

The soil cover of Serbia is diverse due to heterogeneous conditions for the formation and pedogenesis of certain soil types. The crucial impact on the genesis and evolution of soils in Serbia was had by the climate, geomorphological structure of the terrain, geological substrates, vegetation, soil flora and fauna. Physical and chemical characteristics of different soil types vary significantly; therefore, particular types of soil have severe restrictions for use. For example, due to extremely low water-retention capacity, the aeolian sands (WRB, Arenosols, see Table 6.1, Chap. 6, which gives soil names according to the classification system used in Serbia and their equivalents in the WRB) have low productive values. Due to excessive leaching, the base exchange capacity as well as fertility of luvisol is low. Other unfavourable processes (excessive acidification, translocation of iron and aluminium oxides with organic complexes to illuvial horizons, anaerobic conditions due to long-term waterlogged periods that produce gleyed soils, toxic effects of increased salt concentration in halomorphic soils, etc.) may significantly reduce soil fertility. Different measures such as soil drainage, irrigation, recultivation and technical regulations that reduce erosion risks may improve physical, chemical and biological properties of soil.

The most fertile soil in Serbia is Chernozem, within the Pannonian Plain and its surroundings (Fig. 2.1). The Pannonian Plain is also covered by the following: (1) alluvial deposits, on the fluvial terraces, on which fluvisols, humogley (WRB, Gleysol, humic), solontchak and solonetz develop; (2) loess terraces, on which gleyed chernozem soil and solontchak and solonetz develop; (3) aeolic sand with the types: arenosols, rendzina (WRB, Leptosol, calcaric) and chernozems. Soils on Fruška gora and the Vršac Mountains are heterogeneous, comprising rendzina (WRB, Leptosol, calcaric), ranker (WRB, Leptosol, eutric), eutric and distric cambisols, luvisols and colluvial soils on a heterogeneous substrate. The Pannonian region is characterized by a continental climate, and the dominant crops are wheat, maize,

sunflowers, soya and sugar beet. All types of vegetables are farmed, but orchards and vineyards are somewhat less common. The degradation and pollution of the soils in this area is a result of numerous factors. Aeolian erosion occurs due to the powerful gusts of wind, which are particularly marked in the area of Deliblato and Subotica Sands. The strong winds often remove nutritious materials from the surface of agricultural land and when they blow during periods of severe drought, they even remove parts of the surface soil horizons.

The surface mining of coal is also a contributory factor in the degradation and permanent loss of agricultural land. Soil pollution occurs in areas where there are industrial plants and numerous livestock farms and is a result of localized acid rain and the deposition and release of pollutants. Besides industry, traffic contributes to the pollution of soils, above all through lead accumulation along motorways and other major roads. The salinization of soils is also becoming more widespread despite efforts to halt the process and to ameliorate salinized areas. Compaction arises from the use of heavy agricultural machinery when cultivating land, particularly at times when the soil is poorly drained after heavy rain or melting snow. There is periodic flooding, especially in the valleys of those rivers into which water from the Carpathian Mountains flows.

Tertiary lake sediments, limestone or sediments rich in alkali bases, predominate in the hilly area of central Serbia (Fig. 2.2). On structurally lighter—sandy—sediments, eutric cambisol (typic and lessive) soil has developed, which in Serbia is called *gajnjača* (WRB, Cambisol, eutric), in the sequence regosol–rendzina (WRB, Leptosol, calcaric)–eutric cambisol–luvisol. On the structurally heavy—clayey—sediments, vertisol is predominantly found. Chernozem can be found on small areas in central Serbia, mainly on loess and pseudogley in specific climatic and lithogenic conditions. In the southern part of this region, due to marked erosion, there are many areas of colluvial soils. On lower fluvial terraces,



Fig. 2.1 Agricultural fields in Pannonian Plain (photo <http://www.rgz.gov.rs>)

fluvisols, humic gleysol and eugley (WRB, Gleysol) are present. The climate is moderate continental and the xerothermic forests dominate in this region. Wheat, maize and sugar beet are grown on agricultural land, while vegetable farming is developed in the river valleys. Vineyards and orchards occupy a significant area, particularly in the highlands. The kinds of soil degradation and damage in this region are different from the first. Water erosion dominates in almost all parts of the region in spring and autumn, particularly on those slopes where there is no vegetation. Flooding is also very common as the region abounds in rivers whose drainage basins are far away in the mountain region, which results in the deposition of sand and gravel on the fertile areas of the river valleys. The meandering of rivers has a similar effect. A further problem is the large number of sand and gravel borrow pits in the river valleys. Surface mining is very common in this region and occupies large areas, which often results in the permanent loss of fertile cultivable soil. The exploitation of ore is accompanied by the formation of spoil

tips, which reduces the amount of agricultural land yet further. Soil pollution is particularly marked in the vicinity of the numerous coal-burning industrial plants (thermal power stations), ore-processing plants (smelters, etc.) and industrial waste deposits, such as fly ash and slag from thermal power stations and smelters, and is the result of the toxic effects of acid rain and the dispersion of aerosol and particles of ash and slag over surrounding agricultural land.

The mountainous regions of western and eastern Serbia involve the Dinaric Alps, the Rhodope Mountains, the Šar-Pindus range and the Carpathian and Balkan Mountains. Kalkomelanosols (WRB, Leptosols) are present on the limestone and dolomite rocks at the highest altitudes, with the other areas dominated by kalkocambisols (WRB, no adequate WRB name) and luvisols. Rankers (WRB, Leptosols) occur on the acid silicate rocks in the higher zones and on the steepest slopes, while dystric cambisols dominate the other areas. There are small areas of podzols and brunipodzols (WRB, Podzol, humic) on quartzite rocks, with



Fig. 2.2 Agricultural fields, meadows and pastures in hilly area of central Serbia (*photo* Mitrović, M.)

rankers (WRB, Leptosols), eutric cambisol, luvisols and smonitza (WRB, Vertisol) found on the basic rocks. The climate is continental, characterized by warm summers and very cold winters with high precipitation, approximately 600 mm annually. The mountains are dominated by forests, pasture and natural meadows. In terms of agricultural cultivation, wheat, maize, barley, rye, oats and potatoes are grown. Fruit farming is very well developed and there are also vineyards. In this region, tobacco cultivation is very common.

The processes of soil degradation and pollution are also present in the mountainous region with water erosion at its most pronounced. All forms of soil removal are present next to the rivers and in the valleys beneath the mountains, particularly on those slopes where there is a lack of vegetation due to felling. Rocky wastelands occur in places on the limestone and also on the silicate rocks. There are frequent flash floods, which results in the removal of large amounts of soil. Pollution and the permanent loss of soil due to industrial activity occur only in and around mines, where ore and coal are excavated at great depths and flotation tailings and tailings disposed of on the surface, which results in the degradation or complete destruction of areas of soil for agricultural cultivation. Quarries also occupy a significant area and hence contribute to the significant loss of soil.

2.1 Soil Types and Their Production Value

The soils of Serbia are extremely heterogeneous as a result of the varied geological base, climate, vegetation and pedofauna. Some soils are naturally fertile, providing optimal conditions for high-, stable- and good-quality yields, such as carbonate chernozems on loess, while others have unfavourable characteristics to such an extent that production on them is not economically viable. There are also soil types with exceptionally unfavourable characteristics even for the formation of natural vegetation, such as solontchak and solonetz (Table 2.1).

Soils are divided into eight fertility classes, reflecting the relative suitability for agricultural production with classes 1–4 representing higher quality soils. However, about 45% of the total territory belongs to soil classes 4–8, which are not suitable for tillage and profitable crop production, and this land is used for semi-subsistence vegetable or fruit production or as meadows (Protić et al. 2005).

The most frequent soil types in the Republic of Serbia are as follows: (1) lithosol (WRB, Leptosol), an undeveloped soil composed of weathered rocks belonging to soil productivity class 8; (2) arenosol, an undeveloped sandy soil, which is not suitable for crop production and also belongs to soil productivity class 8; (3) kalkomelanosol (WRB, Lep-

Table 2.1 Main soil types and restrictions for land use in Serbia

Soil type Serbian class/WRB	Area (ha)	Restrictions
Lithosol/Leptosol	107,000	Unproductive soil
Arenosol	86,000	Severe restrictions due to excessive filtration; Poor to medium productive soil
Rendzinas/Leptosol, calcaric	~ 527,000	Severe to medium restrictions
Kalkomelanosol/Leptosol	~ 155,000	Severe restrictions
Ranker/Leptosol, eutric, dystic	572,000	Severe restrictions
Chernozem	1 2200,000	Fertile soil; No restrictions
Smonitza/Vertisol	780,000	Moderate restrictions
Kalkocambisol/No adequate WRB name	~ 350,000	Severe to medium restrictions
Eutric cambisol/Cambisol, eutric	560.000	Moderate restrictions
Dystic cambisol/Cambisol, dystic	~ 2 280.000	Severe to very severe restrictions
Luvisol	~ 510.000	Moderate to medium restrictions
Pseudogley/Stagnosol	538,000	Moderate to severe restrictions—conditionally productive soil
Podzol	~ 17,000	Severe to very severe restrictions
Fluvisol, Humofluvisol/Fluvisol, humic Humogley/Gleysol, humic; Eugley/Gleysol	~ 760,000	No restrictions to serious restrictions—conditionally highly productive soil
Solontchak and Solonetz	233,000	Severe restrictions
Histosol	~ 3.000	Moderate to severe restrictions
Deposol/Anthrosol	~ 50.000	Unproductive soil; Moderate to severe restrictions

Source Protić et al. (2005)

tosol) and kalkocambisol (WRB, no adequate WRB name) are categorized in productivity class 7 and are used mainly as natural pastures or are forested with only small areas used for cultivation; (4) ranker (WRB, Leptosol, eutric) is mainly used for pastures and meadows with smaller areas used for the cultivation of potatoes, barley and oats. Rankers belong to soil productivity class 7, meaning they are not suitable for intensive plant cultivation; (5) chernozem is mainly found in Vojvodina where it accounts for approximately 1,000,000 ha, with only 200,000 ha in other parts of Serbia. It is categorized in soil productivity class 1, which in conditions of optimal irrigation produces high, stable yields of cultivated crops; (6) vertisol is a soil type which belongs to productivity class 3. It has an unfavourable water, air and temperature regime, but has favourable chemical characteristics; (7) eutric cambisol belongs to soil productivity class 2. It is a medium heavy soil which has a very favourable water and air regime. It is suitable for crop, vegetable, fruit and viticulture production; (8) dystic cambisol belongs to

productivity class 5 or 6, depending on the gradient of the terrain on which it is formed and solum thickness. In nature, this soil is covered with forest vegetation and small areas are used for fruit, crop and vegetable cultivation. Satisfactory yields can be obtained when growing potatoes, rye, oats and barley; (9) ranker (WRB, Leptosol, eutric) and eutric cambisol are characterized by unfavourable physical and chemical properties and are mainly used as pastures and meadows. Due to their significant limitations for plant cultivation, they belong to productivity class 7; (10) pseudogley (WRB, Stagnosol) is soil which is characterized by an unfavourable water, air and temperature regime and belongs to productivity class 4. More intensive use of pseudogley for plant cultivation is possible if accompanied by complex ameliorative measures; (11) fluvisol and humogley (WRB, Gleysol, humic) belong to productivity class 3, which comprises soils that are used for plant production, but with certain limitations. Due to the additional water content of the solum from flood and/or underground water and the

Table 2.2 Productivity structure of soils in Serbia

Classes	Area (km ²)				Structure (%)			
	Total Serbia	Vojvodina	Central Serbia	Kosovo and Metohija	Total Serbia	Vojvodina	Central Serbia	Kosovo and Metohija
1	11,650	9688	1675	287	14.40	51.40	3.20	2.80
2	9357	3284	5481	592	11.60	17.40	10.60	5.80
3	10,522	3823	5383	1316	13.00	20.30	10.50	13.00
4	8682	355	7133	1194	10.80	1.90	13.80	11.80
Total for cultivation	40,211	17,150	19,672	3389	49.80	91.00	38.10	33.40
5	11,073	531	9002	1540	13.70	2.80	17.40	15.20
6	20,144	889	17,185	2070	25.00	4.70	33.20	20.40
7	8069	193	5232	2644	10.00	1.00	10.10	26.10
8	1178	72	604	502	1.50	0.50	1.20	64.90
Total unfavourable for cultivation	40,464	1685	32,023	6756	50.20	9.00	61.90	66.60
Total cultivable soil	80,675	18,835	51,695	10,145	100.0	100.0	100.0	100.0

Source Spatial Plan of the Republic of Serbia 2010–2020 (2010)

mechanical composition, fluvisols and humogleys (WRB, Gleysol, humic) are characterized by an unfavourable water, air and temperature regime; (12) solontchak and solonetz are used as natural, quite barren pastures due to their unfavourable chemical and physical properties. In terms of their suitability for plant production, solontchak and solonetz belong to productivity class 7. In order to be included in the reserves of cultivable soils, solontchak and solonetz need to be ameliorated.

In Serbia, soils that are favourable for cultivation are present in almost equal measure to those which are not. Limitations in terms of intensive agricultural production are least marked in Vojvodina and most pronounced in Kosovo and Metohija, which, like the majority of central Serbia, is characterized by wide variations in the natural fertility of soils along narrow geomorphological entities.

Since there are no significant climatic limitations when it comes to plant cultivation in the Republic of Serbia, if many of the soil types with low productivity were subject to certain ameliorative measures, which were then monitored, and if available fertilizers were used, significantly more favourable conditions could be achieved for a wide range of agricultural cultivation and the development of livestock breeding.

The scientific basis of the Soil Fertility and Fertilizer Use Control System was established in 1980 and was legislated in 1985. The system encompasses the control of all factors that determine soil fertility and fertilizer action, i.e., how soil affects the growth, development and yield of crops and which measures should be undertaken to ensure high, stable and economic yields and effective biosphere protection.

Unfortunately, due to economic crises, the system was not fully exploited (Vidojević and Manojlović 2007).

2.2 Soil Under Agriculture

Data from the Spatial Plan of the Republic of Serbia 2010–2020 (2010) show that soil under agriculture makes up approximately 81% of the Republic's total territory (central Serbia 52%, Vojvodina 19% and Kosovo and Metohija 10%) (Table 2.2).

Intensive agricultural production is least restricted in Vojvodina and most restricted in Kosovo and Metohija. The latter territory, similar to that of central Serbia, has a wide range of natural fertility in narrow geomorphological units (Vidojević and Manojlović 2007).

References

- Protić N, Martinović Lj, Miličić B, Stevanović D, Mojasevic M (2005) The status of soil surveys in Serbia and Montenegro. In: Jones RJA, Houšková B, Bullock P, Montanarella L (eds) Soil resources of Europe, 2nd edn. European Soil Bureau, Luxembourg, Research Report No. 9, pp 297–315
- Spatial Plan of the Republic of Serbia 2010–2020 (2010) <http://www.rapp.gov.rs/sr-Latn-CS/content/cid310/prostorni-plan-republike-srbije>
- Vidojević D, Manojlović M (2007) Overview of soil information and policies in Serbia. In: Hengl T, Panagos P, Jones A, Tóth G (eds) Status and prospect of soil information in southeastern Europe: soil databases, projects and applications, European Commission, Directorate-General Joint Research Centre, Institute for Environment and Sustainability, pp 87–189

The Soils of Serbia

Pavlovic, P.; Kostić, N.; Karadžić, B.; Mitrović, M.

2017, XVI, 225 p. 121 illus., Hardcover

ISBN: 978-94-017-8659-1