

Comparison of the CORINE Land Cover data and Agricultural Land Use Monitoring Data as a basis for groundwater vulnerability mapping in the Peca border region

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Abstract

In the article the land use data analysis as a basis for groundwater recharge area protection and vulnerability estimation in the region of Peca is represented. The area is positioned on the Karavanke mountains border region between Slovenia and Austria. Preliminary results of Slovene part are presented in the article.

This paper wants to show usefulness of CORINE Land Cover (CLC) and major differences in results between CLC and more detailed data of Agricultural Land Use Monitoring (ALUM). Differences between results of both datasets are minor on first level of categorization especially when it comes to two most prevailing categories, but much bigger on next levels of more detailed nomenclature. Some categories are even not detected by CLC dataset.

By both methodologies on first level of nomenclature forest is far prevailing land use category covering 78 (CLC) and 81 % (ALUM) of the area followed by agricultural land with about 16% (CLC) and 17 % (ALUM). Differences important for groundwater vulnerability study occurred in artificial areas with 2 % (CLC) and 3,9 % (ALUM) surface.

Introduction

In the recent past natural resources became important not only as natural and economical wellness but also as an integral part of the environment that must be protected from the anthropogenic influences. Among them water resources are of paramount value. To study and prepare the data for groundwater vulnerability land use analysis is important part of the estimation process.

Land use reflects a complex correlation between natural (slope, altitude, exposure of slopes of the surface area), historical (such as characteristics of settling, economic conditions in the past, land ownership situa-

tion...), and socioeconomic factors. It constantly changes, which is reflected in the changing of land categories or/and their relative proportions (Gabrovec & Kladnik, 1997).

The land use study has been performed in the border Karavanke mountain region of Peca between Austria and Slovenia. The main goal of the land use analysis has been to prepare data for vulnerability mapping of the carbonate aquifer of Peca and its wider area in east Karavanke region. The aquifer represents a major and very important drinking water source for area on both sides of the border. Due to its karstic characteristics it is considered to be very vulnerable

and land use is an important indicator of its potential pollution sources.

Geographical Settings

The area belongs to Alpine region and is positioned on the Karavanke mountains border region between Slovenia and Austria. It partly lies in three municipalities Črna na Koroškem, Mežica and Prevalje. On its west it is limited by river Koprivna, on south the border of the area follows river Meža, the most important river in the area, up to north to Poljana and further on to the Austrian-Slovene border crossing at Holmec.

It covers 64 km² and shows big topographical differences on short distances. It is mostly mountainous except of northeastern and south plain parts. Altitude reaches the highest point in Peca mountain crest on 2125 meters (Kordeževa glava) and the lowest on 435 meters in east part. An average altitude is 998 meters. Average slope value is 25°, but there are big differences between individual parts. The highest slope values are in Peca mountain crest and also in south near settlement Žerjav, where they reach even 50°. Plain surface is present in east and northeast of the area, which is also suitable for agriculture. The rest of the surface is covered mostly by forest.

There are 10 settlements, except of Mežica with 3656 inhabitants, all minor villages. Altogether there are about 5230 inhabitants (MOPE, 2002).

Data

We decided to use CORINE Land Cover (CLC) as basic dataset for whole region and Agricultural land use monitoring data (ALUM) for comparison and reference data set.

CORINE Land Cover Slovenia (CLC)

The CORINE Land Cover (COoRdination of Information on the Environment) programme was established by the European Commission in 1985 aiming at »gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the European Community«. The aim was there-

fore to create for the first time in Europe a spatially referenced Land Cover database following a single standardized methodology (European Commission Phare Programme, 2000).



Figure 1: Area of interest

CLC Slovenia is a digital land cover database of the country; consistent and comparable with the other land cover databases in the Phare countries (Petek, 2002).

The most frequent domain of CLC data usage appeared to be environmental, land and spatial planning, followed by general mapping. It is also used in many other specialized areas (nature conservation, water management, soil, air, meteorological and geological studies). CLC data are often used for the enhancement of existing models or the development of new ones. In combination with other data sets constitutes a very important input to integrated environmental analysis, evolution studies, evaluation of pressures and trend analysis (European Commission Phare Programme, 2000).

CLC nomenclature is divided into three levels:

- First level: 5 headings
- Second level: 15 headings
- Third level: 44 headings

Agricultural land use monitoring data (ALUM)

Ministry of Agriculture, Forestry and Food of Republic of Slovenia made the dataset. The objective was the creation of a database of agricultural land use, including the definition of data maintenance and methods of application for specific assignments imposed to the Ministry of Agriculture, Forestry and Food. It also includes the addition of agricultural and forest land use to parcels in the Land Cadastre database. The merging of the Land Cadastre data layers with the data layer of land use will make possible the administrative control of subsidy applications for subsidies based on agricultural land area. The acquired land use data will also be applied in creating the Farm Register, the Permanent Plantation Cadastres (vineyards, orchards, olive groves and hop fields) and in other assignments related to the implementation of the agricultural policy.

The methodology divides land use into 7 main categories on four levels, but focusing on agricultural land, which is the main disadvantage of the methodology for many users. Agricultural land is divided into four levels and is very detailed while other categories are considered »less important« and are divided only into three or two levels.

In our area agricultural land is divided on all four levels, while other categories are not divided into any subcategories.

Other data sets

In the past there were several different approaches and methodologies to land use surveys in Slovenia. The basic source in undertaking land use studies used by most authors in the past was the data maintained by the Surveying and Mapping Authority of Slovenia. The data are assembled on the basis of cadastral records showing current situation in all the cadastral municipalities. But considering the fact that the data is not updated regularly it is obvious that it does not show up-to date situation. This is the main disadvantage of the data. Land use is recorded on a parcel. The dominant use of the parcel is the one the database collects no matter the fact that there are mixed categories in most of parcels. The second most used database is statistical data maintained by

Statistical office of Slovenia. In our opinion these two datasets do not meet needs of the study.

Methodology

GIS tools (Arc View 3.1.) were used. The method of intersecting or overlaying layers was chosen. Some basic descriptive statistic analysis were obtained for determination of locations, percentages and sizes of individual land categories. Datasets have been geocoded and put in digital cover polygon format.

Analysis and Results

CORINE Land Cover Slovenia (CLC)

In the area of Peca there are three major land use categories of CLC present:

- Artificial surfaces
- Agricultural areas
- Forests and semi-natural areas

Wetlands and Water bodies categories are not defined.

The categories of first level categorization are presented in the figure 2.

On the second level they are divided into seven land use categories:

- 1.1. Urban fabric
- 1.2. Industrial, commercial and transport
- 2.3. Pastures
- 2.4. Heterogeneous Agricultural areas
- 3.1. Forests
- 3.2. Shrub and/or herbaceous vegetation associations
- 3.3. Open spaces with little or no vegetation

On the third level they are divided on the following categories:

- 1.1.2. Discontinuous urban fabric
- 1.2.1. Industrial or commercial units
- 2.3.1. Pastures
- 2.4.2. Complex cultivation
- 2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
- 3.1.1. Broad-leaved forest
- 3.1.2. Coniferous forest
- 3.1.3. Mixed forest
- 3.2.2. Moors and heath land
- 3.3.2. Bare rock
- 3.3.3. Sparsely -vegetated areas

Table 1. Table of proportions and sizes of CLC categories

Classification 1 st level	Classification 2 nd level	Classification 3 rd level	Area [km ²]	Share [%]
1. Artificial surfaces	1.1. Urban fabric	1.1.2. Discontinuous urban fabric	1,22	2
	1.2. Industrial, commercial and transport	1.2.1. Industrial or commercial units	0,06	< 0,1
2. Agricultural areas	2.3. Pastures	2.3.1. Pastures	5,33	8,3
	2.4. Heterogeneous Agricultural areas	2.4.2. Complex Cultivation	0,12	0,18
		2.4.3. Areas principally occupied by agriculture, interspersed with significant natural areas	5,32	8,32
		3.1.1. Broad leaved forest	2,39	3,7
3. Forests and semi-natural areas	3.1. Forests	3.1.2. Coniferous forest	30,04	47
		3.1.3. Mixed forest	12,66	19,8
		3.2.2. Moors and heath land	5,16	8,1
	3.2. Shrub and/or herbaceous vegetation associations			
	3.3. Open spaces with little or no vegetation	3.3.2. Bare rock	0,46	0,7
		3.3.3. Sparsely vegetated areas	1,18	1,8

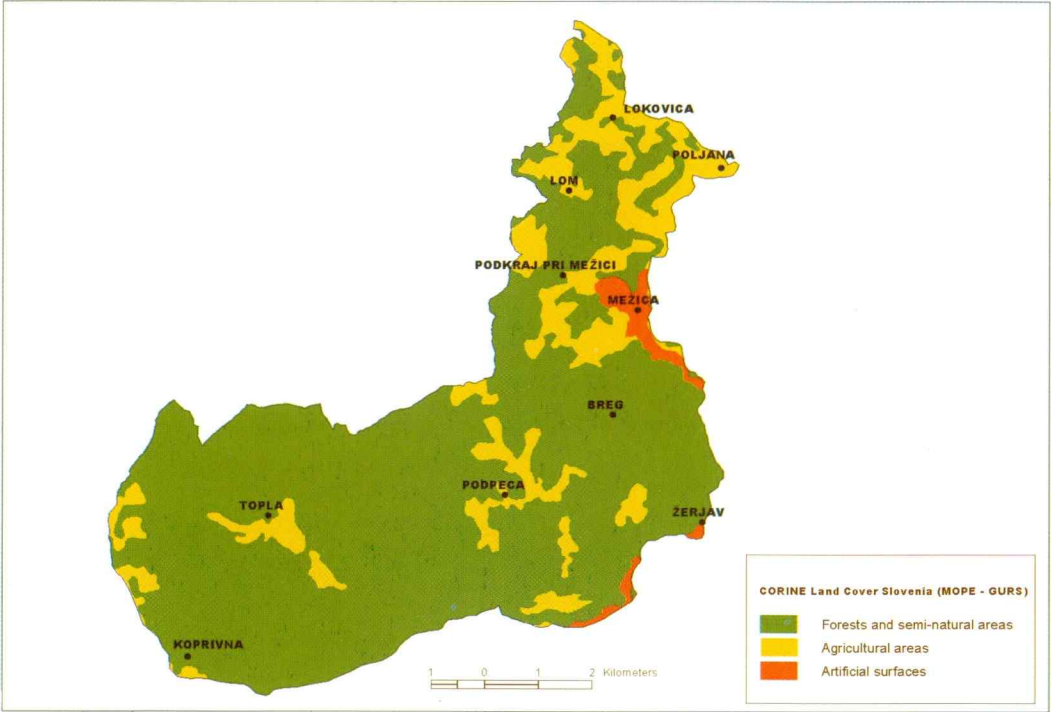


Figure 2: CLC Slovenia (MOPE-GURS, 2002) - Categorization on 1st level

It is obvious that forests and semi-natural areas with 51,88 km² or 81,16 % are the most prevailing category. Forests, mostly coniferous and less mixed and broad-leaved forests, cover more than 70 % of the area. Moors and heath land cover another 8 %. Sparsely vegetated and bare rock areas are present in Peca mountain crest with 2,5 %.

Agricultural areas cover almost 17 % or 10,76 km², most of it pastures and so called areas principally occupied by agriculture, interspersed with significant natural areas (together 16 % of the area), complex cultivation is less present.

Artificial surfaces of only 1,28 km² or 2% with two subcategories are detected: discon-

Table 2. Table of proportions and sizes of ALUM					
1 st level	2 nd level	3 rd level	4 th level	Area [km ²]	Share [%]
1. Agricultural land	1.1.Arable land			0,45	0,7
	1.2.Areas under permanent cultures (permanent crops)	1.2.1.Viticulture land	1.2.1.1.Vineyards	0,001	< 0,01
		1.2.2.Orchards	1.2.2.2.Extensive orchards	0,5	0,8
	1.3.Meadows and pastures	1.3.1.Intensive meadows		4,96	7,76
		1.3.2.Extensive meadows	1.3.2.2.Other extensive meadows	2,87	4,5
	1.4.Other agricultural areas	1.4.1.Overgrown areas		1,42	2,2
	1.5.Riparian overgrowth and forest hedges			0,3	0,47
				49,74	77,8
2.Forest and other overgrowth areas				2,49	3,9
3.Built-up areas and related surfaces				0,02	0,03
5.Dried open areas with special vegetation				1,04	1,63
6.Open areas with little or no vegetation				0,13	0,2
7.Water					

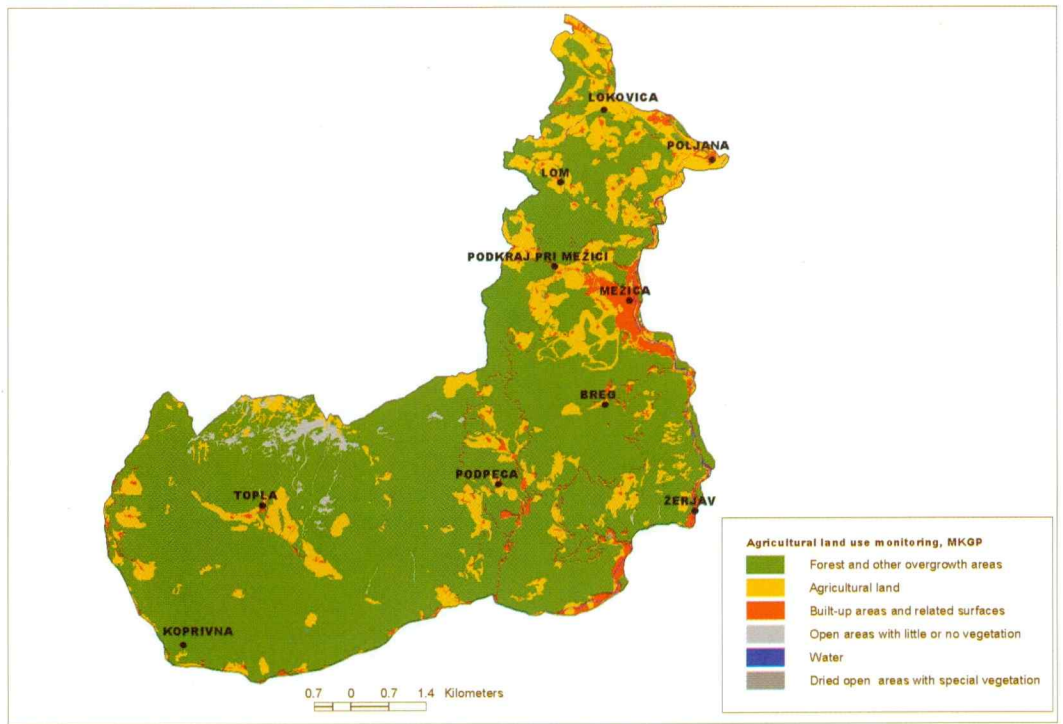


Figure 3: ALUM map of the Peca area (Ministry of Agriculture, Forestry and Food of Slovenia, 2002)

tinuous urban fabric and industrial or commercial units.

Agricultural land use monitoring data

(ALUM)

In the area of Peca there are six major land use categories of ALUM present:

1. Agricultural land

2. Forest and other overgrowth areas
3. Built-up areas and related surfaces
4. Dried open areas with special vegetation
5. Open areas with little or no vegetation
6. Water

In the investigated area agricultural land is divided on all four levels, while other categories are not divided into any subcategories. The categories of agricultural land are:

- 1.1. Arable land
- 1.2. Areas under permanent cultures (permanent crops)
- 1.3. Meadows and pastures
- 1.4. Other agricultural areas
- 1.5. Riparian overgrowth and forest hedges

On the third level they are divided on the following categories:

- 1.2.1. Viticulture land
- 1.2.2. Orchards
- 1.3.1. Intensive meadows
- 1.3.2. Extensive meadows
- 1.4.1. Overgrown areas

On the fourth level they are divided on the following categories:

- 1.2.1.1. Vineyards
- 1.2.2.2. Extensive orchards
- 1.3.2.1. Other extensive meadows

Prevailing category is forest and other overgrowth areas covering 49,74 km² or 77,8 % of surface. The category does not have any subcategories.

Agricultural land covers 10,5 km² or 16 %. Prevailing subcategories are meadows and pastures (three quarters of agricultural land), followed by overgrown areas. Subcategories present are arable land, areas under permanent cultures (vineyards, extensive orchards), meadows and pastures (intensive pastures and extensive meadows), other agricultural areas (overgrown areas) and riparian overgrowth and forest hedges.

Agricultural land is followed by built-up areas and related surfaces covering almost 2,5 km² or 3,9 % of surface. Open areas with little or no vegetation cover Peca crest area of 1 km² or 1,63%. Other two categories present are dried open areas with special vegetation with 0,02 km² or 0,03 % and water with 0,13 km² or 0,2 % of the area.

Conclusion

It is widely predicted that CORINE Land Cover (CLC) database usefulness is bigger

on international and state level, but less on regional and local level in cases when small areas with particularities are analyzed. In comparison with more detailed land use categorization (ALUM) obtained and provided by Ministry of Agriculture, Forestry and Food of Slovenia relatively big differences between results of the two databases occurred. A relevant comparison is not even possible due to different nomenclature, mapping scale, area of the smallest unit etc. By both datasets forest is far prevailing land use category covering more than three quarters or 78 % (ALUM) and 81 % (CLC) of surface followed by agricultural land with about 16 % (ALUM) and 17 % (CLC) %. The differences are also present in artificial areas. It is covered by 3,9 % (ALUM) and 2,1 % (CLC). No major differences in proportions of two most prevailing land cover categories (forests, agriculture land) on first level can be found but big differences are present when it comes to subcategories on lower levels that cover smaller parts of surface (settlements, roads, dump sites...). Some of the categories are even absent (CLC does not detect any water bodies). In general we can so far conclude that CLC database is appropriate for land use analysis on regional level as well but mostly in certain specific cases when for instance the region is shared by two states and no other common methodology for both states exists. We can also say that the CLC data show quite realistic picture of the area and use main characteristics. But however for more detailed picture it is necessary to use more detailed data. On the base of the results we can so far conclude that Peca aquifer and also its wider area (Slovene part) is at the moment not endangered in greater scale.

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