CONSTRAINTS IN LAND USE BY AGRICULTURE, NATURE PROTECTION ISSUES, RURAL DEVELOPMENT AND BIODIVERSITY IN VARIOUS REGIONS OF AUSTRIA - AN ANALYTICAL APPROACH BASED ON SPATIAL INFORMATION TECHNIQUES

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"Constraints in land use by agriculture, nature protection issues, rural development and biodiversity in various regions of Austria - An analytical approach based on spatial information techniques"

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[2] Please note that the four maps are not included in the document but are available separately on the Agri-Biodiversity website under Meeting Documents.

1 INTRODUCTION

It is the aim of this paper to isolate some hot spots of conflicting land use interests in Austria out of three different spatial information systems. The main driving forces are identified and linked to the status quo of biological diversity of landscape. By this spatial analyses it might be possible to contribute to a peaceful together of different land uses.

Different land uses and the degree of intensity of various land uses lead to a tension in landscape development, especially when requirements of nature protection and economic interests are contradictory. This paper provides spatial analysis and solution of different interventions, that means mental attitudes and resistances as well as real ones. Land use intensity of agricultural areas is roughly estimated by the land use categorisation of the CORINE Land Cover programme. Areas of different nature protection requirements are shown.

These two land use aspects are compared to a scientifically deduced environmental indicator, called “need of protection of the landscape for maintenance of biodiversity”. The main driving forces and their influences can be identified by looking at the different criteria leading to the environmental indicator value. Changes of land use intensity including nature protection obligations will lead to changes of the “need of protection of the landscape” whereby different ways of development – nearby all combinations of aspects - could be the case. Following spatial aspects are discussed:

- level of need of protection of landscape for maintenance of biodiversity,
- agricultural activity,
- existing nature protection requirements and
- “hot spots” of growth of Building Area.

2 LAND USE IN AUSTRIA

2.1 Description of the natural area

Austria’s central location in Europe which is characterised by well-developed climatic gradients (West-East, North-South) and the landscape-determining mountain chains of the Alps, yields very heterogeneous cultural landscapes. The various usages, particularly farming, have highlighted the highly differentiated landscapes (e.g. alpine region) or have exaggerated them in certain regions (e.g. Pannonian plains).

About 65 % of Austrians federal territory are Alpine regions according to the definition provided in the Alpine Convention (ANONYMOUS, 1995). Mountain areas, as defined by EU Regulation No. 75/268, cover 58,571 km² - about 70 % of Austrians federal territory -, as they also include the mountain areas found in the Wald- and Mühlviertel regions in Upper and Lower Austria. Only in the eastern parts of the country the landscape is flattish and dominated by agricultural use (mainly arable land) with numerous islands of semi-natural habitats.

Overall, Austria has a Central European climate (temperate, wet), although the eastern regions display features of a Pannonian climate (hot, dry). The Northern Alps are considered Austria’s weather divide. Heavy precipitation occurs quite frequently, especially during the summer, due to the barrier effect. The northern line of longitudinal valleys, a low line dominating the landscape, separates the Northern Limestone Alps from the chains of the Central Alps with their predominantly crystalline rock.

With over 2,500 mm per year, the Central Alps also receive large quantities of precipitation, except the inner Ötztal and the upper Inn River valley which only see precipitation of up to 700 mm a year (FINK, 1993). The inner Alpine basins and the adjacent valleys are climate inversion areas featuring low temperatures during the winter and frequent layers of fog.

2.2 History in land use (OECD, 2001)

During prehistoric times, almost the entire Austrian area was covered by forests. As a naturally occurring form of vegetation, the only ecological limitations to forests had been decreasing temperature with rising altitude (timberline) and requirements regarding adequate soil conditions on the other. Essentially only high-altitude regions, water surfaces, moor areas, and areas that due to physical factors like the relief, etc. did not permit permanent soil formation were not covered by forests. Altogether, forests covered approx. 90 - 95 % of the area of Central Europe (FIRBAS, 1949, quoted in KRAL, 1994).

The establishment of the first permanent settlements introduced arable crop farming in the plan areas of the eastern parts of Austria and in the mountain valley bottoms. In the Alpine Zone the cleared areas have been used as grassland. The remaining forests have been needed for protection of valleys – where crop production took place - against avalanches.

Mountain livestock husbandry in the Austrian Alps formed the basis for survival in the Alps as well as for diversity of crop production in the flattish areas, where fertile meadows close to the farms as well as intermediate pastures were necessary and the animals were needed as draught animals to cultivate arable land. These needs of pastures and mountain meadows still constitute typical cultivation ecosystems (FINK et al., 1989 in: GRABHERR, 1993). Mountain meadows are found on steep slopes and are mown by hand for the production of winter hey. The intensification of settlement activities, however, has considerably altered the ecological balance of many regions. These changes led to:

- The establishment of alpine pastures as cultivated zones through the extension of alpine meadows. These developments led to an enormous biodiversity extension of the area covered by the original Alpine turf and mountain hey meadows and sub-Alpine pastures.
- Forested areas maintained to serve as a protective area between the alpine bedrock, wasteland, pasture and the valley. The biodiversity in terms of ecology and landscape in this zone was enhanced through mosaic felling of sub-Alpine forests hosting a low variety of species.
- In the flattish part of Austria the development of semi-natural islands in the cultivated surrounding are the other aspect to hence and preserve important sites of vulnerable biodiversity. These areas have protection function against flooding or the land becoming marshy.

3 ASPECTS OF SPATIAL ANALYSES TO EXAMINE BIODIVERSITY OF LANDSCAPE

3.1 CORINE Land Cover

Among others the Federal Environment Agency is “National Reference Centre on Land Cover” for the European Environment Agency (EEA) and “Primary Contact Point” for the European Topic Centre on Land Cover (ETC/LC). In this function the Agency supports all those European institutions, which are dealing with land cover and land use. As contact point for the EEA the Agency provides fundamental contribution for European-wide homogenous consistent environmental data. Looking at the discussion about renewable energy and resources it is obvious, that the “pressure” on land caused by human activities still increases. The use of land and its consumption has strongly influenced the European landscape.

The strategy of the EEA is now to make information and data bases about homogenous land cover data for environmental analysis available. One of the most important issues nowadays is the definition of indicators, which can be used for long-term monitoring. By using the European data base “CORINE Land Cover” several indicators can be developed.

CORINE Land Cover is a compilation of national land cover and land use inventories based on one methodology and nomenclature. Near all EU15 Member States (except Sweden and Finland), 12 central and east European countries and the coastal zones of Maraca and Tunisia were mapped according to the CORINE Land Cover guidelines. The methodology consists of computer-assisted photo-interpretation of satellite data on a scale of 1 : 100.000. The data were mapped according to the CORINE Land Cover Nomenclature, which consists of 44 different landcover / landuse types. The surface area of the smallest mapping unit is 25 hectares.

This data base can be used as an analytical tool for different environmental analysis. The spatial component of this inventory is a key element for an integration within a geographic information system and further spatial analysis.

3.2 Need to maintain biodiversity of cultivated landscapes

3.2.1 Hemeroby – a measure of man’s influence on ecosystems

Hemeroby is a complementary term for „naturalness“, this term was introduced because of the observation that a significant number of plant species – this also holds true for animal species – in the agricultural landscapes of Europe are strongly influenced by and act as indicators of the intensity of agricultural utilisation (GRABHERR, 1997).

The results of a study carried out by the Austrian Federal Environment Agency (WRBKA et al., 2001) reveal a clear hemerobic gradient between the cultivated Alpine landscapes of Western Austria and the forelands and basins of the eastern part of the country.

Tab. 1: Classification scheme for hemeroby

Degree of hemeroby	**Value**
Ahemerobic	1
Oligo-hemerobic	2
meso-hemerobic	3
eu-hemerob	4-5
poly-hemerobic	6
meta-hemerobic	7

The evaluation of Austrian cultural landscape mainly formed by agriculture showed following results:

- Most of the Alpine rock and ice regions were classified ahemerobic - that is, almost completely free from anthropogenic influence. Human interference is mostly observed locally and in isolated cases only, in the form of the touristic development of the Alpine mountain summits. Though of importance in the individual case, these developments are not relevant statistically.
- Oligo-hemerobic landscape parts, such as the pastures and pioneer formations of the alpine and sub-alpine zones, show only minor impacts of anthropogenic influence. They are characterised by at least temporary, but in some areas also clearly visible impacts of extensive grazing.

- Mountain meadows are classified meso-hemerobic. Having been submitted to mild disturbances only, this landscape type was able to support species-rich ecosystems which have almost completely disappeared due to labour-intensive management. In the pan-European context, the landscapes classified ahemerobic to oligo-hemerobic represent islands of naturalness. In Austria, they cover approximately 12 % of the entire Federal territory, and in the western part of the Central Alps (Hohe Tauern, Stubaier Alpen and Ötztaler Alpen) they still exist in the form of large, compact areas.
- The cultivated landscapes characterised or dominated by intensively used meadows and pastures are considered eu-hemerobic; they include small structures like hedges and field shrubs, but also small rough meadows and extensively managed pastures.
- Cultivated landscapes severely influenced by man, such as the crop and forage growing areas of the hilly country or in the cleared islands of the external rim of the Alps, and the intensively managed cropping areas of the basins, are found mainly in the landscapes outside the Alps. Because of their lower intensity of relief, they allow a higher degree of agricultural intensification. Cultural Land with dominating arable land or vine yards are classified as poly-hemerobic, Inner-Alpine landscapes with such a high management intensity occur only in the Klagenfurt Basin and in a few valley-bottom areas of the main Alpine rivers (River Inn, River Mur).

3.2.2 Landscape categorisation "Need of protection for the maintenance of biodiversity" (WRBKA et al., 2001)

To come to the landscape characteristic "need of protection for the maintenance of biodiversity on agricultural areas" certain criteria have to be evaluated and interrelated to each other with help of the method of "logic combination":

- age
- hemeroby
- share of small structures
- share of non-dissected, seminatural ecosystems
- rareness
- pattern of extension and spread
- mean size of area (polygons)
- elongation

The decision tree to come to the feature "need of protection for the maintenance of biodiversity" with all logic combinations of criteria is shown in Fig. 1. Some criteria can be quantified, like the age of landscape. For others like "naturalness" the evaluation is shown in Chapter 3.2.1 for the degree of hemeroby. The evaluation of the "need for protection of landscape for maintenance of biodiversity" requires the consideration of some different parameters, which have to be combined to a single evaluation result.

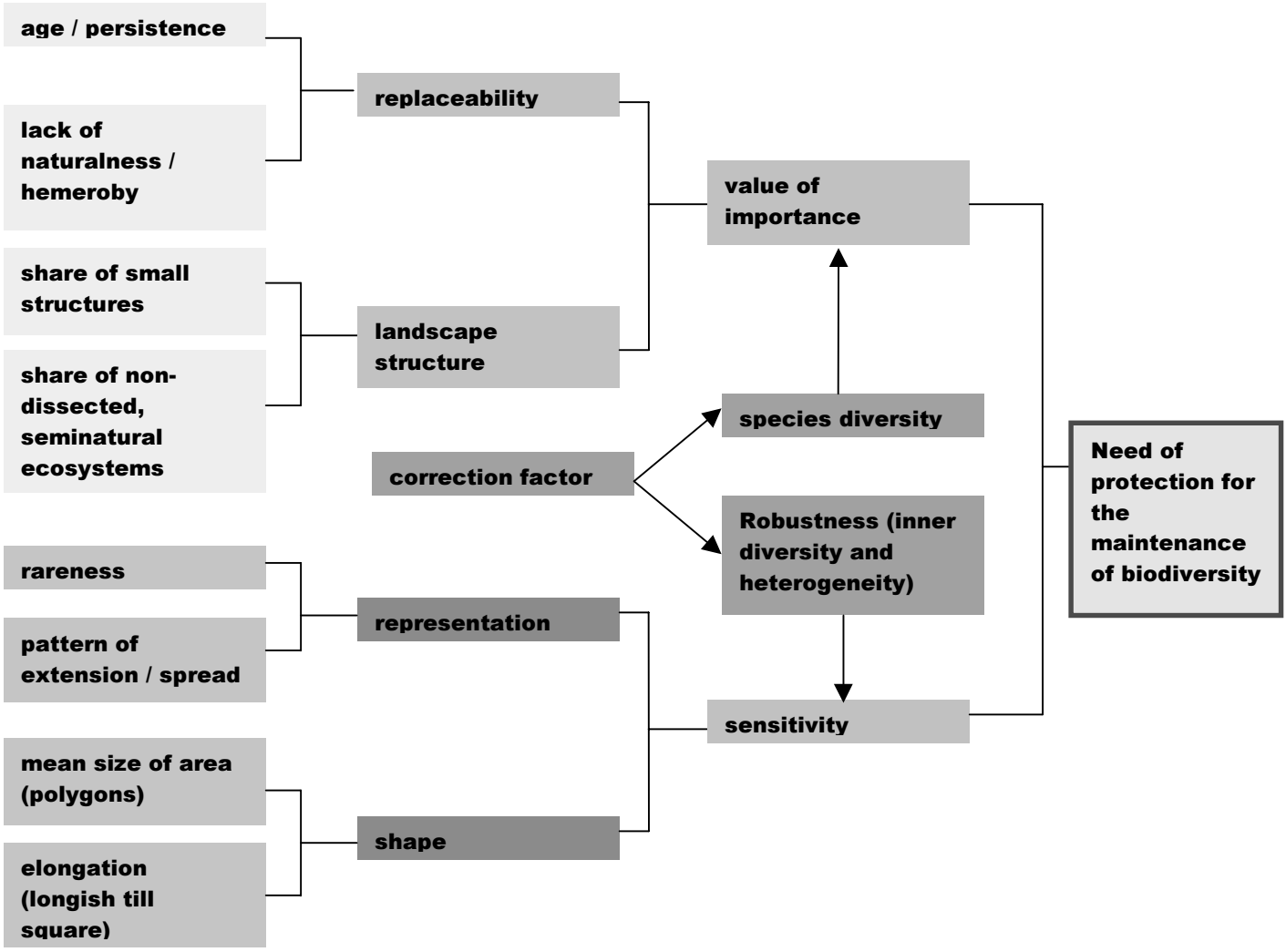

Fig. 1: Decision tree for ecological evaluation of Austrian cultural landscapes (WRBKA et al., 2001, modified)

The "replaceability" of landscapes results from the combination of the criteria "age" or "persistence" and "lack of naturalness" or "hemeroby". Old, seminatural ecosystems are not replaceable because they are beyond man's time and planning horizon and cannot be restored within short periods of time. The replaceability of very young ecosystems lacking naturalness, among them industrial and settlement areas, ruderal sites and fallow land, is very high due to their dynamic development.

WRBKA *et al*. (2001) lately aggregated the criteria "replaceability" and "existence/richness of seminatural ecosystems" to one value which is meant to describe the importance of Austria's cultivated and natural landscapes to the maintenance of biodiversity.

Consequently, the need to protect landscapes results from the "importance of biodiversity maintenance" and the "sensitivity" of the respective areas. It is highest in areas of rare, small-structured landscapes or in landscapes important to the maintenance of biodiversity.

3.3 Nature protection areas

The Federal Environment Agency has been collecting basic data on protected areas in Austria. The protection issues between the different regions differs slightly in their main objectives because of the provincial attitude. There are areas where natural habitats are of concern and on the other hand areas where landscape characteristics are of main interest. These protected areas are situated mostly on forest sites, but for about 25 % of the protection areas are situated on agricultural land. This status of agricultural land causes common restrictions on the behaviour of the farmer.

Measures for the protection of nature and landscape involve among others the designation of protected areas. An overview of the areas protected under nature conservation law in Austria is given in Tab. 2. The different kinds of level of nature protection are shown in the maps 1 and 2.

Tab. 2: Areas protected under nature conservation law in Austria (UBA, 2001)

Category	Number	Surface Area (ha)	% of national area
National Park	6	230,334	2,7
Nature Park	31	228,598	2,7
Nature Reserve	379	331,507	3,9
Landscape Protection Area	267	1,327,696	15,8
Protected Part of Landscape	338	23,717	0,3
Other Protected Areas	90	165,480	1,7

The dispersion of the protected areas follows in the main the Alpine area, where all different land uses (meadows, pastures, forests, valleys) are comprised.

For the eastern parts of Austria main emphasis lies on the preservation of natural “islands” in the agricultural land and the intention is to build bridges and corridors between these islands. These issues could not be fulfilled by declaring protection areas, so the agricultural management has to realise and respect these efforts by leaving landscape elements - such as linear semi-natural habitats - and to build up a network of areas enabling biodiversity.

4 RESULTS OF SPATIAL ANALYSES AND PROPOSAL FOR INDICATORS FOR BIODIVERSITY

4.1 Spatial analysis for Austria: Linking the land use with the biodiversity and nature protection issue

The different need of protection for the maintenance of biodiversity on agricultural areas has been analysed on basis of CORINE Land Cover agricultural land. The following Tab. 3 shows the used CORINE Land Cover classes.

Tab. 3: CORINE Land Cover Classes used for spatial analyses

Code	Description
2.1.1	Non-irrigated arable land
2.2.1	Vineyards
2.3.1	Pastures
2.4.2	Complex cultivation patterns
2.4.3	Agriculture with natural vegetation
3.2.1	Alpine Meadows

The overall Austrian situation is pictured in Map. 1 to get an overview. The varicoloured areas show where agricultural land was identified on basis of the LC programme. White areas are mainly forests, as well as rural and municipal estates and water and infrastructure areas. The agricultural areas are filled with five different colours viewing the degree of need of protection for the maintenance of biological diversity according to WRBKA et al. (2001). The colour red means the highest level of protection needed and green the lowest one.

As a third component nature protection areas are linked with agricultural areas and their need of protection for the maintenance of biological diversity. They are shown in the maps as grey hatched areas. Different shading means different level of nature protection obligations, the differences in detail are not important and therefore left aside for the following first proposal of biodiversity indicators.

The results of spatial analyses for Austria as a whole are shown in Tab. 4, Tab. 5, Tab. 6 and Tab. 7.

It can be outlined that „hot spot“ areas with highest need of protection regarding biodiversity are mainly Alpine meadows and Pastures. This outcome is due to the presence of almost undisturbed landscapes like the Alpine rock and ice regions and the adjacent zone of alpine lawns (meadows), alpine pastures and mountain pine shrubs. Main important characteristics of these areas regarding biodiversity are their large extent and share of non-dissected semi-natural ecosystems.

Cultivated landscapes with high need of protection for the maintenance of biodiversity occur primarily within the external rim of the Alps but also on inner-Alpine slopes. These are grasslands still endowed with a large number of structural elements and where the entire area has not been subject to the intensification of grassland utilisation yet.

The forest-dominated benched slopes and hilly areas of the Alps were assigned to middle need of protection for the maintenance of biodiversity, because they are usually very strongly affected by human interference.

Cultivated landscapes presently of minor importance to biodiversity conservation (low need of protection) include forage-growing landscapes such as the maize growing areas of the Klagenfurt Basin. In this type of cultural landscape the remaining islands and networks of semi-natural areas can not be overvalued enough regarding their importance for biological diversity and limiting the pressure of agricultural activity is of utmost importance there.

The cultivated and natural landscapes with the highest need for protection include the Alpine summits slightly impaired by man as well as the extensively used alpine pastures. Most of the cultivated landscapes with high need for protection are located in the grassland-dominated mountain areas, that is the traditionally managed settlement areas of mountain farmers found in the inner-Alpine slope zone and in the slope zone of the external rim of the Alps. Taking account of the above-described factors, the intensively used grassland areas of valleys and the major part of the forested landscapes are characterised by a middle need for protection.

On the other hand areas with low need of protection are mostly found in the category (non-irrigated) arable land. This agricultural landscape with only low relevancy for conservation of biological diversity in Austria is spacious, large pattern and strongly geometric arable land (checkerboard landscape).

An interesting result is that nearly 70 % of the vine-yard area is of high and highest need of protection for the maintenance of biodiversity. This can be due to the orthogonal, very dense network of connecting corridors in vine-dominated slope zones like in the Wachau, Weinviertel or in the south of Vienna (Thermenlinie and Leithagebirge) (network landscapes). These “high valued” regions (red and orange coloured) are imbedded in “low valued” surrounding (green coloured areas) as it can bee seen in Map. 3. What is hidden in Map. 3, is the network of semi-natural habitats - because of their small extents - within the intensive used farmland. But this network is necessary for saving biodiversity in the red, “highest need of protection” areas.

The illyric fruit-, vine and forage-growing complexes in Styria and southern Burgenland are typical scattered patch-landscapes. They consist of many particularly sites (fruit-tree-meadows and small scaled dry grassland patches), which are embedded in cultural landscape (“islands”).

Tab. 4: Need of protection for the maintenance of biodiversity (WRBKA et al., 2001) according to CORINE Land Cover agricultural areas; Area in hectares

	Area in hectares					
CORINE Land Cover type	**Highest Need of Protection**	**High Need of Protection**	**Middle Need of Protection**	**Low Need of Protection**	**Currently no Need of Protection**	**Total**
Agriculture with natural vegetation	2,763	20,981	14,892	27,877	1,466	67,978
Alpine Meadows	318,317	18,843	222,004	318	172	559,653
Complex Cultivation Patterns	37,978	228,351	294,433	315,052	5,878	881,692
Non-irrigated Arable Land	24,415	78,697	84,099	944,237	8,928	1,140,376
Pastures	52,748	344,130	336,319	143,573	6,220	882,990
Vineyards	25,488	14,376	1,308	17,150	180	58,502
Total	**461,708**	**705,378**	**953,054**	**1,448,207**	**22,844**	**3,591,191**

Tab. 5: Need of protection for the maintenance of biodiversity (WRBKA et al., 2001) according to CORINE Land Cover agricultural areas; Areas in %

	Percentage of area					
CORINE Land Cover type	**Highest Need of Protection**	**High Need of Protection**	**Middle Need of Protection**	**Low Need of Protection**	**Currently no Need of Protection**	**Total**
Agriculture with natural vegetation	0,1%	0,6%	0,4%	0,8%	0,0%	1,9%
Alpine Meadows	8,9%	0,5%	6,2%	0,0%	0,0%	15,6%
Complex Cultivation Patterns	1,1%	6,4%	8,2%	8,8%	0,2%	24,6%
Non-irrigated Arable Land	0,7%	2,2%	2,3%	26,3%	0,2%	31,8%
Pastures	1,5%	9,6%	9,4%	4,0%	0,2%	24,6%
Vineyards	0,7%	0,4%	0,0%	0,5%	0,0%	1,6%
Total	**12,9%**	**19,6%**	**26,5%**	**40,3%**	**0,6%**	**100,0%**

Tab. 6: Need of protection for the maintenance of biodiversity (WRBKA et al., 2001) on agricultural land (definition according to CORINE Land Cover) situated in nature protection areas; Areas in hectares

	Area in hectares					
Category of nature protection site	**Highest Need of Protection**	**High Need of Protection**	**Middle Need of Protection**	**Low Need of Protection**	**Currently no Need of Protection**	**Total**
National Park	46,309	1,174	7,828	577	7	55,895
Nature Reserve	26,302	1,965	19,496	9,042	76	56,880
Landscape Protection Area	96,989	87,747	113,049	73,173	2,417	373,374
Nature Park	17,834	10,965	17,703	16,581	217	63,299
Protected Part of Landscape	111	83	1,833	170	25	2,222
Other Protected Areas	15,345	710	13,213	281	54	29,603
Total *						

* Due to double nomination of areas for different categories of nature protection areas the total protected area is not equal the sum of the areas of the different protection site categories.

Tab. 7: Need of protection for the maintenance of biodiversity (WRBKA et al., 2001) on agricultural land (definition according to CORINE Land Cover) situated in nature protection areas; Areas in %

	Percentage of area					
Category of nature protection site	**Highest Need of Protection**	**High Need of Protection**	**Middle Need of Protection**	**Low Need of Protection**	**Currently no Need of Protection**	**Total**
National Park	83%	2%	14%	1%	0%	100%
Nature Reserve	46%	3%	34%	16%	0%	100%
Landscape Protection Area	26%	24%	30%	20%	1%	100%
Nature Park	28%	17%	28%	26%	0%	100%
Protected Part of Landscape	5%	4%	83%	8%	1%	100%
Other Protected Areas	52%	2%	45%	1%	0%	100%

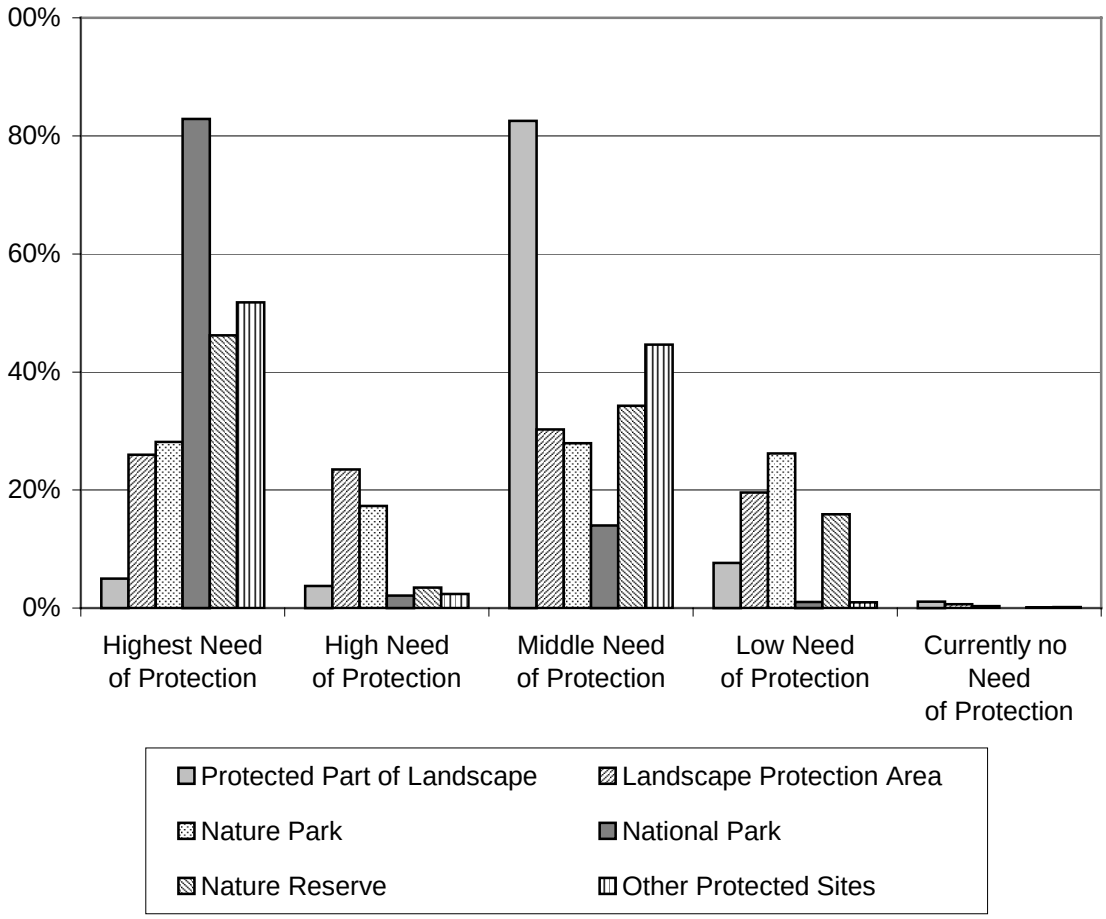

Fig. 2: Need of protection for the maintenance of biodiversity (WRBKA et al., 2001) on agricultural land (definition according to CORINE Land Cover) situated in nature protection areas, areas in %.

4.2 Indicator proposal 1: The share of agricultural land that maintains or prepares valued habitats for biodiversity

Following the information in Tab. 4 about 1,150,000 ha or 32 % of agricultural land needs a high or very high protection status if biodiversity on that areas should - at minimum - remain on the endangered status. At this stage following indicator could be proposed:

Indicator proposal (1):

$$BDI = \text{agricultural area}_{\text{high +very high valued}}\ [ha] / \text{agricultural area}\ [ha]$$

- Strongness of the indicator: One figure could show the restrains on agricultural practise. Strong context to the protection activity of different groups.
- Weakness of the indicator: There is the need for a systematic qualitative evaluation of all agricultural areas important for biodiversity. A regular monitoring system has to be established to reflect changes e.g. by destroying landscape elements or abandonment of land use.

The message of this indicator is: The higher (>0,9) the ***BDI***, the more the current intensity of agricultural management is appropriate for the aim of conserving and supporting biodiversity.

For whole of Austria the indicator value is 0,3 (1,167,085 ha / 3,591,190 ha). That means one third of the agricultural area in Austria features high need of protection for the maintenance of biological areas.

4.3 Indicator proposal 2: Share of high and very high valued agricultural land protected by existing protection measurement

Indicator proposal (2):

$$BDP = \text{protected agricultural area}_{\text{high + very high valued}}\ [ha] / \text{agricultural area}_{\text{high + very high valued}}\ [ha]$$

- Strongness of the indicator: This indicator shows the share of “high valued” agricultural land (from point of view of biodiversity conservation and promotion) already concerned by nature protection obligations. High value of the indicator means strong nature protection interests, necessities and possibilities to care for biological diversity.
- Weakness of the indicator: There is need for explanation, why the values e.g. is high – is it because of strong nature protection interests in this region, is it because it is necessary otherwise biological diversity would decline or is it because there is already high maintenance of biodiversity (because of natural realities), so it is easy to establish nature protection areas. On the other hand a low value can also mean, that it is not necessary to protect biodiversity of cultural landscape, because it is already done by other land users like agriculture.

For whole of Austria the indicator value is 0,2 (261,423 ha / 1,167,085 ha). That means that 20 % of the agricultural area in Austria with high need of protection for the maintenance of biological diversity is already protected by nature conservation obligations. The remaining 80 % of these highly sensitive areas are maintained by agriculture.

4.4 Linking indicator proposals 1 and 2

An interesting point in combining indicator proposals 1 and 2 is to filter agricultural areas, where no nature protection areas are already established but highest need of protection for maintenance of biodiversity is pointed out according to WRBKA et al. (2001).

Indicator proposal (3):

$$BDAgr = 1 - BDP$$

Areas with a high BDAgr should be chosen for monitoring programmes by means of indicator species, because in these areas it is of high importance to maintain agricultural influences in the specific “sustainable” degree of intensity. In this regions agriculture is responsible and at the same time claimed to a high extend.

- **Some arguments for positive solutions of balancing agricultural and nature protection interests to conserve and promote biodiversity**

As already shown above it would be necessary in the Alps to declare many areas of the agricultural land as protection areas, but this would cause in the medium run abandonment and loss of adapted biodiversity. On the other hand in arable assembles (like in northern and eastern Austria) such measurements could be reduced to some specific biodiversity islands.

Both developments would not help to save biodiversity on agricultural land because of missing links between such biodiversity islands.

A better solution would be to find a right dosage of agricultural measurements, which are adequate responds of the farmers to respect the needs of semi-natural areas. It also has to be kept in mind that the efforts to introduce biodiversity management plans could cause high costs if they were not adapted to agricultural praxis in the region.

Agriculture fulfils many more functions than just food production (multi-functionality) and therefore represents an integral part of the sustainable development of rural areas, including biodiversity conservation.

The goals and functions of agricultural activity are listed in HOVORKA (1998) by means of the example of mountain farming:

- Food production.
- Design, maintenance and tending of cultivated and recreational landscapes (main tourist resources).
- Conservation of the natural resources – soil, water, biodiversity (also available for the people not living in the Alps).
- Continued settlement as well as the continuation of social and other economic activities of peripheral rural areas.
- Development of ecologically friendly forms of management.
- Giving a new impetus to economic activities at the regional level.
- Protection against natural hazards – continuation of traditional flood and avalanche control measures.

Nearly the same but rather holistic is to say about agriculture in arable land.

The small structure of sites as well as variation of intensity of agricultural use and tending measures (fertilisation or nutrient deprivation, level of pesticide application and others) allows the occurrence of a high biological diversity. If the patchwork of sites is small scaled and includes landscape structure elements, such as trees, hedgerows, residual surfaces and wetlands, species pending to open landscape can use these situations to settle. Landscape structure elements serve for food, living, nesting and other aspects of their needs in their certain activity radius.

One positive example is agricultural activity in mountain areas, where ecologically valuable, species-rich meadows and pastures have developed. While mountain meadows support approximately 30 – 60 species and fertile alpine meadows approximately 30 – 50 species, only 20 – 45 species occur on poor wet meadows and traditionally managed fertile meadows and the modern “intensive grassland”, whether ploughed or not, rarely supports more than 10 different species (GRABHERR & REITER, 1995).

A negative example for agricultural influences on biodiversity of cultural landscapes are some valleys and basins, where grassland is used very intensely and only small parts of the formerly wide-spread moor-grass meadows, lowland moors and managed meadows have

been left because of river damming and draining (BMLF, Federal Ministry of Agriculture and Forestry, 1998).

4.5 Results for Region Tyrol (Map. 2)

Linking the agricultural land use issue (according to CORINE Land Cover classification) with the biodiversity maintenance issue (according to WRBKA et al., 2001) and the nature protection issue creates the following picture, shown in Map. 2 for the alpine region in Tyrol.

As for the Tyrolean area in mountainous region it can be shown that most of the area in the Inn valley is of middle and low need of biodiversity protection, these are mostly arable land areas with a more intensive level of production. Areas with high and highest need of protection are situated in mountainous grassland regions.

The nature protection areas are mainly forests, but also agriculture has considerable portion on nature protection areas. It can be derived that most of the areas with high and highest need of protection for the maintenance of biodiversity on agricultural areas are tended by agricultural activities, not protected by nature protection activities.

Proposed indicator 1 BDI has the value of 0,48 for this region (291,985 ha / 607,685 ha) that is above the Austrian mean (0,3). This can be interpreted that in this region the proportion of valuable agricultural areas from the point of view of relevance for biological diversity is considerably high (nearly half of the agricultural area).

Indicator 2 BDP will be 0,23 for this region (71,801 ha / 291,985 ha), that means that nature protection obligations are not established to a great extend on agricultural areas, which seems not to be necessary, because agricultural practise to a very high extend is responsible and has been caring for this high need of protection for the maintenance of biodiversity (BDAgr = 0,77). Further development of habitat quality of these areas should be monitored with help of bioindicators.

4.6 Results for Region Wald- und Weinviertel in Lower Austria (Map. 3)

Linking the agricultural land use issue (according to CORINE Land Cover classification) with the biodiversity maintenance issue (according to WRBKA, 2001) and the nature protection issue creates the following picture, shown in Map. 3 for the flattish/hilly region “Wald- and Weinviertel” in Lower Austria.

Only small patches of areas with high and highest need of protection for maintenance of biodiversity on agricultural areas can be seen. They are situated in a surrounding of low need of protection, but are connected by a - at this scale non-visible - network of corridors and semi-natural habitats.

Nature protection areas on agricultural area are only very small scaled.

Proposed indicator 1 BDI has the value of 0,28 (446,116 ha / 1,549,431 ha), which means a much smaller value than for region “Tyrol”. Only almost 30 % of agricultural area in this region can be considered as of highest and high need of protection for the maintenance of biodiversity, which means that agriculture should search for possibilities to rise this share.

Indicator 2 BDP will be 0,17 (77,503 ha / 446,116 ha), which is also a minor share than for the Region Tyrol, that means that only small extents of this already small proportion of agricultural high sensitive area is already protected by nature protection obligations. The map in Map. 3 shows, that these areas are mainly small patches. As a consequence an increase of nature protection areas in this region for the maintenance of biodiversity can be promoted.

On contrary, indicator 3 will be more than 80 % which again gives great importance to agricultural management in these region and is a even higher value than in the region

“Tyrol”. Therefore monitoring programmes in this region would be of utmost importance, because agriculture is strongly influencing large areas of low need of protection as well as remaining small patches with high need of protection for maintenance of biodiversity.

5 PRESSURE ON AGRICULTURAL LAND BY RURAL DEVELOPMENT ACTIVITY

5.1 Indicator proposal 4: Development of building areas [3]

Rural development is mostly connected with the loss of agricultural land and its conversion into building and leisure areas. Beside the loss of fertile soil sites further effects follow these changes such as infrastructure dissections of semi-natural sites and water logging. These effects have a negative impact on biodiversity and above all the loss of land will become irreversible.

- Monitoring of land use changes

One of the main data basis to visualise and investigate the degree of sustainability of development are data on certain types of land use in a spatial-time scale.

Changes in the rim of settlements towards more building area causes for the farmers loss of production land, intensification of the remaining areas and longer distances within the farm due to fragmentation of farm area. A more municipal situation forces the farmer to settle on the outskirts of villages.

Indicator proposal (4):

$$BDC = \text{building areas}_{(n+1)}\ [ha] \times 100 / \text{building areas}_{(n)}\ [ha] \qquad [\%]$$

n ... given time (year)
n+1 time elapsed

- Strongness of the indicator: There is a strict context between growth of the building area and the loss of agricultural land and as a consequence of biodiversity.
- Weakness of the indicator: It is not a “natural law” that new buildings and leisure areas cause pressure on biodiversity in the surrounding of settlements.

As visualised in Map. 4 in some Austrian regions building areas increased up to 140 % from 1995 to 1999.

In the Region Tyrol and especially in the valley “Inntal” there is high land use pressure from growing of building areas (more then 40 % from 1995 to 1999). In this alpine area pressure on land resources is in general high and remaining agricultural areas are at risk to be used more intensive. Interests of biodiversity and of agriculture are missed out for the benefit of building area. This development has to be watched carefully and interests of agriculture and biodiversity have to be pushed forward to come to a well-balanced use of area, especially in valley bottoms of the alpine region.

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[3] The growth of built-up areas is a “headline Indicator” in the European Union. Building areas are areas without infrastructure and transport network

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7 ANNEX: MAPS (not included in the document but available on the Agri-Biodiversity website under Meeting Documents).

Map. 1: Austria: Nature Protection Areas and Different Need of Protection for the maintenance of biodiversity on agricultural areas (according to CORINE Land Cover)

Map. 2: Region Tyrol: Nature Protection Areas and Different Need of Protection

Map. 3: Region Wald- and Weinviertel: Nature Protection Areas and Different Need of Protection

Map. 4: Growth of Building Area according to the Real Estate Database 1995 - 1999