SOILS OF SLOVENIA

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Slovenia is a small country covering a mere 20,273 m^2, but boasts great diversity in geology, relief, hydrological systems, and vegetation. This diversity is clearly reflected in its pedological characteristics.

Principal pedogenetic factors and processes in Slovenia

Because of its exceptional diversity and distinct variation over short distances, the bedrock is the most important pedogenetic factor in Slovenia. Through mechanical and chemical weathering, mineral elements enter the soil and have a decisive influence on its basic characteristics. A special stamp is given to Slovenia by the carbonate rock and the corresponding karst surfaces, which is why we often divide soils relative to their origin on carbonate or noncarbonate bedrock.

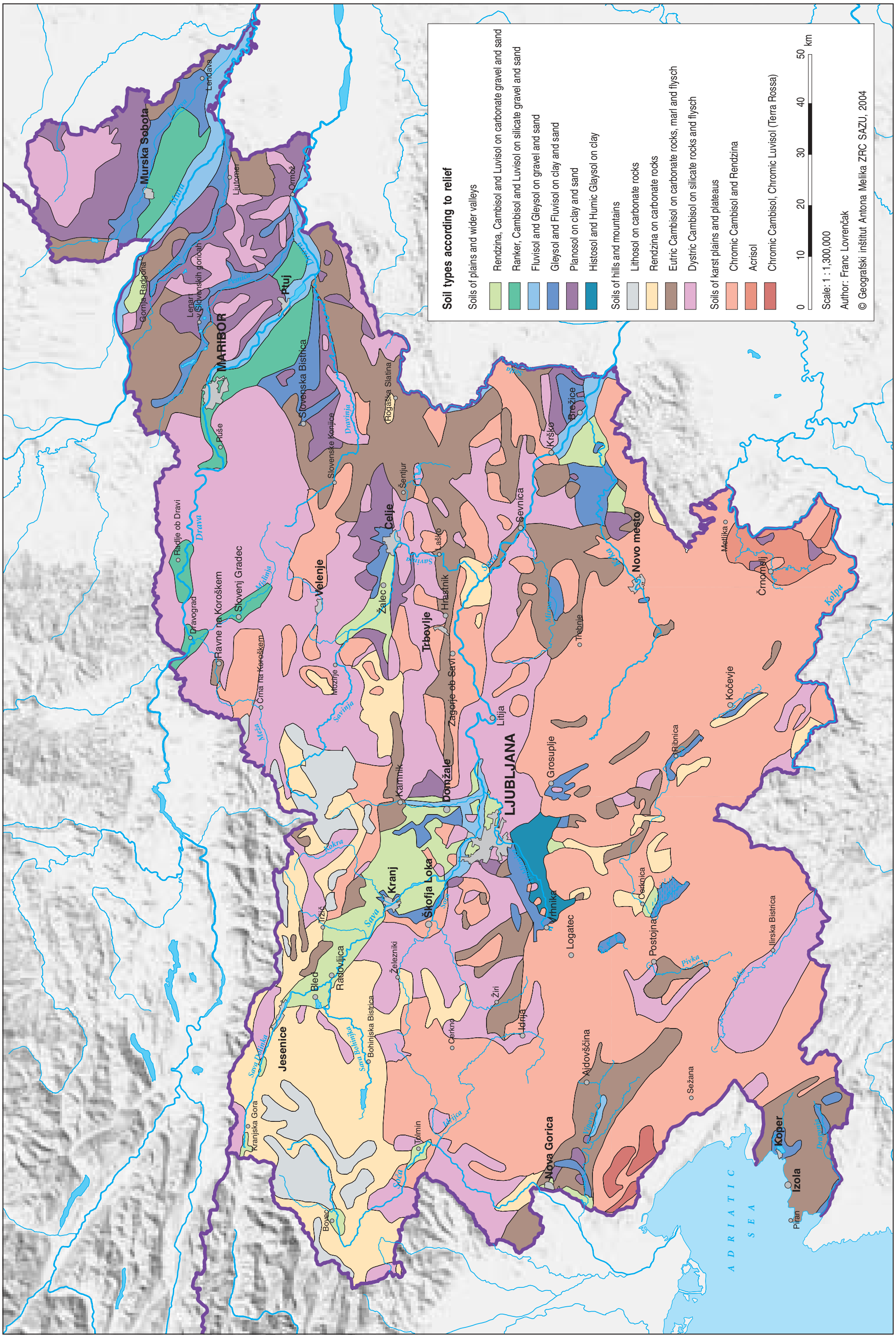
As a pedogenetic factor, relief has an indirect influence on the development of the soil with altitude, inclination, and exposition. Inclination substantially influences the distribution of the soil mass and water in the soil, while exposition and altitude influence the water regime and the temperature regime of the soil.

The climate above the ground directly influences the climate of the soil, i. e., its warmth and water-air regime. The climate of the soil is directly linked to the degree of disintegration of mineral components and particularly effects the disintegration and proportions of organic matter. However, from the viewpoint of pedogeography, regional climatic changes are minor because of Slovenia's small size, and we often treat the climate as a constant.

The importance of water as a pedogenetic factor is reflected in the fact that the basic division in the Slovene classification system distinguishes automorphic and hydromorphic soils. The influence of water is reflected in its movement through the soil profile. Vertical movement causes the shifting or washing away of tiny particles (nutrients, minerals of clays, and organic matter) that leads to the formation of horizons and therefore types of soil. The rising of water and the deposit of dissolved matter is a rare phenomenon in Slovenia because of its humid climate. Water also moves through the soil horizontally and influences the shifting of soil in the area (erosion, denudation, solifluction …). And finally, lack of movement or stagnation of water in the soil leads to alternating oxidation and reduction processes and thus to the formation of gley, pseudogley, and peat soils.

The living world (plants and animals) constantly changes the soil mechanically and chemically and together with the decomposition of dead matter contributes to the influx of organic and nutrient substances. This ensures the preservation of the basic quality of the soil, its fertility. Dead organic matter thus influences a whole range of properties of the soil (structure, water-air regime, accessibility to nutrients …). Because of the large proportion of forest in Slovenia, the influx of organic matter into natural soils is practically permanently guaranteed.

Today, man represents one of the most important pedogenetic factors. From the pedogenesis point of view, the changes that man causes are momentary and began with Neolithic cultivation. Man can have a positive influence on the soil by improving the fertility, but his negative influence on the soil is of much greater concern, primarily anthropogenetically accelerated water and wind erosion, chemical (pollution, salinization), and mechanical (soil compaction) degradation, and the increasingly frequent irreversible use of soil as a consequence of urbanization.


Soil types according to relief
Soils of plains and wider valleys
Rendzina, Cambisol and Luvisol on carbonate gravel and sand
Ranker, Cambisol and Luvisol on silicate gravel and sand
Fluvisol and Gleysol on gravel and sand
Gleysol and Fluvisol on clay and sand
Planosol on clay and sand
Histosol and Humic Gleysol on clay
Soils of hills and mountains
Lithosol on carbonate rocks
Rendzina on carbonate rocks
Eutric Cambisol on carbonate rocks, marl and flysch
Dystric Cambisol on silicate rocks and flysch
Soils of karst plains and plateaus
Chromic Cambisol and Rendzina
Acrisol
Chromic Cambisol, Chromic Luvisol (Terra Rossa)
0 10 20 30 40 50 km
Scale: 1 : 1,300,000
Author: Franc Lovrenčak
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Murska Sobota
Lendava
Ljutomer
Ormož
Gornja Radgona
Lenart v Slovenskih goricah
Ptuj
MARIBOR
Slovenska Bistrica
Rogaška Slatina
Brežice
Krško
Ruše
Slovenske Konjice
Šentjur
Radlje ob Dravi
Drava
Celje
Sevnica
Laško
Dravograd
Slovenj Gradec
Velenje
Novo mesto
Metlika
Črnomelj
Kolpa
Ravne na Koroškem
Žalec
Hrastnik
Trbovlje
Trebnje
Črna na Koroškem
Mozirje
Savinja
Zagorje ob Savi
Litija
Kočevje
Ribnica
Grosuplje
Kamnik
Domžale
LJUBLJANA
Kranj
Škofja Loka
Vrhnika
Cerknica
Tržič
Sava
Logatec
Postojna
Ilirska Bistrica
Pivka
Bled
Radovljica
Železniki
Žiri
Idrija
Jesenice
Cerkno
Bohinjska Bistrica
Ajdovščina
Sežana
Kranjska Gora
Tolmin
Nova Gorica
Koper
Izola
Piran
Bovec
ADRIATIC SEA

◄ *Figure 1: Distribution of soils in Slovenia.*

Due to its varied relief, great inclinations, and abundance of precipitation, Slovenia is potentially quite threatened by water erosion, but for the moment it is safe because of the high proportion of forest and the abandonment of farming on unsuitable land. The pollution of the soil is mostly the consequence of industrial and urban development, and in some places pollution exceeds the allowed limits several times over. This problem is of major concern in the valleys and basins, which are unfortunately the only areas suitable for intensive agriculture and settlement and are also areas of groundwater supplies. The greatest problem, however, is the fact that the most fertile soils are located in areas of interest for urbanization, industrialization, and the construction of infrastructure. Because Slovenia has little surface area suitable for agriculture, its must guard its soils as a strategic asset, especially as we lost over 17,000 hectares of fertile soil between 1958 and 1988 (*Medmrežje 2*), and a further 4,078 hectares between 1993 and 1997 (*Okolje v Sloveniji* 2002, 2003).

As a pedogenetic factor, time is treated as the period in which the soil is formed. From the geological point of view, this process is exceptionally short, and from the human point of view, very long. Due to extremely dynamic factors and processes, the soils in Slovenia are relatively young since the majority are younger than 10,000 years (Prus 2002).

To have a complete picture of the formation of soils in Slovenia, it is necessary in addition to knowing pedogenetic factors to have a good knowledge of pedogenetic processes. Among the most important are the weathering of the bedrock and the formation of clay minerals, leaching, braunification, acidification, and gleying and pseudgleying.

Figure 2: The arial view on Alpine and subalpine Slovenia (photography Jurij Senegačnik).

Alpine and subalpine Slovenia

Decisive factors for the formation of the soil in the highest parts of Slovenia are the geological foundation and the relief, primarily the inclination and the altitude. In the broadest sense, we divide soils into those formed on carbonate bedrock and those on noncarbonate bedrock. On sloping surfaces, the development of the soil goes from poorly developed regolith on scree and extreme inclinations through young and often shallow rendzina on carbonate rock or ranker on a silicate base. Older forms are brown forrest soils and distric brown soils on lesser inclinations where signs of leaching may already appear. On flat plateaus (Jelovica, Pokljuka) with abundant precipitation where the runoff is hindered, gleyed peat soils were also formed. In the valleys and basins of central Slovenia (Ljubljana basin, Celje basin) fertile eutric brown soils developed on gravel deposits and leveled relief and on older terraces are often leached and therefore acid. Immediately beside the rivers spread belts of brown fluvisols soils.

According to the international FAO classification, various forms of leptosols (lithic, umbric, rendzic), cambisols, luvisols, fluvisols, and histosols are found in alpine and subalpine Slovenia.

Submediterranean Slovenia

A distinctive duality in the bedrock is characteristic here due to the alternating hard carbonate rock (limestone and dolomite) and the softer flysch. On the hard carbonate bedrock, a mosaic soils is characteristic where the types of the soil and their thickness alternate over exceptionally short distances. The alternating materials are mainly shallow rendzina, brown forrest soil, and in the Kras region as a special form, a distinctly red jerina or jerovica (previously called »terra rossa« but according to the international FAO classification, this is chromic cambisol) that can exceed depths of two meters in individual pockets. The experts do not entirely agree about the origin of the latter, whether it is still forming

Table 1: Occurrence of soils in Slovenia.

Type of soil	Proportion [%]
Acrisols	0.7
Leached soils	1.1
Distric brown soils on Ice Age river rubble	2.2
Distric brown soils on noncarbonate flysch	3.6
Distric brown soils on various silicate rock	20.6
Eutric brown soils on rocks with alkaline or neutral reaction	6.4
Eutric brown soils on sandstone and flysch	7.5
Eutric brown soils on Ice Age river rubble	2.1
Regolith and rendzina on limestone and dolomite	2.6
Rendzina on limestone and dolomite and on Ice-Age river rubble	9.1
Brown forrest soils, typical and leached	32.2
Jerina (Chromic cambisol)	0.4
Riverine soils	2.2
Pseudogleyed soils, distric	5.0
Pseudogleyed soils, eutric	0.2
Gleyed soils	3.4
Peat soils	0.5

today in warmer and dryer submediterranean Slovenia or if jerina is the relict remains of a warmer period in the past. The typical red colour is the result of the presence of hematite. Due to the alternating mineral structure of flysch, even the soils on flysch are not uniform (Koper littoral region, Brkini, Goriška Brda). Typical is the undeveloped form regosol, but otherwise various forms of rendzina and distric and eutric brown soils occur, creating good conditions for vineyards and orchards. The latter soils rank among the most fertile soils of this part of Slovenia (Vipava Valley), but on plains they are often pseudogleyed or gleyed and thus become marshy.

According to the international FAO classification, various types of regosols, leptosols, cambisols and eutric fluvisols are found in submediterranean Slovenia.

Dinaric Slovenia

Soils in the karst Dinaric Slovenia are similar to those in the Kras region described above. Formations on limestone and dolomite distinctly prevail, alternating at short distances (rendzina and brown forrest soils). However, pockets of soil between intervening rock outcroppings are even more distinctive here. The cultivation on such surfaces is very difficult because the rock must be cleared. The undulating and very irregular relief presents a further obstacle. The thicker layers of soil were created artificially by removing rocks from the surface and adding soil at the bottom of dolines. The rocks were used to build the typical stone walls that form property boundaries and protect the soil from wind erosion.

Flat relief is found at the bottom of larger uvalas and karst poljes, but the fine silt and clay deposits hinder the flow of water through the soil. Floods are frequent, and therefore gley and pseudogley are to a large degree suitable only for meadows. The absence of surface waters due to the karst surface also means a relatively small proportion of riverine soils, although especially in Dolenjska they represent important field surfaces.

A special type of soil developed in Bela Krajina **[Do not understand the problem?]** where thick layers of insoluble residues gathered on limestone plateau. The unique anthropogenic land use in the form of collecting and mowing of fern for **strewing** litter almost completely stopped the influx of organic matter and nutrients and greatly impoverished the soil. In spite of the carbonate bedrock, heavily acidic and leached acrid soils were formed with a typical secondary forest association of birch and eagle fern (*Pteridio aquilinum*).

According to the standards of the international FAO classification, various forms of leptosols, cambisols, fluvisols, gleysols, luvisols, and acrisols are found in Dinaric Slovenia.

Subpannonian Slovenia

A smaller presence of carbonate rock is characteristic of northeastern Slovenia, and therefore soils typical of noncarbonate bedrock, ranker and distric brown soils, dominate on sloping relief. Along with the bedrock and the relief, water is also a decisive pedogenetic factor. Due to the abundance of surface waters, the high level of the water table, and the relatively flat surface, the most riverine, gleyed, and pseudogleyed soils in Slovenia are found here and have a predominantly distric character. The great part of these surfaces is also marshy or has been subject to drainage and land improvements in order to acquire field surfaces.

A substantial proportion of the region is covered by Tertiary flysch hills where the eutric soils make intensive winegrowing possible.

In spite of the naturally poorer fertility of the soil, the northeastern part of the country became the most important agricultural area of Slovenia because of its flat surface.

Figure 3: Subpannonian Slovenia (photography Luka Pintar).

According to the international FAO classification, various forms of fluvisols, regosols, leptosols, cambisols, planosols, and gleysols are found in subpannonian Slovenia.

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