarchy structure).

By means of the AHP, local priorities (absolute weighting on one level) were estimated which reflect the relative impact of agri-environmental measures on the environmental objectives. For this estimation, the Eigenvector method was used in order to normalize the results of the pair-wise comparisons. Thus, the priority vectors for the agri-environmental measures and weights for the environmental objectives were calculated using the method of normalized matrix columns.

Figure 2
Structure of the AHP Approach for Agri-environmental Measures in Poland



Source: Author's performance.

Table 1
AHP Scale

Scale Points	*Definition*
1/9	Extremely less important
1/7	Demonstratively less important
1/5	Strongly less important
1/3	Moderately less important
1	Equally important
3	Moderately more important
5	Strongly more important
7	Demonstratively more important
9	Extremely more important

Source: Saaty and Kearns 1985: 27.

These vectors were further used for the operationalization of the objective function; therefore they are called as objective coefficients (Table 2). In this case, the operationalization means considering regional assessments with regard to environmental and economic conditions in the voivodship Subcarpathia.

According to the results, differences between the estimation of different stakeholders were found. The coefficients in the expert group prove that the objective 'Protection of natural resources' (Objective 1) has the greatest importance only for the measure 'Organic farming'. For all other measures the objectives 'Protection and conservation of biodiversity' (Objective 2) and 'Conservation of cultural landscape' (Objective 3) have higher importance. The objective coefficients are, however, on a similar level. Another tendency was found for agri-environmental advisors. The measures 'Sustainable agriculture', 'Organic farming' and 'Extensive pasture farming' were assessed with high coefficients for minimal one objective, while other measures have lower importance for environmental benefit. A similar tendency was found for the farmer group, in which no specific differences in the evaluation with regard to the respective objectives were found.

The objective coefficients estimated with the AHP approach can be used for an evaluation of environmental priorities. In this case, the ranking of agri-environmental measures in terms of the respective environmental objective can be defined. However, the question is, which environmental objective has the highest importance and which should be taken as an indicator for the 'correct' (most beneficial) ranking of measures. In order to avoid accidental choices, objective weights were also estimated with the AHP approach with pair-wise comparison. The objective coefficients and objective weights were included in the objective function and cost-effectiveness analysis to ascertain the effectiveness of agri-environmental measures.

Table 2
Objective Coefficients for Agri-environmental Measures and Objective Weights According to the Assessment of Regional Stakeholders

Experts	*Sustainable Agriculture*	*Organic Farming*	*Extensive Meadow Farming*	*Extensive Pasture Farming*	*Ground and Water Protection*	*Buffer Zones*	*Domestic Farm animal Species*	*Objective Weights*
Objective 1	15,8	22,4	10,5	12,3	15,9	13,1	10,0	34,3
Objective 2	9,8	14,3	12,0	12,5	17,5	14,7	19,2	36,2
Objective 3	11,7	13,3	15,7	12,6	17,5	16,8	12,4	29,5
Agri-environmental advisors								
Objective 1	23,0	25,2	15,1	13,0	10,7	6,4	6,7	35,0
Objective 2	10,1	20,4	25,1	19,2	6,6	6,0	12,7	31,8
Objective 3	12,4	22,8	23,0	23,6	6,2	6,6	5,3	33,2
Farmers								
Objective 1	21,9	25,5	15,2	13,4	11,6	6,4	6,0	41,9
Objective 2	17,6	20,5	18,9	16,6	9,1	6,7	10,7	29,0
Objective 3	15,6	22,6	20,2	18,8	9,9	7,3	5,7	29,1

Source: Author's calculation.

Cost-effectiveness Analysis for Assessment of Effectiveness of Agri-environmental Measures

The cost-effectiveness analysis for agri-environmental measures is based on the results of the AHP estimation and statistical data regarding expenditures on agri-environmental measures in the voivodship Subcarpathia (ARiMR 2006). The benefits and costs of agri-environmental measures were assumed as constant variables in the investigated time period. The cost-effectiveness analysis was conducted in three steps: benefit analysis, cost analysis and cost-effectiveness analysis.

Benefit of agri-environmental measures

The benefit analysis aims to alleviate decisions on the best alternative in terms of the awaited or else achieved benefits. The estimation of the benefit of agri-environmental measures in the voivodship Subcarpathia was carried out in several steps which are:

1. Creation of the objective system for environmental objectives

For the evaluation of agri-environmental measures, the objectives are already given; these are derived from the National Agri-environmental Programme 2004–2006. Thus, the definition and creation of environmental objectives was not necessary.

The next steps are:

2. Setting the objective weights and
3. Estimation of objective coefficients

These were already conducted using the AHP approach.

The estimation of objective weights should conform with methodical requirements of an effectiveness analysis, according to which the sum of the objective weights should amount to 1 or 100 per cent.

4. Estimation of environmental benefit of agri-environmental measures from the stakeholders' point of view

The environmental benefit was estimated as a sum of partial benefit values of the agri-environmental measures with regard to the three analyzed environmental objectives. The partial benefit was defined with the following formula:

$$NT_{ij} = N_{ij} x_i \,, \tag{1}$$

with:

NT_{ij}—partial benefit of the measure 'i' for the objective 'j'
N_{ij}—benefit coefficient estimated as $N_{ij} = z_{ij} \times g_j$
x_i—budget amount applied for in 2005, within of the respective agri-environmental measures

The benefit coefficient N_{ij} has a descriptive environmental unit (environmental quality/€), which results from the estimated objective coefficients. By multiplication of the benefit coefficients with the budget, a non-monetary unit for the objective function is created—'environmental quality'. As no reference values are known for the environmental benefit of agri-environmental measures, a monetary expression of the environmental benefit would also have no significance for the interpretation of results.

The benefit coefficients were calculated as a product of objective coefficients (z_{ij}) and objective weights (g_j).

With the addition of the partial benefit for all objectives, the total benefit of the agri-environmental measures was estimated with the following formula (amalgamation of the benefit values):

$$NG_i = NT_{i1} + NT_{i2} + NT_{i3}, \quad (2)$$

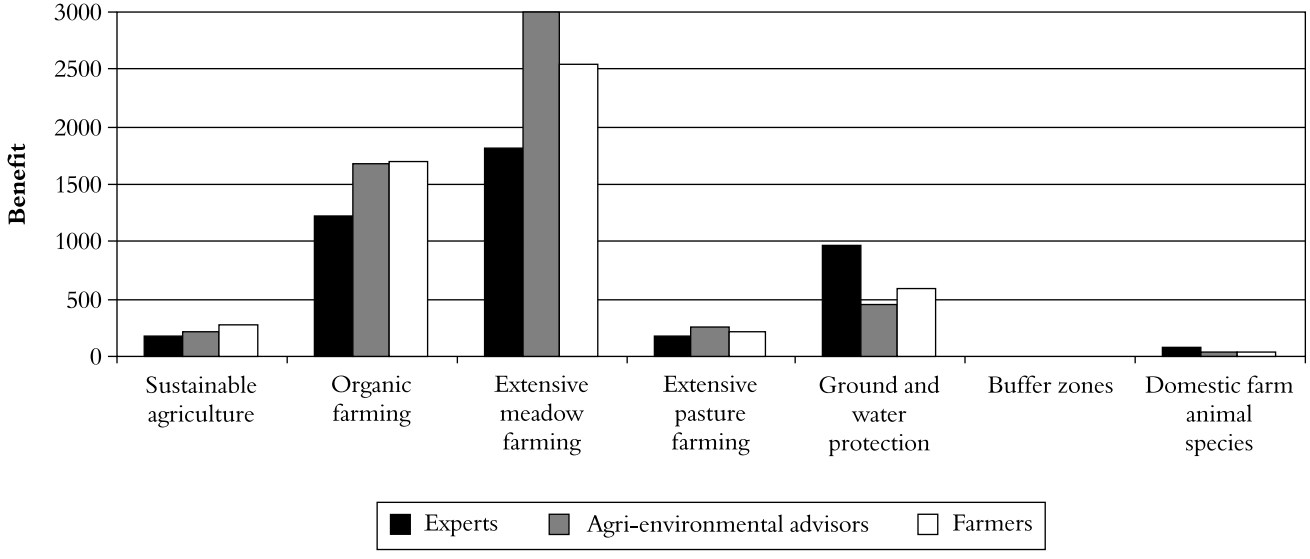
with:

NG_i—total benefit of the measure 'i'
$NT_{i1–i3}$—partial benefit of the measure 'i' for three objectives

The ranking of alternatives was estimated with regard to the total benefit of agri-environmental measures in the voivodship Subcarpathia for all stakeholder groups. The results are presented in Figure 3.

The analysis of the total benefit[1] of agri-environmental measures indicates that the measures 'Extensive meadow farming', 'Organic farming' and 'Ground and water protection' create the highest environmental benefit. Other measures, such as 'Sustainable agriculture', 'Extensive pasture farming', 'Domestic farm animal species' and 'Buffer zones', again have a very low contribution to the environmental benefit. This tendency is confirmed by statements given by all interviewed stakeholders in the voivodship Subcarpathia. The assessment of environmental benefit by farmers and agri-environmental advisors is similarly high which can be explained with the fact that these stakeholders know the actual

Figure 3
Total Benefit of Agri-environmental Measures from the Stakeholders' Point of View in the Voivodship Subcarpathia



Source: Author's study.

situation and environmental problems in the voivodship from their own practical experience. Only the measures 'Ground and water protection', 'Domestic farm animal species' and 'Buffer zones' deviate from the named tendency and have the highest importance with regard to the environmental benefit from the point of view of agricultural experts.

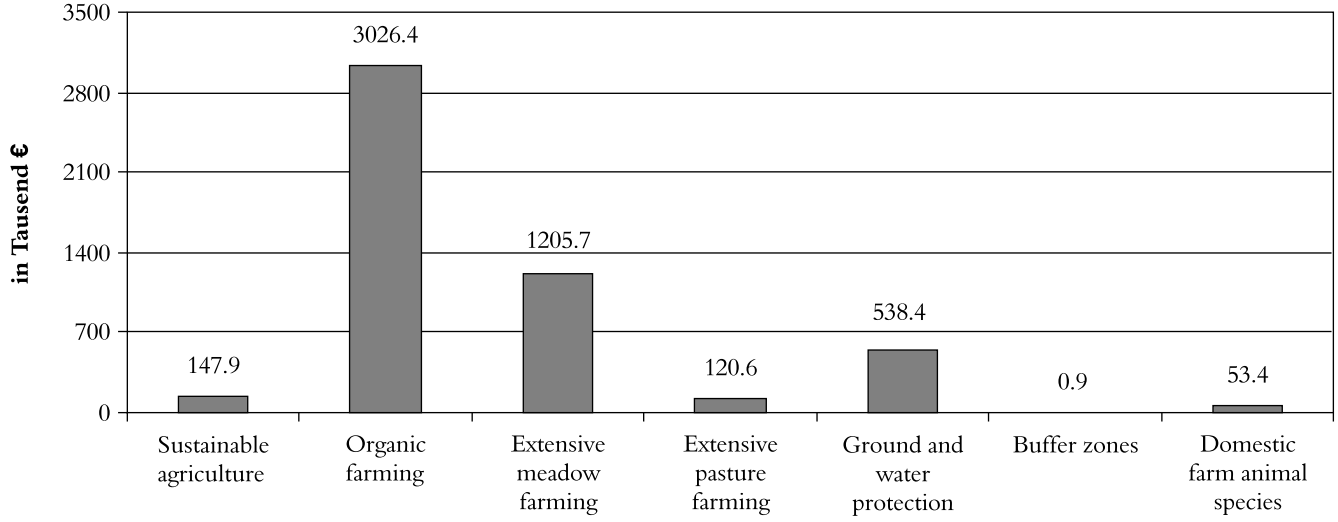
Costs of agri-environmental measures

For the estimation of costs of agri-environmental measures in the voivodship Subcarpathia, income losses, additional costs and additional benefit, which were calculated by the Ministry of Agriculture and Development of Rural Areas, were taken into consideration (MRiRW 2004b: L). The income losses are defined as lost revenue which could be achieved with the traditional agricultural production in the case if agri-environmental measures were not implemented. The additional costs are defined as all costs resulting for farmers from the implementation of the agri-environmental measures such as investment costs or work effort. The additional benefit was defined by the Ministry as the decrease of production costs in the traditional agricultural production as well as the improvement of soil quality. In this research study, the calculations estimated by the Polish Ministry for Agriculture and Development of Rural Areas are approved as correct. However, the question of the calculation method and calculation methodology are not discussed.

The direct costs for each measure per unit (1 ha farming area, 1 m^2 for the measure 'Buffer zones' and one head for the measure 'Domestic farm animal species') were calculated as a sum of the estimated income losses and additional costs of implementation of agri-environmental measures. The sum was minimized by additional benefit. Thus, potential complication of benefits and costs should have been omitted. The direct costs per unit of agri-environmental measures were then multiplied with the farming area involved in the realization of agri-environmental measures in the voivodship Subcarpathia in 2005. Hence, total costs of agri-environmental measures in the voivodship were estimated. The cost structure is displayed in Figure 4.

The cost analysis makes it possible to create a ranking of measures with the highest costs. The results show that the realization of the measures 'Organic farming' and 'Extensive meadow farming' requires the highest costs followed by the measures 'Ground and water protection', 'Sustainable agriculture', 'Extensive pasture farming', 'Domestic farm animal species' and 'Buffer zones'. The costs of the measures 'Sustainable agriculture' and 'Extensive pasture farming' are comparably high.

Figure 4
Total Cost of Agri-environmental Measures in the Voivodship Subcarpathia in 2005



Source: Author's study according to MRiRW (2004b: L).

Effectiveness of agri-environmental measures

In order to estimate the effectiveness of agri-environmental measures in the voivodship Subcarpathia, the total benefits and costs were investigated for the respective agri-environmental measure as a ratio and compared with each other (Formula 3). Thus, a relation can be stated—the higher the benefit–cost ratio, the more effective is the measure.

$$E_i = \frac{GN_i}{GK_i}, \tag{3}$$

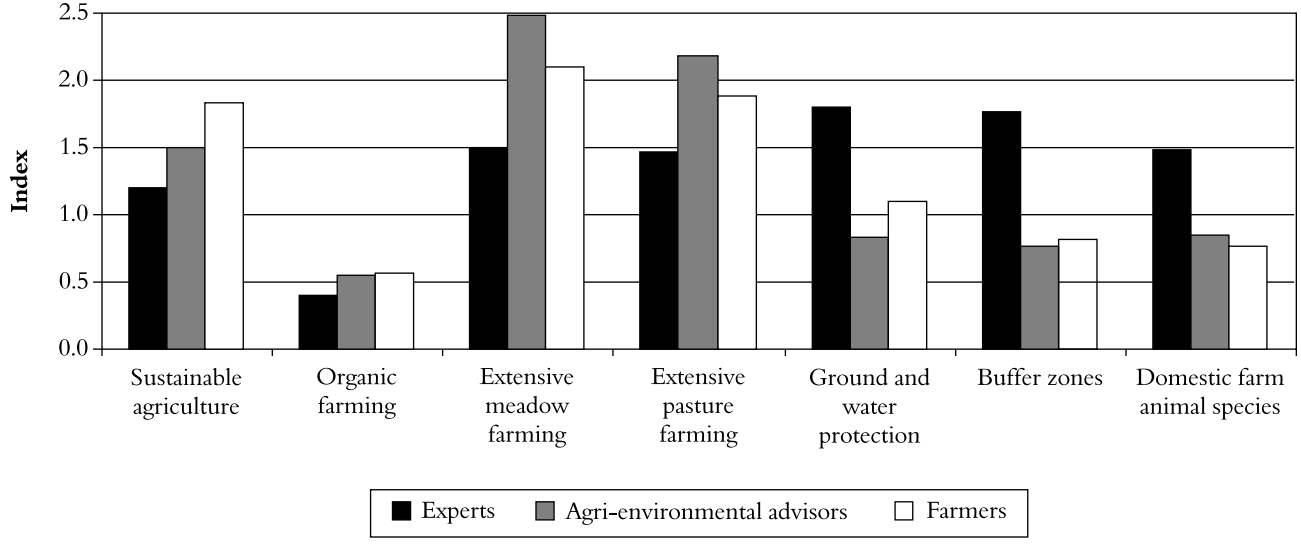
with:

E_i—effectiveness of the measure 'i',
GN_i—total benefit of the measure 'i',
GK_i—total costs of the measure 'i'

By means of effectiveness analysis, the relations between the two variables are estimated (Figure 5). However, it should be considered that absolute values of benefits and costs have different meaning due to different units.

The analysis shows visible differences in the cost-effectiveness of agri-environmental measures by different stakeholders, which is determined by different assessment of environmental benefit. Thus, the measures 'Ground and water protection' and 'Buffer zones' are most effective from the point of view of experts. The lowest effectiveness was found for 'Organic farming' which can be explained with high costs of the realization of this measure. According to the statement of agri-environmental advisors, the following ranking can be created in terms of the effectiveness of the agri-environmental measures: 'Extensive meadow farming', 'Extensive pasture farming', 'Sustainable agriculture', 'Domestic farm animal species', 'Ground and water protection', 'Buffer zones' and 'Organic farming'. The last four measures are characterized by a low cost–benefit ratio of less than one. Hence, these measures are not recommendable from the point of view of agri-environmental advisors. A similar tendency was found for farmers. Therefore, the measures 'Extensive meadow farming', 'Sustainable agriculture', 'Extensive pasture farming' and 'Ground and water protection' can be called as effective in terms of the environmental benefit which is confirmed by the cost-benefit ratio of more than one. All other measures are low effective according to the statements of farmers.

Figure 5
Cost-effectiveness of Agri-environmental Measures from the Point of View of Stakeholders in the Voivodship Subcarpathia

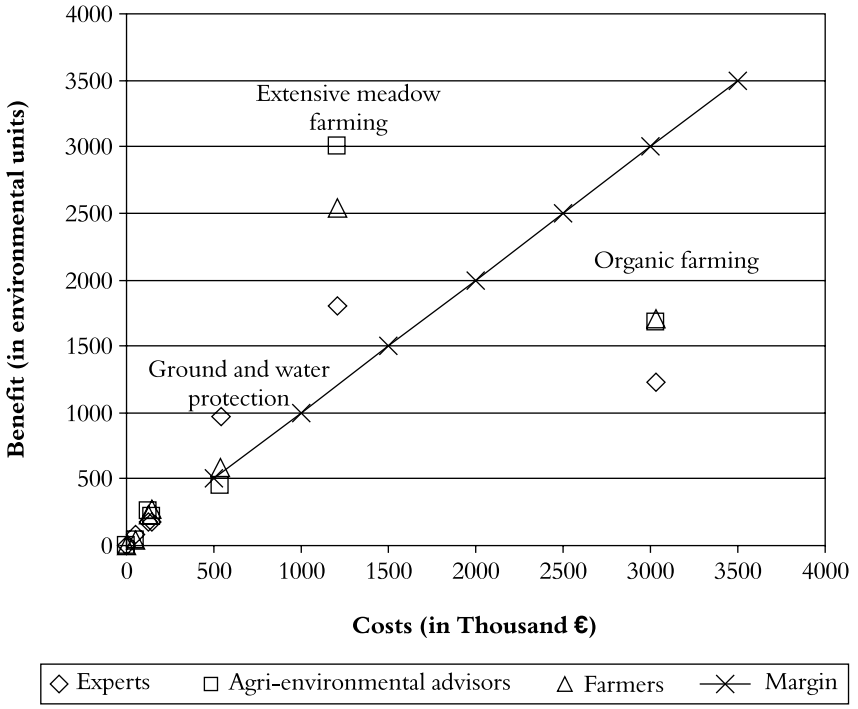


Source: Author's study.

Relations between benefits and costs

The cost-benefit ratios reflect relative relations while the absolute values are not differentiated. In order to differentiate the agri-environmental measures with regard to the benefit and cost value criteria, the values were depicted in plot diagrams. The results are displayed in Figure 6.

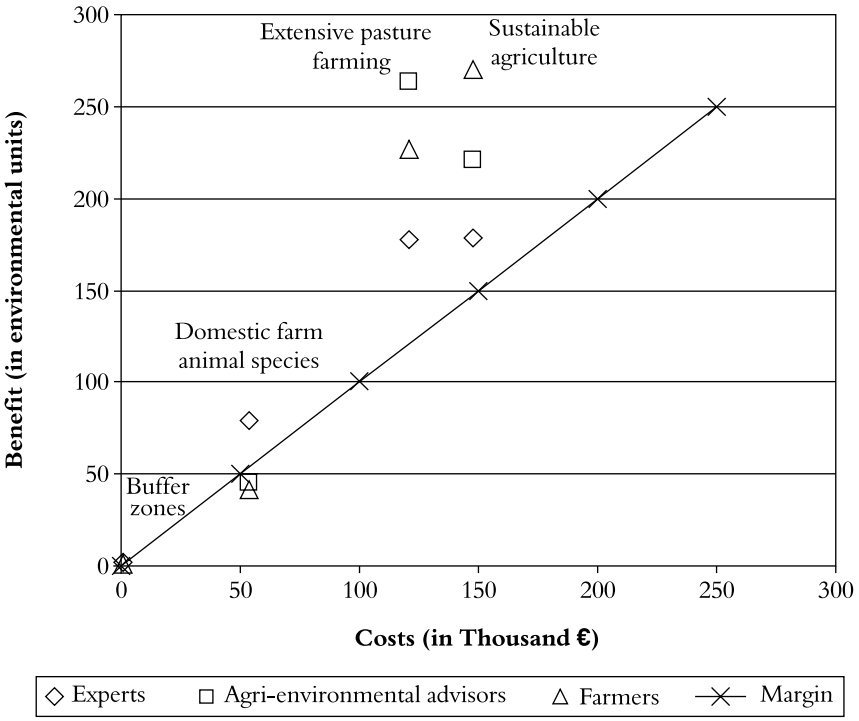
Figure 6
Plot Diagram for Benefit and Cost Values of Agri-environmental Measures from the point of View of Stakeholders in the Voivodship Subcarpathia



Source: Author's study.

The analysis of the absolute benefit and cost values shows a strong dispersion between the respective agri-environmental measures. The measures 'Extensive meadow farming', 'Ground and water protection' and 'Organic farming' reveal relatively high benefit or cost values, while other measures are characterized by low values for both variables and are cumulated in the left diagram corner. The detailed focus on these measures shows following allocation (Figure 7).

Figure 7
Plot Diagram for Low Benefit and Cost Values of Agri-environmental Measures from the point of View of Stakeholders in the Voivodship Subcarpathia



Source: Author's study.

According to the results (Figures 6 and 7) the measures 'Extensive meadow farming', 'Extensive pasture farming' and 'Sustainable agriculture' indicate higher benefits than costs. The values for the measure 'Ground and water protection' and 'Domestic farm animal species' are located at the margin line. The estimated values for each stakeholder group deviate a little from each other. The measure 'Buffer zones' is located near to zero as both benefit and cost values are very low for this measure. The measure 'Organic farming' is located under the margin although the benefit is high in comparison to benefits of other measures.

The results reveal that for the benefit maximization the measures: 'Extensive meadow farming', 'Ground and water protection' and 'Organic farming' are recommendable, however, high costs have to be taken into account for the last measure. Provided costs minimization as the political objective, the measures

'Domestic farm animal species', 'Extensive pasture farming' and 'Sustainable agriculture' are suitable.

The analysis shows that agri-environmental measures are differently effective in the voivodship Subcarpathia which was also confirmed by investigation for different stakeholders' groups. Depending on political strategies of maximization of environmental benefit or minimization of costs the appropriate strategies with respect to the respective measures should be deliberated in an interactive decision-making process. By means of this analysis, political decision makers should be motivated to implement scientific approaches as methodical instruments in evaluation processes of political programmes.

ADVANTAGES AND RESTRICTIONS OF THE COST-EFFECTIVENESS ANALYSIS IN THE EVALUATION OF AGRI-ENVIRONMENTAL MEASURES IN POLAND

The cost-effectiveness analysis for the agri-environmental measures in Poland is based on objective coefficients estimated by stakeholders by means of the AHP approach. The AHP approach can be used for political decision support; however, estimations are based solely on the assessment of benefit components. In order to consider cost components which are decisive for farmers by realization of agri-environmental measures, the cost-effectiveness analysis was implemented. With the cost-effectiveness analysis, the benefit and costs components can be compared which allows estimation of effective and ineffective measures. In the presented cost-effectiveness analysis, no budget constraints for the agri-environmental measures were considered. Without budget restrictions, all measures can be realized and no other simulation analysis is possible. In the political decision-making processes, other restrictions and conditions such as regional economic and ecological problems are relevant for the evaluation and design of political strategies. Therefore, other methodical approaches are recommendable to consider possible restrictions and to reflect the real problems (see Kirschke et al. 2007; Ziolkowska 2007a; Ziolkowska and Kirschke 2007).

CONCLUSIONS

In the article, two evaluation approaches (Analytic Hierarchy Process and cost-effectiveness analysis) are discussed and practically used for evaluation of agri-environmental measures in Poland after the accession to the EU. The results show advantages of combining approaches in order to extend methodological analyses. Additionally, the results prove the necessity of an extended evaluation of agri-environmental measures in Poland. The missing evaluation of agri-environmental measures is determined by the short membership in the EU

and, thus, little experience with agri-environmental policy. The results of the explorative case study in the voivodship Subcarpathia deliver new findings on the necessity to consider regional assessments with regard to environmental objectives in order to more effectively create agri-environmental measures in the new financing period 2007–2013. The case study reveals differences in environmental priorities between the respective stakeholders. According to the results, the measures 'Extensive meadow farming' and 'Organic farming' denote the highest environmental benefit with regard to the envisaged environmental objectives defined in the National Agri-environmental Programme 2004–2006 from the point of view of all stakeholders. The lowest benefit was found for the measures 'Buffer zones' and 'Domestic farm animal species'. On the other hand, according to statistical analysis, the measures 'Extensive meadow farming' and 'Organic farming' indicate the highest implementation costs. The cost-effectiveness of agri-environmental measures is differentiated depending on the stakeholders group. According to experts, the most effective measures are 'Ground and water protection' and 'Buffer zones'. According to the statements of experts and agri-environmental advisors, 'Extensive meadow farming', 'Extensive pasture farming' and 'Sustainable agriculture' are most cost-effective and, thus, recommendable for the further realization. The presented cost-effectiveness analysis does not include any budgetary restriction. Hence, other approaches are recommended for designing agri-environmental measures in an interactive decision-making processes.

Dr. Jadwiga Ziolkowska is Chair, Agricultural Policy, Humboldt University of Berlin. E-mail: jadwiga.ziolkowska@agrar.hu-berlin.de

Note

1. In order to ensure clarity of results, the estimated benefit scores were divided by 1000, which does not distort the results. However, it makes the interpretation of results easier and more clear.

References

ARiMR (Agencja Restrukturyzacji i Modernizacji Rolnictwa) (Agency for Restructuring and Modernisation of Agriculture). 2006. 'Liczba wniosków o wsparcie w ramach programu rolno-œrodowiskowego' (Applications for financial support from the Agri-Environmental Programme), Unpublished Document. Rzeszow: ARiMR.

Europäische Kommission (European Commission). 1999. 'Verordnung (EG) Nr. 1257/1999 des Rates vom 17. Mai 1999 über die Förderung der Entwicklung des ländlichen Raums durch den Europäischen Ausrichtungs- und Garantiefonds für die Landwirtschaft

(EAGFL) und zur Änderung bzw. Aufhebung bestimmter Verordnungen' (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.) *Amtsblatt der Europäischen Gemeinschaften* (*Official Journal of the European Union*), L 160: 80–102.

Forman, E.H. and S.I. Gass. 2001. 'The Analytic Hierarchy Process—An Exposition', *Operations Research*, 49 (4): 469–86.

Guo, L.S. and Y.S. He. 1999. 'Integrated Multi-Criterial Decision Model: A Case Study for the Allocation of Facilities in Chinese Agriculture', *Journal of Agricultural Engineering Research*, 73 (1): 87–94.

Ho, W. 2008. 'Integrated Analytic Hierarchy Process and its Applications—A Literature Review', *European Journal of Operational Research*, 186 (1): 211–28.

Kirschke, D. and K. Jechlitschka. 2002. Angewandte Mikroökonomie und Wirtschaftspolitik mit Excel (Applied Microeconomics and Economic Policy Using Excel). München: Verlag Franz Vahlen.

Kirschke, D., E. Daenecke, A. Häger, K. Kästner, K. Jechlitschka and S. Wegener. 2004. 'Entscheidungsunterstützung bei der Gestaltung von Agrar-Umweltprogrammen: Ein interaktiver, PC-gestützter Programmierungsansatz für Sachsen-Anhalt'('Decision Support for Design of Agri-environmental Measures: Interactive Computer-Based Programming Approach for Saxony-Anhalt'), *Berichte über Landwirtschaft* (Reports About Agriculture-*Journal on Agricultural Policy and Farming*), 82: 494–517.

Kirschke, D., A. Häger, K. Jechlitschka and S. Wegener. 2007. 'Distortions in a Multi-level Co-financing System: The Case of the Agri-environmental Programme of Saxony-Anhalt', *Agrarwirtschaft*, 56 (7): 297–304.

Kurttila, M., M. Pesonen, J. Kangas and M. Kajanus. 2000. 'Utilizing the Analytic Hierarchy Process (AHP) in SWOT Analysis—A Hybrid Method and its Application to A Forestcertification Case', *Forest Policy and Economics*, 1 (1): 41–52.

Malczewski, J., R. Moreno-Sanchez, L.A. Bojorquez-Tapia and E. Ongay-Delhumeau. 1997. 'Multicriteria Group Decisionmaking Model for Environmental Conflict Analysis in the Cape Region, Mexico', *Journal of Environmental Planning and Management*, 40 (3): 349–74.

Masozera, M.K., J.R.R. Alavalapati, S.K. Jacobson and R.K. Shrestha. 2006. 'Assessing the Suitability of Community-based Management for the Nyungwe Forest Reserve, Rwanda', *Forest Policy and Economics*, 8 (2): 206–16.

MRiRW (Ministerstwo Rolnictwa i Rozwoju Wsi) (Ministry of Agriculture and Rural Development). 2004a. Plan Rozwoju Obszarów Wiejskich na lata 2004–2006 (Plan for Development of Rural Areas for 2004–2006). Warsaw.

Mrirw. 2004. Plan Rozwoju Obszarów Wiejskich na lata 2004–2006: Załącznik B, E, F, G, H, L, P. (Plan for Development of Rural Areas for 2004–2006. Attachments B, E, F, G, H, L, P) http://www.minrol.gov.pl (accessed on 12 November 2004).

———. 2007. 'Informator Planu Rozwoju Obszarów Wiejskich na lata 2004–2006' Information on the Plan for Development of Rural Areas for 2004–2006, *PROWinki*, 6 (87).

Pohl, B. 2001. 'Decision-making Support for Rural Development Strategies', in D. Kirschke, M. Odening and H. von Witzke (eds), *Berliner Schriften zur Agrar- und*

Umweltökonomik Bd. (*Berliner Journal for Agricultural and Environmental Economics 1*). Aachen: Shaker Verlag.

Poister, T.H. 1978. *Public Program Analysis: Applied Research Methods*. Baltimore: University Park Press.

Portney, P.R. 2000. 'The Contingent Valuation Debate: Why Economists Should Care', in R. Stavins (ed.), *Economics of the Environment: Selected Readings*, pp. 253–67. New York: W.W. Norton & Co.

Prager, K. 2006. 'Communication Processes in Agri-Environmental Policy Development and Decision Making. Berlin', Ph.D. thesis. Berlin: Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät.

Rathwell, M. and A. Burns. 1985. 'Information Systems Support for Group Planning and Decision-Making Activities', *MIS Quarterly*, 9 (3): 255–71.

Rohr, T. 2004. 'Einsatz eines mehrkriteriellen Entscheidungsverfahrens im Naturschutzmanagament. Dargestellt am Naturschutzprojekt, Weidelandschaft Eidertal' (Implementation of multicriteria decision support systems in nature protection management. Presented on the example of nature protection project pasture landscape Eidertal), Ph.D. thesis. Kiel: Christian-Albrechts-Universität zu Kiel: Agrarwissenschaftliche Fakultät (Christian-Albrechts-University of Kiel: Faculty of Agriculture).

Saaty, T. 1990. *The Analytic Hierarchy Process. Planing, Priority Setting, Resource Allocation*. Pittsburgh: RWS Publications.

Saaty, T. and K. Kearns. 1985. *Analytical Planning. The Organisation of Systems*. Pittsburgh, RWS Publications.

Saaty, T. and L. Vargas. 1991. *Prediction, Projection and Forecasting. Applications of the Analytic Hierarchy Process in Economics, Finance, Politics, Games and Sports*. Boston: Kluwer Academic Publishers.

Saaty, T., L. Vargas and K. Dellmann. 2003. 'The Allocation of Intangible Resources: The Analytic Hierarchy Process and Linear Programming', *Socio-Economic Planning Sciences*, 37 (3): 169–84.

Shrestha, R.K., J.R.R. Alavalapati and R.S. Kalmbacher. 2004. 'Exploring the Potential for Silvopasture Adoption in Southcentral Florida: An Application of SWOT-AHP Method', *Agricultural Systems*, 81 (3): 185–99.

Steuer, R.E. and P. Na. 2003. 'Multiple Criteria Decision Making Combined with Finance: A Categorized Bibliographic Study', *European Journal of Operational Research*, 150 (3): 496–515.

Vaidya, O.S. and S. Kumar. 2006. 'Analytic Hierarchy Process: An Overview of Applications', *European Journal of Operational Research*, 169 (1): 1–29.

Van De Ven, A. and A. Delbecq. 1974. 'The Effectiveness of Nominal, Delphi, and Interacting Group Decision Making Processes', *The Academy of Management Journal*, 17 (4): 605–21.

Weber, K. 1993. Mehrkriterielle Entscheidungen (Multicriteria decisions). München: R. Oldenburg Verlag.

Ziolkowska, J. 2007a. Agrar-Umweltpolitik in Polen nach dem EU-Beitritt: Bewertungs- und Gestaltungsansätze und Fallstudie für die Wojewodschaft Vorkarpaten (Agri-environmental Policy in Poland after the Accession to the European Union: Evaluation

and Design Approaches and Case Study for the Voivodship Subcarpathia). Berliner Schriften zur Agrar- und Umweltökonomik 12 (*Berliner Journal for Agricultural and Environmental Economics 12*). Aachen: Shaker.

———. 2007b. 'Environmental Issues in Polish Agriculture—Development and Perspectives', in A. Knierim, U.-J. Nagel and C. Schäfer (eds), *Managing Economic, Social and Biological Transformations*, pp. 73–79. Weikersheim: Margraf Publishers.

Ziolkowska, J. and D. Kirschke. 2007. 'Effective and Objective-oriented Budget Allocation for Agri-environmental Programmes in Poland from a Regional Perspective', in Academy of Agricultural and Forestry Sciences of Latvia, Latvia University of Agriculture (ed.), Proceedings of the International Scientific Conference 'Economic Science for Rural Development' vom 24–25. April 2007, No. 14.