Application of Natural Resources Indicators to Agricultural Land Management in Slovenia

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Summary

The group of indicators to establish the impact of land management measures on natural resources in the agricultural landscapes in Slovenia is discussed and identified. Each chosen natural resource indicator is defined regarding indicator status, quality parameters of an indicator and indicator costs. The indicators are divided into two subgroups: abiotic indicators and biodiversity indicators, whereby biodiversity indicators are threatened on tree levels: genetic, species and ecosystem level. The result is the synthesis of natural resources indicators with the tabular review of their main characteristics, named indicators personal data. With selected indicator group the evaluation and monitoring of management measures regarding sustainability is possible. The weaknesses of some selected natural resources indicators are discussed and the fact that the indicators characteristics are not stable, but are time and space dependable is taken into consideration.

Key words

natural resources; agricultural land management; indicators

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Received: January 24, 2006

Introduction

According to the Agricultural Land Act (Official paper of RS No. 59/96) under agricultural land management in Slovenia the following measures are stated: exchange of agricultural land, land consolidation and hydro- and agromelioration. Most measures, especially land consolidation and hydro melioration were carried out in the 70s, whereby in the late 80s the interest for them slowly decreased, mainly due to agro-political as well as environmental reasons (Borec, 2000).

In the last decade the importance of some land management measures has increased; partly due to the needs of Common Agricultural Policies (CAP) and also due to the climatic changes that dramatically influenced the need for irrigation measures.

In the research, the impact of land management measures on natural resources and evaluation of measures regarding sustainability are discussed whereby the sustainable principle is understood as an innovative policy framework, as well as higher input of scientific knowledge (Piorr, 2003).

The practice to ascertain the changes of natural resources in agricultural landscape in Slovenia was previously based on the data of some sectoral monitoring and often time consuming and expensive research activities. The results of such punctual work were complex and scattered information across many institutions. The lack of clear information was an important reason for searching, collecting and using standardized indicators.

In Slovenia, indicators for monitoring the state and changes in the environment are already used externally at the national level. Beside indicators at the national level, some sectoral indicator groups are used for the needs of individual professions, but their applicability is still mostly unassessed.

In the research the procedure for the identification of a group of indicators is represented. In the framework of the research the selected indicator group is defined as a tool for achieving improvement, maintenance and perseverance of natural resources, when land management measures in the agricultural landscape are taken.

Methods

Tree basic fields of knowledge that are presented in Figure 1 were considered in selecting indicator group.

Good knowledge of local natural resources and landscape comprised studies of existing Evidences on the State of the Environment, Yearly Reports on Environment Condition, implementations of the Natura 2000, Rural Development Measures, CAP measures, the knowledge of present landscape types in Slovenia, the results of different studies and research activities on the national level.

By the analysis of the existing and related indicator groups the relevant indicators were searched horizontally, where the indicators differ according to the topic: environmental indicators, agri-environmental indicators, biodiversity indicators, landscape indicators, indicators for the development of rural areas, etc. They are so called sectoral indicators. The indicators were searched vertically as well. In this respect, the indicators are divided with regard to the international, regional and local level. With the analysis of international indicators the research was focused on a group of OECD indicators, because they are extremely well classified although slightly too abstract for the use on the ecosystem level (Borec, 2000). In the analysis of indicators at regional and local level the research was limited to those groups of indicators, which are closely connected to the research goals.

The legal framework comprises good knowledge of the adopted international conventions: Convention on Climate Change; Convention on Biological Diversity; Ramsar Convention; World Declaration on Environment and Development; World Conservation Union (IUCN); Agenda 21; national acts (The Environment Protection Act, Nature Conservation Act, Agriculture Act); some other national documents (National Program on Nature Conservation, Agricultural Development Strategy of

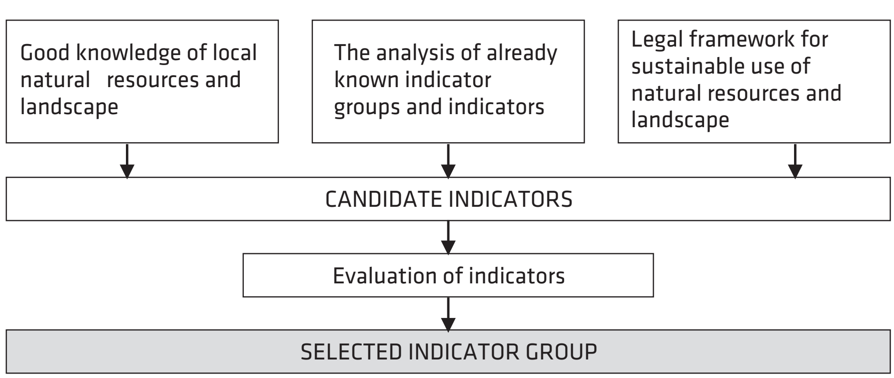

Figure 1.
Visual presentation of the method for selecting the indicator group

Slovenia, The Strategy of the Republic Slovenia for Accession to the European Union) and national documents related to CAP.

By using this method the indicator group with many indicator candidates was considered. Every considered indicator candidate is not suitable for usage, which is why each indicator was evaluated. The indicator evaluation comprehends tree main criteria, called "indicator personal data": indicator status, indicator quality and indicator costs. Indicator status is determinated with three sub criteria regarding indicator use: an indicator is only being planned; information is available in the anticipated form, but has not been defined as an indicator yet and an indicator has already been defined and used.

The quality of an indicator can vary considerably and depends mainly on the purpose of its future use (Tschirley, 1997; Lowe et al., 1999; Romstad, 1999; Parris, 1999). The indicator quality criteria were taken into consideration according to OECD (2001): the measurement of an indicator (measurability), its professional relevance (predictability), analytical sense (monitoring), the simplicity of interpretation (communication) and political relevance (suitability regarding agricultural policy). The indicator costs are determined by the amount of expenses for gathering information and by the expenses needed for information flow during recording, statistics, analysis and politics (Radej et al., 1999). Driving force - Sate - Response framework to address the environmental linkages is taken into consideration According to OECD (1998). In the framework of such a concept Driving force represents human activities, processes and patterns that have impact on natural resources. Sate indicators indicate the "state" of natural resources and the Response indicators indicate policy options and other responses to changes of natural resources in agricultural landscape. The research result of evaluation of each indicator candidate is the indicator group with the personal data for each indicator.

Results and discussion

The compilation of candidate indicators is divided according to the Figure 2.

Considering the fact that land management measures influence abiotic components as well as biodiversity of agricultural landscape, natural resources indicators were divided in two subgroups: abiotic indicators and biodiversity indicators. The use of an indicator to assess biodiversity as a whole is theoretically and practically impossible (Duelli and Obrist, 2003), which is why the biodiversity indicators are treated on three levels (Figure 2). Such treatment is based on a definition of Convention on Biological Diversity (www.biodiv.org/convention/

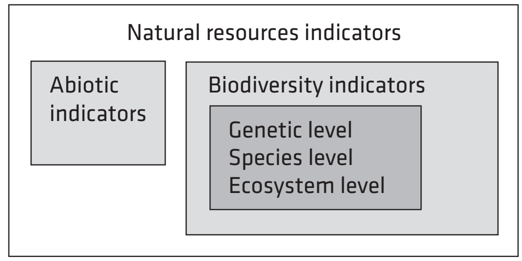

Figure 2.
The organization of candidate indicators into groups

articles.asp. 2004). Sustainable use of the components of biodiversity is defined in the Convention as use "in a way and at a rate that does not lead to the long-term decline of biodiversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations" (EEA: themes.eea.eu.int/Environmental_issues/biodiversity/indicators. 2005).

Abiotic indicators

Among abiotic natural resources, the monitoring of water quality, water supplies and soil quality was given a priority. The decision is based on the following facts: (a) the consumption of agents used for plant protection and mineral fertilizers has increased in Slovenia lately, which is connected with the increase in soil and water pollution (Report on the State of Environment in Slovenia, 2002); (b) the whole of Slovenia is considered to be a sensitive area with regard to the Decree amending the Decree on the input of hazardous substances and plant nutrients into the soil (Official paper of the RS 35/01); (c) monitoring of the most important parameters of water and soil pollution is a regular practice in Slovenia (Report on the State of Environment in Slovenia, 2002); (d) according to National Programme on Irrigation (1994), there is 10000 ha of agricultural land intended for irrigation.

By identification of abiotic indicators the available data base, existing monitoring and the accessibility of data have also been considered as restriction. According to this, the following indicators with their personal data (Table 1) were included in the subgroup of abiotic indicators.

All required data intended for indicator subgroup (Table 1) are already monitored and all stated indicators are defined in the Environmental Indicator Group used for Reports for the State and Changes in the Environment on nation level (Indicators for State and Changes in the Environment: gov.si/mop; 2005).

Modification of abiotic resources in agricultural landscape are stated as good indicators of agricultural intensity, because negative influences could be quickly shown (Borec, 2000). In addition, these indicators have

Table 1. Selected abiotic indicators with indicators personal data

Indicator	Status	Quality					Costs
		Predictabil.	Measurabil.	Monitoring	Communic.	Suitability	
Fertilizer consumption	defined	perfect	perfect	ongoing	perfect	direct	low
Pesticide consumption	defined	perfect	perfect	ongoing	perfect	direct	low
Nitrates in ground water	defined	perfect	perfect	ongoing	perfect	direct	low
Pesticides in groundwater	defined	perfect	perfect	ongoing	perfect	direct	low
Water used for irrigation	info. available	suitable	perfect	is planned	medium	indirect	medium
Nitrates in flowing waters	defined	perfect	perfect	ongoing	perfect	direct	low
Pesticides in flowing waters	defined	perfect	perfect	ongoing	perfect	direct	low

also some priorities over biodiversity indicators: they comprise information which is more comprehensible, they are easier to measure, they have greater communication value, they are more exact and the monitoring for all selected indicators is already running on the national level.

Biodiversity indicators

Three basic groups of measures, which are usually not used separately, have a great impact on preservation of biodiversity in Slovenia: (a) financial supports to individuals for a particular land use or production process, (b) measures for areas of particular biodiversity importance and (c) measures based on voluntary initiatives (Biological and Landscape Diversity in Slovenia, 2001).

International organisations (e.g. FAO, www.biodiv.org/convention/articles.asp. 2004; OECD, 2001; EEA, themes.eea.eu.int/Environmental_issues/biodiversity/indicators 2005) as well as many authors (e.g. Büchs, 2003; Borec, 2000; Dijk van, 1997) dealt with links between agriculture and biodiversity and with selection of biodiversity indicators. The search for biodiversity indicators is more difficult and less research activities have been done than in the sphere of abiotic indicators (OECD, 1998).

In the article three levels of biodiversity are taken into consideration (Figure 2), with the emphasis given to species and ecosystem indicators. This can be discussed with the fact that because of Bird and Habitat Directive, a satisfactory data base already exists. At the same time, species and habitat indicators are defined as sufficiently relevant in many indicator groups (Dijk van, 1997).

Genetic level

Genetic erosion may be defined as a permanent reduction in richness or evenness of common localized alleles or the loss of combination of alleles over time in a defined area (FAO: fao.org/biodiversity/crops_en.asp; 2005). This definition which recognizes that genetic diversity has two distinct components: the number of different entities and their relative frequencies.

For the conservation and sustainable use of plant genetic resources for food and agriculture The Global Plan of Action was adopted by 150 countries and endorsed by the FAO Conference (FAO: fao.org/biodiversity/crops_en.asp; 2005). The Global Plan of Action is intended as a framework, guide and catalyst for action at community, national, regional and international levels. It seeks to create an efficient system for the conservation and sustainable use of plant genetic resources through better co-operation, co-ordination and planning and through the strengthening of capacities (FAO: fao.org/biodiversity/crops_en.asp; 2005).

To obtain the development of genetic diversity indicators it is essential to clear picture on the current status of the extent and maintenance of native diversity in agricultural production.

Brown et al. (1997) provide a useful list of indicators that could be measured singly or in combinations of individuals and populations of a given species in a defined area as part of a systematic effort to monitor changes in genetic diversity in the species.

Colette (2001) indicated that genetic indicators must reveal information about genetic diversity, genetic erosion and vulnerability.

While searching for appropriate indicators, the fact that land management measures influenced the extension of production intensification which caused the long-term genetic erosion is taken into consideration. Plant genetic erosion could be expressed in narrow cultivation, in the exchange of less productive local cultivars with highly productive and in precise plant selection (Iyimen-Schwarz and Schulz, 2003). Many researchers (Debouck, 2002; Dudnik et al., 2001; Wetterich, 2003; Garcia Cidad, 2001; Eysel et al. 2001; Virchow, 2001; Klingenstein, 2001) and international organisations like OECD (2001), FAO (fao.org/biodiversity/crops_en.asp; 2005), US Environmental Protection Agency (epa.gov/

eerd/ 2005), EPA (epa.nsw.gov.au/soe/95/13_1.htm; 2005), ENTRI (sedac.ciesin.columbia.edu/entri/; 2005) provide a rich source of topics related to status and trends in agricultural genetic resources, as well as the methods for monitoring them.

Data sources for diversity indicators arise from Slovene Plant Gene Bank which includes endangered species and indigenous cultivars, lines and clones, bred from the indigenous plants and wild relatives of crops found in natural sites (Biological and Landscape Diversity in Slovenia, 2001). Regarding the available data base and the purpose of the research, the Share of cultivated species from the old local / national cultivar (Wetterich, 2001) and Number of endangered national crop varieties used (OECD, 2001) were proposed for subgroup of genetic indicators.

Species level

In order to monitor the biodiversity species and habitats occurring in that area should be monitored. Many authors advocate the combined use of species and habitat approaches (Dijk van, 1997) although the relationship between the two is generally not sufficiently clarified. It is advisable that species indicators also monitor the quality of habitats, which is why many authors define some species indicators as quality indicators (OECD, 2001). Species diversity can be measured as a simple number of species, usually of selected group of organisms, or species richness may be combined with the evenness of the abundance distribution of the species (Duelli and Obrist, 2003). Tucker and Heath (1994), Tucker and Evans (1997) and Heath and Evans (2000) reported that the most important species groups on agricultural landscape are birds, with many species of conservation concern, so they could also be good indicators for other group of organisms. Indeed, in Slovenia much information on birds is available, both on status and trends and on habitat requirements (Biological and Landscape Diversity in Slovenia, 2001). Stated by many authors (Bücks, 2003), there are also other important animal species (carabidae species, insect species, araneae species, some soil microbes) for monitoring the quality of the agricultural landscape. In Slovenia the monitoring of population density is carried out for one bat species, game species (hoofed game), certain endangered bird species, certain fresh water species, plankton, nekton and bentic marine organisms (Biological and Landscape Diversity in Slovenia, 2001).

According to Döring et. al. (2003) there is also a lot of evidence of a correlation between species diversity of plants and zoological taxa. He stressed out that weed diversity might be suitable for a rapid assessment of faunistic diversity, but is alone not sufficient for a more sensitive measurement particularly if mainly conventionally managed fields have to be evaluated, which is the case in this research. Nevertheless the number of species alone is not a most suitable criterion for quality of biodiversity indication approaches. Thus, the next subgroup of species indicators is recommended for more pragmatic reasons: Status and trends in population of key species (van Dijk, 1997), Population trends in farmland birds (Finland's indicators for sustainable development: un.org/esa/sustdev/natlinfo/indicators/isd.htm; 2005), Number of bird species (Tucker and Heath, 1994; Tucker and Evans, 1997; Heath and Evans, 2000) and Number of threatened plant species (Finland's indicators for sustainable development, un.org/esa/sustdev/natlinfo/indicators/isd.htm; 2005).

Feehan (2001) and Smith et al. (2001) also stressed high importance of wild species that are of economic importance for agriculture (pollinators, soil biodiversity). Unfortunately, because of a poor data base on the local and national level in Slovenia, they have been eliminated for research proposes.

Ecosystem level

Ecosystem diversity indicators represent the quantity aspect of biodiversity, while species based indicators represent quality aspect of biodiversity (OECD, 2001). OECD (2001) recognized the need for four agricultural landscape indicators attributes: landscape structure (i.e. quantity), landscape function (i.e. quality), landscape management and landscape value attributes. Waldhardt (2003) stressed, on the basis of many articles, the importance of landscape characteristics related to land use. Wascher (2002) found out in his Overview on Agricultural Landscape Indicators across OECD countries, that landscape structure was the indicator field that was most commonly in use and where an increasing number of sophisticated techniques were developed. However this is not the case in ecosystem diversity indicators, where the emphasis is given to landscape management – landscape conservation (Garcia Cidad et al., 2001), to status and trends in agricultural ecosystems (Aubrecht et al., 2001) and to agricultural habitat change (Brady, 2003). Jeanneret et al. (2003) wrote that agricultural landscapes are heterogeneous and provided several types of habitats. Because most of the time, single habitats usually prove to be unsuitable for a large number of species, the spatial and temporal distribution of habitats is a key factor for biodiversity in agricultural landscapes. According to Smith et al. (2001) habitat based indicators are more useful then species based indicators, because they represent a more stable part of the ecosystem and are the components over which farmers have most control. Ecosystem diversity indicators prepared by the OECD (2001) are divided into three categories drawn on the classification of agricultural land

Table 2. Selected biodiversity indicators with indicator personal data

Indicator	Status	Quality					Costs
		Predictabil.	Measurabil.	Monitoring	Communic.	Suitability	
Diversity of cultivated crops from the old local/national cultivar	info. available	suitable	suitable	is planned	suitable	indirect	high
Number of endangered national crop varieties	info. available	suitable	suitable	ongoing	suitable	indirect	medium
Status and trends in population of key species	is planned	perfect	difficult	ongoing	perfect	indirect	high
Population trends in farmland birds	info. available	perfect	difficult	ongoing	perfect	indirect	high
Number of birds species	info. available	suitable	suitable	ongoing	suitable	indirect	medium
Number of threatened plant species	info. available	suitable	suitable	is planned	perfect	indirect	medium
Diversity of agricultural land use	info. available	suitable	suitable	is planned	suitable	indirect	medium
Area of semi-natural grassland	info. available	perfect	suitable	is planned	perfect	indirect	medium
Network and fragmentation of landscape elements	is planned	perfect	difficult	is planned	perfect	indirect	high

into intensively farmed, semi-natural and uncultivated natural habitats.

In searching for the appropriate group of ecosystem diversity indicators for Slovenian agricultural landscapes the restriction connected to the availability of data plays a distinct role. At the national level Slovenia uses data from the European level such as CORINE Land Cover. The second very important data source especially in smaller scale, arises from Cartography of Habitat Types in Slovenia (Habitatni tipi Slovenije - HATS), Land Cadastre, different Thematic maps, Classification of Landscape Types in Slovenia and data of National Statistics (Statistični Urad Republike Slovenije - SURS).

According to ecosystem diversity indicators proposed by OECD (2001) the indicator identification was focused on intensively farmed agricultural habitats and semi-natural habitats. The ecological value of intensively farmed agricultural habitats is generally low, but they do provide habitat for some vascular plants, invertebrates, small mammals and birds (OECD, 2001; Barrett and Peles, 1999). Semi-natural habitats are relatively undisturbed by farming practices and chemicals. Their ecological value increases with the reduction of agricultural intensification. Under the semi-natural habitats the semi-natural grassland and semi-natural linear landscape elements were treated. The high importance of identifying suitable indicators is given to grassland due to Slovenian high total grassland area (SURS, stat.si; 2005). The research done on semi-natural grassland in Slovenia is also exhaustive (Kaligarič and Škornik, 2002; Kramberger and Gselman; 2000; Kaligarč and Seliškar, 1999; Vidrih et al., 1994). In addition, many researches stressed the high importance of semi-natural grassland for bird species (Heath and Rayment, 2001; Geronimo et al., 2001; Garcia-Cidad et al., 2001; Tucker and Evans, 1997). The indicator of spatial patterns of linear (semi-natural) landscape elements could express the habitat size and density, habitat fragmentation and/or habitat network (Borec, 2000). These are also habitat characteristics which could be measured (Forman and Godron, 1986). Because we are looking for indicators in the field of more intensive agricultural ecosystem, the indicators for uncultivated habitats are not taken into consideration. The proposed subgroup of ecosystem indicators is composed of Diversity of agricultural land use –the size of parcels of one crop (Wagner, 2003; Borec, 2000), Area of semi-natural grasslands (OECD, 2001) and Spatial patterns (network and fragmentation) of linear landscape elements (Steiner and Köhler, 2003; Slak and Lee, 2003; Borec, 2000).

The group of all selected biodiversity indicators regarding evaluation criteria is presented in the Table 2.

Conclusion

Many expert papers provide a rich source of indicators that can be used in agriculture. In the research, the use of indicator group was defined as a basic tool for evaluating land management measures regarding sustainability. Regarding Driving Force-State-Response framework all selected indicators are considered as state indicators. The imperfection of state indicators lies in the fact that they give us information of the present state and not about the reasons for the present situation (Iyimen Schwarz and Schulz, 2003). By selection of indicators beside the indicators status and quality criteria the price of indicators is also considered as very important indicator attribute. Due to incomplete data bases by several indicators, price represented an important limiting factor while dependence on the cost criterion cannot always be reasonable on the long run (Borec, 2000). Romstad (1999) reported that costs can differ a lot with regard to the country where data is collected. At the same time, we should not allow that the existing statistics play a decisive role in the selection of indicators, because the role of other quality parameters can become endangered. The possibility for international comparison of indicators has not been taken into consideration, because of the level of use (regional or ecosystem level) and due to the target group of users, despite the fact that some indicators can be internationally (mainly those that have been defined for writing Reports on the State of Environment) comparable.

All abiotic indicators selected in the research are standardized, well known, measurable and internationally comparable. The imperfection of the selected abiotic indicators lies only in their definition as state indicators.

It is clear that in order to monitor the biodiversity of a specific area, at least species and habitats occurring in that area should be monitored. By measuring biodiversity some components change relatively slowly with time and thus may not provide the immediate information needed for policy and management decisions. Policy makers need timely information that provides sense of the relative seriousness and urgency of the actions needed. Thus, the information must be more time-sensitive, such as population trends in farmland birds or bird species. The basic disadvantage of selected species diversity indicators lies in the fact that they do not scientifically reveal the exact reasons of species diversity decline. By ecosystem indicators the problems when setting target standards for each indicator could appear. These standards usually differ in landscape type, thus it is advisable to design standards for each landscape type. Similar findings for individual landscape types were also described by Hoffmann and Greef (2003). Summarising research results next general findings could be pointed out: (a) biodiversity is a scientifically complex area, where the understanding of the relationship between agriculture and biodiversity is still in an early phase of development and requires further research; (b) for better understanding (cause and effect relationships between indicators, usefulness of indicators for policy makers) it is important to develop better linkages between biodiversity and other natural resources indicators; (c) further examinations are needed in the sphere of soil micro flora and fauna; (d) further studies are required to estimate the economic benefits of biodiversity and the costs and benefits of the trade-offs between increased agricultural production and biodiversity loss.

In addition, considering the group of natural resources indicators selected for establishing the impact of land management measures on natural resources and also for the evaluation of land management measures and monitoring purposes, next activities will be needed in the future: (a) analytical consistency, accuracy and measurability of indicators are weak in some indicators, which is why they need to be further improved; (b) the interpretation of trends in some indicators should be improved; (c) the measurement of external environmental expenses as well as agricultural benefits has to be taken into consideration (changing physical indicators into monetary indicators); (d) the linkage between scientific and political use of indicators has to be strengthened; (d) links between biodiversity indicators and other indicators have to be developed further; (e) the development of pressure and response indicators must be stimulated; (f) the practical use of indicators should not be overlooked; (g) the inclusion of indicators in special reports written by various specialised services must become particularly important.

By listing some weaknesses of selected group of indicators we have to consider the fact, that the indicator characteristics are not stable, but are time and space dependable, which is why their evaluation can only be temporarily limited. Information that are gathered in the indicator group still represent the basis for effective environmental monitoring and sustainable development, which is of interest for agriculture and planning professionals as well as for local and governmental policymakers today and in the future.

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