

## **MANAGEMENT OF SOIL AS A NATURAL RESOURCE IN THE SAVINJSKA STATISTICAL REGION IN SLOVENIA**

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UDK: 631.4(497.4)

COBISS: 1.02 – Review article

### ***Abstract***

#### **Management of Soil as a Natural Resource in the Savinjska Statistical Region**

Animals, plants and microorganisms could not exist without soil, because without it life on Earth would not be possible. Thus we should always be concerned with preserving the soil condition. This should be a personal, a municipal, as well as a national concern. Nevertheless, the role of soil is not sufficiently incorporated into the planning of sustainable development of the Savinjska statistical region, therefore more active approaches are needed in the field of soil management and protection (education, research, raising public awareness, soil protection programs, soil related educational excursions, etc.).

#### ***Key words***

soil, natural resource, soil degradation, soil contamination, soil management, soil protection, land use

*The editor received the article on 20.1.2010.*

## 1. Introduction

Animals, plants and microorganisms could not exist without soil, because without it life on Earth would not be possible. Soil provides plants with water and nutrients, supports the plants' roots, stores and retains minerals, organic matter, water and energy as well as various chemical substances. It is a natural filter for groundwater, which is the main source of drinking water. Furthermore, soil is the habitat for a variety of organisms, which through complicated and interconnected processes enable the cycling of substances and energy. It is the basis of human activity, the basis of the landscape, as well as of our heritage. All the aforementioned functions are dependent on soil. Damaging the soil structure affects the other elements of the environment as well as the ecosystem, because soil is formed very slowly (Lobnik, Suhadolc, Turk 2005). It takes many centuries for only one centimeter of soil to form, but due to inappropriate use it can be blown or washed away in a couple of years. The European Union is facing accelerated soil degradation (Lobnik, Suhadolc, Turk 2005). As soil is an irreplaceable natural resource, preservation and sustainable management of soil is of great importance, and this is emphasized by many authors (Lobnik 2005; Lovrenčak 2006; Rowell 1994).

The distinct biotic diversity of the Savinjska statistical region and the diversity of its landscape are the reasons for the great soil variety of this region. Therefore, the main objective of this paper is to determine and assess the role of soil in the Savinjska statistical region, because soil is an irreplaceable natural resource, and of great importance for the sustainable development of the countryside.

## 2. Characteristics of the Savinjska Statistical Region

Slovenia is divided into twelve statistical regions: Gorenjska, Goriška, Jugovzhodna Slovenija, Koroška, Obalno-kraška, Osrednjeslovenska, Podravska, Pomurska, Savinjska, Spodnjeoposavska and Zasavska.



Fig. 1: Statistical regions in Slovenia.

Source: <http://sl.wikipedia.org/wiki/Slika:Slov-reg.png>

The Savinjska statistical region has the natural geographical-characteristics of the Alpine and the pre-Alpine regions, as well as the Pannonian regions. It encompasses 2,332 km<sup>2</sup>, which represents 11% of the area of Slovenia, and is third in size among the Slovenian statistical regions. According to data from 2005, the region had 257,525 inhabitants at the time, with a population density of 108 inhabitants per km<sup>2</sup>, which is above the Slovenian average. There are two main urban and economic centers in the region: Celje and Velenje. The population density is higher there, with more than 400 inhabitants per km<sup>2</sup> (Regionalni razvojni program 2007, 38). In the Savinjska statistical region there are 31 municipalities, with eight administrative units: Celje, Laško, Mozirje, Slovenske Konjice, Šentjur pri Celju, Šmarje pri Jelšah, Velenje and Žalec.

## **2. Soil Types and Land Use in the Savinjska Statistical Region**

In the Savinjska statistical region the physical-geographical and socio-geographical factors are changing rapidly from a macro-, as well as a micro-spatial perspective. Furthermore, they are heavily intertwined, which results in great soil variety. An analysis of the pedological maps of the region and soil surveying both showed that eutric cambisol is found in the region; it can mainly be found in Spodnja Savinjska Valley. The reasons for this frequency are the carbonate fluvial deposits accumulated by the Savinja river. As growing hop and other crops require high anthropogenic inputs, there is intensive agricultural use of this soil. This is evident from data concerning pollution, which shows that these soils and the groundwater are polluted (Lampič 1999; Zupan, Grčman, Lobnik 2008).

In the vicinity of the rivers Savinja and Voglajna, which still overflow and hinder pedogenesis, up to 30 cm of riverine soil has formed. The plains along the Ložnica, the Hudinja, the downstream of Sotla and the area of Velenje are covered with gleysol, which is the result of clay sedimentation. The prevailing vegetation cover here is grass. Due to hydromelioration some of the drained areas have been put to agricultural use.

The mountains Boč and Donačka gora are mainly covered with kalkokambisol and rendzinas. A kalkokambisol zone also spreads across Srednjesotelsko gričevje, from Virštanj, Pilšatanj to the hills near Dekmance. On the Pleistocene sediments on the left side of the river Bistrica a thick layer of kalkokambisol is found. Kalkokambisol also formed on the limestone of Paški Kozjak, as did a light to a medium thick layer of rendzinas. Rendzinas are dominant in the triangle between Kozje, Križani vrh and Gradišče.

Dystric cambisol covers the hills of Ložniško gričevje and Hudinjsko gričevje, the latter consisting of Miocene sands and sandstones. Rapid disintegration of these old rocks is the reason why these non-carbonate soils formed. They are covered by spruces and pine trees. Dystric cambisol and ranker are also found in the area of Macelj.

The connection between natural and socio-geographical factors is reflected in the land use, which is affected by natural and social factors. The former include altitude, slope, illumination, and the latter include the past and present economic situation and landholding relations. Different land categories (fields, vineyards, orchards, meadows, pastureland and forests) are presented as the primary sector (different branches of agriculture and forestry) reflect how soil is being used.

In addition to the current land-use category allocation, it is most important to determine changes in land use. Various processes are involved here. When the different land use categories are predominantly covered with forests, the process is called reforestation. The more intensive land use categories (fields, vineyards and orchards) are transformed into meadows and pastureland by planting. Transforming less intensive categories into more intensive is called intensification (transforming forests into pastureland; pastureland into meadows; meadows into fields, orchards or vineyards; fields into orchards and vineyards; orchards into vineyards). The term urbanization applies in case of settlement expansion; fertile land is transformed into infertile land (construction, building infrastructure networks, etc).

Land use is presented with the help of the 2008 Graphical Units of Agricultural Land (in Slovene: GERK), which show the actual use of the land, based on shots taken from the air. The land use map and the calculations determining the area in each municipality ascribed to a particular land use category (in hectares and percentage) were done using GIS tools.

Forests cover almost 60% of the area of the region, about 33% are agricultural areas, a bit less than 6% are urban areas, 2% of the area is in the process of overgrowing, and 1% consists of water and other surfaces. Among agricultural areas meadows prevail (73%), there are about 18% of fields, while a bit less than 10% consist of orchards, vineyards and other permanent plantations (Petauer 2009).

In the Savinjska statistical region, there are great differences in land use between different areas. Some municipalities in Zgornja Savinjska dolina (Luče, Ljubno, Solčava, Gornji Grad, Nazarje) have the largest share of forests, which cover over 70% of the area of the municipality. Forests also cover from 60% to 70% of the area in the following municipalities: Dobrna, Laško, Šoštanj, Vransko, Vitanje, Rogatec, Rečica ob Savinji, Prebold, Radeče and Mozirje. The municipalities of Rogaška Slatina, Bistrica ob Sotli, Šmarje pri Jelšah, Slovenske Konjice, Dobje, Celje, Žalec, Šmartno ob Paki, Šentjur and Podčetrtek have the lowest percentage of forests (from 30% to 50% of the area) (Petauer 2009).

The municipalities of Dobje, Šmarje pri Jelšah, Šentjur, Rogaška Slatina, Podčetrtek and Bistrica ob Sotli have the highest percentage of meadows (from 30% to 50%). A high percentage of fields is found in some municipalities of Spodnja Savinjska dolina: Braslovče 27%, Žalec 22%, Polzela 16% and in the south and southeastern part of the region: Rogaška Slatina 26%, Bistrica ob Sotli 20%, Slovenske Konjice 17%. The share of urban (built-up) areas is the highest in municipalities with "larger settlements" (Celje, Velenje, Žalec, Slovenske Konjice, Rogaška Slatina) and in some smaller municipalities (Šmartno ob Paki, Polzela) (Petauer 2009).

We can conclude that in the Savinjska statistical region there is a similar pattern of changes in land use to that of other parts of Slovenia. There is a reduction of cultivated land, whereas the share of forests and uncultivated land is increasing. The dominant processes in land use category change are urbanization, overgrowing and forestation.

### **3. Soil Condition (Quality) in the Savinjska Statistical Region**

The various activities and their direct and indirect effects impose a heavy burden on the soils in the area of the Savinjska statistical region (from the environmental

perspective). The type of burdening differs according to different areas of the region.

### 3.1 Soil Degradation

Šaleška dolina is the area where the use of natural resources is most intensive, as are the consequences, not only in the region, but also in Slovenia as a whole. The Velenje coal mine (underground mining) produces about 4.000.000 tons of lignite annually, resulting in the subsidence of the surface (Šterbenk 1999). The result is not only the degradation of the soil, but of the landscape as a whole.

As a result, about 3 million m<sup>3</sup> of the surface subside each year (Šterbenk 1999). The main reason for the subsidence, and consequently degradation, is the geological structure of the soil, consisting of new and sandy sediments, which are unstable and collapse after coal mining ceases. After the mining ceases, the surface continues to subside for about 15 to 20 years, which is a big obstacle for the development of human activity in the subsiding area. Nevertheless, more than a third of this area has been re-cultivated already, and brought to good use (tourism, agriculture, waste disposal sites, etc.). 2.4 km<sup>2</sup> of the subsiding area is covered by lakes (Velenjsko jezero, Družmirsko jezero and Škalsko jezero) (Šterbenk 1999).

According to the data provided by the Geological Institute of Slovenia for the year 2007, mineral resources were produced in 25 locations across the Savinjska statistical region (limestone in 6, dolomite in 16 and silicate in 3 locations). About 3 million tons of different raw materials were produced that year, and the reserves are estimated at more than 60 million tons. In the aforementioned cases the result in the excavation areas is complete soil loss, due to production of raw materials. Fig. 2 shows some of the more important locations.

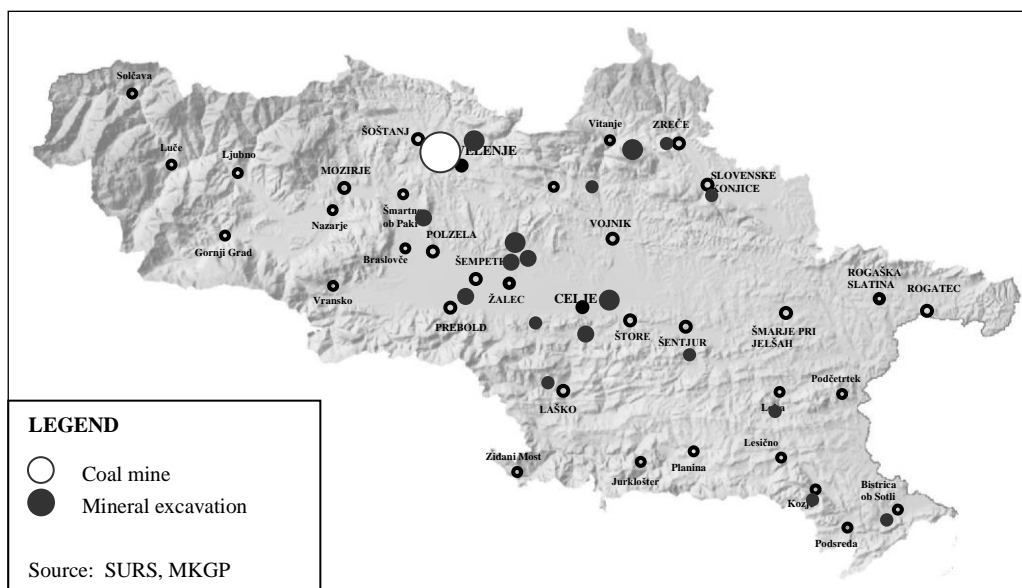


Fig. 2: Important coal mining locations and raw materials production in the Savinjska statistical region.

Source: Author.

### 3.2 Soil Contamination

In the broader area of Celje, research on soil (ground) contamination was first conducted in 1989 by the Pedology Department of the Biotechnical Faculty. More than 10 different parameters in 119 sample locations were analyzed. In the past, a lot of heavy industry (Železarna Štore, EMO Celje, Cinkarna Celje, etc.) was located in the broader area of Celje, placing a heavy burden on the region’s environment. The most problematic were emissions of SO<sub>2</sub>, NO<sub>x</sub>, smoke, deposited particulate matter (heavy metals) and fluorides. Traffic and large- or small-scale individual burning of materials contributed to air pollution and consequently, soil contamination. The results showed that the soil was heavily contaminated with heavy metals, mostly with cadmium, chrome, zinc, lead, and to a lesser extent with arsenic, mercury and nickel.

The research continued in 2001 in seven locations in the Savinjska statistical region. In the years from 2004 to 2007, additional 15 areas (locations) were included in the research (Fig. 3). The areas included in the research differ in land use, the type of (potential) pollution and the presence of organic and non-organic substances in the soil. Soil was also analyzed in some other areas (e.g. Spodnja Savinjska dolina: analysis from the perspective of agricultural production). Local monitoring is conducted in Šaleška dolina (the consequences of environmental problems related to the Termoelektrarna Šoštanj power plant and the Premogovnik Velenje coal mine).

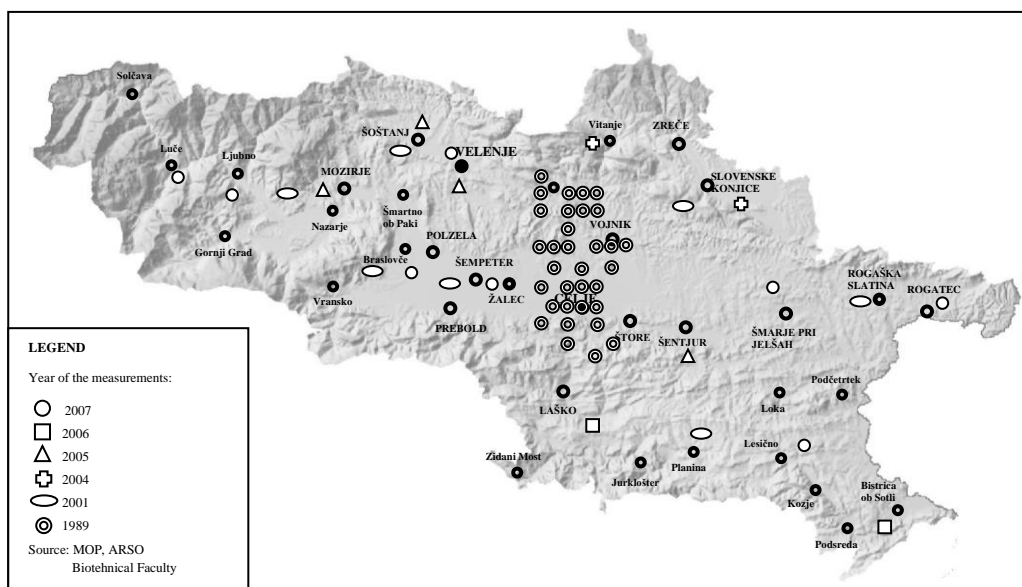


Fig. 3: Locations of the monitoring points in the area of the Savinjska statistical region (1989-2007).

The biggest problems arise in areas with a combination of intensive agricultural and industrial production, in addition to traffic infrastructure (Spodnja Savinjska dolina and Celjska kotlina). In general, marginal areas in the region have fewer problems. There the soil is less contaminated and degraded, because of the more preserved forests and less intensive industry. In most areas where certain measurements or

constant monitoring were conducted, a gradual decrease in the level of contamination is evident in recent years. For the most part, this is the result of lower emissions (and consequently imissions) into the air, in addition to the self-cleaning abilities of the soil. In the locations included in the measurements of 2006 and 2007, the emission limit value was exceeded in four categories, namely: lead, cobalt, nickel and arsenic. In no location the emission limit value reached the critical point.

The quality of the soil in the area of the Savinjska statistical region is affected not only by the "polluters", but also by some of the bigger polluters in the immediate vicinity (the Termoelektrarna Trbovlje power plant, the Lafarge Cement Trbovlje cement factory, etc.).

#### **4. Soil Management in the Municipalities of the Savinjska Statistical Region**

Soil management is a process that also encourages the sustainable development of other natural resources, without endangering the stability of the other vital ecosystems. This can benefit the economy and society in general. The objective of soil management is to establish a sustainable balance between using the resources needed to survive, and preserving resources for future generations. An integrated management approach includes soil management in urbanized, as well as rural environments, thus cooperation with all sectors that affect soil is needed. The involvement of the public and developing a positive attitude towards soil as a natural resource is also of crucial importance.

In the continuation of the study, we shall try to establish whether soil is included in the development programs of the municipalities in the Savinjska statistical region, as well as determine the role it plays. The municipalities have the power to affect soil management and have the responsibility to do so. The Slovenian Environmental Protection Law (UL RS, No. 39) states that municipalities must encourage economic and social development, which, in meeting the needs of the present generation, likewise allows for equal opportunities of the future generations, and secures the long-term preservation of the environment.

The study has established:

- That the municipalities do not have ordinances, acts or regulations for soil preservation, whereas that *is* the case with the preservation of water resources and air. Nevertheless, a variety of acts concerning the environment, economy, communal infrastructure (land use, agriculture, traffic regulation, etc.) were passed, which indirectly also concern soil as a natural resource. A "Regional Development Plan" for the years from 2007 to 2013 was adopted for the Savinjska statistical region, and it includes issues only indirectly related to soil.
- That there is no monitoring of soil fertility in the municipalities. The monitoring of soil fertility is not conducted systematically, as prescribed by the Agricultural Land Law. Farmers granted various subsidies from EU funds are obliged to allow for soil analysis of the areas they cultivate, but a wholesome system for monitoring soil fertility has yet to be established. Measures for improving environmental protection and soil quality could also be put into effect by establishing monitoring of soil fertility.
- That the municipalities do not have thematic maps of land contamination and proposed use or/and sanitation. In the municipality of Celje a map from 1989 exists, and soil contamination is being monitored in some locations; research on soil pollution was conducted in all of Slovenia, because this is prescribed by the National Envi-

ronmental Protection Program, whereas the municipalities do not have this kind of data or maps at their disposal.

- That soil vulnerability maps that show the pollution of sensitive areas with pesticides have not been commissioned by the municipalities. Here we have to point out the rural areas (Imensko polje, Bistriško polje) and especially the area of Spodnja Savinjska dolina where there is intensive agriculture, and groundwater is located a mere one meter under the surface.
- That the municipalities do not keep records of the change of intended use of high quality farmland. The Savinjska statistical region lost cultivated areas, because these were used for settlements, industrial buildings, supermarkets and infrastructure. The intended use can be changed on the basis of the spatial plan of the municipality, without the consent of the Ministry of Agriculture, Forestry and Food. In the last five years, about 30.000 hectares of farmland were lost, and it is alarming that this trend continues (Lobnik 2005).
- That in the municipalities there is not enough expert staff in the field of soil management.

The results of the study suggest that the role of soil is not sufficiently incorporated into the planning of sustainable development of the Savinjska statistical region, therefore more active approaches are needed in the field of soil management and protection (education, research, raising public awareness, soil protection programs, soil related educational excursions, etc.). Public awareness regarding the importance of soil is still very low in this region. The fourth pillar of the Thematic Strategy for Soil Protection emphasizes that the lack of public awareness regarding soil protection is a problem, and therefore it has to be raised. Thus measures have to be taken, in order for the general public to gain more knowledge about soil, its characteristics and its importance as an integral part of the landscape. Only this way we can fully appreciate the value of soil, and ensure that it is managed economically and intelligently.

## **5. Conclusion**

Soil is an irreplaceable natural resource and habitat. Although it is less noticeable in the landscape, it is nevertheless of no lesser importance than the other factors. It is also of great importance for humans, because without it growing crops would be impossible. Furthermore, it is the basis of human activity. Due to continuous population growth the need for food production is increasing. Thus, soil is becoming more important as a natural resource which should ensure more food.

There is great soil variety in the Savinjska statistical region, and this fact has to be taken into consideration when planning for sustainable development of Slovenia, because soil quantity and quality can be affected negatively. Nevertheless, we can conclude that the role of soil as an irreplaceable and vital natural resource is not sufficiently incorporated into the planning for sustainable development of the Savinjska statistical region. Thus we should strive towards a more comprehensive soil management from the perspective of the different functions soil has, and encourage the modernization and adaptation of soil protection policies, in order to achieve sustainable development. Different approaches on regional and municipal levels could ensure the raising of public awareness regarding the role of soil and its importance as a natural resource.



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### **Summary**

Soil is an irreplaceable natural resource and habitat. Although it is less noticeable in the landscape, it is nevertheless of no lesser importance than the other factors. It is also of great importance for humans, because without it growing crops would not be possible. Furthermore, it is the basis of human activity.

The distinct biotic diversity of the Savinjska statistical region and the diversity of its landscape are the reasons for the great soil variety in this region. The fertile eutric cambisol can mainly be found in Spodnja Savinjska dolina, where intensive agricultural production requires high anthropogenic inputs, and causes the pollution of the soil and the groundwater. Rendzinas formed on a carbonate foundation found on inclined surfaces, and ranker formed on a silicate foundation. Postcarbonate soil prevails in the highlands, while on the volcanic and carbonate rock dystric cambisol prevails. By the rivers of Savinja, Dreta, Paka, Ložnica, Hudinja and Sotla, riverside soil has developed up to the depth of 30 cm, while pseudogleys appear in the clayey surroundings.

The connection between natural and socio-geographical factors is reflected in the use of soil. Forests cover almost 60% of the area of the Savinjska statistical region, about 33% are agricultural areas, a bit less than 6% are urban areas, 2% of the area is in the process of overgrowing, and 1% consists of water and other surfaces. Among agricultural areas, meadows prevail (73%), there are about 18% of fields, while a bit less than 10% consist of orchards, vineyards and other permanent plantations.

In the Savinjska statistical region there is a similar pattern in changes in land use to that of other parts of Slovenia. There is a reduction of cultivated land, whereas the share of forests and uncultivated land is rising. The dominant processes of land use category change are urbanization, overgrowing and forestation.

The various activities and their direct and indirect effects impose (from an environmental perspective) a heavy burden on the soils in the area of the Savinjska statistical region. The type of burdening differs between the different areas of the region.

The biggest problems arise in areas with a combination of intensive agricultural and industrial production, in addition to traffic infrastructure (Spodnja Savinjska dolina and Celjska kotlina). In general, the marginal areas in the region have fewer problems. There the soil is less contaminated and degraded, because of the more preserved forests and less intensive industry. In most areas where certain measurements or constant monitoring were conducted, a gradual decrease in the level of contamination is evident in recent years. For the most part, this is the result of lower emissions (and consequently imissions) into the air, in addition to the self-cleaning abilities of the soil. In the locations included in the measurements of 2006 and 2007, the emission limit value was exceeded in four categories, namely: lead, cobalt, nickel and arsenic. In no location the emission limit value reached the critical point.

The study also established:

- That the municipalities do not have ordinances, acts or regulations for soil presser-

vation, whereas that *is* the case with the preservation of water resources and air.

- That there is no monitoring of soil fertility in the municipalities.
- That the municipalities do not have thematic maps of land contamination and proposed use or/and sanitation, except in the municipality of Celje, where a map from 1989 exists.
- That soil vulnerability maps which show the pollution of sensitive areas with pesticides have not been commissioned by the municipalities.
- That the municipalities do not keep records of the change of intended use of high quality farmland.
- That the municipalities lack expert staff in the field of soil management.

The results of the study suggest that the role of soil is not sufficiently incorporated into the planning of sustainable development of the Savinjska statistical region, therefore more active approaches are needed in the field of soil management and protection (education, research, raising public awareness, soil protection programs, soil related educational excursions, etc.). We should strive towards a more comprehensive soil management from the perspective of the different functions of the soil, and encourage the modernization and adaptation of soil protection policies, in order to achieve sustainable development.