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STATE OF THE ART OF SOIL MANAGEMENT IN THE WESTERN BALKANS

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STATE OF THE ART OF SOIL MANAGEMENT IN THE WESTERN BALKANS

REGIONAL ASSESSMENT

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1. Introduction

The Western Balkans region shows a great variety of climate, soil, and geomorphological characteristics. The region was blessed by some of the most fertile soils in Europe, for example, those in the Pannonia Plain. There are also gorgeous forested mountains and meadows and fascinating beaches. Nevertheless, the soil in the region is also characterised by several natural constraints that include salinity, sodicity, poor drainage and texture conditions, shallowness and stoniness and other limitations.

The Western Balkans soils are an essential natural resource base for biomass production, especially food, feed and fibre, and for safeguarding and enhancing ecosystem functions and services for environmental protection. However, they are under pressure from various threats. For instance, the land-use change could impact soil quality and the entire environment. Habitats and food, as well as air and water quality depend, on one hand, on sustainable land use, and on the other, on the quality of the soil being the source of nutrients, polluter buffer, and water filter.

Changes in soil may happen spontaneously, but recently they have been occurring because of a range of anthropogenic pressures. These pressures are the main reason for soil degradation in certain areas of Western Balkans where soil resources are overused, degraded and irreparably lost due to bad land management practices. These processes jeopardize the key role of the soil as the basis for human and livestock food supply or as sources of fibre and energy and undermine the ecosystem functions needed to mitigate climate change. Knowledge of the state of the soil in the region is based on comprehensive studies and research that was well developed in the past. However, in many countries, these data are obsolete, and it is impossible to provide a comparative overview of the state of soil resources and soil degradation. The situation is further complicated due to the time spans of data collection and different methodologies used to asses soil degradation.

However, soil protection in Western Balkan countries has been gaining more attention recently, also inspired by the mission Soil Deal for Europe, approved by the European Commission and the European Green Deal outcomes. The main functions of soil in the region could be preserved by taking appropriate sustainable land use measures, which have numerous effects, both at the local, national, and regional levels.

2. Legal framework and Strategic documents for soil management in the Western Balkans

EU soil policy

The Soil Thematic Strategy COM(2006)231 (STS) adopted by the European Commission (EC) in 2006 aimed to protect European soils by preventing further degradation, conserving soil functions, and restoring degraded soils. The STS was accompanied by a proposal for the Soil Framework Directive and

its impact assessment. The main threats to soil were described, focusing on erosion, decline in organic matter and biodiversity, contamination, sealing, compaction, salinisation, landslides and flooding. The EC proposal for the Soil Framework Directive (SFD), aimed at implementing the legislative pillar of the Soil Thematic Strategy, was never adopted.

However, in November 2021, EC adopted the new EU Soil Strategy for 2030 – Reaping the benefits of healthy soils for people, food, nature and climate (COM(2021) 699 final). Therefore, this Soil Strategy builds on and will significantly contribute to several of the objectives of the European Green Deal. Strategy is complementary to other European initiatives such as the next Zero Pollution Action Plan, the EU biodiversity strategy for 2030 and the "Farm to Fork" Strategy, as well as with Sustainable Development Goals (SDGs). This Strategy sets ambitious and necessary goals, which must be met urgently. The new EU Soil Strategy derives a long-term vision for soil from the ambition of the European Green Deal and lists key objectives and targets for the medium and long term policy on soil.

Legal framework for soil management in the Western Balkans

The legal framework for soil protection and management in the Western Balkans is not limited to one regulation but relies on several by-laws regulating spatial planning, protection of the environment and water, agricultural land, forests and forest land, etc. Most countries in the region have laws on agricultural land, while some also have laws on soil protection. A downside in the existing legislation of the countries is the lack of an integrated systemic approach to soil management in the manner which would consider the adaptations of soil to the local climate conditions, soil types and other aspects regarding land management.

The most important conclusion from the review of the Legal framework for soil management in the Western Balkans is that there is no country in the region with a comprehensive legal framework that covers soil protection, restoration, sustainable use and monitoring, which would create the necessary conditions to integrate soil protection in other policy areas, and thus ensure soil protection and restoration. Another reason for this is the lack of a comprehensive and coherent framework of EU policy for the protection of soil and its resources, which is the key gap that reduces the effects of existing incentives and measures and limits the capacity of both the European Union and the Western Balkan countries, which are in the stage of preparation for EU accession and are striving to reach the Green Agenda, UN Sustainable Development Goals, no net land take by 2050, land degradation neutrality and other objectives related to the development of green infrastructure and bio-economy.

Strategic documents for soil management in the Western Balkans

With a view to harmonization with EU policy, all Western Balkan countries have set soil-related goals in their respective strategic documents on agriculture and rural development. These documents, among other things, focus on agroecology, and they provide a sound basis for the development of soil protection policy and related measures for the integration of the environment in agricultural policies.

Regardless of the differences between the analysed countries, it is worth noting that all the countries present very similar strategic priorities, objectives, and measures in their strategic documents related to agriculture and environmental protection. Most of them are the result of EU accession.

As regards agriculture and rural development, strategies in all the countries mentioned sets of priorities and activities aimed at soil management, as follows:

- Restoration, preservation and improvement of the ecosystem through sustainable management of natural resources and climate actions;
- Improved management of natural resources and resource efficiency ensuring the sustainability of the environment;

- Introduction of agricultural methods that protect the environment and mitigate climate influence (environmentally friendly practices);
- Introduction of EU accession policies related to natural resources management and climate actions focused on sustainable use and management of land, forest and water resources and waste management, as well as improved application of pollution prevention laws and regulations;
- Reversed trend of environmental degradation (soil erosion, water pollution and biodiversity loss) due to unsustainable soil management and agricultural practice;
- Organic production, control, certification and organic production control system;
- pasture revitalization and preservation;
- Control of non-selective conversion of agricultural land for other land uses;
- Preservation of the landscape and agroecosystems, agricultural surfaces of high natural value and their respective resources;
- Awareness raising on climate change, its impacts and mitigation measures, and on the methods of protection from such change;
- Implementation of cross-compliance as a mechanism that links direct payments with harmonization between farmers and basic environmental standards, including requirements for the maintenance of soil in good agricultural and ecological state.

Environmental protection strategies in Western Balkans countries, including the protection of nature, biodiversity, and water, contain the provisions that ensure the development (based on European standards) of policy for the protection of soil as a natural resource.

To harmonize with the requirements set in the new EU Soil Strategy for 2030, it is necessary to harmonize and finalize the goals set within the strategic documents in Western Balkans countries.

3. A general assessment of data available in the Western Balkans

In summarising land use and land cover data, differences in data from different sources within one country have been observed. Data analysis shows that agricultural land can occupy from 37% of the country (Montenegro) to 49% of the surface of the country (Northern Macedonia). Although there is a considerable area under agricultural land in Western Balkan countries, which is essential for the survival and economic development of the countries, it is necessary to consider the management of non-agricultural land, which often influences the quality of life and the state of the entire environment.

Data availability is very diverse in WB countries. In some countries, the set of soil data can be covered to a large degree, although with a different frequency and sometimes by diverging national methodology. Through a combination of statistical and environmental data sources, considerable information is available or at least possible to collect.

In WB countries, there is nearly no structured soil monitoring or regular reporting on the state of soil. All available data have been put together in a targeted effort of reporting on international conventions or other obligations. Some of this sporadically published information is deemed not even to be based on

measurements but rather on estimates. Table 1 provides an overview of the availability of soil and land data in hard copy or GIS format in WB countries, derived from the national reports. It is worth noting that data availability in certain cases means that data exists, but it is not publicly available, and in certain cases, its quality is questionable and subject to verification and/or improvement.

Table 1. Soil and land data available in hard copy or GIS format in the Western Balkans

	ALB		BIH FBIH		BIH RS		KOS*		MNE		MKD		SRB	
	Hard copy	GIS	Hard copy	GIS	Hard copy	GIS	Hard copy	GIS	Hard copy	GIS	Hard copy	GIS	Hard copy	GIS
Soil maps		✓	✓	✓		✓		✓	✓	✓		✓	✓	✓
Land use		✓		✓		✓		✓		✓		✓		✓
Land cover		✓		✓		✓		✓		✓		✓		✓
Soil physical properties	✓			✓	✓	✓		✓	✓	✓		✓		✓
Soil chemical properties		✓		✓		✓		✓	✓	✓	✓	✓		✓
Erosion	✓		ND			✓		✓	✓	✓		✓	✓	
Soil organic carbon loss		✓	ND			✓		✓		✓		✓		✓
Compaction	ND		ND		ND		ND		ND		ND		ND	
Contamination	✓			✓	✓	✓	✓		✓		✓			✓
Soil sealing	✓		ND		ND		ND		ND			✓		✓
Salinization	✓		ND		ND		NR		ND			✓	✓	✓
Acidification		✓		✓	✓	✓	✓	✓		✓	ND		✓	✓
Soil biodiversity	ND		ND		ND		ND		ND		ND		✓	
Drought	ND		ND		✓		ND			✓		✓		✓
Floods	✓		✓		✓		✓	✓	✓			✓	✓	✓
Desertification	✓		ND		✓		ND		✓			✓	ND	

ND – No data, NR – Not relevant

4. Drivers which affect soil quality in the Western Balkans

The main drivers affecting soil quality in Western Balkan countries include natural – biophysical and human-induced drivers. An example of natural resources is the geomorphological composition of Albania with large areas located in sloping and steep zones, which makes them erosion prone. On the other hand, the lithological content of serpentine rocks is responsible for the formation of soils rich in heavy metals. Natural drivers are very difficult to manage or control, even according to best management practices, but it can be done.

However, socio-economic and management processes are related to anthropogenic degradation, e.g., the human-induced change of soil characteristics leads to reduced productivity of soil and ecosystem services. This is manifested through different forms of physical, chemical, and biological degradation. Based on the report submitted by the national experts, human activities in question include irregular use of soil in agriculture and inadequate agricultural practices (e.g. burning of stubble, overuse of pastures, small land lots, monocultures); privatization of agricultural land; unplanned and illegal forest clearance and fires; overuse of fertilizers and pesticides in greenhouses; poor quality of irrigation water; destruction and contamination of soil due to urbanization; uncontrolled construction of infrastructure or industrial facilities; lack of systematic approach in the process of urbanization and expansion of road infrastructure; inadequate waste disposal; industrial and mining activities. An example of a human-induced driver includes potentially contaminated and contaminated sites reported by the Republic of Serbia. A total of 422 potentially contaminated and contaminated sites have been identified in the Republic of Serbia, according to data from the Serbian Environmental Protection Agency (2020). The largest share in the total number is that of public utility landfills with 43.13%, followed by industrial and commercial sites with 36.30% and industrial waste landfills with 10.43%. The largest share within the industry is that of the oil industry with 41.89%, followed by the chemical industry with 14.41%, and the metal industry with 11.71% of localities.

5. The main soil degradation processes in the Western Balkans

The unsustainable use and management of soil and land is leading to increased soil degradation and the loss of a key resource that is fundamental to life on the planet. Soil threats in WB countries are complex, and although they are unevenly distributed around the region, their dimension is regional, and they are frequently interlinked. If not managed, soil threats will lead to soil degradation, and the capacity of soil to carry out its vital ecosystem functions will be lost. When many threats occur simultaneously, the combined effect tends to aggravate soil degradation (Jones *et al.*, 2005). General threats to soils in WB countries include the following:

Land take and soil sealing occur when agricultural or non-developed land is lost to urban sprawl, industrial development or transport infrastructure. It normally includes the removal of topsoil layers and leads to the loss of important soil functions, such as food production, water storage or temperature regulation. While the annual rate of land take and consequent habitat loss has gradually slowed, ecosystems are under pressure from the fragmentation of peri-urban and rural landscapes. The EU 2050 target of no net land take is unlikely to be met unless annual rates of land take are further reduced and/or land recycling is increased (EEA, 2019). Data on soil sealing are limited for the countries in the region. Albania reported that in the period 1990-2020, it may have lost about 50,000 ha of agricultural land due to urbanization. It is estimated that the annual rate of land take and sealing is 4.69% per year, mostly driven by housing needs, followed by industrial activities and infrastructure development. The greatest impacts of soil sealing are observable around the biggest urban areas in North Macedonia. According to some recent investigations, the permanent increase of population in the Skopje region results in the radical sealing of agricultural land. The mean annual rate of soil sealing for the whole Skopje region is 0.14%. An analysis of contributions of certain land use categories and classes of soils that have been sealed by urban development in the Republic of Serbia from 1990 to 2018 has shown that mostly pastures and heterogeneous agricultural areas were sealed (Serbian Environmental Protection Agency, 2020). Data on soil sealing for the entire region can be obtained by the Corine Land Cover data analysis.

Biodiversity decline: soil biodiversity reflects an enormous variety of organisms, from bacteria to mammals, which shape the metabolic capacity of terrestrial ecosystems and many soil functions. Soil biodiversity is affected by all soil threats and degradation processes. Biodiversity decline data is lacking in all the countries of the Western Balkans.

Compaction can be induced by the use of heavy machinery in agriculture. Compaction reduces the capacity of soil to store and conduct water, makes it less permeable for plant roots and increases the risk of soil loss by water erosion. However, the general assessment is that this type of degradation is not of great importance on most agricultural lands in the region due to the lower use of agricultural machinery compared to developed agricultural countries. Some countries report that the problem of soil compaction is present, particularly on agricultural land cultivated with heavy machinery. Unfortunately, there is insufficient research and data in the countries to estimate the area affected by soil compaction.

Contamination: Due to over 100 years of industrialization, soil contamination is a widespread problem in Western Balkan countries. The main contaminants associated with these industrial activities are mineral oils, trace elements (such as arsenic, cadmium, lead, nickel or zinc) and organic contaminants such as halogenated and non-halogenated solvents, PCBs and PAHs. PFASs are also a major concern in Europe, having been detected in soils, groundwater, biota, and in the European population (FAO and UNEP, 2021). The number of sites where contamination takes place is impossible to estimate. Some countries have made preliminary estimates (the Republic of Serbia), but it is not possible to get aggregated data for the region. Even though, due to strict legislation, some progress has been made as regards adequate waste management in the region, recent estimates have shown that inadequate waste management is still an important source of soil pollution. Diffuse soil contamination is one of the specific threats to soils in the Western Balkans. Agriculture is traditionally the main land use activity in Western European countries, having a share of 45% of total land use. Trace elements from fertilizers (e.g. cadmium from mineral fertilizers) and some fungicides (mainly copper) and pesticide residues are the contaminants of major concern in the region in agricultural soils. Contaminants of emerging concern, such as microplastics, pharmaceuticals and personal care products, and PFASs, are still poorly studied in the region, and require further attention, as preliminary studies indicate a significant burden of these contaminants in European soils.

Erosion: Erosion is an important driver of land degradation in the region**.** There is also the trend of unplanned deforestation, which results in increased erosion. Water erosion is quite a present problem, particularly on sloping land. There are no official data for most WB countries as regards areas affected by erosion and no erosion monitoring system in place. The Republic of North Macedonia prepared the new Soil erosion map recently using Erosion Potential Method (Gavrilovic et al., 2008) for the whole country territory and the RUSLE model for the agricultural areas. The main findings are that almost 33.57% of the territory is affected by the first three categories of soil erosion. Results from the analysis of soil erosion on agricultural land (RUSLE method) have shown that mean annual soil losses on agricultural land are E = 4.1 t/ha. Countrywide average soil loss in Albania is about 30 t/ha/year, but the values of 185/t/ha/year are also reported in extreme cases. Overall, 22% of the country's area has a higher soil loss rate than the tolerable value of 10 t/ha/year. This 22% is responsible for the majority (93%) of soil erosion. It has been estimated that 80% of agricultural land in the Republic of Serbia is affected by soil erosion of varying degrees. Water erosion is a dominant-negative factor in central and hilly-mountainous regions, while in the Vojvodina region, aeolian erosion predominates, endangering about 85% of agricultural land.

Landslides can be triggered by factors such as land abandonment and change in land use. They occur more frequently in areas with highly erodible soils or clay-based subsoils on steeply sloping ground under intense and abundant precipitation. While there is no data on the total affected areas in the region, countries have reported landslides in their territories. The Republic of Serbia reports a threat from landslides in one-third of the country.

Organic matter decline: organic matter is a key component of soil, controlling many vital functions. Some 45% of soils in Europe have a low or very low organic matter content (0–2% organic carbon). This is particularly evident in the soils of many southern European countries (Zdruli et al., 2004). A key driver is the conversion of woodland and grassland to arable crops (Jones et al., 2012). Albanian soils are relatively poor in soil organic carbon content. Certain studies and research in Bosnia and Herzegovina show that the soil organic carbon content is mostly at the middle level. Soil organic carbon content is low in the territory of Brčko District, primarily because the given area is characterized by agricultural land (in relation to forests and forest land), where agricultural production has a commercial character and generally does not imply the implementation of sustainable land management measures that inevitably lead to its degradation. The results of soil organic carbon content in Kosovo* range from 0.02% to 2.79%, depending on the soil type, depth, land use, slope, soil cover, etc. For Montenegro, there is no data on soil organic carbon change. The analysis conducted on many soil samples as part of the fertility control of agricultural land in the Republic of Serbia shows that most samples had the content of organic carbon ranging between 1 and 2%. A major form of degradation of agricultural land in the Republic of Serbia comes from a loss of organic matter.

Salinisation is the result of the accumulation of salts and other substances from irrigation water and fertilizers. High levels of salt will eventually make soils unsuitable for plant growth. The main driver is the inappropriate management of irrigated agricultural land. Albania reported that salinisation and acidification altogether cover about 15,000 ha, they are largely affected by natural conditions, except for salinity built up due to poor quality irrigation water.

Other most important drivers that affect soil degradation processes in WB countries are droughts and floods.

Based on the above finding, an assessment is made of the status and trend of the main soil threats in WB countries, and respective data is presented in Table 2.

Table 2. Summary of soil threats in the Western Balkans

Soil treats		ALB	BIH FBIH	BIH RS	KOS*	MNE	MKD	SRB
Land take and soil sealing	In densely populatedparts of WB countries soil sealing is one of the most threatening phenomena.	↑↓	↑↓	↘	↘	↘	↘	↘
Contamination	Soil contamination is a problem in some parts of WB countries. The most frequent contaminants are heavy metals and mineral oil.	↑↓	↑↓	↘	↘	=	↘	=
Organic carbon change	The loss of organic carbon is evident in most agricultural soils.	=	=	↘	↘	↘	↘	↘
Soil erosion	Water erosion is active in all cultivated mountainous areas and wind erosion in lowland areas.	↘	↘	↘	↘	↘	↘	↘

Legend: Stable = Variable ↑↓, Improving ↗, Deteriorating ↘

In the framework of UNCCD initiative establishing the national process of Land Degradation Neutrality (LDN) Target Setting Programme, and with a view to effective soil protection, retention of the neutral status of soil without the loss of fertility and productivity, as well as improvement of soil quality, certain countries of the Western Balkans supported the initiative and implemented activities in the course of 2017 and 2018. Hot spots, and a set of LDN objectives and measures have been defined.

6. Problems with soil management

Soils have diverse chemical, physical and biological properties. Therefore, they differ in their responses to management practices, their inherent ability to deliver ecosystem services, as well as their resilience to disturbance and vulnerability to degradation.

Based on the report submitted by the national experts, the main problems influencing soil management in the region include the lack of awareness and knowledge about sustainable soil management, lack of legislative framework, division of responsibilities and lack of cooperation among the institutions, industrial activities, mining, and urban development. Soil management and protection is a complex issue and responsibilities are shared among institutions, which is why an insufficient level of cooperation and communication among the responsible institutions is an even bigger challenge. The lack of legislative framework is mostly related to soil monitoring and soil protection. Application of inadequate agricultural practices is the result of lack of information and knowledge in this area, poor economic situation, inadequate inspection controls due to insufficient capacities and so on. Table 3 presents the main challenges in soil management and actions aimed at achieving sustainable soil management based on the Voluntary Guidelines for Sustainable Soil Management (FAO, 2017).

Table 3. Main problems with soil management in the Western Balkans

Main problems	Core actions for achieving sustainable soil management (SSM) in WB
Lack of knowledge and awareness of sustainable soil management	Promoting effective education programmes. Capacity development on SSM should be enhanced so that more professionals are brought up to date with state-of-the-art methods and tools.
Lack of legislative framework	Establishing or strengthening inclusive SSM-supportive agricultural/ environmental policies.
Division of responsibilities and lack of cooperation among institutions	Fostering cooperation/collaboration on soils at the national and international level. Promoting communication on SSM practices.
Inadequate agricultural practices	Agricultural extension services should promote SSM principles and practices.
Lack of systematic soil condition monitoring and targeted soil research	The assessment of soil status should be a precondition to planning any SSM intervention. It is important that investment in soil research is increased to enable national research programs and their partners to work with land users to identify and address the constraints they face in increasing the ecosystem services provided by soils (i.e., soil productivity). Where appropriate, national soil information systems should be established or strengthened.
Low level of support to agricultural producers	Increasing responsible investment and positive incentives aimed at promoting sustainable soil management.
Industrial activities and mining	Preventing or minimizing soil degradation and restoring/rehabilitating degraded soils (including historically degraded soils).
Urban expansion	Where policy and legislation aim to minimize land conversion, measures should be implemented to encourage densification and re-use of existing urban or industrial areas such as abandoned areas and brownfields, and restore degraded neighbourhoods after appropriate reclamation measures have been implemented.

7. Capacity assessment of the country to deal with sustainable soil management

In all the countries, ministries of agriculture are the ones responsible for the management of agriculture soil and land. The responsibility for environmental policy and protection belongs to the ministries in charge of the environment. Also, the ministries responsible for the environment are usually the focal points for the international conventions related to the environment and soil (biodiversity, climate change, land degradation and desertification).

The modernization and capacity building of ministries, administration, and control systems is creat-

ing serious expenses for each country in the process of EU accession. This is even more visible for the countries mentioned above due to their poor state administration, financial limitations and insufficient political understanding of the process and its needs. Institutional development creates many administrative, financial, and professional challenges and requires extraordinary efforts and political will of the countries in question.

As much as it is necessary to build institutions, it is equally important to increase institutional cooperation, data exchange and other forms of collaboration among institutions. Soil management policy includes interaction between environmental and agricultural policies. The higher the environmental standards, the greater the efforts that should be invested by agricultural stakeholders so that agricultural producers are able to meet the standards and ensure awareness raising, training and education required to meet the standards. The biggest challenge in the region is building the capacities of existing institutions. Institutions in the region are facing problems related to lack of professional expertise, insufficient level of personal and institutional capacities, and so on.

When it comes to the capacities of scientific institutions, the countries in the region find that there are institutions with capacities to meet future soil examination requirements and introduce sustainable soil management. Capacity building of these institutions both in terms of technical requirements and human resources is their ongoing need and action.

8. Proposal of joint actions for establishing the Regional Soil Partnership

At present, countries in the region lack the economic power to implement strategic national projects aimed at the protection and improvement of soil. Thus, only short-term and feasible goals can be considered. Presently, the most important actions include initiatives of changing perceptions about the importance of soil, both in the system of environmental protection and in the context of climate change. By including as many stakeholders as possible in the healthy soil concept, significant desirable goals could be achieved in both the short-term and long-term period.

Based on the report submitted by the national experts, the following activities aimed at establishing the regional soil partnership are proposed (Table 4).

Table 4. Short-term and long-term actions for establishing the Regional Soil Partnership

Short-term activities	Long-term activities
Establish the Western Balkans Soil Partnership as an open forum to bring together Western Balkan soil scientists to freely discuss and share knowledge, data, good practices, and experiences on sustainable soil management; Establish a regional centre where scientists from the region would deal with numerical and process modelling approaches to increase human and technical capacities for monitoring of soil degradation processes; Establish the Regional Soil Platform for data storing and data sharing; Promote ready-made solutions in agriculture applicable in the region; Adopt standard methodologies of work for harmonized monitoring (field and laboratory), methodology for data formatting and storage; Mutual field survey campaigns and regular meetings of experts for sharing experiences and know-how; Establish regular procedures for laboratory Inter-comparison; Identify the most important land degradation processes in the region; Create national and regional assessments of soil degradation following the methodologies that are already being used in the EU member states; Select and collect best soil management practices in a standard format; Establish close contacts with FAO's Global Soil Partnership, European Soil Partnership, Alpine Soil Partnership, European Commission DG AGRI, CLIMA, Research and the Joint Research Centre; Act regionally at European and other levels in order to expand cooperation, exchange knowledge, experiences and implement certain programs and projects that would contribute to a better state of sustainable soil management in the region.	Establish a GIS-based regional soil information system nominated "Soils without Borders"; Establish a soil monitoring system throughout the region to monitor soil quality following the same procedure that is used in the EU member states; Harmonize pedagogical maps of the region; Prepare the Soil Atlas of the Western Balkans inspired by the already published Soil Atlas of Europe; Create the Western Balkans Soil Museum; Harmonize national datasets; Regular training sessions and exchange of young scientists; Technical support to laboratories dealing with soil testing in the form of analytical equipment; Increase the number of the soil analyses; Improve the reionization of agriculture; Increase the quality control of irrigation water as well as institutional supervision for the implementation of this control.

9. Proposal of further actions for 2022

1. Establish Soil Partnership for the Western Balkans as an open forum gathering all stakeholders in the region, where they would be able to discuss openly and exchange knowledge, data, best practices and experiences about sustainable soil management.
2. Prepare a detailed, integrated and scientific assessment of the soil degradation process in the Western Balkans, and an inventory of soil protection instruments at the regional level.
3. Assess the capacities of the Western Balkan countries for the implementation of the new Soil Strategy for 2030.
4. In the context of regional meetings and exchange of best practices work on:
   - Harmonization of guidelines and methods, measurements, soil protection indicators and sustainable soil management practices
   - Improvement of the quality and availability of data and information about soil: collection, analysis, verification, reporting, monitoring, and integration with other disciplines
   - Awareness raising in the area of soil protection and land use
5. Establish the regional Soil Platform for data storing and data sharing.

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ALBANIA SOIL REPORT

Prepared by
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The Republic of Albania is located in South-Eastern Europe, in the western part of the Balkan peninsula, between the geographical coordinates 39°16' N latitude and 42°39' E longitude. It borders Montenegro in the North-West, Kosovo* in the North-East, North Macedonia in the East, and Greece in the South and South-East. On the western side, Albania is washed by the Adriatic and Ionian seas. The overall length of the borderline is 1,094 km, with 657 km of land border, and 316 km of sea-border. The country's total area is 28,748 square kilometres, and out of this area, only 16.2%, mainly in the western coastal plans, is less than 100m above sea level. The rest of the nations' territory, from north to south, is characterised by interconnected ranges of hills and mountains with scattered inland valleys.

1. Land use and land cover in the country

It is important to clarify upfront that data on land use and land cover presented in this report make a distinction between natural pastures and meadows, and arable land. Contrary to FAO's methodological concept of Utilised Agricultural Area (UAA) that considers both natural pastures and meadows as agricultural land together with arable (cultivated land) and permanent crops, this distinction is made here. Following this precondition, the structure of agricultural land use in Albania (including cereals, industrial crops such as sunflower, tobacco, medicinal, horticulture in open field and greenhouses, forage crops, as well as permanent crops such as fruit trees, olives, vineyards, and citrus in 2019, was **611,346 ha**. This is 87,654 ha less compared with 699,000 ha in 1990. Out of the surface area of 611,346 ha of agricultural land, **86,380 ha** are permanent crops. In total, the agricultural land area covers about 24% of the country.

Nevertheless, based on data from the Ministry of Agriculture and Rural Development (MARD), currently, about 82% (or 503,380 ha) of agricultural area was cultivated in 2019 (see also Table 1). The remaining 18% was left fallow or abandoned. Irrigation systems cover 360,000 ha, but 140,000 ha are currently not in use and not rehabilitated (problems with channels, water control structures, pumps etc.). Therefore, they require at least partial rehabilitation and annual maintenance.

Table 1 shows the trends of cultivated areas for different categories with a constant increase of vegetables and especially greenhouses indicating a gradual market orientation of the agriculture, while within the field crops, alfalfa covers about half of the area.

Table 1: Cultivated areas (2015 – 2019)

Cultures (ha)	Years					Variation
	2015	2016	2017	2018	2019	2015 -2019 (%)
Total cultivated field crops including forages and vegetables	413,100	418,300	424,200	420,300	417,000	0.94
Vegetables	37,168	38,803	39,423	39,468	41,440	11.49
Vegetables in greenhouses	1,244	1,406	1,540	1,650	1,734	39.39
Orchards	20,500	20,510	20,290	18,480	18,990	-7.37
Olive trees	46,500				53,802	11.52
Citrus trees	1,282	1,354	1,394	1,454	1,521	18.64
Vineyards	10,438	10,533	10,695	10,787	12,067	3.87

Source: Aggregated data from MARD. Note: Vegetables and greenhouse areas are included in the first category of total cultivated crops but are provided separately to show the increasing trends.

The rest of the land cover area is classified as Non-Agriculture Land, covering 76%. That is subdivided among forests and areas with forestry biomass, including shrubs 1,077,113 ha (or 37%), natural pastures and meadows 478,080 ha (or 17%) and other 623,607 ha (22%). The last category (other) includes land occupied by buildings, infrastructure, quarries, tracks, ponds, water bodies, infertile land that cannot be used for agriculture, rocky areas, etc.

2. General assessment of available data

Soil classification in the country started with the first soil maps dating back to 1930. However, the first Soil Map of Albania at a scale of 1:200,000 was compiled in the late 1950s (Zdruli, 1997), and the soil classification system was adapted from the Russian System. In 1971 and 1980 (using the same soil classification system), two soil surveys were completed, at a scaleof1:50,000 and 1:10,000, for the entire country's agricultural land of about 700,000 ha. About 500 state farms and agricultural cooperatives had their soil maps at a scale of 1:10,000, and each district had its soil map at a scale of 1:50,000 along with soil reports and laboratory analytical data for each parcel of agricultural land. In addition, a national soil map at a scale of 1:200,000 was also prepared.

Until 1990, soil fertility was monitored throughout the agricultural land once in 4-5 years. Representative soil samples were taken for each 10 ha in flat areas and 3-5 ha in hilly and mountainous regions. This monitoring system, along with a wide range of experimental trials, helped establish appropriate soil fertility and plant nutrition management plans. In addition, these soil studies provided the first assessment of land resources and helped make the appropriate decisions for fertilizer use, irrigation systems, and land reclamation projects.

The first efforts to convert the national soil classification system to well-known international systems such as USDA Soil Taxonomy, FAO – UNESCO Soil Map of the World and the World Reference Base for Soil Resources, also known as WRB, were undertaken by Zdruli (1997, 1998, 2001). In 1998, the Albanian soil database was introduced into the Soil Geographic Database of Europe at a scale of 1:1,000,000. This was followed in 2001 by a more detailed soil survey aiming at the creation of a new soil map at a scale of 1:250,000 (shown on the cover of this report) and a national soil database prepared according to the WRB 1998 system and another much more detailed soil database for the coastal areas at a scale of 1:50,000.

The Albanian pedological landscape is very diverse, as shown in Figure 1. The dominant soils are Cambisols, Luvisols, Regosols, Phaeozems, Leptosols, followed by the rest of the soil types. Regarding the main physical and chemical soil properties at the country level, they include saline and sodic soils (about 25,000 ha in 2021 vs. 10,000 ha in 1990), 60,000 ha alkaline soils mainly in the western coastal area, acid soils (or low pH) on about 90,000 ha largely distributed in the north-eastern part of the country, magnesium (serpentine) soils on about 12,000 ha and heavy clay soils covering about 60,000 ha (Zdruli et al., 2002, Zdruli, 2005).

In terms of soil fertility, Albanian soils are largely rich in potassium, medium for phosphorous and relatively poor in nitrogen and soil organic carbon (SOC) content. Older data from the Soil Science Institute (Qilimi, 1996) show that soil fertility has decreased mainly in soil organic matter content, nitrogen, and potassium compared to 20 years ago, resulting in nutrient mining of the soils. This trend may have been

further aggravated given that the amounts of applied chemical fertilizers, except for greenhouses, have been constantly decreasing, and the use of organic manure is sporadic and site-specific.

Unfortunately, the wealth of soil information collected before the 1990s was lost during the political transition period. To remedy this situation, in 2003, the Ministry of Agriculture, under the Agriculture Land Inventory of Albania Programme launched a soil survey to collect new soil data. This extensive ongoing national programme intends to collect soil data and produce very detailed soil maps at a scale of 1:10,000 based on soil types and land suitability, along with creating a comprehensive digital soil database. By 2016, this soil survey covered about 240,000ha (or 34%) of total agricultural land. The Ministry of Agriculture intends to complete the soil survey for all agricultural land in the country as soon as possible.

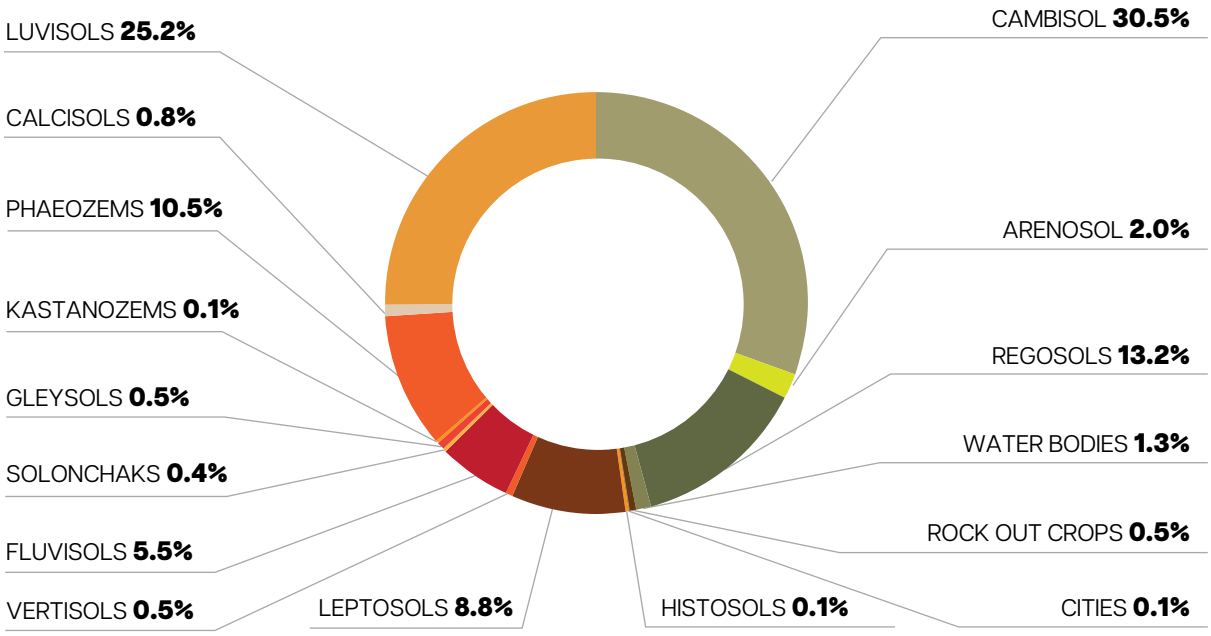

Fig. 1. Distribution of soil types according to WRB methodology in Albania

In 2015, with funding provided by the EC Joint Research Centre (JRC) in Ispra, Italy, Albania completed the Land Use/ Cover Area Frame Survey (LUCAS) to sample and analyse the main properties of topsoil in 120 soil samples collected in a grid-based system spread throughout the country. A standardized sampling procedure was used to collect around 0.5 kg of topsoil (0-20 cm). The samples were dispatched to JRC for physical and chemical analyses, but the analytical results are not yet available.

3. Legal framework

The most important legislation related to soil management and protection in Albania is the Law on Land Protection No. 9244, approved by the Albanian Parliament in 2004. However, the Law has been generally weakly implemented, especially in the first years after its approval. Nevertheless, the situation has slightly improved lately, particularly in terms of housing expansion into agricultural land in rural areas; instead, the infrastructure development continues to consume parts of fertile agricultural soils, especially in the highly intense economic area between Tirana and Durres and in the vicinity of large cities.

The Strategy for Agriculture, Rural Development and Fisheries 2021–2027 (SARDF 2021–2027) being drafted by the Ministry of Agriculture in the frame of the GIZ-SRD Project "Support to MARD in the elaboration of the SARDF 2021–2027" and implemented by GFA Consulting Group, Hamburg, Germany notes that "no agricultural practices promoting soil conservation have been identified in Albania at the policy level ".

The SARDF 2021–2027 raises attention to several issues related to legal connections between rural development and soil management. They include the promotion of organic farming as a practice that also promotes soil quality, the Water Framework and Nitrate Directives, even though Albania has no legal obligations linked to them.

Issue	Name of national acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes/No/Partly)
Law 9244	Law on Land Protection 1994		Partly

3a. Planned transposition of EU legislation

Even in the EU, soil legislation is yet to be completed, especially after the withdrawal of the Soil Directive in 2014. Nevertheless, in November 2021 European Parliament approved the EU Soil Strategy 2030, the primary policy document to support sustainable soil management. Moreover, it is crucial to emphasize that the EC approved the Mission Soil Deal for Europe that should have ramifications also for the non-EU member states such as Albania. This has become even more imperative in the context of the EU Green Deal for Western Balkans inspired by the ambitious targets of the EU Green Deal. Based on this context, the soil legislation in Albania is yet to be drafted and finalized in terms of maintaining and improving soil health.

The SARDF 2021–2027 raised concerns that "good agricultural practices are not systematically promoted in Albania", and that weak manure management is a cause of soil and water contamination. The Nitrates Directive has not yet been transposed. Consequently, there is no "Code of Good Agricultural Practices and no Action Programme" for the prevention and reduction of nitrate pollution caused by agriculture. Therefore, continuing (IPARD) investments without imposing mandatory manure management may lead to a considerable increase in nitrate pollution and ammonia emissions.

The SARDF 2021–2027 notes also that "despite that the Water Framework Directive is transposed it still has important implementation gaps such as basin management plans that may hinder any future investments planned in irrigation and drainage systems". Regarding water quality, the EU legislation that

is directly applicable to farmers as well as to water and "soil pollution by the inappropriate storage and use of pesticides is not complete". Furthermore, the lack of wastewater treatment leads to an increase in nutrients in water bodies.

Albania ratified the Convention on Long-Range Transboundary Air Pollution in 2005 but did not sign the legally binding Protocols, such as the Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. Therefore, there is no target for reducing ammonia emissions (as compared to EU MS). Furthermore, Albania does not report data on ammonia emission from agriculture or reports uncorrelated data (such as agricultural soils – as mentioned in the Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive for Albania, 2017).[1]

3b. Strategy

Albania is bound by the Sofia Declaration on Green Agenda for the Western Balkans to increase administrative capacities implementing environmental obligations on monitoring, promoting, and enforcing compliance on EU biodiversity priorities, which also includes soils.

This will be done by consolidating the advisory system for delivering information, advisory and training focusing on environmental conditionalities that are part of the Common Agriculture Policy (CAP). This will ensure that agriculture-related environmental baseline indicators can be developed**.** Unfortunately, Albania is missing most of these basic indicators. For example, the use of pesticides and veterinary medicines, agricultural areas with high natural value, water quality and soil erosion by water are important indicators. They are part of the baseline indicators that should be made available for EU acquis alignment as well as for evidence-based policy decisions. To accomplish these targets, the development and implementation of the Land Parcel Identification System (LPIS) would be very useful. The LPIS should be combined in a GIS platform with the soil information system under development by the QTTB Fushe Kruje to provide comprehensive information on soil quality and cadastral system.

The SARDF 2021–2027 has put forward a set of actions relevant to soil management. They include the use of IPARD III and national funds for co-financing afforestation of land vulnerable to soil erosion that should be a priority. Furthermore, in case of larger and more intensive farms, modern agricultural practices with a focus on water conservation and soil protection should be adopted. Furthermore, there is the need to support sustainable agricultural management practices, such as no-till, strip-till (especially on slopes), crop rotations with forage-legume crops, planting of forest and woodland (including agro-forest belts and woody landscape features) especially in flat areas, investments in new technologies, training, and advisory activities according to specific demands since currently they are weakly implemented.

Higher efficiency in the use of fertilizers will require not only machinery, but also soil tests and training. Furthermore, while a certain efficiency should be gained through the sustainable use of pesticides and improving nitrogen use efficiency, implementing environmental and especially climate change standards would be necessary.

1 https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2017_s3/albania_s3_reviewreport-2017.pdf

4. Drivers which affect soil quality

Drivers affecting soil quality include bio-physical, socio-economic, and management processes. The geomorphological setting of Albania with extensive areas located in sloping and steep zones make them naturally vulnerable to erosion. On the other side, the lithological composition of certain rock formations spread mostly in serpentine areas is responsible for the formation of soils that are inherently rich in heavy metals. Perfect examples are the magnesia soils or the so-called Smonitsa or Chromic Vertisols according to WRB classification. The naturally derived drivers are very difficult to manage or control even through sound management practices, but not impossible.

Furthermore, Albania's soils are heavily impacted by human-induced factors such as industrial and urban waste contamination, uncontrolled urban sprawl, wild forest fires, especially the devastating ones of the summer 2021, and unsustainable farming practices. Among them it is worth to mention the overuse of fertilizers and pesticides in greenhouses or irrigation with poor quality water, particularly in the lower western coastal plains that are more than ever using polluted drainage water for irrigation. Among the unsustainable farming practices, it is also worth mentioning stubble burning as a widely applied practice that reduces organic matter in soils, also contributing to air pollution and affecting biodiversity.

5. The main soil degradation processes

Despite the process of soil degradation being very relevant for the country, data available on its extent are scattered and neither complete nor updated. The most relevant and widespread process is **soil erosion,** followed by erosive river flows, coastal erosion and flash flooding in low-lying areas that are already common, especially in the areas of Shkoder, Lezhe, and Fier. By 2030, it is predicted that approximately 32% of coastal areas will experience regular flooding, and large amounts of arable land will be lost due to inundation and increased salinity (Zdruli and Cukaliev, 2017). Countrywide average soil loss is about 30 t/ha/year but values of 185/t/ha/year are also reported in extreme cases. Overall, 22% of the country's area has a higher soil loss rate than the tolerable value of 10/t/ha/year. This 22% is responsible for the majority (93%) of soil erosion. The main source for soil losses is agriculture, which generates *cca.* 90% of the total losses, especially agricultural land that is located on high slopes. It is estimated that at the national scale, every year, 20-90 tons/ha of soil or 2.5-3 mm of soil layer is eroded and discharged with negative consequences towards the siltation of lakes, hydropower plants and reservoirs, prior to being washed into the Adriatic Sea.

No data are available for the **excess use of agrochemicals,** especially chemical fertilizers and pesticides in open fields leading to soil and water contamination. However, it is estimated that there are no serious threats related to this apart from the greenhouses. In fact, there is the risk that soil fertility may be lowering due to the so-called nutrient mining process. Nevertheless, some positive impacts towards soil fertility improvement in arable cultivated soils could come from the expansion of alfalfa that can fix

nitrogen, increase soil organic matter, and improve soil physical properties.

Data on soil **compaction** and soil **biodiversity loss** are missing. Therefore, it is suggested that they could be included in the upcoming research activities.

Soil contamination comes from natural causes such as the heavy metal contaminated geological formations, but human-induced sources are of great concern . They include the mining and ore processing industry, which has left behind several polluted sites, such as the one in the Elbasan metallurgical complex (Luli, 2010). Accidental oil spills and improper disposal of wastewater used for oil extraction are also a cause of soil pollution by benzene, toluene, ethylbenzene and xylene (BTEX), volatile organic compounds or crude oil. The oil extraction industry is important to the economy of Albania, which has two of the largest onshore oil fields in Europe. In 2015, extensive pollution of neighbouring agricultural soils occurred following an incident at the Patos-Marinza oil field that resulted in an explosion of gas, sludge, and water (Beqiraj and Topi, 2016). The Ballsh Oil Refinery has also significant crude oil losses to the environment, estimated at 22,500 tonnes per year, which cause contamination. Moreover, the country has two refineries which have not undergone modernization processes and therefore have limited capacity for oil treatment and refining and could have a negative impact on the environment (UNECE, 2018).

Furthermore, the pesticide producing chemical plant of Durrës has left a legacy of soils polluted with lindane at concentrations a hundred times higher than EU threshold levels, as well as several neighbouring waste accumulation areas with a total of more than 20,000 tonnes of lindane and other chemical residues. Also, the chlor-alkali and PVC plant in Vlorë, caused severe pollution of 50,000 to 60,000 m^2 with mercury at values exceeding 10,000 mg/kg, which penetrated the soil profile up to a depth of 1.5 metres.

Plastic pollution is also a problem with much of that accumulated along the riverbeds as well as along the coast.

Data on **soil sealing** are also limited but it is estimated that for the period 1990-2020, Albania may have lost about 50,000 ha of agriculture land to urbanisation. Sprawl areas expanded mainly in surroundings of the capital city Tirana which has now more than 1 million inhabitants compared to 250,000 in 1990. Furthermore, sealing is spread along the main transportation networks to other big cities such as Durres, Fier, Vlore, and Shkoder. The coastal areas along the Adriatic and Ionian seas have seen also intensive urbanisation. It is estimated that the annual rate of land take and sealing is 4.69% per year mostly driven by housing needs, followed by industrial activities and infrastructure development.

Salinisation and **acidification** altogether cover about 115,000 ha, and are largely affected by natural conditions, except for salinity built up due to poor quality irrigation water as previously described in this report.

Albania has signed the United Nations Convention to Combat Desertification (UNCCD) and is included in the Annex IV of the UNCCD. In terms of **desertification,** based on UNCCD aridity index as "land degradation **in arid, semi-arid, and dry sub-humid areas",** the country does not meet that criterion. Nevertheless, the most relevant, in terms of proximity to aridity index, the desertification process is relevant in Albania due to its exposure to hot Mediterranean climate, especially along the coasts. Hence the affected area should be in the range of about 25% of the territory.

Soil organic carbon (SOC) stocks most likely have remained stable over the last three decades or after the political change of the 90s. For instance, agriculture land is cultivated at around 80% capacity with the rest left fallow. It is a well known fact that fallow land tends either to increase carbon sequestration or at least C remains stable. Another positive fact is that alfalfa has become almost the predominant crop in arable lands, enriching thus soil with C and N. One more consideration is the extensive brush

and shrub cover around the country that has sustained rather stable conditions in terms of SOC stock. On the down side, there is the degradation of forests due to illegal cuttings and forest fires that has accelerated both erosion and carbon losses. Soil sealing and land take around big cities have also reduced the potential for carbon sequestration. Peatlands are known to store large amounts of SOC, but they are almost entirely drained in Albania, and the remaining ones are not significant in terms of area extension.

Soil degradation is a slow process and not easily seen or measured. Rehabilitation of degraded soils is expensive and seldom does the land revert to its original performance. Consequently, if we ignore this process today, future generations will pay the price.

6. Problems with soil management

As previously mentioned, soil management lacks the appropriate legislation framework and the necessary awareness from the farmers. Implementation of agro-ecological principles of advanced farming systems, such as conservation and regenerative agriculture, will also improve soil management. Albania is mostly blessed with fertile soils, at least on about 400,000 ha, with great potential for stable and promising crop yields. But while striving to increase productivity, farmers must also pay attention to improve soil quality through the application of practices such as cover crops, reasonable use of chemical inputs, crop rotations with the inclusion of legumes, and minimum soil disturbance through tillage.

7. Capacity assessment of the country to deal with sustainable soil management

The national focal point for field soil survey, data collection, validation and GIS processing of soil information is the Centre of Agriculture Technology Transfer (QTTB), based in Fushe Kruje, 10 km north of Tirana. This institution is under the Ministry of Agriculture and is, in a sense, the successor of the former Soil Science Institute of Tirana. The digital GIS database established by QTTB contains a set of soil characteristics, including exchangeable sodium percentage (ESP), electrical conductivity (EC), cation exchange capacity (CEC), topsoil fertility (pH, soil organic matter (SOM), available P, exchangeable Ca, K, Mg and Na), topsoil and subsoil structure, slope, flood risk, soil depth, topsoil stoniness, topsoil and subsoil texture, natural drainage, total available water, and erosion risk. QTTB is equipped with a laboratory for soil, water, plant analyses and provides analytical services to farmers and/or clients. The Agricultural University of Tirana also has a very well-equipped laboratory.

8. How can the problems be overcome regionally?

Albania strongly supports the creation of the Western Balkans Soil Partnership (WBSP). Moreover, it would like to propose the following actions:

- The Western Balkans Soil Partnership (WBSP) should be an open forum to bring together Western Balkan soil scientists to freely discuss and share knowledge on sustainable soil management.
- The WBSP should elect a Steering Committee with representatives from all the countries to act as an advisory board and supervisory/monitoring entity.
- Financial resources should be identified and provided for at least one annual meeting of the WBSP combined with a meeting of the Steering Committee.
- The WBSP should propose an action plan following the topics assigned to SWG under the Sofia Declaration.
- Actions could, *inter alia*, include the establishment of a GIS-based regional soil information system titled "Soils without Borders".
- Based on LUCAS methodology, a soil monitoring system should be established throughout the region to monitor soil quality following the same procedure that is used in EU member states.
- SWG Secretariat, through its main office in Skopje, should coordinate the creation and management of the regional soil information system.
- All Western Balkan countries should provide to SWG the GIS shape files of their national soil maps at a scale of 1:1250,000 preferably using WRB methodology.
- A main deliverable of the WBSP would be the preparation of the Soil Atlas of the Western Balkans inspired by the already published Soil Atlas of Europe.
- WBSP should support the creation of the Western Balkan Soil Museum in a place TBD.
- WBSP should encourage and support the creation of national and regional assessments of soil degradation according to the methodologies already used in EU member states.
- Countries should select and collect best soil management practices in a standard format to be provided by SWG.
- WBSP should establish close contacts with FAO's Global Soil Partnership, European Soil Partnership, Alpine Soil Partnership, European Commission DG AGRI, CLIMA, and the Joint Research Centre.

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Summary of soil and land data availability for Albania

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/ Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Soil maps	National soil survey	QTTB Fushe Kruje	Soil types (WRB)	Decades	Country/ region/ municipality	1:250000 1:50000 1:10000		Yes
Land use	CORINE	M. Agriculture Institute of National Statistics (INSTAT)	Cropping pattern	Yearly	Country/ region	Medium		Yes
Land cover	CORINE	State Authority for the Geospatial Information (ASIG)	Land categories	4-5 years	Country/region/municipality/parcel	Orthophoto for the entire territory of Albania with 20/35 cm resolution		Yes
Soil physical properties	Field surveys	QTTB Fushe Kruje	Texture and structure	Decades	Country/ region	1:250000 1:50000 1.10000	Yes (Descriptive)	
Soil chemical properties	Laboratory analyses	QTTB Fushe Kruje; Agricultural University of Tirana	Exchangeable sodium percent (ESP), electrical conductivity (EC), cation exchange capacity (CEC), topsoil fertility (pH), soil organic matter (SOM), available P, exchangeable Ca, K, Mg and Na	Sporadic	Country/ region	Detailed for 240,000 ha		Yes
Erosion	USLE	QTTB Fushe Kruje	Ton/ha/year	Sporadic	Country/ region	Medium/Low	Yes	
Soil organic carbon loss	Field survey	QTTB Fushe Kruje	SOM g/kg of soil converted in % SOC g/kg of soil converted in %	Sporadic	Country/ region	Medium/Low		Yes
Compaction	No data							
Contamination	Field survey	Ministry of the Environment	Heavy metals, Cd, Co, Cr, Cu, Ni, Pb and Zn mg/1kg of soil	Sporadic	Regions	Low	Descriptive	
Soil sealing	Estimates	M. Agriculture M. Tourism and Environment	Surface area in ha lost	Sporadic	Country/ region	Low	Descriptive	
Salinization	Field surveys	QTTB Fushe Kruje	EC and/or salt content g/litter	Sporadic	Parcel level in greenhouses	High for greenhouses	Descriptive	
Acidification	Field survey	QTTB Fushe Kruje	pH	Sporadic	Region	Low		GIS
Soil biodiversity	No data							
Drought	No data							
Floods	Estimates	M. Agriculture	Areas inundated in ha	Sporadic	Region	Medium	Descriptive	
Desertification	Estimates	M. Environment	Areas affected in km^2	UNCCD reporting	Country	Low	Descriptive	

BOSNIA AND HERZEGOVINA SOIL REPORT

Prepared by
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1. Land use and land cover in the country

Bosnia and Herzegovina (BiH) is a sovereign state with parliamentary state organization and a decentralized political and administrative structure. It is regulated by the Dayton Agreement (1995) and consists of three separate administrative units: the Federation of Bosnia and Herzegovina (FBIH), the Republic of Srpska (RS) and Brčko District of Bosnia and Herzegovina (BD BIH). FBiH consists of 10 cantons and covers an area of 51% of the territory of BiH, while 49% of BiH territory of BiH belongs to RS. The city of Brčko is a special administrative unit, a district.

Bosnia and Herzegovina area covers 51,209.2 km^2. The total land area is 51,197.0 km^2, while 12.2 km^2 is under sea. According to BiH Statistics Agency data for 2016, BiH has 3,531,159 inhabitants.

Land in BiH is one of the most important natural resources with a primary function related to the production of food and raw materials. The structure of land use in BiH and BD BiH is shown in Table 1.

Table 1. Structure of land use in BiH and DB

	Ploughed fields and gardens	Orchards	Vineyards	Meadows	Pastures	Agricultural land - Total	Forest land	TOTAL
BiH	100,493.10	99,389.6	5,603.5	460,166.3	588,181.0	2,158,271.4	279,509.00	4,953,361.4
%	46.6	4.6	0.2	21.3	27.2	43,6	56.4	100
BD	26,479	3220	0	835	725	31,259	0	31,259
%	84.7	10.3	0	2.7	2.3	100	0	100

In accordance with statistical data, there is about 2.15 million ha of agricultural land in BiH, of which about 1.0 million is arable land, 588,000 ha are pastures, 460,000 ha is under meadows, about 99,300 ha are orchards, and 5,600 ha vineyards. About 2.8 million ha are under forest vegetation (BiH Agency for Statistics and Statistical Offices of the Republic of Srpska and the Federation of BiH, 2016).

Regarding other characteristics related to the state of land in BiH, they could be summarized as follows: automorphic soils are the most represented, and they cover 86% of the total area of BiH, while hydromorphic soils occupy the remaining 14%. The most widespread soil types are Calcomelanosol (Cambic-soil on limestone and dolomites) which covers 21.45%; Dystric Cambisol (acid brown soil) which covers 17.71%, and; Calcocambisol (brown soil on limestone) on 17.15% of BiH surfaces. The most widespread hydromorphic soils are Fluvisol and Pseudogley soil types. The main characteristics of soils in BiH are acid soils, covering around one-third of the total land, humus content is low, the content of the most important nutrients is low, especially in phosphorus, soils are mainly shallow (deep only at alluvial areas and in the north of BiH). Excess water on about 14% of the territory, inadequate soil fertility management and its improvement, water erosion is a widely present problem, particularly on sloping land, which is dominant in BiH. High-quality soils account for only 15%, moderate quality 22%, while the rest are classified as low quality (32%) and very low quality (30%) soils in the total BiH land resources. Numerous causes of soil degradation are present in BiH, such as surface exploitation of different raw materials, building of settlements on arable areas, landfills, water accumulations, construction of infrastructure (roads, railroads, etc.), industrial facilities, occurrence of water erosion and landslides, presence of landmines and drought. Hilly terrain and a relatively large quantity of precipitation in BiH mean that a significant proportion of the BIH territory is exposed to water-induced erosion. This phenomenon is

most prevalent in central and southern parts of the country where the annual quantity of precipitation amounts to no less than 2,000 mm. As more than 80% of the BiH territory is on slopes exceeding 13%, water-induced erosion is an increasingly present problem, especially on surfaces suffering from unplanned exploitation of forests and total deforestation of the terrain. There are no official data for BiH as regards areas affected by erosion, and there is no erosion monitoring system in place. Current data are of partial character, usually collected at the municipality level through various project activities. The design of an erosion map of SR BiH was completed in 1985. Two copies of the erosion map were made then. During the war (1992-1995), both copies were destroyed. The total average amount of sediment created on the territory of SR BiH per year is 16,518,031 m^3 or 323 m^3/km^2.

In Bosnia and Herzegovina, there is great potential for irrigation because the abundance of water is one of the main characteristics of the water balance at the state level. Only about 0.8% of arable land is irrigated, and estimates of actual irrigation needs in Bosnia and Herzegovina indicate that this is not enough when spatial and temporal variations in rainfall are taken into account. Fertile lowlands account for 16% of agricultural land in Bosnia and Herzegovina, 62% are less fertile hilly and mountainous areas, while the Mediterranean area accounts for 22%.

Land use and land cover in Federation of Bosnia and Herzegovina (FBIH)

The total area of FBiH is 2,660,800 ha or 51% of BiH territory. The structure of land use in the FBiH is shown in Table 2. It can be seen that major part is the forest area with 1,522,886.0 ha or 57.1%, and the rest of 1,145,560.0 ha or 42.9% are agricultural areas.

Within the barrier of agricultural land, 37.1% is mostly under pastures, followed by arable land and gardens 34.6%, meadows with 24.1%, orchards with 3.8% and the least vineyards with 0.4%.

Table 2. Structure of land use in FBiH

	Ploughed fields and gardens	Orchards	Vineyards	Meadows	Pastures	Agricultural land	Forest land	TOTAL
FBiH	396,182.0	43,978.0	5,090.0	275,516.0	424,794.0	1,145,560.0	1,522,886.0	2,668,446.0
%	34.6	3.8	0.4	24.1	37.1	42.9	57.1	100.0

According to the data of the Copernicus program for 2019, the structure of coverage of the FBiH area was as follows: Area under Forests had 1,820,253 ha (64.41%), Scrubland 85,678 ha (3.22%), Herbaceous vegetation 257.033 ha (9.66%), Herbaceous wetland 2,395 (0.09%), Cropland 432.114 (16.24), Built-up area 52,684 (1.98%), Permanent water bodies 10,377 (1.98%). Compared to 2015, according to the same data source, there were some changes. For example, there was a decrease in forest area by 1,065 ha (0.04%), then the area under scrubland by 532 ha (0.02%). On the other hand, there was an increase in areas compared to 2015 under Herbaceous vegetation by 266 ha (0.01%), Herbaceous wetland by 1,065 ha (0.04%), Built-up area increase by 267 ha (0.01 %) compared to 2015 and under Permanent water bodies, it was 266 ha (0.01%). The areas under Cropland have remained the same when it comes to comparing 2019 and 2015.

As can be seen and concluded from the above data, there is a process of land degradation primarily caused by deforestation, by neglecting the land and urbanization.

Land use and land cover in the Republic of Srpska

In the Republic of Srpska (RS), the soil cover is very heterogeneous, where predominate soil types are: Dystric Cambisol, Brown soil on limestone and dolomite, Luvisol, Pseudogley, and Fluvisol.

The main characteristics of soils are: acid soils cover around one-third of the total land, humus content is low, the content of the most important nutrients is low (especially in phosphorus), soils are mainly shallow (deep only at alluvial areas and in the north, such as Lijevče field, Posavina, Semberija), excess water on about 14% of the territory, inadequate soil fertility management and its improvement, water erosion is a widely present problem, particularly on sloping land.

According to the RS Institute of Statistics data, in 2019, the total area under agricultural land in the Republic of Srpska was 1,008,000 ha (25.80% of the total territory), of which arable land occupies 816,000 ha (82% of the total agricultural land). Of the total arable land, there are 577,000 ha under arable land and gardens, 52,000 ha under orchards, 1,000 ha under vineyards and 185,000 ha under meadows. Pastures cover an area of 191,000 ha. Existing national data about agricultural land organization level shows that from total areas planned for irrigation development, land consolidation is realized on 28,524 ha (39.48%), land protection from external waters on 53,375 ha (73.88%) and land protection from inland waters 11,718 ha (16.22%). Forests and forest lands of the RS occupy 1,314,889.47 ha or 53% of the territory.

According to the global dataset for the observed period 2000-2010, there were land use changes in two directions: conversion of forests into shrubs, grasslands and sparsely vegetated land and conversion of forests into cropland. Those data show a decrease of forest area on 6,400 ha, where 5,000 ha were converted into cropland, and 1,400 ha in shrubs, grasslands and sparsely vegetated land. The land use changes are mainly related to the areas of intensive agricultural production in the northern part of the Republic of Srpska and Semberija, through the conversion of forests into cropland on one hand, and degradation of high-quality forests into partially vegetated areas and shrubs on the other. Also, the changes are evident in the Herzegovina region, which are mostly related to the degradation of vulnerable (already degraded) forest ecosystems on karst under different land degradation drivers and wildfires as the most significant one. Urbanization is not detected properly in terms of land use change.

Land use and land cover in the Brčko District

According to the Statistics Agency of BiH, the total land area of the Brčko District is 49,332 ha, where 35,282 ha belongs to agricultural land (71.5%), 9,607 ha are forests and 4,443 ha is infertile land. When it comes to land use categories, cropland occupies 30,423 ha (61.67%), orchards 3,211 ha (6.51%), meadows 840 ha (1.7%), pastures occupy 720 ha (1.46%) and pools, reed tracts and fishponds 88 ha (0.18%).

2. General assessment of available data

Federation of Bosnia and Herzegovina

Soil names are given according to the original from the data on the pedological map of the Federation of BiH on a scale 1:200000. All agricultural soils/lands are divided into two soil groups: automorphic and hydromorphic soils. In the division of automorphic soils, 16 types of soils are found with 75 lower systematic units isolated at the level of subtypes or varieties with a total of 997,562.1 ha of soils, which is 93.94%. Within hydromorphic soils, there are 6 types with a total of 64,646.8 ha or 6.06% of agricultural land. Most areas are under Calcocambisol (brown soil on limestone and dolomite) with a total area in FBiH of 221,731.7 ha, followed by district brown soil with 132,899.9 ha, which is 12.5% of agricultural soils of FBiH. The third type of soil by representation in FBiH is eutric brown soil, with an area of 113,360.4 ha or 10.7% of the agricultural land in FBiH.

The following soil types are represented in FBiH according to WRB classification: Acrisols, Albic Luvisols, Calcaric Cambisols, Chromic Vertisols, Dystric Leptosols, Eutric Cambisols, Ferric Cambisols, Fluvisols, Gleysols, Eutric Gleysols, Haplic Podzols, Molrography, Regosols, Rendzic Leptosols, Rhodic Cambisols, Stagnic Luvisols, Stagnosols, Terric Histosols and Folic Histosols.

The Republic of Srpska

The main consistent source of soil data was derived from the basic soil map of RS at a scale of 1:50000. Most of the older soil maps have been classified according to the modified Yugoslav classification system (1985). During the implementation of the FAO project "Inventory of the Post-War Situation of Land Resources in BiH" (2000-2002), all sheets of the BiH soil map were scanned and digitized. The same was done for the analytical data (physical and chemical properties) from all annexes containing soil profiles. The old classification was translated into the new soil classification system of BiH as well as into the FAO classification, and all information is presently available in GIS format. In the Republic of Srpska, from 2002 until today, soil analyses have been performed continuously in certain places, and most of these data are kept in one database, in the Department for Agroecology with the Agricultural Institute of the Republic of Srpska, Banja Luka. In addition, the Department for Agroecology has been continuously implementing the Programme "Systemic control of fertility of agricultural land of the Republic of Srpska" for 7 years, where more than 7500 samples have been analysed. The main problem is that the data are collected using the random sampling system and that there is no established monitoring. Existing national data related to soil organic carbon content cannot be used for baseline because those data are obtained by different analytical and field procedures without time sequence.

In accordance with Article 16 of the Law on Agricultural Land, the Republic of Srpska has begun the establishment of a land information system. It is based on cadastral data, partly georeferenced and incorporated into satellite images. The problem is that the database located in the Department for Agroecology is not connected to the system. Therefore, the Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska has started establishing a land information system (he so-called ZIS ETFARM), but it has not been finalised yet. Currently, global data and the European CORINE database are the only data sources that can be used to monitor land status and losses. The problem is inter-institutional cooperation in the exchange of existing databases. In that sense, there is cooperation between the Ministry of Agriculture, Forestry and Water Management and the Republic Authority for Geodetic and Property Affairs, while cooperation with other institutions is at a low level.

3. Legal framework

Federation of Bosnia and Herzegovina

According to the legislation in FBiH, the issue of protection of land against various forms of degradation is not regulated by a single regulation but is a subject matter that is addressed by multiple sectoral regulations governing spatial planning; protection of the environment and water; agricultural land; forests and forest land, etc. The general characteristic of all the mentioned laws and by-laws related to land is that they are largely not harmonized with European legal procedures, and further harmonization is necessary. The following regulations governing resource management and environmental protection are in force in FBiH.

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Law/By-Laws			
Official Gazette of FBiH No: 52/09	Law on Agricultural Land	Directive 2004/35/EC of the European Parliament and of the Council on environmental responsibility for the prevention and remedying of environmental damage	Partly
Official Gazette of FBiH No: 15/21	Law on Environmental Protection	Directive 2004/35/EC of the European Parliament and of the Council on liability for the environment with regard to the prevention and remedy of environmental damage	Partly
Official Gazette of FBiH No: 33/03	Waste Management Law	Council Directive 86/278/ EEC on the protection of the environment, and in particular of the soil, from the use of sewage sludge in agriculture	No
Official Gazette of FBiH No: 01-02-767/06	Law on Waters	Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy	No
Official Gazette of FBiH No: 26/10	Law on Mining		
Official Gazette of FBiH No: 57/16	Law on Land Consolidation		
Official Gazette of FBiH No: 2/06, 72/07, 32/08, 4/10, 13/10 and 45/10	Law on Spatial Planning and Land Use		
Official Gazette of FBiH No: 40/02	Law on Concessions		

Official Gazette of SR BiH, No. 22/1984, 12/1987, 26/1990 and 36/1990, Official Gazette of RBiH, No. 4/1993 - other decree and Official Gazette of FBiH, no. 58/2002 - other law	Law on survey and Real Estate Cadastre		
Official Gazette of the Federation of BiH, No. 43/11	Rulebook on uniform methodology for the classification of agricultural land into benefit categories		
Official Gazette of FBiH, No. 39/10	Rulebook on conditions that must be met by scientific and professional institutions and laboratories for performing project development activities, as well as measuring and testing land		
Official Gazette of FBiH, No. 38/11	Rulebook on the methodology of monitoring the condition of agricultural land		
Official Gazette of FBiH, No. 14/10	Rulebook on calculation and payment of reimbursement for soil drainage and irrigation		
Official Gazette of the Federation of BiH, No. 72/09	Rulebook on determining the permitted amounts of harmful and dangerous substances in soil and methods of their testing	Nitrate Directive (91/676/EEC), Council Directive, concerning the protection of waters against pollution caused by nitrates from agricultural sources	Partially
Official Gazette of FBiH, No. 10/10	Rulebook on the procedure and conditions for the replacement of agricultural land		
Official Gazette of FBiH, No. 72/09	Rulebook on the content and form of forms and manner of keeping records on agricultural land		
Official Gazette of FBiH, No. 78/09	Rulebook on conditions and manner of use of funds realized from exchange, lease and concession of agricultural land owned by the state		
Official Gazette of FBiH, No. 72/09	Instruction on the procedure, actions and conditions for performing soil fertility control		
Official Gazette of FBiH, No. 73/09	Instruction on the obligatory unified methodology for the preparation of reclamation projects		
Official Gazette of FBiH, No. 78/09	Instruction on the unique methodology for classifying agricultural land into soil quality categories		

a) Planned transposition of EU legislation

Issue	Name of acts (laws and by-laws)	EU legislation	(Remark)
Law/By-Laws			
Law	Law on Land Protection		The law should support the integration of the LDN concept
By-laws	By-laws related to land protection		

b) Strategy

Strategic documents related to land in FBiH: Mid-term Development Strategy for the Agricultural Sector, Agricultural Land Management Strategy and Environmental Strategy.

The development of a new strategy for agriculture is in the process. Adoption of the Spatial Plan of FBiH is also in the process.

The Republic of Srpska

Bosnia and Herzegovina is a sovereign state with a parliamentary state political and administrative structure, where land and land resources are under the exclusive competence of the entities, so land is regulated by entity legislation.

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Law/ By-Laws	Law on Agricultural Land (Official Gazette RS, No. 93/06,86/07,14/10,05/12 and 58/19)	Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage	Partly
	Rulebook on conditions for performing fertility testing of agricultural land and determining the amount of mineral fertilizers and pesticides (Official Gazette RS, No. 35/14)	Directive 2004/10/EC of the European Parliament and of the Council of 11 February 2004 on the harmonization of laws, regulations and administrative provisions relating to the application of the principles of good laboratory practice and the verification of their applications for tests on chemical substances.	Partly
	Rulebook on permitted quantities of hazardous and harmful substances in agricultural land and water for irrigation and methods for their testing (Official Gazette RS, No. 56/16)	The EU Thematic Strategy for Soil Protection, Title 4. Actions and Means, 4.1. Legislative proposal, 4.1.2. Contamination	Partly
	Rulebook on conditions for performing activities of determining hazardous and harmful substances in agricultural land and irrigation water (Official Gazette RS, No. 72/16)	The EU Thematic Strategy for Soil Protection, Title 4. Actions and Means, 4.1. Legislative proposal, 4.1.2. Contamination	Partly

	Law on Environmental Protection (Official Gazette RS, No. 71/12, 79/15 и 70/20)	Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment	Partly
	Rulebook on the content of the remediation and reclamation project (Official Gazette RS, number: 97/20)	Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage	Partly
	Law on Spatial Planning and Civil Engineering in RS (Official Gazette RS, No. 40/13, 106/15, 03/16 and 84/19).	Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings. Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). Directive 2006/123/EC of the European Parliament and of the Council of 12 December 2006 on services in the internal market	Partly
	Law on Nature Protection in RS (Official Gazette RS, No. 20/14).	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (codified version). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora	Partly
	Rulebook on the Register of Protected Natural Resources (Official Gazette RS, No. 79/11)		
	Rulebook on the manner of preparation, content and formation of spatial planning documents (Official Gazette RS, No. 69/13)		
	Rulebook on the content, holders of the spatial information system and the methodology of data collection and processing (Official Gazette RS, No. 93/13)		

a) Planned transposition of EU legislation

Issue	Name of acts (laws and by-laws)	EU legislation	(Remark)
Law/By-Laws			

b) Strategy

The only planning document in RS that refers to agricultural land is the Basis for protection, arrangement and use of agricultural land for municipalities/cities in RS and RS. Although it is not a strategy in nature but a spatial planning document in the field of protection, arrangement and future use of agricultural land for individual municipalities/cities in RS and RS itself, it is in part a combination of strategy and action plan for sustainable agricultural land management in RS. As this document dates from 2009, the data are outdated and unusable, and in 2020 its revision was launched. A revised and updated document is expected during 2022.

Brčko District

Brčko District of BiH is local government unit under sovereignty of Bosnia and Herzegovina, with numerous laws and rules related to land resources.

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Law/By-Laws	Law on Agricultural Land (Official Gazette of BD, No. 32/04)		No data
	Law on Environmental Protection (Official Gazette of BD, No. 24/04)		
	The Law on Spatial Planning and Civil Engineering in RS (Official Gazette of BD, No. 29/08).		
	The Law on Nature Protection (Official Gazette of BD, No. 24/04).		

4. Drivers which affect soil quality

Federation of Bosnia and Herzegovina

Globalization has particularly affected these drivers, leading to increased human mobility with social, economic and environmental implications. Patterns of settlement and consumption result in pressures on ecosystem services, including those provided by soils. The major drivers of land degradation in FBiH are as follows:

- Population migration and rural depopulation lead to increased urbanization (mostly illegal), the creation of illegal communal landfills and the occurrence of landslides. Thus, according to FAOST data, the total population in BiH in 2012 was 3,604,972 and in 2018 was 3,323,925, which for this period of 7 years represents a decrease of 281,047 inhabitants. In the same period, the number of

inhabitants in rural areas decreased by 149,510, respectively from 1,962,769 (2012) to 1,813,259 (2018). In the same period, the number of inhabitants in urban areas increased by 4,864, respectively from 1,685.431 (2012) to 1,690.295 (2018). These data suggest that there is a very significant and worrying process of depopulation of rural areas, which usually results in degradation of agricultural land caused by the growth of invasive weed species, low vegetation and forest vegetation.

- Forests are a significant economic resource in FBiH. About 81.8% of forests in FBiH are state-owned, and about 18.2% are privately owned. Non-existence of a law on forests in FBiH, and in connection with that, poor quality of forest management, leads to a significant process of soil degradation. Unplanned and illegal deforestation and fires pose the greatest threat to land degradation. Data from the CORINE database for the years 2000 to 2012 in FBiH show that there has been an increased transition of forests into the category of shrubs, grassland and sparsely vegetated areas. Forest areas in this period were reduced by 17.962 ha. Approximately 85% of the total decrease is related to deforestation, while about 12% was caused by wildfires. On the other hand, there was an increase in the area under forests in the amount of 10,898 ha as a consequence of gradual transition of agricultural land, pastures and abandoned areas resulting from population displacement.

Also, in the mentioned period, according to CORINE data, there was a decrease of 6,347 ha in the areas under cropland that were converted into artificial areas.

The EFFISA report for 2020 states that in that year, the total fire area was the largest in the last decades and the third-largest total number recorded in the entire area covered by EFFIS. Total burned area in BiH was 100.107 ha, of which 51,700.45 ha (51.65%) under forest / other wooded land, 32,708.29 ha (32.67%) under other natural land, 15,668.29 ha (15.65%) under agriculture, and 29.97 ha (0.03%) under artificial surfaces. (Source: JRC Technical Reports: Forest Fire in Europe, Middle East and North Africa 2020).

Areas under mines in FBiH and BiH also pose a great danger to human life but also prevent these areas from being used and managed. According to estimates by the Bosnia and Herzegovina Mine Action Centre-BHMAC (2019), the current size of suspected mine-contaminated land area in Bosnia and Herzegovina is 1,018 km^2 or 2.1% of the total area, scattered over 8,525 suspected micro-locations, and affecting 545,603 inhabitants or 15% of the total population.

Other drivers that affect soil degradation processes in FBiH are:

- Industrialization and expansion of the area under exploitation of minerals as well as landfills with mining waste and other materials
- Inadequate agricultural systems (application of improper practices in agriculture) lead to the occurrence of erosion and soil pollution
- Obsolete industrial technologies that lead to land contamination
- Climate change reflecting in extremes such as droughts and floods

The Republic of Srpska

Numerous drivers of soil degradation are present in RS, such as the building of settlements on arable areas, surface exploitation of different raw materials, landfills, water accumulations, construction of infrastructure (roads, railroads, etc.), active operation of thermal power plants, industrial facilities, the occurrence of water erosion and landslides, improper land and forest management practices, presence of landmines and radioactive substances, flood and drought.

5. The main soil degradation processes

Federation of Bosnia and Herzegovina

Land degradation is a global problem, often caused by a combination of factors such as poor land management, unsustainable agricultural practices, pollution, and deforestation. Land degradation may exacerbate the impacts of natural disasters and contributes to social issues such as migration. Various forms of soil degradation such as erosion, loss of organic matter, compaction, salinization, landslides, contamination, sealing, desertification, etc., have negative impacts on human health, natural ecosystems and climate, as well as on our economy.

BiH and FBiH have not been spared from similar degradation processes of land and soil and their harmful impact on the entire ecosystem.

Excessive use of agrochemicals

According to FAO data, the consumption of mineral fertilizers in BiH from 1995 to 2019 looked as follows: nitrogen consumption per ha ranged from a minimum of 2.94 kg/ha (1996) to a maximum of 99.5 kg/ha (2015). Consumption in the last measuring year (2019) was 61.96 kg N/ha.

Phosphorus consumption in this period ranged from a minimum of 2.94 kg P_2O_5/ha (1996) to a maximum of 11.69 kg P_2O_5 (2004). The total consumption of this nutrient in the last measuring year (2019) was 8.3 kg P_20_5/ha.

Potassium consumption in this period ranged from a minimum of 2.94 kg K_2O/ha (1996) to a maximum of 11.71 kg K_2O (2004). The total consumption of this nutrient in the last measuring year (2019) was 8.95 kg K_2O/ha.

This consumption is significantly lower compared to economically developed countries, such as Germany, which in 2019 had nitrogen consumption in the amount of 115.18 kg N/ha, phosphorus 20.8 kg P_2O5/ha and potassium 35.2 kg K_2O/ha. The reason for lower fertilizer consumption in BiH compared to economically developed countries is a less intensive form of crop production and weaker purchasing power of Bosnian farmers. These data indicate that the consumption of fertilizers in BiH is significantly lower than the average consumption of economically developed countries and significantly lower nitrogen consumption than the maximum allowed 170 kg/ha (Nitrates Directive).

Unfortunately, there are no official data on the use of pesticides.

Soil erosion

Steep terrains in FBiH, of which over 70% and a relatively large amount of precipitation, in addition to the increasingly present unplanned deforestation, are the main risk factors for water-type soil erosion. In the FBiH, there are no official data on areas exposed to erosion, nor is there an organized system for monitoring erosion.

Designing an erosion map of SR BiH was completed in 1985. Two copies of the erosion map were then made. During the war (1992 - 1995), both copies were destroyed. The total average amount of sediment created on the territory of SR BiH per year was 16,518,031 m^3 or 323 m^3/km^2.

Soil organic carbon

A functional system of organic carbon analysis and a monitoring network in FBiH has not yet been established. There are indications that the Federal Institute of Pedology in Sarajevo will start monitoring it. However, according to the map of organic carbon content in top soils in Europe, prepared for use by JRC of the European Commission, it can be said that the majority of soil in FBiH falls under two classes: class 2 - 6% organic carbon content in top soils, and class 1 - 2% organic carbon content in top soils.

Certain studies and research show that the content of organic carbon in the soils of FBiH is mostly at the middle level. According to ISRIC data on the content of organic carbon (SOC) ranges between 0 to 174 t/ha, while the average is 111.7 t/ha. Carbon stocks in forest areas amount to 119.3 t/ha, and in agricultural 107.9 t/ha. The average level of carbon stocks in wetlands and water bodies is 98.3 t/ha.

Soil compaction

Soil compaction is related to the degradation of soil structure due to imposed stresses by machinery and livestock trampling. Soil compaction (reduced or disrupted pore continuity) reduces soil aeration by destroying soil aggregates and collapsing macropore density and reduces water drainage and infiltration, generating higher runoff. Compaction limits root growth and seed germination by high mechanical impedance, affecting soil biodiversity and causing surface soil crusting.

Unfortunately, soil compaction is not monitored in FBiH. However, the general assessment is that this type of degradation is not of great importance on most agricultural lands in FBiH due to the lower use of agricultural machinery compared to developed agricultural countries.

Soil contamination

Soil may filter, fix and neutralize, but also release pollutants when conditions change (e.g., heavy metal release with lowering pH). Therefore, the prevention of soil contamination remains the best way to maintain healthy soils and food safety according to the Sustainable Development Goals.

Areas in FBiH with a potentially high risk of contamination with pollutants consist of extremely acidic soils with a pH below 4.5, with light texture, non-carbonated and with a relatively small share of humus in the soil profile. These are mainly Distric Brown soils, Rankers, Luvisols, Acrisols, Podzols, Deposols, etc. Such soils account for 9.69% (252,129.74 ha). Soils with pH ranging from 4.5 to 5.5 have a potentially medium risk of contamination with pollutants. These soils are of relatively lighter, loamy structure, medium humus, non-carbonated, and medium deep. Here too, we have Distric Brown, Colluvial, Pseudogley soils and Rankers, formed on different geological substrates or substrate mixtures, with a slightly higher pH or less affected by leaching and the process of unbasification. They are represented on 13.1% of the territory of the Federation of Bosnia and Herzegovina or 338,753.18 hectares. The remaining largest part of 1,985,736.72 hectares, or 76.28% of FBiH territory, consists of a soil group with pH above 5.5 and poses the least risk of contamination with pollutants.

However, potentially the largest and most vulnerable areas in FBiH exposed to the contamination process are lands near industrial areas (Tuzla and Zenica cantons, etc.). Thus, for example, only coal exploitation in BiH takes place on an area of 18,000 ha, while the area for waste disposal covers almost 6,000 ha.

A positive fact is that the Federal Institute for Agropedology in FBiH has established a system for monitoring the level of soil pollution with heavy metals and organic pollutants.

According to research by this institute from 2013, out of 260 tested locations, 26 or 10% have the highest percentage of pollution both in terms of the number of elements and the level of pollution for all tested heavy metals. 54 sites or 21% of the total examined were contaminated with three elements

(Cd, Ni, and Mn). As for other locations, 53 or 20% were not polluted with any element, i.e., they were completely clean areas. Based on the conducted analyses, it was determined that there was no soil contamination with organic pollutants (PAHs) at the investigated locations.

Soil sealing

Land conversion and subsequent soil sealing for settlements and infrastructure affect all soils but are of particular concern on productive, arable soils because of their importance for food production, food security and nutrition, and circular economy targets.

Agricultural land in FBiH is significantly exposed to this type of degradation. It was additionally contributed by large demographic movements of the population after the war in 1995, followed by large construction and infrastructural destruction, which after the war meant the reconstruction of all these facilities and construction of new ones.

The lack of legislation, such as the FBiH spatial plan, further contributes to this type of degradation of agricultural land. Also, non-compliance with existing legislation, such as the conversion of non-agricultural land into agricultural land on the basis of collected fees taken in the conversion of agricultural land into construction land.

Estimates of the condition of these areas that are under soil sealing in FBiH are obtained from the CORINE database.

Soil acidification

Human-induced acidification of agricultural and forest soils is primarily associated with removal of base cations and loss of soil buffering capacity or increases in nitrogen and sulphur inputs (e.g., atmospheric deposition). In FBiH, there is no systematic monitoring of the state of soil acidification, but it is regularly monitored and measured through the analysis of soil fertility and appropriate measures to reduce it are accordingly provided if necessary. About 25% of land in FBiH has a pH reaction below 5.5.

Biodiversity

Bosnia and Herzegovina, due to its specific position in three different climatic and geological regions (the Mediterranean, Continental, and Mountainous), has a particularly rich biological diversity. It is one of the richest countries in Europe in terms of biodiversity, with over 5,000 different plant species and about 1,800 (30%) of the total endemic flora in the Balkans is located in BiH.

The animal kingdom is rich and diverse, especially compared to other Balkan and European countries. This rich biodiversity is increasingly threatened by different forms of degradation and climate change.

Soil drought

As a result of climate change, periods of soil drought during plant vegetation are becoming more frequent. During extended dry periods, soil surface and even the lower profile become desiccated, and protective ground cover is reduced or entirely removed, especially if grazing by stock continues. Reduction of the ground cover increases the risk of soil erosion, especially if, after a dry period, there is more abundant rainfall.

In order to reduce the negative effects of drought on soil degradation and plant growth and development, there is an increasing need to irrigate agricultural land. However, due to underdeveloped irrigation infrastructure in FBiH, only 0.65% of agricultural land is irrigated, which is very little in terms of needs. On the other hand, in Bosnia and Herzegovina, there is great potential for irrigation because water abundance is one of the main characteristics of BiH.

Floods

Bosnia and Herzegovina is the richest country in the region in terms of water potential and the fourth in Europe. However, most of Bosnia and Herzegovina's rivers and streams have a regime of torrents with high waters during rains and snowmelt, which causes floods. Floods are natural phenomena, but lately, they have been occurring more and more as a consequence of man's irresponsible behaviour towards nature.

The Republic of Srpska

In geomorphological terms, the Republic of Srpska is endangered by soil erosion due to the slope of the terrain, where 23.29% of the territory li a slope of 10-20 degrees, and almost 5% of the territory lies on slopes greater than 50 degrees. Erosion is an important driver of land degradation, particularly in the northern part, where agricultural production is the most intensive, as well as in the Herzegovina region, where shallow limestone-dolomite and erosion have great consequences on biodiversity and quality of life of the rural population. Furthermore, frequent fires in this area further intensify erosion processes of already shallow soils, which ultimately contributes to the formation of barrenness. Although the problem of land erosion is a permanent loss of agricultural land, we can observe it from the water management aspect and the ecological aspect. The water management aspect of land erosion is much better known. It is related to the transport of sediments in river flows, i.e. to the problem of material accumulation because the erosion process exceeds the transport power of watercourses, as a result of which water management facilities occur, among which accumulations are the most endangered. However, the ecological aspect of the issue of soil erosion and the product of erosion work is less known. Soil erosion has a new dimension because erosive soil material used for agricultural production usually contains certain amounts of substances (nitrates, phosphates, pesticides) which, when moved to another area, are dangerous and harmful substances. By introducing existing nitrates, phosphates, pesticides into watercourses, they reduce the use-value of water for conventional purposes, and in watercourses, they cause changes in the biological balance. In addition to the above, mined areas are also one of the significant problems related to land degradation and the possibility of its use.

The land degradation neutrality process has revealed many important challenges on entity and local levels, particularly in agricultural regions frequently affected by drought and floods in the recent decade. Drought is a complex phenomenon with many negative impacts on the environment and people, making food security very challenging. This is particularly pronounced when dry periods are unusually long.

According to the Mine Action Centre (BH MAC) Report for 2019, it is estimated that there are about 199.59 km^2 of suspected mine areas in the Republic of Srpska, which is 0.8% of its total territory.

The problem of migration of the population from rural areas and in general is very pronounced, with a trend of further growth. This phenomenon is also one of the reasons for the low level of use of this natural resource, with a tendency to further decrease. Rural areas occupy a large part of the Republic of Srpska, but due to the intensive process of population displacement in the past 30 years, large areas of agricultural land have been neglected and uncultivated, overgrown with shrubby and woody vegetation, which has increased the area under shrubs and weak forests. Although very common forms of degradation, the above processes are reversible and, as such, are not problematic in the long run from the point of view of changes in the RS agricultural land fund.

In addition to these changes, the land is partly degraded in the processes of exploitation of mineral resources in mines and polluted by active thermal power plants. The largest mining areas are in the municipalities Ugljevik, Gacko, Milići, Stanari, and Prijedor, while thermal power plants in municipalities Ugljevik, Gacko, and Stanari are still active.

Industrial production has been constantly decreasing during the last 30 years, so it does not significantly affect soil pollution. Regardless of the current situation, due to the work of the industry in the pre-war period, there are areas in some municipalities (Banja Luka, Modriča, Brod), which many decades ago were highly polluted with hazardous and toxic substances. Therefore, remediation processes should be initiated. However, the cadastre of polluted areas has not yet been established in RS.

A problem that should be pointed out is the accelerated and aggressive urbanization of the northern parts of the Republic of Srpska due to internal migrations of residents who are intensively moving to larger cities and leaving the villages.

Such movements lead to the conversion of large areas of arable agricultural land into construction land, and what is especially important to point out is that the process of converting agricultural land into construction land is irreversible and final. Only in that case, there is no possibility to recultivate the land with certain measures and return it to its original function. According to the final report on the Programme for achieving neutrality of land degradation in the Republic of Srpska (February 2018), three hotspots of land degradation have been identified, which require urgent action. These are the areas of Semberija and Lijevče polje in the north of RS and Herzegovina in the south. It is not a coincidence that two out of the three hotspots have been identified in the north, confirming that the north of RS is the most affected by permanent loss of agricultural land for non-agricultural purposes. In addition to permanent loss to urbanization processes, the expansion of settlements creates a huge amount of solid waste, which pollutes surrounding areas. In this regard, except for registered landfills, a lot of wild solid-waste landfills can be found in the vicinity of populated areas.

Finally, pollution due to NATO bombing with depleted uranium in the area of Han Pijesak and Kalinovik must be mentioned, the consequences of which still remain.

Brčko District

Annual investment by BD Government for afforestation measures is 30,000.00 KM, as over-exploitation of high-quality forests was recognized in the past as important land degradation driver. Mine areas are also important soil degradation drivers with 2.5% of total territory of BD still under mines. BD Government invests 1.5 million KM in demining activities every year. BD Spatial Plan is the only document that regulates any possible conversion of agricultural land, so there is systematic approach in land planning and management.

Global data indicate no significant land use change or land productivity dynamics in the territory of Brčko District for the observed period 2000-2010 ,. Areas with preserved or increased land productivity are dominant. Soil organic carbon content is low, primarily because the given area is characterized by agricultural land (in relation to forests and forest land), where agricultural production has a commercial character and generally does not imply the implementation of sustainable land management measures, which inevitably leads to soil degradation.

6. Problems with soil management

Federation of Bosnia and Herzegovina

Soil is one of the most important parts of the natural environment and mostly a non-renewable natural resource. It also holds a number of functions such as food production, climate-ecological-biological regulation, water filtration, buffering, the foundation of infrastructure, source of raw materials and cultural heritage. However, there are several reasons that contribute to poor land management in FBiH: the first is a lack of public attention to this valuable resource. The reasons for this relationship could be found in the insufficient education of the population and the opinion that there is enough land and that measures for its protection are not necessary.

The second reason is, as a result of certain socio-economic movements in the society, a good part of the population leaves rural areas and land cultivation.

The third reason is that legal provisions on land use and protection are the subject of several laws, which makes it difficult to implement a unified land policy, leaving possibility for various abuses, especially in terms of changing the purpose of land use, etc. Lack of adequate institutions and services to monitor the state of land and various forms of land degradation, etc. represents problems for sustainable land management.

Unfortunately, there are several examples of poor soil management, such as:

On some plots in FBiH, poor agro-technical measures are implemented that contribute to degrading processes such as tillage on sloping terrains, unprofessional and inadequate use of agrochemicals (fertilizers and pesticides), excessive grazing of pastures and the like.

A significant problem of soil and water pollution is inadequate disposal of municipal and industrial waste.

National Report on the State of the Environment in BiH from 2012 states that 49 locations were registered in FBiH for communal waste disposal, and it is estimated that there are about 1,100 illegal wild landfills in BiH. FBiH is rich in mineral resources, especially coal. Coal mining lags behind waste material tailings, which are disposed on an area of about 4,000 ha. Land reclamation on these areas is not at a satisfactory level.

A major problem in FBiH is the increasingly pronounced unplanned and illegal construction that leads to a number of problems (destruction of land, landslides, etc.). There is also a trend of unplanned deforestation, which results in more frequent floods and increased erosion.

The Republic of Srpska

When looking at the assessment of land management capacity in RS, the situation seems satisfactory. In RS, policy management institutions (a sector in MAFWM)are established , as well as inspection supervision, training centres, and laboratory facilities with equipment. However, the situation in land policy is still not at a satisfactory level. There are several factors that affect this. Low connections between institutions, unprofessional staff and almost no data exchange. Also, there is a large fluctuation of the workforce, which adversely affects the links between institutions and staff.

Mismanagement practices are also used in the field (land, water, and forest). The reasons for this are that information/knowledge exchange is at a low level, the socio-economic situation is weak and knowledge and awareness among stakeholders about land importance is a question of secondary importance.

7. Capacity assessment of the country to deal with sustainable soil management

Federation of Bosnia and Herzegovina

Sustainable soil management is an important global issue and involves the inclusion of a series of complex measures and actions. One of the preconditions for a more significant solution to this issue is the adoption of a single law on soil management and protection. Unfortunately, there is no such law at the EU level, but it does not exist at the BiH level either. This law should, through a holistic approach, regulate all issues related to the management and protection of not only soil but also water, air and various sources of pollution of these natural resources. Unfortunately, when it comes to BiH and the adoption of such a law, there are certain weaknesses manifested through the constitutional and current political system in the country, which unfortunately does not allow for and does not show enough interest in the adoption of such legal solutions.

In addition to the legal framework and public policies that should recognize the importance and support for the establishment of such systems, it is very important that there is a certain level of knowledge of the population, professional and scientific community about this issue. In this sense, it is necessary to conduct additional education and raise awareness among people throughout BiH about the importance of preserving and protecting the soil as an invaluable and non-renewable resource.

It is very important to develop a general awareness among people that land is a common good in the interest of all of us and that regardless of the fact that it is mostly privately owned, owners should and must take sufficient care of preserving and protecting soil. In this sense, it is necessary to engage the wider community and make appropriate policy solutions that would encourage these activities.

It is also necessary to systematically analyse and monitor all indicators related to soil degradation processes and act on them in a timely and appropriate manner. For this activity, it is necessary to strengthen institutional capacities, human resources and technical equipment that would enable systematic monitoring and sustainable management of this important resource. Unfortunately, this is not possible in BiH at the moment.

The Republic of Srpska

Ministry of Spatial Planning, Civil Engineering and Ecology of the Republic of Srpska is responsible for protected areas, non-agricultural land (urban, industries, landfills, etc). Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska is in charge of the main land resources (agricultural land, forestry land, and water land) and for creating land politics. In this Ministry, within the Department for Agriculture, Food Industry and Rural Development, the Sector of Agricultural Land is established. The main competencies of this sector are: legislative framework related to agricultural land resources, strategic framework, land rights, agricultural land management, agricultural land protection, agricul-

tural land usage, concessions and rental of agricultural land in RS.

Inspection control and supervision over land is the responsibility of Republic Inspection Administration in three sectors: Agricultural Inspection Sector – responsible for agricultural land, Forestry Inspection Sector – responsible for forest land and Urban Planning, Civil Engineering and Environmental Inspection Sector – responsible for non-agricultural land. In most municipalities, inspection departments with these competencies are also established.

The Institute for Agroecology was established within the Agricultural Institute of the Republic of Srpska, Banja Luka, , has a well-equipped laboratory for analysis of soil fertility, pesticide residues, and hazardous and harmful substances in soil.

There is also the Institute for Ecology and Environmental Protection within the Institute for Protection and Ecology of the Republic of Srpska, Banja Luka, with a well-equipped laboratory for ecological analysis of non-agricultural land. In addition, there are equipped laboratories at the agricultural faculties of the universities in Banja Luka and East Sarajevo, but their function is primarily research, and in part only for land analysis for farmers.

The basic centres for the education of new staff are the agricultural faculties of the universities in Banja Luka and East Sarajevo, which have exceptional experts and rich study programmes.

Brčko District

Within the BD Government, the Department for Agriculture, Forestry and Water Management has been established, which is responsible for land politics, and the Department for Spatial Planning and Property Rights Matters, which is responsible for spatial planning.

8. How can the problems be overcome regionally?

Federation of Bosnia and Herzegovina

The problem of sustainable soil management in the region can be overcome through stronger mutual organization and connection of countries, their scientific and professional institutions, exchange of knowledge and experiences and their application.

Also, similar to the Alpine Soil Partnership, it would be desirable to form a regional soil partnership for the Western Balkans and through this partnership to promote and influence the general social and political public on the importance of land and its sustainable management in the chain of sustainable agriculture and sustainable economic development. Also, through such a partnership, it would be possible to act regionally at European and other levels in order to expand cooperation, exchange knowledge, experiences and implement certain projects that would contribute to a better state of sustainable soil management in the region.

The Republic of Srpska

Through better regional cooperation in the countries of the Western Balkans, primarily between scientific and research institutions: exchange data and knowledge (training, coaching, good practices) at the regional level will lead to overcoming or to some extent mitigating the negative effects of soil pressures and to sustainable soil management, both in individual countries and in the Western Balkan region.

Summary of soil and land data availability in the Federation of Bosnia and Herzegovina

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Soil maps	National/ entity soil survey	Institute of Agropedology	Soil types (WRB)	Periodically	Country, entity, municipality	1:200000 1:50000 1:25000	Yes	Yes
Land use	CORINE	FEDERAL Directorate for Geodetic and Property Legal Affairs and Faculty of Agriculture and Food Sciences, Sarajevo	Cropping pattern	Every 6 Years	Country, Entities	Medium		Yes
Land cover	CORINE	FEDERAL Directorate for Geodetic and Property Legal Affairs and Faculty of Agriculture and Food Sciences, Sarajevo	Land Cover	Every 6 Years	Country, region/municipality/parcel	Orthophoto for the entire territory of BiH		Yes
Soil physical properties	Field surveys	Institute of Agropedology	Specific weight, Volume weight, Pore volume, Absolute capacity for water and air, Soil textural composition, Soil water, permeability, Water constants Stability of macrostructural, aggregates	Every year	FBiH	13 localities in FBiH		Yes
	Field surveys	Institute of Agropedology	Texture and structure	Every 3 years	FBiH	500 localities in FBiH		Yes
Soil chemical properties	Laboratory analyses	Institute of Agropedology	pH H_2O and KCl, Humus, $CaCO_3$, Content of available P_2O_5 and K_2O, Carbon content, Contents of N	Every year	FBiH	13 localities in FBiH		Yes
	Laboratory analyses	Institute of Agropedology	pH H_2O and KCl,Humus, $CaCO_3$, Content of available P_2O_5 and K_2O, Carbon content, Contents of N	Every 3 years	FBiH	500 localities in FBiH		Yes
Erosion	No data							
Soil organic carbon loss	No data							
Compaction	No data							

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Contamination	Field survey	Institute of Agropedology	Inorganic and organic pollutants	Every year	FBiH	13 localities in FBiH		Yes
	Field survey	Institute of Agropedology	Inorganic and organic pollutants	Every 3 years	FBiH	500 localities in FBiH		Yes
	Field survey	Institute of Agropedology	Inorganic and organic pollutants	Every year		8 localities in FBIH		Yes
Soil sealing	No data							
Salinization	No data							
Acidification	Field survey	Institute of Agropedology Agro-Mediterranean institute Mostar and Agricultural Faculty in BiH	pH	Sporadic	FBiH	1:50000		Yes
Soil biodiversity	No data							
Drought	No data							
Floods	Estimates	M. Agriculture	Areas inundated in ha	Sporadic	Region	Medium	Descriptive	
Desertification	No data							

Summary of soil and land data availability: The Republic of Srpska entity in Bosnia and Herzegovina

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/ Municipality/ Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Soil maps	National soil survey	Department for Agroecology in the Agricultural Institute of the Republic of Srpska, Banja Luka	Soil types and varieties (New soil classification system of BiH, FAO classification)	Sporadic	Country/ region/ municipality	1:50000		Yes
Land use	CORINE, global dataset	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Universities use global dataset for investigation	Cropping pattern	6	Country/ region	100000		Yes
Land cover	CORINE	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka	Land categories	6	Country/ region/ municipality/ parcel	100000 as standard CORINE scale		Yes
Soil physical properties	Field surveys	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Laboratories at the agricultural faculties of the universities of Banja Luka and East Sarajevo	Texture and structure	Sporadic	Country/ region/ several municipalities	1:250000 1:50000	Yes (Descriptive)	Yes (for several municipalities)
Soil chemical properties	Laboratory analyses	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Laboratories at the agricultural faculties of the universities of Banja Luka and East Sarajevo	Exchangeable sodium percent (ESP), electrical conductivity (EC), cation exchange capacity (CEC), topsoil fertility (pH), soil organic matter (SOM), available P, exchangeable Ca, K, Mg and Na	Sporadic	Country/ region/ several municipalities	Detailed for 240,000 ha		Yes
Erosion	USLE	Public Institution JU Vode RS	Ton/ha/year		Country/ region: several regions in RS	100,000	Descriptive	Yes

Soil organic carbon loss	Field survey	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Laboratories at the agricultural faculties of the universities of Banja Luka and East Sarajevo	SOM g/kg of soil converted in % SOC g/kg of soil converted in %	Sporadic	Country/ region	Medium/ Low		Yes
Compaction	No data							
Contamination	Field survey	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Laboratories at the agricultural faculties of the universities of Banja Luka and East Sarajevo	Heavy metals, Cd, Co, Cr, Cu, Ni, Pb and Zn mg/1kg of soil	Sporadic	Regions	Low	Yes (Descriptive)	Yes
Soil sealing	No data							
Salinization	No data							
Acidification	Field survey	Department for Agroecology in Public Institute the Agricultural Institute of the Republic of Srpska, Banja Luka /Laboratories at the agricultural faculties of the universities of Banja Luka and East Sarajevo	pH	Sporadic	Region	Medium	Descriptive	Yes
Soil biodiversity	No data							
Drought	Estimates	M. Agriculture	Areas inundated in ha	Sporadic	Region	Medium		
Floods	Estimates	M. Agriculture	Areas inundated in ha	Sporadic	Region	Medium	Descriptive	
Desertification	Estimates	M. Agriculture	Areas affected in km2	UNCCD Reporting	Country	Low	Descriptive	

KOSOVO* SOIL REPORT

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This designation is without prejudice to positions on the status and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

1. Land use and land cover in the country

The total area of Kosovo* is 10,908 km^2, of which 420,141 ha of agricultural land was used for agricultural production in 2019.

The most significant areas of utilised land consist of meadows and pastures (including common land), which constitutes 217,932 ha or 51.9% of the utilised area of agricultural land.

The category of arable land, i.e. fields, was 188,365 ha or 44.8% in 2019, which includes area under vegetables in open field (first crop) and greenhouses (first crop). Tree plantations cover an area of 9,244 ha or 2.2%, while vineyard plantations cover 3,367 ha or 0.8%. Gardens cover the smallest part of the agricultural land area with 1,122 ha or 0.3% and plant seedlings with a total of 111 ha or 0.03%.

In 2019, the total arable land was 0.11 ha per capita, while the average of the total utilised agricultural area per capita was 0.24 ha.

The size of the farm from 2 to under 5 ha accounts for 35% of the total area of arable land, the size from 5 to under 10 ha for 21% of the area, the size from 1 to under 2 ha for 16% of areas, while the smallest area is from 0 to under 0.5 ha and accounts for 3.17%.

There are 130,775 agricultural holdings in Kosovo*. The largest number of agricultural holdings farm arable land sized 0 to under 0.5 ha (30.4%), followed by 2 to under 5 ha (23.0%), 1 to under 2 ha (21.9%) and other groups. The smallest number of agricultural holdings is from 20 to under 30 ha (0.2%) and 30 or more hectares (0.2%) in size.[2]

Data reported by municipal directorates for agriculture show that in 2019, about 17,719 ha were irrigated from various sources.

The organic agriculture sector in Kosovo* is still in the early stages of development. According to MAFRD data , about 480 ha with medicinal and aromatic plants are cultivated in Kosovo*, 522.47 ha with pumpkin for seed/organic oil production, and 34.07 ha with chestnuts, as well as 373,488 ha of areas certified for the collection of medicinal plants and wild fruits.

2. General assessment of available data

In the absence of other adequate sources of land data, the Kosovo* Land Atlas IDWE 1974 still serves as the primary source of land information and land issues in Kosovo*. This atlas has been digitised, but it does not include comments on the physical, chemical and biological properties of soil.

On the initiative of MAFRD and efforts by the Agricultural Institute of Kosovo*, the completion of soil research and preparation of pedological map according to WRB 2014 (update 2015) classification has begun. In this context, the pilot project for the municipality of Rahovec has been completed. A report has been published with all the research details with data on soil's chemical, physical and biological

2 Sources: MAFRD (2020): Green Report 2020, Pristina, Kosovo*

content and the pedological map in digital form. MAFRD also took another initiative through the engagement of the Agricultural Institute of Kosovo* in another project for the inventory of agricultural and non-agricultural lands in digital format according to WRB 2014 (updated 2015) classification for the municipalities of Peja, Kline, Istog, Deçan, and Junik. But, due to the situation with COVID-19, the works and activities in this project were suspended due to the lack of coverage of research in the entire territory of Kosovo* and the preparation of a pedological map according to the WRB classification (update 2015), the Faculty of Agriculture in Prishtina still uses the land systematisation according to the authors: Škorić, Ćirić, and Filipovski (1985).[3] Therefore, it is more than necessary that the land inventory project started by the Agricultural Institute of Peja to continue by securing the funds to begin the inventory of the remaining lands of Kosovo* and to prepare the systematisation for the whole of Kosovo* according to WRB 2014 (update 2015) to produce a unified digital pedological map for the whole of Kosovo*.

The institutions responsible for land monitoring are: the Agricultural Institute of Kosovo*and Kosovo* Hydrometeorological Institute. Both of these institutions operate within the respective ministries.

The classification used in student materials within the land course of the Faculty of Agriculture and Veterinary Science is provided below, with the terms adopted according to WRB 2014 (update 2015), based on the report of the pilot project for the production of a pedological map in Rahovec[4] and publication of FAO WBR 2014 (update 2015)[5]:

Lithic Leptosols - Are located in hilly-mountainous regions, along the mountains such as Albanian Alps, Sharr mountain range, Karadak mountains, Kopaonik mountain range, and the municipalities of Peja, Gjilan, Leposavic, and Prizren, occupying an area of about 42,143 ha or about 3.8% of the total area.

Colluvic Regosols - Are located in Prizren, the valley of Opoja-Dragashi, the valley of Suhareka, Shtërpcë, and Istog, covering an area of about 69,830 ha, or 6.3% of the total area.

Rendzic Leptosols – Are located in lower exposures in the regions of Regosol presentation in the municipalities of Skenderaj, Klina, and Istog. The total area with this soil is about 26,332 ha or about 2.42%.

Humic Leptosols - Are located in the hilly-mountainous regions. They are mostly widespread in the municipalities of Dragash, Leposavic, Prizren, Mitrovica, Gjakova, Shtërpcë, etc. covering an area of about 121,822 ha or about 11.24% of the total area.

Vertisols - Cover an area of 108,444 ha or 10% of the total area. They are located in the municipalities of Lipjan, Rahovec, Vushtrri, Kamenica, Gjilan, Drenas, Ferizaj, Prishtina, etc.

Haplic Cambisol (Eutric) - Stretches over 47.5% of the total land area (close to half of the total land area, while the eutric Cambisol alone makes up about 173,710 ha, or 16% of the total land area.

Haplic Cambisol (Dystric) - Is the most widespread type of soil in Kosovo*, comprising about 282,802 ha, or 26% of the total land area. It is located in the municipalities of Kamenica, Gjilan, Podujeva, Kaçanik, Gjakova, etc.

Calcic Cambisol - Stretches over 32,631 ha, or 3% of the total area. The municipalities where this soil is the most widespread are Peja, Istog, Gjilan, Zubin Potok, Deçan, etc.

Rhodic Cambisol - Stretches in areas dominated by carbonate rocks. In Kosovo*, it covers an area of about 27,845 ha or 2.56% of the total area. It mainly stretches in the municipalities of Malisheva, Prizren, Klina Gllogoc, Gjakova, etc.

3 Xh. Elezi (2012): Pjelloria dhe Plehërimi i Tokës (Pjesë e ligjëratës), Universiteti i Prishtinës- Fakulteti i Bujqësisë dhe Veterrinarisë, Prishtinë, Kosovë.

4 L. Sopi – Consult Engineering Sh.P.K. (2020): Konsolidimi dhe Inventarizimi i Tokave Bujqësore, Raporti i dyt (2020), Prishtinë, Kosovë.

5 FAO (2015): World Soil Resources Reports106 "World Reference Base for Soil Resources 2014 (update 2015).

Haplic Fluvisol - Stretches in areas flooded by rivers and covers an area of about 83,862 ha or 7.71% of the total area. These are the areas of vegetable cultivation (on the Drini i Bardhë side) in Peja, through Gjakova and Klina to Prizren, but also along other rivers in the municipalities of Deçan, Vushtrri, Podujevë, etc.

Haplic Planosol - Stretches in areas with precipitation> 700mm, respectively, with semi humidity and humidity. It covers 40,245 ha or 3.7% of the total area in the municipalities of Gjakova, Viti, Ferizaj, Podujeva, Prizren, Gllogoc, Istog, etc.

Mollic Fluvisol - Stretches in river valleys and is associated with Alluvium. In Kosovo*, it covers an area of 13,748 ha or 1.26% of the total area. It is located in many municipalities: Rahovec, Lipjan, Gjilan, Viti, Gjakova, Shtime, Ferizaj, etc.

3. Legal framework

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonised with EU regulation (Yes / No / Partly)
Government of Kosovo*	Law No. 02 / L-26 On Agricultural Land	N/a	
Government of Kosovo*	Law No. 04 / L-040 On the Regulation of Agricultural Land		
Government of Kosovo*	Law No.03 / L-029 On Agricultural Inspection		
Government of Kosovo*	Law no. 2003/3 On Kosovo* Forests		
MAFRD	Administrative Instruction MA-No.36/06 On the Recultivation of Agricultural Land		
MAFRD	Administrative Instruction MA-No.37/06 On the Protection of Agricultural Land from Erosion		
MAFRD	Administrative Instruction MA-No.38/06 On the Control of Agricultural Land Fertility		
MAFRD	Administrative Instruction MA-No.41/06 On Changing the Destination of Agricultural Land		

Listed below are the laws within other ministries approved by the Government of Kosovo*, which correspond and relate directly or indirectly to the management of agricultural land:

- Law No. 04 / L-174 On Spatial Planning
- Law No. 06 / L-092 On Leasing and Exchange of Immovable Property of the Municipality
- Law No. 03 / L-025 On Environmental Protection
- Law No. 03 / L-233 On Nature Protection
- Law No. 04 / L-159 On Economic Zones
- Law No. 06 / L-005 On Immovable Property Tax
- Law No. 04 / L-034 On Privatization Agency of Kosovo* amended and supplemented by Law No. 06 / L-023 On amendment and supplementation of Law No. 04 / L-034 On Privatization Agency of Kosovo* amended and supplemented by Law No. 04 / L -115 and Law No. 05 / L-080
- Law No. 04 / L-013 On Cadastre
- Law No.06 / L-024 on the Treatment of Unauthorised Constructions

- Law No.03 / L-040 on Local Self-Government
- Law No. 05 / L-087 on Minor Offenses

c) Strategy

- Land Consolidation Strategy 2010-2020 – The aim of the Strategy is to increase the competitiveness of the agriculture and forestry sector, based on ownership of sustainable land use for farmers, environmental protection, land use, rural infrastructure development, and improvement of life of rural residents.[6]

4. Drivers which affect soil quality

Process of urbanization and change of destination of agricultural lands –Since 2005, the Law on Agricultural Land has been in force in Kosovo*, aiming to create a legal basis for the use, protection and regulation of agricultural land. According to MAFRD data, about 500 hectares of agricultural land changed their designated use within a year. Agricultural lands were transformed into supposedly industrial areas, but predominantly various warehouses, business facilities, collective dwellings, etc.

Expansion of road infrastructure – This is another significant factor causing the loss of agricultural land. In addition to the loss of agricultural land, road construction has an impact on erosion and promotes soil erosion, utilisation of aggregates from river beds, intensification of aggregate utilisation by quarries, fragmentation of natural habitats, change of water regime and other socio-environmental aspects.

Overgrazing – Improper use of pastures, non-application of land reclamation and other agro-technical measures are due to lack of projects, funds, and clear definition of responsibilities in the management of jointly owned pastures.

Improper forest management practices – Illegal logging is one of the main reasons for the mismanagement of forests, also including a mix of competencies between state institutions managing forests (MAFRD, regional directorates, and municipalities). Considering this situation, the Kosovo* Forest Agency has tried to draft a law, which would help streamline the competencies regarding forests. The impact of illegal logging, in addition to biodiversity, rainfall regime and other processes, affects the uncontrolled erosion of forest lands and the loss of millions of m^3 of fertile layers of soil.

Forest fires –- This is a factor that not only brings damage to forests and biodiversity but also increases greenhouse gas emissions in this sector. According to the Kosovo* Forest Agency data, during the period 2008-2018, an area of 14,144 ha of private and public forests was burned. In July 2021, MAFRD established the Task Force for the Protection and Legal Use of Forests in Kosovo*. This Task Force was formed pursuant to the Decision of the Government of Kosovo* - No. 21/19 dated 14 July 2021. MAFRD emphasises that this Task Force was created with one goal: to protect and enable the legal use of forests and also to protect agricultural land in Kosovo*.[7]

Privatisation of agricultural land – The process of privatisation of agricultural land in Kosovo* by the Privatization Agency of Kosovo* is based mainly on the highest bids offered and does not take into account other components that decide the fate of this land in the future such as strategic plan for the

6 MAFRD (2010); Land Consolidation Strategy 2010-2020, Prishtina, Kosovo*
7 https://aktivpress.com/toka-e-kosoves-do-te-mbrohet-me-task-force/

protection and sustainable management of agricultural land, except in some cases when the land is sold with a special provision. Therefore, much agricultural land has been mismanaged or its purpose has been changed after privatisation.

5. The main soil degradation processes

Use of mineral fertilizers – One of the main soil impacts from the agricultural sector is the use of chemical fertilizers, pesticides and other agricultural chemicals. According to data from agricultural questionnaires conducted by the Kosovo* Agency of Statistics, in 2019 about 76,467 tons of fertilizers were used containing nitrogen (NPK, UREA, and KAN). The general trend of fertilizer use in agriculture is increasing.

Use of plant protection products – Another environmental pressure is the use of pesticides and other agricultural chemicals. According to the data from the Survey of Agricultural Households for the years 2015-2019 conducted by the Kosovo* Agency of Statistics, in 2015 115,083.40 ha were treated with pesticides, to mark an increase of 3,967.53 ha of areas treated with pesticides in 2019, totalling 119,050.93 ha.

Erosion – There is currently no annual data on the effect of erosion. However, based on some data obtained from previous research, the Kosovo* Environmental Protection Agency has made an assessment in GIS for the spatial extent of land surfaces with very strong erosive intensity and other surfaces with high, medium intensity and poorly erosive, as well as soil surfaces without erosion. Research has shown that 7.35% of land surfaces in Kosovo* have extreme erosive intensity, 16.1% strong, 35.4% medium, 24.55% weak, 10.1% very weak, and 6.5% without erosion. Areas with strong erosion and strong erosive potential lie mainly in mountainous areas, while those with low erosion and without erosion lie mainly in valleys and flatland areas.

Soil organic carbon – Research done individually does not provide a systematic database for the entire territory of Kosovo*. Identification of Soil Organic Carbon (SOC)is based on the research of 71 open profiles in the project of the municipality of Rahovec for the preparation of pedological map according to WRB 2014 (update 2015). The results of SOC content range from 0.02% to 2.79%, depending on the type of soil, depth, type of land use, slope, soil cover, etc.

Compaction – Compaction occurs mainly due to heavy machinery that compacts the ground during the process of work or transportation, but can also occur due to the passage of animals. Lately, farmers are being supplied with heavier machinery and more advanced equipment; hence this phenomenon is more frequent.

Contamination – The following includes some of the basic sources of contamination of agricultural land:

- Contamination from landfills - Kosovo* produces a total of 2,554,308 million tons of waste[8]. According to this strategy there are 4 main sources of waste: a) municipal, b) industrial, c) construction and demolition and d) mining and quarrying.
  There is no waste recycling system in Kosovo*, although, in some municipalities, there are initiatives for waste separation at the source. There are several licensed companies that deal with the activity

8 Strategjia (2021-2030) dhe Plani i Veprimit (2021-2023) për Menaxhimin e Integruar të Mbeturinave në Kosovë

of waste treatment and recycling.
In terms of the composition of waste that is recycled, 69% includes waste from ferrous metals and other metals, 13% plastic waste, and 14% waste from paper and cardboard. In 2019, several initiatives for the recycling of glass waste started. The amount of recycled waste represents only about 5% of the total amount of waste generated nationwide.

- Contamination from KEK ash dump – Another big problem from our industry today are the large ash dumps created by the use of these resources. In Obiliq alone, it is considered that over 600 ha are covered by ash dumps. Irrigated lands are covered by KEK ash which, in addition to occupying these areas, has negative impacts on thousands of ha, by being distributed by wind on the surface of high-quality arable land under the existing irrigation network. The exact effects of pollution from the mining industry in Kosovo* are difficult to determine, due to the lack of monitoring and analysis. The main reasons for this include very outdated technology with which these resources are exploited.
- Contamination from vehicle junkyards and vehicle used spare parts outlets – These activities contribute to temporary loss of agricultural land. They are everywhere; in towns and suburbs, villages and near the main roads. There are no exact data on how much land is occupied by vehicle junkyards, but it is estimated that they use up a high number of hectares. In addition to physically occupying these surfaces, the soil here is heavily contaminated with engine oils and other products, including ubiquitous steel and plastic parts. Therefore, in addition to the temporary loss of land, these facilities contribute to significant contamination of agricultural land.
- Contamination from vehicle CO_2 emissions – In Kosovo*, the number of vehicles registered in 2019 was 354,878, and it is well known that the quality of diesel products is below standard and most vehicles do not have a catalytic system. Regarding the age of vehicles in Kosovo*, the highest number of vehicles from all categories belong to the group that meets the EURO3 and EURO4 standards, which can be considered middle-aged vehicles. These categories are followed by the category of vehicles prior to EURO1, which can be considered old vehicles, while the lowest number of vehicles circulating in Kosovo* belongs to the category EURO6, which are considered as new environmental-friendly vehicles.

Soil sealing – The land surface coverage with impermeable materials due to urban development and infrastructure construction in Kosovo* is relatively high due to the rapid process of urbanisation. But there is no accurate data on the surface covered by this material as many dumps of excavated soil and construction material are illegal.

Salinisation – Salting in Kosovo* is not a significant problem as this phenomenon occurs only on a part of 20 ha in the meadows of Partesh. There is no knowledge about the existence of Solonetz and Solonchaks land in Kosovo*.

Acidification – Data on soil acidity result from various analyses of the chemical, physical and water properties of soil, but these were created for specific project areas with different requirements, for example, analyses performed on the possibility of planting vineyards, orchards, etc. Unfortunately, there is no general analysis conducted at the national level that is available to the public.

A study conducted by several authors, where a total of 46 samples of genetic horizons were taken from 11 profiles which belong to four different soil types classified according to the WRB, spread throughout Kosovo*, has shown that the pH in H_2O is mainly weakly acidic, basic and weakly alkaline, decreasing in depth, while in profiles with a certain amount of $CaCO_3$, the pH is increasing.[9]

If we refer to the pilot project of Rahovec, pH values in H_2O range from 5.13 to 9.19, while pH in KCl

9 Bresilla, B. Zogaj, M. Szegi, T. Micheli, E. Bresilla, K. (2013): Correlation of some soil types of Kosovo* from the old Yugoslavian Soil Classification (YSC) into World Reference Bases for soil resources (WRB)

ranges from 3.54 to 8.11.

Soil biodiversity – Demand for land in Kosovo* is high and follows the same trend as in the rest of Europe. Food production, urbanisation, infrastructure, industry, recreation, etc., all compete for land areas, with impacts on biodiversity and ecosystem services. The system of protected areas is a very important instrument for the management and conservation of soil biodiversity. Currently, there are 116 Protected Natural Areas in Kosovo* that cover an overall area of 118,913.95 ha (10.9% of the area of Kosovo*).[10] Therefore, there is urgent need to make an inventory of biodiversity resources to protect the remaining valuable biodiversity resources in Kosovo*.

Floods – A significant portion of the protective belt of flooded rivers has been destroyed. For personal interests, the part of the population living around rivers and especially around the river Sitnica has caused great damage to the population around by exploiting the soil and gravel from the protective belt of the river. In addition to the destruction of autumn crops, mainly wheat, there have also been floods in residential buildings. According to a study and assessment conducted by the Kosovo* Environmental Protection Agency, over 1,400 ha of riverbeds have been degraded throughout Kosovo*. According to the March 2006 report by the Ministry of Agriculture for the Government of Kosovo*, it is mentioned that with floods during autumn and previous winter, 5,232 ha of crops were destroyed, i.e. 30% of autumn crops. In addition to material damage, floods also cause damage to soil contamination and degradation through industrial waste, municipal waste, etc. **Therefore, each municipality should develop a strategy and measures to mitigate the increased risk of flooding.**

6. Problems with soil management

Negative effects on fertility – It is evident that farmers often use improper agro-technical measures that have negative effects on fertility and lead to low and unplanned agricultural productivity. The tradition of agricultural production, in most cases, continues to be accepted by older generations.

Physical degradation of the soil – Failure to apply appropriate agro-technical measures affects the physical degradation of soil through the destruction of soil structure and the destruction of the balance of the air-water regime on the ground. This is especially pronounced in Vertisols soils.

Erosion – In many cases, the use of improper agro-technical measures also causes the process of erosion, especially during tillage of perennial crops, such as vineyards and trees on plots with a particular slope. The measure of planting grass in vineyards and around trees is very little or not applied.

Improper tillage – Applied by farmers affects the loss of humus in the soil. Many farmers, ploughing the slopes, plough lengthwise. Proper tillage means tillage in the direction of the isohypses, not lengthwise.A big problem arises when there is heavy rainfall, causing leakage of that fertile accumulating layer of humus, which in most cases is at a depth of 20 to 25 cm.

Burning crop residues – Is a practice still practised by many farmers. By burning crop residues, microflora and fauna are destroyed in the part of arable layer of the soil. The microbiological process of decomposition of organic matter is minimised, and this is directly reflected in the fertility of the soil.

During the last twenty years, various seminars have been organised by various international and local

10 https://sq.wikipedia.org/wiki/Zonat_e_mbrojtura_t%C3%AB_natyr%C3%ABs_n%C3%AB_Kosov%C3%AB

organisations as well as various NGOs with the aim of training farmers in this regard. The number of attendees at the beginning was quite high. However, with time it started to fall, so that in recent years it has been difficult to organise a seminar which will gather a considerable number of farmers. On the other hand, the participants of the seminars have difficulty applying the suggested measures, and most of them continue using traditional ones.

7. Capacity assessment of the country to deal with sustainable soil management

Unsustainable management of agricultural land is reflected in the loss of agricultural land and reduction of the area under agricultural land used for production; fragmentation of agricultural land; degradation of agricultural land; degradation of socially owned pastures, poor management and non-application of land reclamation; and other agro-technical measures of socially owned pastures, etc.

All this comes mainly from the non-implementation of the legislation in force, mainly due to the lack of human capacities at the central and local levels to address issues, the mix of competencies between the central and local levels and abuses. According to Law No. 02/L-26 On Agricultural Land, the competent municipal body for agriculture is obliged to keep records of uncultivated land, land given for use, and of changed purpose of land use. But even after 16 years of enforcing the law, we still do not have an overview of the loss of agricultural land, change of purpose, areas covered by erosion and many other data.

The legislation on agricultural land in force needs to be updated because the existing one does not clearly define the competencies of the central and local levels (regarding the approval of the draft development plan for changing the purpose of agricultural land for category I-IV and forest land to non-agricultural land purposes, oversight of the implementation of the law by inspection or other authorised bodies). The current legislation does not provide for the establishment of the Agricultural Land Fund, which is more than necessary for the process of consolidation of agricultural lands. The process of land consolidation based on current legislation has proved very little successful or unsuccessful; therefore, these and many other issues are issues that need to be addressed in updated future legislation.

The Agricultural Institute of Peja, in addition to the competencies for monitoring agricultural inputs, food and preservation of the environment, and land quality, also performs many technical and scientific activities related to laboratory analysis of soils. In addition to the laboratory of the Agricultural Institute of Kosovo* there is also the private laboratory for soil analysis Agrovet in Fushë Kosovë. Both laboratories have professional staff engaged, are equipped with the most modern equipment and present a complete infrastructure for soil analysis in Kosovo*.

Proposals:

- **Application of the Integrated Agricultural Land Management (MITB) System –** In addition to the legislation in force that needs to be updated, cooperation should be consolidated at the inter-ministerial level, respectively inter-institutional level at the central and local levels. This can be achieved through Integrated Agricultural Land Management System. Integrated Agricultural Land Management System is a strategic approach that promotes responsible use of public land and is a

unifying inter-industrial, cross-sectoral, inter-ministerial instrument to manage and plan land properly, reducing losses of agricultural land, degradation, and other consequences that are present in Kosovo* setting.

- **Mandatory application of the Agro-Ecological Zoning process at the central and municipal levels –** Agro-Ecological Zoning is a process of a group of agricultural areas based on the chemical, physical-mechanical and biological properties of land for agricultural production. Agro-Ecological Zoning is included in the Administrative Instruction on Municipal Zoning Maps by MESPI but unfortunately as a non-mandatory instrument to facilitate the preparation of municipal zone maps. Therefore, municipalities do not consider the application of this process mandatory, even though it can be used as a mechanism for the protection of agricultural land, especially that of categories I-IV.

8. How can the problems be overcome regionally?

Establishment of a partnership at the level of Western Balkan countries – Given that all Western Balkan countries have similar problems with sustainable agricultural land management, establishing a joint partnership between Western Balkan countries would be more than necessary, because it would provide a common platform for the sustainable management of agricultural land.

This platform should contain the common standards for all the countries of the Western Balkans, both in terms of representation and in terms of management, the problems, causes and consequences faced by agricultural land that ought to be analysed in detail.

The platform should then serve to exchange knowledge and best practices, make proposals and lobby at various levels of Western Balkan countries and regional and European levels towards the conservation and sustainable management of agricultural land, especially from degradation and loss of agricultural land for non-agricultural purposes (change of use).

The platform should propose the application of a digital agricultural land monitoring system which would provide information on specific issues at any time. Information should be transparent and accessible to the general public.

The objectives, standards applied and the action plan within the platform must be in full compliance with the action plan for the realization of the Green Agenda for the Western Balkans and all the objectives, standards and action plans used in the EU member states.

Summary of soil and land data availability: Kosovo*

Name of the parameter	Data source/ method	**Institution in charge**	**What is measured**	**Frequency of monitoring**	**Data gathering level *Country/Region/Municipality/Parcel***	**Resolution or scale**	**Availability of data**	
							Hard copy	**GIS**
Soil maps	National soil survey		Soil types (WRB)	Decades	For several municipalities	1:50000 1.10000		Yes
Land use	CORINE	Ministry of Agriculture Forestry and Rural development Institute of National Statistics (INSTAT)	Cropping pattern	Decades	Municipality	Medium		Yes
Land cover	CORINE	Environment Agency and Kosovo* Cadastral Agency within the Ministry of Environment, Spatial Planning and Infrastructure	Land categories	4-5 years	Country/ region/municipality/parcel	Orthophoto for the entire territory of Kosovo* with 10/20 cm resolution		Yes
Soil physical properties	Field surveys		Texture and structure	Decades	For several municipalities	1:50000 1.10000		Yes
Soil chemical properties	Laboratory analyses		Exchangeable sodium percent (ESP), electrical conductivity (EC), cation exchange capacity (CEC), topsoil fertility (pH), soil organic matter (SOM), available P, exchangeable Ca, K, Mg and Na	Sporadic	For several municipalities	Detailed For several municipalities		Yes
Erosion	USLE	Ministry of Environment, Spatial Planning and Infrastructure	Ton/ha/year	Sporadic	For several municipalities	Medium/Low		Yes
Soil organic carbon loss	Field survey	Kosovo* Agriculture Institute	SOM g/kg of soil converted in % SOC g/kg of soil converted in %	Sporadic	For several municipalities	Medium/Low		Yes
Compaction	No data	Kosovo* Agriculture Institute						

Name of the parameter	Data source/ method	**Institution in charge**	**What is measured**	**Frequency of monitoring**	**Data gathering level *Country/Region/Municipality/Parcel***	**Resolution or scale**	**Availability of data**	
							Hard copy	**GIS**
Contamination	Field survey	Ministry of Environment, Spatial Planning and Infrastructure / Kosovo* Agriculture Institute	Heavy metals, Cd, Co, Cr, Cu, Ni, Pb and Zn mg/1kg of soil	Sporadic	Regions	Low	Yes (Descriptive)	
Soil sealing	No data	Kosovo* Agriculture Institute						
Salinization	Not relevant	Kosovo* Agriculture Institute						
Acidification	Field survey	Kosovo* Agriculture Institute	pH	Sporadic	For several municipalities	Low	Yes (Descriptive)	Yes
Soil biodiversity	No data	Ministry of Environment, Spatial Planning and Infrastructure						
Drought	No data							
Floods	Estimates	Ministry of Environment, Spatial Planning and Infrastructure	Areas inundated in ha	Sporadic	Region	Medium	Descriptive	Yes
Desertification	No data	Ministry of Environment, Spatial Planning and Infrastructure						

MONTENEGRO SOIL REPORT

Prepared by

Professor Mirko Knežević

1. Land use and land cover in the country

Montenegro is a parliamentary republic with a total area of 13,812 km^2 located in South-East Europe (41˚ 52'- 43˚ 32' N lat. and 18˚ 26'- 20˚ 21'E long.). Water occupies 1.5% of the entire area. The total population of Montenegro is 622,218, and population density is 45.1 inhabitants/km^2. The capital city is Podgorica, and the historical capital city is Cetinje. Montenegro has 24 municipalities, and its currency is the Euro (€). According to estimates from 2017, nominal GDP is €6,354 per capita.

Agricultural land covers an area of about 5,145 km^2 and makes 37% of the total national territory, 6,225 km^2 or 45% is covered by forests, while settlements, roads, water, rocky areas and other categories occupy 2,442 km^2 or 18% of the territory (data from the Spatial Plan, 2008).

MONSTAT has harmonised data with EUROSTAT so data on the structure of agricultural land use differ significantly. In Table 1, comparative data are given according to the old and new methodology.

According to the old structure, agricultural land is 0.83 ha per capita, while according to the new structure, total agricultural utilised land is 0.41 ha per capita. Data from the old structure (2011) show that arable land is 9.99 ares per capita (arable land and gardens, orchards and vineyards). Data from a more recent structure (2019) show that arable land is 2.37 ares per capita (utilised kitchen gardens and/or gardens, utilised arable land, vineyards, orchards – plantations and extensive nurseries). Data according to the structure from 2011 and 2019 differ significantly. Irrigation is carried out on 12,518 farms, and 5,204.2 ha are irrigated.

Table 1. The structure of agricultural land use (2011 and 2019)

Structure (2011)	Surface area (ha)	Surface area (ha)	Structure (2019)
Agricultural land	**515,740**	**257,469.6**	Total agricultural utilised land
Arable land and gardens	45,748	2,009.8	*Utilised kitchen gardens and/or gardens*
Orchards	12,007	7,204.6	*Utilised arable land*
Vineyards	4,399	2,880.0	*Vineyards*
Meadows	126,990	1,373.3	*Orchards - plantations*
Pastures	323,953	1,214.6	*Orchards- extensive*
Ponds, fishponds, swamps	2,643	69.8	*Nurseries*
		242,717.5	*Perennial meadows and pastures*

(Source: MONSTAT – Statistical Yearbook 2012 and 2020)

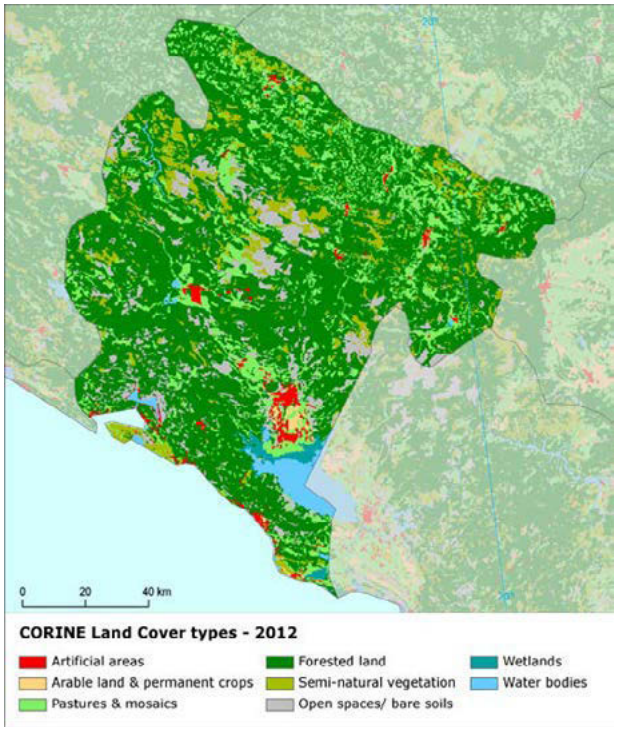
In addition to the official MONSTAT data, the data of Corina Land cover are also shown in Table 2. and Picture 1.

Table 2. Land cover types

Land cover types (2012)	Land cover (hundreds ha)
Artificial areas	249
Arable land & permanent crops	43
Pastures & meadows	2140
Forested land	8,557
Semi-natural vegetation	1,102
Open spaces/ bare soils	1,146
Wetlands	126
Water bodies	287
TOTAL [hundreds ha]	13,650

(Source: ME-Montenegro-landcover-2012)

Picture 1. Montenegro-landcover-2012



2. General assessment of available data

During the period 1958-1988, a detailed soil map at a scale of 1:50000 was prepared in Montenegro by the Biotechnical Faculty (former Agricultural Institute). The soil survey involved the study of two thousand profiles. Unfortunately, as in other Former Yugoslav Republics, the enormous effort was not adequately presented to the broad professional community and land users.

The Soil Atlas, its maps at a scale of 1:50000 and the monograph Soil of Montenegro Mountains (Fustic and Djuretic, 2000) provide relevant data on the presence of certain types of land, lower systematic units and their distribution.

Based on the Soil Map of former Yugoslavia at a scale of 1:50000, the most common types of soil in Montenegro are Calcomelanosol (47%) and Dystric Cambisol (28%), followed by Eutric Cambisol (8%), Terra Rossa (6%), Fluvisols (2,4%), Rendzina (2,2%), while other soil types cover the remaining area.

According to data from these sources, the most common soil types are those formed on carbonate rocks, or Calcomelanosol (national soil classification), covering 660,000 ha within which Litosols and Regosols appear as initial soils. In succession to Calcomelanosol, Calcocambisol appears in lower areas over an area of 30,000 ha and Terra Rossa, formed in the coastal area and in the Skadar Lake basin up to the height of 500-600 m. The surface area of Terra Rossa is about 84,000 ha. The so-called Rendzina are formed on carbonate regolith of moraine, glacio-fluvial sediment, and scree, covering a surface area of 31,200 ha. At 1,500 meters above sea level, Ranker soils are found on silicate substrates, spread over a

surface area of 6,830 ha. Montenegro has not yet harmonized its national classification with the World Reference Base for Soil Resources.

Dystric Cambisols and Brown Acid Soil occupy 394,820 hectares. They are created on the quartz silicate substrates, which are poor with alkali, but with leaching due to higher rainfall, soil is further acidified, and this contributes to forest litter of conifers and deciduous trees, which slowly decomposes and increases the content of humic acids in the soil. These soils most likely will meet the pH criteria for being classified as Areas of Natural Constraints (ANC).

Eutric Cambisols appears on 118,300 hectares of similar structure profile as Brown Acid Soils. Eutric Cambisols were formed on substrates with the presence of $CaCO_3$, but despite that, they tend to be usually acidic or moderately acidic. On the plains, substrate diluvial clays, as in the case of Bjelopavlići Plain and Lješkopolje waterlogging after heavy rainfall, are evident above the impermeable illuvial horizon, causing the appearance of pseudogley on about 550 ha. These areas are also potentially suitable to be classified as ANCs.

The Fluvisols occupy 34,250 ha in the river valleys, on the shores of Skadar Lake, Plav Lake and Šaško Lake and in the coastal areas. In the lowest parts of the terrain, Fluvisol exceeds in the Eugley and Histosol, which could potentially be classified as ANCs.

The surface of sand-gravel land (3,500 hectares) located in Stoj near Ulcinj and waterbeds are insignificant. Also, the surfaces of technogenic soil and recultivated soil are insignificant.

Most of the soils represented in Montenegro have a shallow soil profile and low contents of nutrients. Of the total area, not considering infertile land (rocks, wetlands, lakes, rivers, roads, and urban settlements), the soils of Montenegro (Fustic and Djuretic, 2000) are grouped in five categories of effective fertility, as shown in Table 3.

Table 3. Categories of effective fertility with an estimated area

No.	Categories fertility	Bonity	Surface area (ha)	%
1.	High fertility	I and II	20,000	1.5
2.	Medium fertility	III and IV	60,000	4.3
3.	Limited fertility	V and VI	350,000	25.3
4.	Low fertility	VII and VIII	640,000	46.2
5.	Infertile	without bonity (unclassified)	312,000	22.7
Total			1,382,000	100

Pedological data describe the mechanical-physical and chemical properties (MPC properties) of soil obtained through various laboratory methods. In addition, there was a systematic project in the past, spanning almost three decades, where several thousand soil profiles were dug throughout Montenegro, and their properties entered in handwriting in six notebooks.

A pedological map in digital form with the appropriate database can be created with the digitisation of data and their positioning. By appropriate polygons (representing mapped soil types) and analytical data, the interpolation and spatial representation of physical and chemical characteristics of soil can be performed. Thematic maps related to soil texture (coarse sand, fine sand, silt, and clay) as well as basic chemical properties of soil (available phosphorus and potassium, soil reaction, organic matter and total carbonates) could be created.

In total, the properties of ~7,666 profiles, or ~16,151 profile layers (every soil profile has 1 or more

horizons, corresponding to soil layers) were digitized, out of which ~4,986 have mechanical properties, and ~6,692 have chemical properties, while ~ 4,030 have both MP and C properties. ~3,536 profiles or ~6,555 horizons have geographical coordinates.

Data in Zemljišta Crne Gore were almost entirely georeferenced, in the sense that the authors of the book mentioned the section map where a profile is located, as well as the square inside the section map, which allowed to relatively easily find the exact coordinates of the profile.

Nevertheless, half of the information (about 1,800 profiles with about 4,000 layers) can be used bearing in mind that the area of Montenegro is about 13,812 km^2, on average, which means there is one profile on 7.7 km^2, which can be considered a sufficient volume of data.

The data, which may be available to the full extent for 1,800 profiles, are as follows: the upper depth of the horizon, the lower depth of the horizon, % of skeleton, % of coarse sand, % of fine sand, % of silt, % of clay, % of total sand, % of total clay, hygroscopic moisture, pH in H_2O, pH in KCl, the content of $CaCO_3$ (%), the content of organic matter (%), available P_2O_5 (mg/100 g of soil) and available K_2O (mg/100 g of soil). Hydrolytic acidity, sum of base cations, the adsorption capacity of adsorbed cations, degree of saturation of base cations were not provided for all profiles but only for about 47% of the profiles (around 850).

The percentage composition of the individual fractions was determined using Pipette method B.

Chemical soil parameters were determined by methods widely used in Former Yugoslav Republics(Džamić et al., 1996).

In order to monitor the condition of the land, i.e. to determine the content of hazardous and harmful substances in the soil during 2019, sampling and analysis of land from 33 locations was performed in 10 urban settlements in Montenegro.

In these samples, analysis for the possible presence of inorganic substances (cadmium, lead, mercury, arsenic, chromium, nickel, fluorine, copper, molybdenum, boron, zinc and cobalt) and organic substances (polycyclic aromatic hydrocarbons - PAH, polychlorinated biphenyls - PCB congeners, organotin compounds, triazines, dithiocarbamates, carbamates, chlorphenoxy and organochlorine pesticides) was performed. Soil samples near substations were tested for possible PCB content of congeners and dioxins and furans. The results of testing soil samples from locations determined by the Programme for testing harmful substances in the soil of Montenegro in 2019, show satisfactory results.

3. Legal framework

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Official Gazette Montenegro No. 15/92, 59/92, , 27/94, 73/10, 32/11	Law on Agricultural Land		
Official Gazette Montenegro No. 21/2009	Law on State Property		
Official Gazette Montenegro No. 064/17, 044/18, 063/18, 011/19	Law on Spatial Planning and Construction of Facilities		
Official Gazette Montenegro No. 056/09, 018/11, 040/11, 034/14, 001/15, 030/17, 051/17	Law on Agriculture and Rural Development		
Official Gazette Montenegro No. 029/07, 073/10, 032/11, 040/11, 043/15, 037/17, 037/17, 017/18	Law on Cadastre		
Official Gazette Montenegro No. 19/2009 Law on Property-Legal Relations			
	Decree on the Sale and Lease of State-owned Items		

d) Planned transposition of EU legislation

Issue	Name of acts (laws and by-laws)	EU legislation	(Remark)
Law / By-Laws			

e) Strategy

Montenegro ratified the United Nations Convention to Combat Desertification (UNCCD) in 2007 and thereby undertook the obligation to implement and report on compliance obligations under UNCCD in accordance with its objectives, in terms of sustainable land management and land degradation prevention. In 2007, UNCCD adopted a new Strategy for enhanced implementation for the period 2008-2018 and requested the Member States develop National Action Programmes (NAP) for UNCCD implementation coordinated with a 10-year strategy.

Bearing in mind that, at the global level, the problem of preserving land is significant, UNCCD launched the initiative to establish a voluntary national Land Degradation Neutrality Target Setting Process (LDN TSP), in order to effectively protect land, keep the neutral status of land, with no loss of fertility and productivity or to improve soil quality, if possible. Montenegro supported this initiative, and activities were carried out during 2017 and 2018.

Fifteen hotspots were identified, and a set of targets and measures defined. Twenty-five measures were defined to achieve LDN in Montenegro up to 2030. Different measures are related to the enhancement of LDN baseline in Montenegro, environmental legislation, direct measures to prevent, minimize land degradation and restore degraded land, sustainable agriculture and forestry, land-use changes and

social awareness.

National and specific voluntary LDN targets refer to avoiding, minimizing land degradation, and redirecting land use changes, an increase of land productivity – reduction of soil degradation, protection of natural ecosystems from wildfires, improvement of the soil monitoring system.

Montenegro has the obligation to adopt a new Strategy for Agriculture and Rural Development as the previous one was valid until 2020. Montenegro has opted for adopting the strategy for a period of 7 years, modelled after the Common Agricultural Policy programming period covering a period of 7 years. The previous strategy 2015-2020 was also a requirement for meeting the conditions for opening negotiations on Chapter 11, Agriculture and Rural Development. One of the objectives was for Montenegro to provide a comprehensive roadmap for agricultural policy reform and measures and activities in the process of harmonisation with EU agricultural policy. Keeping in mind that the strategic goal of the Government of Montenegro is to complete the process of harmonising national legislation with EU *acquis* by 2025, the future strategy must focus on continuing the ongoing reforms and adjusting the policy to the new Common Policy for the period until 2027.

4. Drivers which affect soil quality

Technological development in all countries inevitably results in land degradation. This is manifested through various forms of physical, chemical and biological degradation, but also increased pollution, directly or indirectly, through air and water. Montenegro is not spared from degradation by these and natural processes. The National Action Plan to Combat Desertification (NAP) defines the following drivers related to land degradation:

Agriculture, i.e. improper tillage, excessive fertilization and use of chemicals.

Forest management - Preserved forest ecosystems are the most important factor in protecting land from water and wind erosion, and other forms of degradation. Problems arise when forest destruction occurs due to unplanned management (deforestation and conversion to agricultural land, excessive logging and fires). The total forest area affected by fires in Montenegro for 2017 was 21,216 ha (2018 – 3,417 ha, 2019 – 1,170 ha).

Industry and land degradation - Since the 1990s, industrial production in Montenegro has been stagnant, and thus the annual production of industrial waste is lower. The project Industrial Waste Management and Cleaning, which is implemented in cooperation with the World Bank, includes the remediation of identified environmental black points: KAP (red mud basins and industrial waste landfill), Adriatic Shipyard Bijela (industrial waste landfill – grit), thermal power plant Pljevlja (ash and slag landfill Maljevac), and flotation tailings of lead and zinc in Gradac (Hollow Rock Mine, Pljevlja), as well as solving the problem of disposal of hazardous industrial waste at the national level. In addition to the mentioned large waste generators, there are other waste generators, such as the electrode factory in Plužine, the coal mine Pljevlja, plants for the maintenance of mining, construction and other machines, etc. In 2011, the rehabilitation and reclamation of the tailings of the former lead and zinc mine Brskovo in Mojkovac was completed.

The energy sector has an impact on the environment, and thus on land degradation, indirectly through

industry, transport, heating and other activities, which emit gases, causing the greenhouse effect and other harmful consequences for the environment. In addition to the indirect impact mentioned, the energy sector also has a direct impact on land degradation, such as pressure on reallocation or land degradation during the construction of energy infrastructure.

Land loss due to urbanization is difficult to compensate because when infrastructure is built on land, return to original state is possible only at great expense. Another problem of urbanization is that buildings are usually built on fertile land.

Impact of mining on land degradation - Although legal regulations in the field of mining oblige entities engaged in ore exploitation to perform technical and biological reclamation of landfills and other degraded areas in accordance with the pedological composition of the land, climatic and hydrogeological conditions, the most commonly prescribed norms are not complied with or not fully complied with.

Impact of garbage dumps on land degradation - Construction debris as waste is often mixed together with communal waste and disposed of in landfills, and even more often, directly along watercourses, along roads, etc. This additionally occupies the land and contributes to its degradation and environmental pollution.

5. The main soil degradation processes

The National Action Plan to Combat Desertification (NAP), based on defined drivers, also describes the main degradation processes associated with land degradation.

The impact of agriculture, i.e. improper cultivation and use of mineral fertilizers and pesticides, which are used more in the area of the Zeta plain, around Bar, Ulcinj and in the vicinity of urban settlements where fruits and vegetables are mostly grown. In the past, larger areas of arable land were obtained by clearing in Montenegro. Today, that process is almost negligible. However, fires from year to year cover significant areas and cause enormous damage. In Montenegro, urbanization is particularly pronounced in lowlands, which are few anyway.

Emissions of gases and aerosols from metal smelters of KAP, Željezara and other plants, then from the chemical and processing industry, TPP Pljevlja, heating plants, etc., and partly from the environment, cause the appearance of acid rain. The influence of acid rain has been observed on the drying of forests and fruit trees, and it is certainly reflected in the degradation of soil, increasing the acidity and causing changes in other chemical and biological properties of soil.

A significant area of land has been degraded from the formed landfills of various materials (mines and municipal waste). Landfills are most often located right next to river flows, which adversely affects river and groundwater flows and the surrounding land.

A retrospective assessment of LDN trends and drivers was carried out using global datasets about sub-indicators and information from the local level. ESA land cover data for the years 2000 and 2010 indicate the loss of 800 ha of forests and their conversion to shrubs and the conversion of 1,700 ha of forests to croplands. In total, 74,331 ha were found to be in three JRC land productivity dynamics classes with a negative connotation. It means that potentially degraded land in Montenegro, according to the LPD dataset, is around 5.44%. Data about soil organic carbon were provided by ISRIC. An average SOC

stock for the entire country is 125.1 t/ha. According to the FAO GAUL network, the Morača watershed was the most degraded with 31,041 ha, followed by the Neretva-Trebišnjica watershed with 26,613 ha, and Drina watershed with 15,226 ha of degraded land. Fifteen potential hotspots were identified by means of global data and field visits. The most represented type of land degradation is biological degradation caused by wildfires document. For Montenegro, there is no data on soil organic carbon change, compaction, contamination, soil sealing, salinization, acidification, and soil biodiversity.

A drought impact assessment should identify both direct and indirect consequences of drought at the local and national levels, taking into consideration various impacts, such as on the society, economy, and environment. Direct impacts of drought, such as reduced crop yields and final product quality, ground and surface water resources depletion, soil erosion, soil physic-chemical properties deterioration, the occurrence of wildfires, threat to overall flora and fauna status, need to be discussed. Understanding the effects of past events should lead to understanding the overall impact of drought over certain areas or periods of time of interest, as well as possible risk assessment of drought events in the future.

There is no (systematic) archive on the damages particularly related to drought, having in mind that drought was not monitored and analysed regularly until 2010. Drought impact archive was created during the DMCSEE project by using information from newspapers and media reports, reports of agricultural producers, websites of state institutions, local governments, enterprises and statistical yearbooks (MONSTAT).

Floods and erosion are also processes that can potentially endanger people's lives, their property and natural resources. There is the general exposure of the terrain in Montenegro to these processes, as well as the characteristic vertical dismemberment of the vegetation, with pronounced steep and very steep slopes, climate with 1,000 to 5,000 mm of water sediments per year, irresistible soils due to often irrational and inadequate use of natural resources, the occurrence of erosion processes on forest and agricultural lands.

Practically all rivers in Montenegro in their upper course, and some along their entire length, are of a torrential character. This means that there are large differences in the flow of larger and smaller waters and the regular occurrence of torrent waves with a significant concentration of sediments. Each of these torrents threatens settlements and roads, as well as agricultural, forest and other land. Thus, soil erosion and floods in Montenegro are closely related, while wind erosion is not pronounced.

6. Problems with soil management

The land of Montenegro is an extremely sensitive and vulnerable resource that must be managed with special care. As land degradation was not investigated in the previous period when important strategic documents were adopted, nor was significant attention paid to this problem, it is difficult to objectively assess all aspects regarding the degree and area of affected degradation, which makes it difficult to predict the future. On the basis of previous research of Montenegrin land for the basic pedological map at a scale of 1:50000, and partial research of certain specific problems of important complexes of flat terrains, the most important for agriculture , there is a good idea of the type of affiliation. Examinations of reputable lands were performed and the basis of land classification and grading was done, and these

are the preconditions for approaching land grading and making maps (large scale) on the use value of land. Unfortunately, so far these or similar projects that would enable monitoring of the state of land resources have not been implemented. However, development plans and programmes still emphasize the importance of land.

It is obvious that technological development in each country inevitably leads to or results in different types of land degradation. However, the successful solution of the problem of degradation caused by natural processes, such as floods and erosion, and human activity (physical, chemical and biological degradation) depends on the economic power. Montenegro is currently not economically strong enough to solve all the burning problems in a timely manner. Therefore, care for the environment and land protection have not been achieved to the extent desired, many problems are partially solved, and incompletely, which is equally true when it comes to floods, erosion, industrial and municipal waste, and other forms of degradation.

7. Capacity assessment of the country to deal with sustainable soil management

In Montenegro, there are a number of institutions that deal with land in terms of their responsibilities: the Ministry of Ecology, Spatial Planning and Urbanism performs integrated planning, management and valorisation of space. Land related competences are divided between the agricultural and environmental sectors. Administrative capacities are lacking and cross-sectoral cooperation needs to be strengthened.

The Ministry of Agriculture, Forestry and Water Management makes proposals for current and development policy, protection, exploitation and improvement of agricultural land; sustainable management of agricultural resources; development policy in the field of forestry; system solutions for forest and forest land management and protection; preservation; development policy in water management; system solutions for the provision and use of water, water land and water sources for water supply, protection of water from pollution, regulation of water and watercourses and protection from the harmful effects of water.

The Phytosanitary Administration, *inter alia*, performs activities related to the control of plant nutrition products and plant protection products.

The Forest Administration, *inter alia*, performs tasks related to providing and improving the condition of forests; forest management; measures and actions on care, restoration, raising and reclamation of forests (biological reproduction); protection of forests and forest land from illegal appropriation and use, fire.

The Water Administration performs activities related to the provision and implementation of measures and works on the regulation of waters and watercourses, protection against the harmful effects of water and protection of water from pollution;

Environmental Protection Agency of Montenegro performs environmental monitoring activities; analysis of the state of the environment, phenomena and events that may endanger the environment, proposing and taking measures for their prevention and elimination; reporting and coordination of reporting on the state of the environment and therefore land.

The Directorate for Inspection Affairs, *inter alia*, performs inspection supervision in the areas of spatial protection, urbanism, construction, ecology, agriculture, water management, forestry, which makes it an important factor in terms of protection and preservation of land as a segment of the environment.

Republic Institute for Geological Research is a public institution that deals with systematic examination of the development, composition and structure of the Earth's crust in Montenegro, research to determine the reserves of mineral resources, hydrogeological and geological engineering research and testing, as well as various projects in applied geology.

Other institutions that have responsibilities in terms of protection and management of land are the Institute of Hydrometeorology and Seismology of Montenegro, local governments, universities, NGOs and business associations.

University of Montenegro – Biotechnical Faculty, i.e. Centre for Land and Land Reclamation is an institution that should be singled out for its significant role in scientific and professional research on land. The Centre employs two doctors of sciences, an engineer and two senior laboratory assistants. The faculty teaches pedology, agrochemistry and land reclamation. The activity of the Centre is professional and scientific research in the field of land science. It includes examining, studying and solving problems of land use, management and preservation, and giving recommendations for agricultural practices.

8. How can the problems be overcome regionally?

Establishment of a regional centre where scientists from the region would deal with:

- Geostatistics and modelling – numerical and process modelling approaches which would allow increasing human and technical capacities for monitoring soil degradation processes, like SOC dynamics, land use land use change, agro-ecological zoning, soil erosion – intensity and erosion risk management, soil sealing – smart urban planning protection of highly productive soils, soil contamination, etc.
- Establish and harmonize methodologies for soil monitoring schemes as long-term commitment
- Establish a regional soil platform

Summary of soil and land data availability in Montenegro

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Soil maps	National soil survey	BTF	Soil types (national)	-	Country	1:50000	Yes	Partly
Land use	CORINE	Geological Survey of Montenegro	Cropping pattern	4-5 years	Country, EU	Medium		Yes
Land cover	CORINE	Geological Survey of Montenegro	Land categories	4-5 years	Country, EU	Ortho-photo		Yes
Soil physical properties	Field surveys	UCG - BTF	Texture and structure	-	Country	1:50000	Yes (Data and descriptive)	Partly
Soil chemical properties	Laboratory analyses	UCG - BTF	Electrical conductivity (EC), cation exchange capacity (CEC), pH, soil organic matter (SOM), available P.K.	-	Country	1:50000	Yes (Data and descriptive)	Partly
Erosion	Gavrilović (IntErO)	UCG-BTF	Ton/ha/year	Sporadic	Country/region	Medium/ Low	Yes	Partly
Soil organic carbon loss	Field survey	UCG-BTF	SOM g/kg of soil converted in %	Sporadic	Country/region	Medium/ Low		Party
Compaction	No data							
Contamination	Field survey	Ministry of Ecology, Spatial Planning and Urbanism	Heavy metals, Cd, Co, Cr, Cu, Ni, Pb and Zn mg/1kg of soil	Sporadic	Regions	Low	Yes (Descriptive)	
Soil sealing	No data							
Salinization	No data							
Acidification	Field survey	UCG-BTF	pH	Sporadic	Region	Low		Partly
Soil biodiversity	No data							
Drought	Estimates	Institute of Hydrometeorology and Seismology, DMCSEE	SPI, precipitation and percentile	Monthly	Country/region	Medium		Yes
Floods	Estimates	Ministry of Agriculture, Forestry and Water Management	Areas inundated in ha	Sporadic	Region	Medium	Descriptive	
Desertification	Estimates	Ministry of Ecology, Spatial Planning and Urbanism	Areas affected in km^2	UNCCD reporting	Country	Low	Descriptive	

NORTH MACEDONIA SOIL REPORT

Prepared by

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1. Land use and land cover in the country

The total country territory is estimated at 2,541.5 km^2, under different types of use. The State Statistical Office (SSO) keeps records on areas under agricultural land, estimated size 1,261,687 ha, out of which 517,039 ha is cultivated land (arable land, orchards and vineyards and meadows) while the rest of agricultural land are pastures with the total area of 743,911 ha (2020). Agricultural land is under different production systems, depending on production conditions. In some regions, where climate and soil conditions are favourable for agriculture, production systems are intensive, like in the case of vine production in the Tikveš region or apple production in the Prespa region. On the other hand, significant areas of agricultural land is rainfed, with low intensity of production, mainly with cereals which cover 157,500 ha, or more than 30% (30.47%) of the agricultural land. Most intensive agricultural production is in the areas with available water for irrigation, especially areas under irrigation schemes. Most perennial vine plantations and orchards are situated in such areas, covering almost 24.000 ha of vineyards and more than 17.000 ha of orchards. Vegetable production is mainly located around large urban centres and in the south-east part of the country. In low-intensity systems, land is usually sown with cereals (wheat, barley, rye) as a monocrop system or in a rotation with corn or another spring crop. In the long run, such a system with minimum management practices and inputs exhausts agricultural soils, especially organic matter contents, nutrient balance and structure. On the other hand, high-intensity production systems imply intense cultivation and inputs, regular irrigation and numerous passages of mechanization undermining the overall soil environment.

The total estimated area of irrigated land is approximately 84,438 ha (SSO 2020). The seven major hydro-meliorative systems have the net potential for irrigation of approximately 69,000 ha of agricultural land (JSC Water Economy of North Macedonia). The area covered with the HMS Bitolsko Pole was approximated, while the area of another four HMSs is not accounted for due to the lack of data or negligible irrigation areas. A significant part of agricultural land is irrigated using wells, especially Polog Prespa valleys. Most parts of these wells are not well recorded regarding their location, capacity, or irrigated area.

Regarding the pastures, although this category of land use covers a vast territory of 743,911 ha or almost 60% of agricultural land, there is very limited data regarding their spatial distribution, categorization or management. There is no systematic and publicly transparent approach for their inventory, bio-productivity, grazing potential, or applied management practices. In many cases, this category of land use is under the pressure of overgrazing, wildfires or biodiversity degradation.

Another significant type of land are forests areas occupying 1,042,321 ha. According to SSO data for 2020, almost 60% are deciduous forests, while the rest of the forest area are mixed forests covering more than 30% and coniferous forests with only 0.06% of the territory under forests. According to the same dataset, degraded forests are spread over 44,385 ha. According to SSO, forestland encompasses areas under forests and an additional 111,130 ha of land within this category of forestland, which is with sparse forest vegetation. Besides the SSO data, for the above categories of land use, the Ministry of Agriculture, Forestry and Water Economy keeps a record for agricultural land use within its Land parcels Identification System (LPIS). For the forests, the Public Enterprise Macedonian Forests performs an occasional inventory of forest status in the process of preparation of forest management plans. Both datasets are not available for public use.

According to the landcover derived from CORINE LCU 2018, level 1-2: Agricultural areas 35.89%, Forest and semi natural areas 60.07%, Wetlands 0.08%, Water bodies 2.12% and Artificial surfaces 1.84%.

2. General assessment of available data

Soil data are very limited and outdated due to the lack of systematic monitoring of soils in the country for almost three decades, starting from 1995 onwards, when the last phase of the long-term project for the preparation of the Soil Map of Macedonia on a scale of 1:50000 was finalized. During this project, in a period of several decades, the whole territory of the country was surveyed with a general objective to map the spatial distribution of major soil types and subtypes and estimate their chemical and physical properties. Numerous field and laboratory reports and soil maps were produced within this project in hard copy. Since then, no effort has been made to organize systematic and permanent monitoring of soils, except certain ad-hoc case studies within various targeted research aiming at a specific soil property. Such a case is the geochemical atlas of the country containing data for the spatial content of heavy metals in soils. Another significant long-term project which lasted for more than a decade, from early 1990s until the begging of 2000s was the Preparation of Land Productivity Map. The main goal of this survey was to identify the production capability of agricultural and forest soils through low-scale field survey. Unfortunately, this project was stopped due to a lack of funds, and data were stored in hard copy in the Ministry of Agriculture, Forestry and Water Economy(MAFWE).

In general, there is insufficient awareness of the need for permanent monitoring of soil properties as a basic step towards its protection from various types of degradation or unsustainable management practices.

Existing data sets are outdated and must be updated and extended with additional data, especially those related to environmental conditions and management practices influencing soil properties.

In the period 2013-2015, a FAO project was implemented, with a general goal to establish a digital geo-spatial database containing all relevant soil data. More than 115 soil maps were digitized and stored into the Sol Information System database, together with numerical data for 4,300 soil profiles with site-specific data and laboratory data (physical, chemical properties and texture) for more than 11,000 soil horizons (metadata are presented in Annex 1).

World Reference Base classification was used to mark each soil-mapping unit indicating certain soil type or complex of soil types. Within this activity, several other products have been developed based on the newly established digital soil database using a digital soil mapping approach: soil organic carbon map, soil reaction map, soil carbonates contents, etc.

The dominant soil types in the country are Cambisols, Fluvisols (Alluvial and Diluvial sols), Regosols and Rendzic Leptosols, covering almost 40% of the country territory (971,769 ha). **Cambisols** are spread over higher altitudes, mostly under forest vegetation. Cambisols are usually deep soils with a well-developed cambic horizon. On inclined terrains, when the vegetative cover is destroyed for various reasons (clear cut, forest fires, etc.), these soils are very prone to intensive processes of soil erosion. **Fluvisols** are fertile soils spread over river sediments in the lowest parts of the valleys or over diluvial sediments eroded from the upper relief forms and deposited in foothills. In general, Fluvisols are the main agricultural soils with high production potential due to their favourable chemical and physical characteris-

tics and proximity to sufficient irrigation water sources. However, these soils are under prominent and constants human pressure, causing fundamental changes in their properties. **Regosols** occupy a huge area of the country (98,410 ha), especially in dry regions on inclined relief forms and moderate vegetation cover. Regosols have a very limited production potential and are usually sown with annual crops, mostly cereals. **Chromic Cambisols on saprolite**, **Vertisols** and **Humic Calcaric Regosols**, in addition to Fluvisols and Regosols, are the most important agricultural soils covering more than 202,623 ha. All three soils are very fertile and, due to their location and production characteristics, are the perfect environment for establishing perennial plantations of orchards and vineyards.

3. Legal framework

In terms of legal documents related to soil, there are no current specific laws or by-laws governing soil-related issues. However, there are several legal acts, which address soils in a more general context. The **Law on Agricultural Land** is more focused on the rights of use, land tenure and concession, and just briefly enumerates the best practices for maintaining soil fertility, with only a few provisions related to protection from soil erosion and fires.

The **Law on Organic Agriculture** and the **Procedures and rules in organic production** define the allowed and recommended procedures and practices on areas certified for organic production. Some of these provisions are addressed explicitly to the protection of soil fertility, soil cultivation, fertilizer use and improvement of soil properties. These provisions are legally binding to organic producers but do not foresee any procedure for monitoring and controlling the implemented practices and their effects on soil. **Law on Agriculture and Rural Development** is another legal document, which considers soil in a more general context *(lex generalis)*. On the other side, the **Law on Consolidation of Agricultural Land** contains legal provisions related to a very sensitive question in the country – agricultural land parcellation. The Law gives legal grounds for the modalities, instruments and procedures of land consolidation.

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Law	Law on Agricultural Land	/	No
Law	Law on Quality and Safety of Fertilizers, Bio-Stimulators and Improvers of Soil Characteristics	/	Partly
Law	Law on Organic Agriculture	Council Regulation (EC) No. 834/2007 on organic production and labelling of organic products	Partly
By-law	Procedures and rules in organic production	/	Partly
By-law	Cross compliance measures	/	Yes
Law	Law on Agriculture and Rural Development	/	No
Law	Law on Consolidation of Agricultural Land	/	Yes

f) Planned transposition of EU legislation

The first attempt for the elaboration of the **Low on Soil Protection** was made by the Ministry of Environment and Physical Planning several years ago. Unfortunately, this draft has never been finalized, so

at the moment, there is no specific law or by-law treating overall issues related to soils in the country. However, there are certain legal solutions that target certain aspects (Law on Water, Law on the Environment, Law on Nature, etc.).

The work plan of the project Promoting Sustainable Land Management (SLM) Through Strengthening Legal and Institutional Framework, Capacity Building and Restoration of the Most Vulnerable Mountain Landscapes envisages to elaborate a new law on soil protection and a soil strategy. Both of these documents will be in line with the EU Soil Thematic Strategy and should outline its general and specific objectives as well give legal grounds for actions that will be foreseen by the Soil Strategy Action Plan. In addition, it is expected that the National Action Plan to Combat Desertification that was prepared several years ago will be adopted by the Government.

Issue	Name of acts (laws and by-laws)	EU legislation	(Remark)
Law	Law on Soil Protection	EU Soil Thematic Strategy	One draft of the Law on Soil Protection was drafted several years ago, taking into consideration provisions from EU Soil Thematic Strategy. The Law is still in draft.

g) Strategy

The Government has recently adopted a Strategy for Agriculture and Rural Development for the period 2021-2027. The Strategy, within a separate chapter, foresees a set of actions and measures towards enforcement of land consolidation, soil protection and monitoring. In addition, the Strategy foresees integrated management of graphical and numerical soil data within a Register of Agricultural Land that will be interoperable with other digital datasets in the country and in regional offices of the Ministry of Agriculture, Forestry and Water Economy. The Strategy strongly supports linking MASIS with national soil laboratories for storing field and laboratory data into a mutual database.

4. Drivers which affect soil quality

Drivers are usually related to specific natural conditions or human activities in different sectors of the country economy, causing the appearance of certain processes of land degradation (e.g., contamination of soil sealing) or accelerating other naturally driven processes like soil erosion, soil salinization, etc.

Concerning natural conditions, North Macedonia has a very diverse topography and relief forms, with high mountains and hills steeply streaming towards the flat bottom of the valleys. Such conditions, coupled with disturbed climate in the past few decades, e.g., air temperatures, rainfall regimes and more pronounced aridity in some parts of the country, are the perfect playground for the appearance of certain land degradation processes, like soil erosion, salinization, soil organic matter depletion, etc.

In the agricultural sector, the main driving forces are related to unsustainable agricultural practices, like small land parcels, mono-cropping, extensive management especially concerning cultivation practices, fertilization and irrigation. Improper cultivation practices can cause compaction and deterioration of soil structure. Long-term mineral fertilization and slash and burn practices cause severe depletion of soil organic matter.

Moreover, schematic application of agrochemicals can cause overuse of these materials and contamination of the environment on one hand, or malnutrition of plants when insufficient quantities are applied on the other. Similar cases of improper management include uncontrolled use of water for irrigation or applied quantities of plant protection substances. Agricultural waste management and the management of organic by-products is another set of pressures rising in the agricultural sector.

Forestry is another part of the country economy that is closely related to land, and many activities and management practices within this sector can cause a severe impact on soil quality. The most pronounced driving forces in this sector are the intensity of harvesting of wood products especially in the case of illegal cuts and harvesting methods applied. In some cases, clear cut of large areas, especially on inclined terrains, can cause the appearance of intense soil erosion processes. Afforestation is not systematic, and the needed post-planting care of the afforested areas is missing in many cases. There is a lack of preventions measures from forest fires. Some years, forest fires damage huge areas of forestland. In such areas where the vegetation has deteriorated, the topsoil can be wiped out within several intensive rainfall events.

Industry and transport are other driving forces affecting soil quality. Uncontrolled construction of infrastructural objects or industrial capacities, and a lack of a systematic approach in the process of urbanization can lead to the conversion of high-quality agricultural land to unproductive land. Moreover, deposition of inert or hazardous material without security and control measures can cause the spreading of contaminants by wind, leaching or runoff, causing contamination of wide areas of land and watercourses. Another pressure that is usually out of the scope of constructors is topsoil preservation. Topsoil is the most valuable and fertile part of the soil. For this reason, when preparing construction plans either for small or big construction, soil management plans must be prepared to indicate key activities and procedures for storage and preservation of this material.

There is no systematic and comprehensive approach in estimating the effects of these drivers on land and their effects on degradation processes, except for certain ad-hoc activities. For this reason, there is no available systematic dataset outlining the pressures.

Municipal solid waste is one of the basic waste streams generating around 713,564.3 t/year. The generated municipal waste expressed per capita is 349 kg/year or 0.9 kg/day. About 77% of the population is included in the public system of municipal waste collection, which is performed by public enterprises. The rest of the population (23%) do not use utilities.

5. The main soil degradation processes

Soil erosion - Erosion is the most dominant process causing land degradation in the country. Natural conditions, like climate conditions, topographical characteristics, vegetation cover, geology and deforestation are the main contributors to the high rate of water erosion. In the western part of the country, as a result of the rough and steep configuration of the terrain, deep erosion processes are dominant, while in the central part, the processes of sheet erosion prevail. The processes of wind erosion are present in this part of the country, but their intensity is rather low and very localized. Mixed soil erosion processes are visible in the eastern part of the country, while gully erosion is spread over the whole territory of the country. The first version of the **Soil Erosion Map** was prepared during the 1980s using the

Erosion Potential Method (Gavrilovic Z. et al. 2008). A new Soil Erosion Map has been prepared recently using the same EPM model for the entire territory of the country and the RUSLE model for agricultural areas. The main findings are that almost 33.57% of the territory (834,130 ha) are affected by the first three categories of soil erosion.

Results from the analysis of soil erosion on agricultural land (RUSLE method) showed that mean annual soil losses on agricultural land are E = 4,1 t/h. The total annual soil losses on agricultural land are calculated at 3.7 million tonnes. It means that erosion control works should be carried out immediately with a high priority on the terrains where soil losses are over 10 t/ha, which cover 88,094 ha.

Soil organic matter (SOM) is a part of soil defining its properties and ecosystem functions. Soil OM is the binding element of soil structure and is related to its physical properties (infiltration rates and increase in storage capacity for water, air regime, etc.). Furthermore, SOM influences soil chemical properties, like soil reaction (pH), nutrient availability, nitrogen and carbon turnover. It acts as energy source for soil micro-organisms, influences soil biodiversity and is responsible for the maintenance of soil ecosystem functions. In essentially warm and dry areas, like South Europe, depletion of SOM can be rapid because the processes of decomposition are accelerated at high temperatures. Soils that are under intensive agricultural production, especially those on sloping terrain with heavy texture and shallow soil profile, are the most vulnerable. There have been recent attempts on a global scale to map SOM content (FAO-GSOC). Our country supported this initiative, and a SOM content map for the whole country was developed within this initiative. Modern approaches of digital soil mapping were implemented, and a high-resolution raster map for the spatial distribution of SOM in the topsoil was the main output. These analyses helped identify areas with the lowest SOM contents. The findings were in line with our expectations, meaning that the most vulnerable areas with the lowest SOM contents are the agricultural soils, especially those in the central and eastern parts of the country. However, all estimations were made mostly on a quite outdated soil dataset. Keeping in mind that SOM content is a very dynamic category, a continuous and comprehensive monitoring programme should be put in place to monitor and preserve this precious part of the soil.

Soil sealing - The greatest impacts of soil sealing are observable around the biggest urban areas. Rural populations migrate to the cities, and new suburban settlements are developed. Urbanization is one of the dominant processes of the social and economic development of the country. The biggest cities become the main industrial and economic centres of the regions, where most of the population is employed. In an environment of low developed transport infrastructure, the only way is for the employees to move to suburban areas causing significant conversion of arable land. Although cities are uniformly distributed, the population density is not uniform. An obvious expansion of the concentration of population and settlements is noticeable in valleys, creating a strong conflict among the initiatives for the protection of high-quality arable land and agricultural development on one hand, and the necessity of urban development on the other. Soil sealing in the country has not been defined yet. One of the main reasons is inappropriate historical data. According to some recent investigations, the permanent increase of population in Skopje region results in radical sealing of agricultural land. The mean annual rate of soil sealing for the whole Skopje region is 0.14% (Trpcevska-Angelkovic, 2014). A notable fact is that the mean annual decrease of agricultural land is 0.57%, out of which 0.24% is arable land.

However, urbanization and industrialization are inevitable processes. Therefore, a compromise solution needs to be found in order to overcome the conflict. The best way for all stakeholders is to identify the most suitable areas for urbanization, construction of infrastructure, industry, avoiding high-quality soils, protected areas, preserving biodiversity and taking care of human wellbeing.

Excess use of agrochemicals - The term agrochemicals generally encompasses two groups of chemicals used in the common agricultural production: mineral fertilizers and pesticides (insecticides, her-

bicides, fungicides, etc.). According to older data (NEAP, 1997), a significant decrease in the usage of fertilizers and pesticides for the period 1982-1993 is registered (mineral fertilizers 43,000 t – 24,000 t, nitrates 35,000 t – 48,000 t, pesticides 2,706 t – 659 t), but it is a result of a transitional period, economic crises and not because of ecological awareness. The awareness of the operators in terms of the major aspects of fertilization, like the selection of appropriate fertilizer formulation, quantities, time and techniques of application, is insufficient.

Commonly, fertilizers are applied with no previous chemical analysis of soil parameters and fertilization plans. Official statistical data, or any other relevant source of information, for the amount of fertilizers used in agriculture in the country, do not exist. Estimates for the common use of agrochemicals are based on direct contact with operators and data collected from questionnaires from several monitoring campaigns. In the past several years, River Basin Management Plans have been prepared for four major catchments or sub-catchments: the Bregalnica river catchment; the Strumica River catchment; the Lake Prespa catchment and the Lake Ohrid catchment. In order to quantify the diffuse contamination arousing from agricultural soils, more precise estimations have been made for the quantities of agrochemicals applied. For instance, in the Bregalnica catchment (51,000 ha arable land) the total amount of nutrients was estimated at 11,300 t/year or, more than 221 kg/ha/year/ of pure nutrients (NPK). The total quantities of pesticides were estimated at 371.1 t/year or 7.4 kg/ha/year. In Ohrid lake catchment, on a total arable area of 6,689.3 ha, total quantities of nutrients are 1,062.2 t/year or 158.79 kg/ha/year and applied pesticides are estimated at 31.66 t/year or 4.66 kg/ha. Obviously, pressures are different among regions, which is the result of land use, cropping patterns and management practices. The highest levels of nutrients are detected in the Lake Prespa catchment with more than 1,900 t/year on an area of 1,200 ha, or more than 30 kg/ha/year of pure substances.

Soil compaction - Soil compaction occurs when soil is subject to mechanical stress caused by use of heavy machinery or overgrazing, especially in wet soil conditions. A very common problem is the compaction of the soil layer just below the ploughing depth (plough pans). This compacted layer reduces soil permeability and crop yield. The problem of soil compaction is present in the country, particularly on agricultural soils cultivated with heavy machinery. Unfortunately, there is insufficient research in the country to produce soil compaction map or to estimate the area affected by soil compaction.

Soil contamination - According the data by Ministry of Environment and Physical Planning, about 27 million tonnes of waste are generated each year. Out of this, 66% is generated from mining and mine industry, 21% from agriculture, 8% is energetic hazardous waste, 3% is communal waste, etc. On dumpsites or hot spots more than 267.6 mil. m^3 of hazardous waste is deposited, covering 259 ha of land. Soil contamination with heavy metals started when more intensive industrialized forms of mining and smelter activities begun in the country. In the past decade, a significant and intensive field survey has been accomplished by a group of national and international experts, quantifying heavy metal contents, globally at the country level (5x5 km^2). Separate studies for the most polluted sols around specific hot spots (Stafilov, T, 2010, 2011, 2013, 2014, 2015 and Bacheva, K. at all, 2014) were performed as well. These studies give an in-depth estimation of the spatial distribution of more than 39 elements around the main hot spots as well as the quantities of ore tailings deposited on dumpsites.

6. Problems with soil management

1. Agriculture and forestry

   Mismanagement of agricultural land – most common soil cultivation practice is mouldboard ploughing, which permanently mixes the top soil layer, exposing it to increased aeration and leading to soil organic matter loss, downslope cultivation, causing losses of fertile topsoil, deterioration of natural vegetation and biodiversity loss.

   Artificial fires – burning of post harvesting organic material causes reduction of organic matter in the soil, depletes reserve soil moisture and increases land degradation in the burned fields. Such practices imply security risks for the environment. Getting out of control, they can affect the neighbouring natural vegetation (forest, shrubs, etc.).

   Crop rotation – large areas under monocultures lead to exhaustion of plant nutrients, depletion of soil organic matter and ruining of soil structure.

   Fertilization practices – schematic inputs of several formulations of mineral fertilizers without previous laboratory soil testing and preparation of fertilization plans can cause imbalance of nutrients, deactivation of micronutrients and soil fertility decreases. The use of organic fertilizers (manure, composted organic matter) is limited to small areas and practiced almost only by farmers growing vegetables.

   Losses in agricultural biodiversity – local varieties and populations of agricultural crops are abandoned, farmers change to modern varieties that need higher investments in production and sometimes lead to unsatisfactory results.

   Irrigation mismanagement – irrigation systems are not adequately managed, due to which they cannot provide needed services to producers. On farm level, although in the past years the majority of farmers have been willing to instal modern irrigation systems, there is still a big gap of knowledge on how to apply control mechanisms for effective irrigation scheduling.

2. Industrial activities, waste and mining cause significant soil degradation, primary soil pollution, but also erosion and sedimentation.

3. Construction activities have a significant impact on soil characteristics on construction sites, especially on topsoil loss or mixing with inert or polluting materials. Soil erosion is a dominant problem, especially on unprotected construction sites. Based on expert knowledge, there are a lot of unprotected or inappropriately protected slopes on dumpsites, stockpiles, excavation sites, earth fills, etc. A significant problem is the deposition of material from excavation or simply dumping of material on the nearest slopes, causing artificial talus cones that, in the case of intensive rainfalls, move downstream. Preparation of a soil management plan or erosion and sediment control plan is not obligatory according to legislation.

7. Capacity assessment of the country to deal with sustainable soil management

On the administrative level, the responsible authorities are the Ministry of Agriculture, Forestry and Water Economy (MAFWE) with its Sector for Land Consolidation, Exchange and Identification of Land Parcels, which is responsible for activities related to land consolidation, land parcel identification system (LPIS) and record keeping for the land given under concession to private agricultural producers. In addition, MAFWE, through its programme of subsidies, supports a measure of laboratory testing of soils under perennial plantations. The Ministry of Environment and Physical Planning, within its Sector for the Environment, has a Land Department. The main responsibilities of the Land Department are to prepare strategic documents, laws and by-laws related to land, transposition of international and EU legislation and protection of land as invaluable natural resource.

Technical capacities related to soil and soil monitoring are concentrated in research and education centres of universities. Within the Ss Cyril and Methodius University, there are four institutions that have the capacities for soil survey and research in the area of soils. Institute of Agriculture, has four employees (three PhDs and one technician) in the Department for Soil Science and Plant Nutrition. This Department is in charge of field survey and cartography of soils, preparation of technical reports, fertilization programmes, laboratory testing of soil testing, fertilizer and plant material. In addition, it is in charge of hosting and maintenance of MASIS. This Department has a well-equipped soil testing laboratory and field survey equipment and needed hardware and software solutions for implementing digital techniques in soil surveying. The Faculty of Agricultural Sciences and Food has two departments related to soils. The Irrigation Department with two PhDs and one technician, with well-equipped laboratories for the examination of physical soil properties, and the Department of Soil Science with two PhDs and one technician. This department has a small laboratory for testing basic soil properties. The Faculty of Forestry has a Department of Soil Science with one PhD, one assistant and one technician. This department has a moderately equipped laboratory for educational purposes. In addition, this Faculty has a Department for Geodesy and Soil, with two PhDs and one assistant. This department has a sound capacity in GIS and RS and environmental modelling, especially in the area of soil erosion.

Another sound institution with capacities in the area of soil science is the Faculty of Natural Sciences – Institute of Chemistry. This Institute has a broad experience and well-developed capacities in field survey and laboratory testing of heavy metals in soil.

The Tobacco Institute within the St. Kliment Ohridski University has a Department for Soil Science and Plant Nutrition with four employees, three PhDs and one technician. This Department is in charge of monitoring soil properties on tobacco fields and offers services for tobacco producers in the preparation of fertilization plans and best management practices for quality preservation.

8. How can the problems be overcome regionally?

The UNCCD is the only global initiative focusing on land degradation issues. Land degradation was neglected for a long period of time and was considered a national problem and not included in the global mainstream.

In the past decade, several initiatives might be considered as cornerstone, contributing to the overall perspective on land related issues.

One significant step forward is the Global Soil Partnership initiative released under the umbrella of FAO, and its counterpart for Europe, the Europe Soil Partnership. Both networks can serve as a good example of how global or regional networking can contribute towards coping with issues related to land degradation.

With regards to the regional integration of the countries gathered around this activity, there is a good common ground for integration, having in mind the same/similar soil science history, similar methods of soil survey and investigation, similar datasets, common environmental conditions and problems related to land degradation, and very similar capacities and administrative setups.

Having in mind all these aspects, initial steps toward integration and collaboration should focus on the following:

1. Based on these initial baseline reports, the most important land degradation aspects should be identified for each country or group of countries
2. Harmonization of national datasets in case of different laboratory methods, soil survey methods, classification, etc. following GSP experiences
3. Adoption of standard methodologies for harmonized monitoring (field and laboratory), and for data formatting and storage
4. Development of a regional hub for data storing and data sharing procedures
5. Networking with similar regional and global soil networks
6. Mutual field survey campaigns and regular meetings of experts for sharing experiences and know-how
7. Regular training sessions and exchange for young scientists
8. Establishment of regular procedures for laboratory inter-comparison
9. Application for different programmes with project proposals

Summary of soil and land data availability

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Soil maps	MASIS (www.maksoil.ukim.mk)	UKIM – Institute of Agriculture/Ministry of Agriculture, Forestry and Water Economy	Soil types (WRB) Soil texture and chemical properties (mandatory) Soil physical properties (sporadically)	Decades/in one occasion	Country level - separation in a fishnet of cartographic units	1:50000		Yes
Land use	Land parcel identification system (LPIS)	Ministry of Agriculture, Forestry and Water Economy (MAFWE)	Cropping pattern	Yearly	Parcel (agricultural land)	5m pixel size		Yes
Land cover	CORINE Land Cover	Ministry of Environment and Physical Planning	Land cover categories	6 years	Country, region/municipality/parcel	1:100000		Yes
	LandSat and SENTINEL images photointerpretation	Ministry of Environment and Physical Planning (MoEPP)	IPCC land cover categories	Yearly	Country, region/municipality/parcel	30/10 m pixel size		Yes
Soil physical properties	MASIS/standard soil survey methodology (SSSM), Occasional Field Surveys/SSSM	UKIM – Institute of Agriculture UKIM – Faculty of Agricultural Sciences and Food	Texture and physical properties (hygroscopic moisture, bulk and real density, porosity, wilting point, water retention capacity, air capacity, field capacity)	Decades/ sporadically	Country/region	1:50000 1:10000		Yes
	Land production capability/SSSM	MAFWE	Texture	Country/ region	Country/region	1:1000 1:5000	Yes	
Soil chemical properties	MASIS/SSSM Occasional Field Surveys/SSSM	UKIM – Institute of Agriculture UKIM – Faculty of Agricultural Sciences and Food	Carbonates (CaCO3), soil reaction (pH), Soil Organic Matter (SOM), Total nitrogen, Cation Exchange Capacity (CEC)), Hydrolytic acidity, Base saturation, easily available P, and K)	Decades/ sporadically	Country/region	1:50000 1:10000		Yes
	Land production capability/SSSM	MAFWE	Carbonates (CaCO3), soil reaction (pH), Soil Organic Matter (SOM), Total nitrogen, easily available P, and K)	Country/ region	Country/region	1:1000 1:5000	Yes	
Erosion	UNEP Project/Erosion Potential Model	UKIM Faculty of Forestry UKIM – Institute of Agriculture	m^3/ km^2	Sporadic	Country	1:50000		Yes
	UNEP Project/RUSLE	UKIM Faculty of Forestry UKIM – Institute of Agriculture	Ton/ha/year	Sporadic	Country/agricultural land	1:50000		Yes
Soil organic carbon loss	Third National Report to CC/FAO methodology UNEP Project/ FAO methodology	MoEPP/UKIM-Institute of Agriculture	SOM in %	Sporadic	Country/region	50 m pixel size		Yes

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Compaction	No data							
Contamination	Geochemical Atlas of North Macedonia	UKIM Faculty of Natural Sciences	Spatial distribution of 39 elements, in % and mg/kg	Sporadic	Country/region	5 km mesh	Yes	
Soil sealing	UNEP Project/ Estimates in GIS environment	UKIM Faculty of Forestry UKIM – Institute of Agriculture	Surface area in ha lost on three pilot sites	Sporadic	Regions/Parcel	30 m pixel size		Yes
Salinization	MASIS/ SSSM	UKIM – Institute of Agriculture UKIM – Faculty of Agricultural Sciences and Food						
Acidification	No data							
Soil biodiversity	No data							
Drought and Drought sensitivity	UNEP Project	National Hydro-Meteorological Service/ Aridity Index	Area in ha under different category of aridity	Sporadic	Country/region	30 m pixel size		Yes
Floods	Case studies/Horological models	Private companies	Area in ha prone to floods	Sporadic	Regions	5 m pixel size		Yes
Desertification	UNEP Project	National Hydro-Meteorological Service/ Aridity Index	Area in ha under different category of aridity	Sporadic	Country/region	30 m pixel size		Yes

SERBIA SOIL REPORT

Prepared by
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1. Land use and land cover in the country

Two large areas are prominent in the territory of the Republic of Serbia – the Pannonian and the hilly-mountainous area, with numerous subareas. Based on their potential, two areas are generally distinguished according to the specific type of land use, while arable land dominates in the north(Region of Vojvodina, Mačva, Šumadija and the Podunavlje district). In other parts of Serbia, fruit and field crop production dominates, along with pastures and forest soils on fragmented plots. Depending on the data source, forest vegetation occupies roughly between 29.1% (LEIWW, 2017) and 39.96% (SEPA, 2020) of the total territory. There is a significant difference in land use statistical data, data from official institutions and data from CORINE Land Cover 2012 and 2018 databases. Urban areas cover about 3.6% of the territory. Based on data from the Strategy of Agriculture and Rural Development of the Republic of Serbia for the period 2014-2024 (SARDRS 2014) approximately 5.06 million hectares of agricultural land covering 65.21% of the territory (7,759 km^2) was recorded in Serbia. A total of 71% of agricultural land is under intensive use (arable land, orchards and vineyards), while 29% of agricultural land is composed of meadows and pastures. Most agricultural land is used as arable land (3.3 million hectares or 65%), while about 7% is not used regularly. The utilised agricultural area consists of fruit plantations or orchards at 5.3%, vineyards at 0.6%, permanent grassland at 9.9% and pastures at 9.5% of the total area. In the structure of cultivated arable land, cereals participate with 65.9%, industrial crops with 19.0%, vegetables with 1.9%, and forage crops with 9.4% (Statistical Yearbook 2020). The Republic of Serbia has 500,000 hectares of state-owned agricultural land, of which 90,000 hectares are pastures, which means that 410,000 hectares of state-owned arable land is available. The total area of converted agricultural land for the period 2000-2012 averages 0.065% (SEPA, 2016).

Currently, the approximate irrigated area in the Republic of Serbia amounts to 70,000 hectares, of which over 58,000 hectares are located in Vojvodina. Concerning the total agricultural area used, irrigation covers about 1.30% of the area, while the dominant sources of irrigation are watercourses 94% (Statistical Yearbook, 2012). The main areas under irrigation are mainly in the Vojvodina plain, whereas the bulk of its infrastructure was built during the former Socialist Federal Republic of Yugoslavia. Based on the presented Analysis of Water Availability (SIRS, 2020), in Vojvodina, the total area of about 450,000 ha is estimated as suitable for irrigation, while smaller areas in the rest of the country, totalling about 54,000 ha, could be irrigated under the condition of multipurpose reservoir construction and use of groundwater.

2. General assessment of available data

The natural pedodiversity of Serbian land resources is marked by a turbulent geological past. According to the main Pedological Map of Serbia (1: 50,000) and the national classification (Skorić, 1985), there are over 700 cartographic units of different soils. Generally, harmonizing the map with the simplified international WRB (2015) classification, the largest area of arable soil in our country, namely 28% of

the entire area, is composed of Cambisols. Cambisols are commonly found in all parts of the Mediterranean, but they are considered endemic in some parts of Central Serbia. In Central Serbia, Cambisol is the dominant type of soil, with a share of about 38%. Cambisols were formed in a complex process of pedogenesis through the interaction of climate, vegetation and geological background. Before the establishment of agricultural production, they were under deciduous, mostly oak forests, with a significant share of grass communities. As acidic soils with low phosphorus content, Cambisols are suitable for viticulture – fruit production. Chernozem, which covers 18% of Serbian territory, is considered "perfect" for vegetable production, as well as for production under irrigation. This soil type was formed on the geological base of the loess, and has a weak alkaline to alkaline pH reaction. It occupies 60% of the area in the Autonomous Province of Vojvodina. Alluvial soils – Fluvisols - originate from alluvial sediments of rivers and occupy 8% of the area of Serbia. These soils are layered, and have a high content of sand and gravel. As the cities were most often founded in the valleys of large rivers, the two largest Serbian cities, Belgrade and Novi Sad have significant areas under this type of soil. Vertisols – heavy, clayey soils mostly formed on lake clays – occupy 8% of the area of Serbia. Vertisols are fertile soils but are difficult to cultivate. Most commonly found uncultivated soils are Leptosols, and they represent the skeletal lands of hilly and mountainous areas, which occupy 16% of the territory of Serbia. These shallow soils (up to 20 cm), somewhere under grassy vegetation, can be used as pastures. Podzols, Phaeozems and Umbrisols are distributed over limited areas in the country, with 3.5%. Saline soils in Serbia are present at about 1.5%, with 99.94% of saline soils located in the northern part of the country – the Autonomous Province of Vojvodina. Pedological maps of Serbia were digitized as a polygon vector layer and need to be verified for topological errors.

Fertility control of agricultural land in Central Serbia has revealed that acidic soils generally dominate this area (SEPA, 2016). In terms of $CaCO_3$ content, these soils are primarily non-calcareous or low calcareous. The highest percentage of the soils in the studied area have a poor or medium humus content, with a very low or low content of readily available phosphorus and an optimum or high content of readily available potassium. In contrast, soils studied in the Autonomous Province of Vojvodina are high-pH, low calcareous or calcareous soils, with a poor or medium humus content, an optimum content of readily available phosphorus, and an optimum or high content of readily available potassium (Milic et al. 2011).

Several institutions collect data on soil quality: the Ministry of Agriculture, Forestry and Water Management, the Ministry of Environmental Protection, the Secretariat for Agriculture of AP Vojvodina, the Soil Institute Belgrade, the Institute of Field and Vegetable Crops Novi Sad, and agricultural services (AS).

The law prescribes the obligation of land control to each land user, the obligation to control the fertility of arable land according to fertility parameters – basic chemical properties (once in 5 years), which are collected in a common database in the Directorate of Agricultural Land of the Ministry of Agriculture, Forestry and Water Management. The establishment of an information system (database) and the creation of a network of authorized laboratories for testing the fertility of arable agricultural land is currently in progress. There are also data on other parameters of land quality through supported scientific projects, but for now, they are not centralized. These analyses are mostly financed from the state budget. The establishment of an information system and a network of laboratories authorized for arable land and land conversion analysis is currently in process. There are also data on other parameters of soil quality through supported research projects, but they are not centralized. In addition, several scientific projects are aimed at determining the natural concentration of PTEs (potentially toxic elements) in soil, covering different parts of Serbia, but data are not unified or methodologically harmonized.

The Ministry of Environmental Protection, the Environmental Protection Agency (SEPA) as well as the Provincial Secretariat for Urban Planning and Environmental Protection carry out partial monitoring

of agricultural and non-agricultural land, land quality in landfills and illegal dumps, monitoring of vulnerable places (hot spots), assessment of quality, and assessment of the degree of vulnerability of land in the scope of projects for individual municipalities as well as through reports on the environment at the national level. For data collection purposes, the Environmental Protection Agency has developed a centralized information system for environmental protection, which contains soil data in addition to other parameters of environmental monitoring. In addition, as of January 2022, the regulation on systematic monitoring of soil condition and quality will be in force, which will include soil monitoring, methodology for systematic monitoring of soil quality and condition, criteria for determining the number and distribution of measuring points, list of parameters per soil types, list of methods and standards used for soil sampling, analysis of samples and data processing, scope and frequency of measurements, indicators for assessing the risks of soil degradation, deadlines and method of data submission.

3. Legal framework

Management, protection and preservation of land resources in the Republic of Serbia are regulated by the following laws: the Law on Forests, the Law on Agricultural Land, the Law on Spatial Planning and Construction, the Law on Land Protection, the Law on Environmental Protection, etc. Having in mind that the major part of the territory of the Republic of Serbia consists of forests and forest land and/or agricultural land, legal regulations in the field of forests and agriculture, environmental and nature protection constitute the primary and most important legal field in exploitation, management and preservation of land resources. There are several laws and acts under development, in order to produce new legal regulations in the Republic of Serbia. The legislation is being harmonized with that of the European Union as a prerequisite for accession to the EU.

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Official Gazette of RS, No. 62/2006, 65/2008 -other law, 41/2009, 112/2015, 80/2017 and 95/2018 - other law	Law on Agricultural Land		Partly
Official Gazette of RS, No. 41/2009, 10/2013, and 101/2016, 67/21 - other law	Law on Agriculture and Rural Development		Partly
Official Gazette of RS , No. 10/2013, 142/2014, 103/2015 and 101/2016)	Law on Incentives in Agriculture		
Official Gazette of RS, No. 135/2004, 36/2009, 36/2009 – other law, 72/2009 – other law, 43/2011 – decision of the Constitutional Court, 14/2016, 76/2018, 95/2018 - other law	Law on Environmental Protection (Official Gazette of the RS, No. 135/2004, 36/2009, 36/2009 – other law, 72/2009 – other law, 43/2011 – decision of the Constitutional Court, 14/2016, 76/2018, 95/2018 - other law)		Yes
Official Gazette of RS, No. 30/2010, 93/2012, 89/2015 and 95/2018 - other law	Law on Forests		Partly
Official Gazette of RS, No. 112/2015	Law on Soil Protection		Partly

Issue	Name of acts (laws and by-laws)	EU legislation	Harmonized with EU regulation (Yes / No / Partly)
Official Gazette of RS, No. 23/1994	Rulebook on permitted quantities of hazardous and harmful substances in soil and water for irrigation and methods of their testing		Partly
Official Gazette of RS, No. 30/2018 and 64/2019	Regulation on limit values for pollutants, harmful and hazardous substances in soil		Partly
Official Gazette of RS, No. 102/2020	Rulebook on the list of activities that may cause soil pollution and degradation, the procedure, data content, deadlines and other requirements for soil monitoring		Partly
Official Gazette of RS, No. 88/2020	Regulation on systematic monitoring of the condition and quality of soil		Partly
Official Gazette of RS, No. 58/2019	Rulebook on the content and manner of keeping the Cadastre of Contaminated Sites, as well as type, content and forms, manner and deadlines for delivering the data		Partly
Official Gazette of RS, No. 62/2020	Rulebook about the content, procedure of preparation and adoption of the land consolidation programme		No obligation
Official Gazette of RS, No. 85/2020	Rulebook on the content of technical documentation for performance of geodetic-technical works (projects) in land consolidation		No obligation
Official Gazette of RS, No. 102/2020	Rulebook on conditions for preparation of a project for conversion of arable agricultural land		No obligation
Official Gazette of RS, No. 128/2020	Rulebook on conditions for the development of a project for improving the quality of arable agricultural land		No obligation

a) Planned transposition of EU legislation

Issue	Name of acts (laws and by-laws)	EU legislation	(Remark)
In process	Draft Law on Environmental Liability	The Environmental Liability Directive 2004/35/EC	The ELD Directive is in initial stage of transposition
Official Gazette of RS, No. 27/2018	Law on the National Spatial Data Infrastructure	INSPIRE Directive 2007/2/EC	Fully transposed
Official Gazette of RS, No. 135/2004 and 25/2015	Law on Integrated Pollution Prevention and Control	Industrial Emissions Directive 2010/75/EU	Not fully transposed yet
In process	Rulebook on the code of good agricultural practice	Nitrates Directive 91/676/EEC	Alignment is in the initial stage
Official Gazette of RS, No. 135/04 and 36/09	Law on Environmental Impact Assessment	Environmental Impact Assessment Directive (85/337/EEC)	Almost fully transposed into the national legislation
In process	National Sludge Management Strategy	Sewage Sludge Directive 86/278/EEC	The process of harmonization is in the initial stages of implementation
In process	-	Regulation (EU) 2017/852 on mercury	National legislation is at the initial stages of alignment with the new Regulation on mercury
Official Gazette of RS, No. 10/2013, 142/2014, 103/2015 and 101/2016	Law on Incentives in Agriculture	EU Common Agricultural Policy (CAP)	Amendments to this act are being drafted, which partly refers to harmonization with EU regulations

b) Strategy

The major challenges of the agricultural sector, such as climate change, market liberalization, high food safety standards, environmental pollution and rural depopulation, have an impact on the position of farmers, farms, entrepreneurs and all rural residents. The Republic of Serbia attempted to address these challenges by defining the Strategy of Agriculture and Rural Development of the Republic of Serbia (2014–2024). This document establishes the foundation of the new agricultural policy of the Republic of Serbia, defined in accordance with the principles of modern policy management and gradual adoption of the European model of agriculture. In addition to economic goals (growth of production, stability of producers income, growth of market competitiveness), strategic soil management goals include sustainable resource management and environmental protection and improvement of the quality of life in rural areas. The implementation of the concept of sustainable development in agriculture and realization of the goals set within the strategy, i.e. soil management policy, are directed towards efficient soil management and increased availability of land resources: 1. higher use of agricultural land; 2. increase of land ownership and consolidation of plots; 3. establishment of a functional market; 4. improvement of soil infrastructure; 5. increase of ameliorated areas and improvement of soil fertility; 6. acceleration of property restitution – restitution (including cooperative property) and (re)privatization; 7. reduction

of soil loss and degradation; 8. controlled conversion of agricultural land; 9. more efficient use of land of lower quality, i.e. uncultivated agricultural land; 10. systematic monitoring of soil quality; 11. establishment of an efficient soil management system (cadastre, GIS, LPIS). Based on the set goals, it can be concluded that the strategy is focused on more intensive land use rather than on land conservation.

The strategy was not drafted in accordance with the Law on the Planning System of the Republic of Serbia (Official Gazette RS, No. 30/18). It has a complex structure of five strategic goals (aims), six pillars of reform, as well as 14 strategic priority areas (objectives), under which the so-called operational goals ""are defined (which should be measured in accordance with the said law). Such a complex structure of goals greatly complicates the implementation and monitoring of the strategy (Dragutinović and Bogunović, 2018).

4. Drivers which affect soil quality

Many unsustainable activities, such as excessive ore extraction, inappropriate cultivation practices, non-regeneration and deforestation, and uncontrolled waste disposal, have a detrimental impact on soil quality in the Republic of Serbia. In general, soil degradation in the Republic of Serbia is considered a growing environmental and socio-economic concern. As a result, the existing and prospective areas for agricultural production are decreasing, and their properties are deteriorating.

A total of 422 potentially contaminated and contaminated localities have been identified in the Republic of Serbia. The largest share in the total number is that of public utility landfills with 43.13%, followed by industrial and commercial sites with 36.30% and industrial waste landfills with 10.43%. The largest share within the industry is that of the oil industry with 41.89%, followed by the chemical industry with 14.41%, the metal industry with 11.71% of localities, a slightly smaller percentage are energy plants with 8.57% and mines with 4.50% of localities.

Forests and forest land in general greatly contribute to the preservation of land and the environment. One of the important contributions of forests is the protection of land, settlements and infrastructure from erosion and landslides. According to the National Forest Inventory (MAFWM 2008), only 29.3% of the total area of the Republic of Serbia has been afforested, while the National Spatial Plan defines the optimum level at 41.4% . In the region of Vojvodina, the situation with afforested area is even less favourable, as it covers no more than 7% of the total area. As envisaged in the plan of the Public Utility Enterprise Vojvodinašume, afforestation is expected to increase to 14.32%, in accordance with the standards of developed countries in Europe. Inadequate and uncoordinated felling leads to deterioration of physical water and air properties of soils. Forest ecosystems reduce or completely eliminate runoff which leads to soil erosion. Intensive erosion results in torrential watercourses – waters burdened by erosional deposits with an extremely destructive force that destroys settlements, roads, industrial plants, and arable land, often causing human fatalities. Torrential floods in Serbia, an example of which were the floods in May 2014, are the most common natural disaster with estimated damage, according to the Government of the Republic of Serbia, of 1.5 billion EUR (Report on the Floods in Serbia 2014).

Deterioration of soil properties is equally contributed by activities in agricultural production: chemical fertilization, extensive mechanization, disrespect of crop rotation, lack of application of organic fertilizers and soil rest, which mostly negatively affect chemical and physical properties and a general de-

crease of soil biological potential. Intensive cultivation practices are characterized by the application of mechanization with increased mechanical strength, which introduces major changes into agricultural practices and lead to deterioration of soil physical properties (structure and volume mass), as reflected in water, air, heat and biological soil regime. Soil physical and chemical properties also deteriorate due to a decrease in the content of organic matter, caused by intensive cultivation practices and removal of crop residues, their burning and lack of organic fertilization. In addition to the more rational use of mechanization, the issues arising in agriculture must be addressed by introducing innovative cultivation practices – land rest, establishment of pastures and meadows, cover crops – aimed at increasing soil organic matter and improving soil physical and chemical properties.

5. The main soil degradation processes

A major form of degradation of agricultural land in the Republic of Serbia comes from the loss of organic matter. This worldwide issue is caused by intensive agricultural production, intensive tillage, the lack of organic fertilization, irrigation, removal of crop residues or their burning, as well as other unsuitable cultivation practices. The situation in our country is even more complex because of the significant reduction in livestock and a long-term lack of application of organic fertilizers (Statistical Yearbook, 2012). In the 1950s, more than 70% of Vojvodina soils were high in humus, while today, the share of such soils is inconsiderable. About 46.2% of Vojvodina soils are low in humus, whereas 53.3% can be classified as humus soils. The trend of organic matter loss continues to grow. Vojvodina, as the least forested region in Europe, is turning from a former European granary into something of an agrarian desert. Data obtained from systematic fertility control were used to calculate the content of organic carbon in the surface layer of soil in Central Serbia in the period 2010-2018. The analysis conducted on a large number of samples from the control of fertility of agricultural land shows that most samples had the content of organic carbon ranging between 1 and 2% (SEPA 2019). In general, the distribution of the content of organic carbon in the soil surface layer shows higher values in Central Serbia, where forest land occupies a larger area than agricultural land. On 50% of the territory of Serbia, the content of organic carbon in the soil surface layer does not exceed 2%. Reserves of organic carbon content in the surface layer of soil (0 - 30 cm) are 40.71% higher in forests and semi-natural areas compared to agricultural land.

The loss of organic matter also contributes to another major degradation – soil erosion. It has been estimated that 80% of agricultural land deteriorates due to soil erosion of varying degrees. Water erosion is the predominant negative factor in central and hilly-mountainous regions, while in Vojvodina, aeolian erosion dominates, endangering about 85% of agricultural land (Baumgertel et, al. 2019). In addition, great danger comes from landslides in one-third of the area of Serbia. In view of climate change, this risk is increasing due to extreme rainfalls, which we, unfortunately, witnessed during the 2014 floods. One of the most pronounced forms of soil degradation is soil erosion. Land loss caused by erosion is one of the current problems in the world and in the Republic of Serbia. According to estimations, about 1.3 million km^2 of European surface can be damaged by erosion. Average land losses in the Western Balkans are 7.13 t/ha per year (LEIWW, 2017). Soil erosion of different types and intensity affects about 90% of the total area of the Republic of Serbia. Assessment of land loss and establishment of a system of protection against erosion is of strategic importance for ecosystems, economy, spatial planning, and the environment. The most significant anthropogenic factors influencing the development

of erosion processes are deforestation and destruction of forests, inappropriate cultivation practices, inadequate soil cultivation, intensive grazing and animal husbandry, and uncontrolled urbanization and industrialization. The Law on Soil Protection from 2015 envisages the preparation of an erosion map of the Republic of Serbia which would identify the most endangered areas (from weak to excessive erosion) and help decision-makers at the local and regional levels in choosing appropriate anti-erosion measures. The last map of soil erosion in the Republic of Serbia was made in 1974, with only slight modifications thereafter.

Land-use conversion is also one of the major threats to soils worldwide. In our country, there is a trend of loss of pastures due to the devastation of livestock production and a great need for arable land. The use of pastures for tillage results in increased soil erosion and loss of biodiversity. Pastures, as well as mixed agricultural areas, are also lost due to urban construction.

The first association to environmental degradation is pollution. This issue is certainly as important as the previously described ones, but in our country, the situation generally is not so unfavourable. Pollution in Serbia is mainly caused by various air pollutants, inadequate application of agrochemicals (fertilizers and pesticides), irrigation with poor quality water, mining industrial complexes and waste disposal. According to data from 2018, 709 potentially contaminated soil locations have been identified and recorded in Serbia, of which 557 have been registered as contaminated (SEPA 2018). Numerous locations have been restored in the process of more detailed characterization. Contaminated sites mostly represent former industrial complexes (historical pollution), public-communal landfills, illegal landfills, spills and other incidents. Based on many years of research by several institutions, the soils of Serbia do not have an increased content of potentially toxic elements (heavy metals). Some micro localities are polluted as well as larger areas high in nickel and chromium of geochemical-natural origin from the parent substrate, especially on serpentine rocks of the mountains of western Serbia. According to research, nickel and chromium of geochemical origin are not included in the food chain, nor do they have an increased content of potentially toxic elements (heavy metals).

Regarding the application of chemicals, the electronic record-keeping system on the amounts of applied fertilizers and pesticides for each plot has not yet been established in Serbia. By the functional establishment of this system, real data on the consumption of agrochemicals would be obtained, and possibilities for their rationalization would be assessed. A long list of organic soil pollutants, such as antibiotics, micro-plastics, phthalates, incomplete combustion products and hydrocarbons, are monitored to a lesser extent in the Republic of Serbia. The companies which potentially emit soil pollutants are obliged to monitor their emissions and effects on the soil.

Soil degradation leads to the loss of both biodiversity and the entire ecosystem. In our country, systematic monitoring of biodiversity and more detailed identification of the soil taxonomic profile of microbiological communities and fauna is still carried out sporadically through scientific activity, but no consolidated or indicative data on soil biodiversity exist, especially in terms of micro and mesofauna.

Numerous threats to soil quality come from other forms of degradation. Soil acidification in Central Serbia and steady soil alkalization and salinization in Vojvodina, although not easily identifiable, must be closely monitored because they can be intensified due to climate change.

Finally, in view of climate change and higher population density in cities, the so-called urban land must be reconsidered in the context of soil heat and water capacity. Excessive construction in open city spaces causes soil sealing. Reflection of sun rays and temperatures above concrete materials are much higher than above soils, especially soils under vegetation. Also, soils have a much higher atmospheric water absorption capacity than drainage systems in urban areas. Following the example of European cities, it is necessary to identify parts of the cities, especially thermal islands, where concrete can be removed, and permanent or partial vegetation with permeable substrates restored.

6. Problems with soil management

In the parts on soil degradation processes and drivers which affect soil quality, basic concepts are discussed and the main problems described related to soil mismanagement practices in Serbia. For a better understanding of Serbian agriculture, we have to turn the focus on agricultural producers, their land and some missing links in soil management that can have a significant impact on Serbian land use.

Although agriculture is the driving force of economic activity in Serbia, with the growth of 4%, the population in Serbian villages is reducing due to migration to urban areas, population ageing, lack of modernization and poor infrastructure. Agricultural producers in Serbia have a four times lower life standard compared to farmers in the EU. Income in rural households is low and mostly (35–47%) made up of employment-based income (steady or additional) and an increasing share of pensions. In Serbia, small households with low areas suitable for agricultural production prevail. The average size of utilized arable land per farm is 5.4 ha, 99.6% of which belong to private individuals using 82% of the total area. The remaining 0.4 % is owned by legal entities, using 16% of the area, with an average farm size of 210 ha.

The level of support for agriculture (subsidies) is very low compared to the EU. For the prosperous development of agriculture, subsidies must be continually provided due to an increase in the price of oil, gas and other materials. IPARD programs can make a significant contribution to investments in property, equipment and business development of agricultural holdings, but the issue of the degree of utilization of available funds and their distribution across agricultural holdings remains. In addition, farmers face a lack of security in production planning. Market mechanisms in Serbia are not in line with joint markets in the EU, while market regulation and the introduction of new market mechanisms is a must.

In addition to the modernization of agricultural machinery, it is also necessary to assist agricultural producers in the application and introduction of new technologies and application of software solutions, which can significantly affect the future of their production and the future of soil preservation. Although a significant number of producers keep production records, data must be centralized and consolidated into one database, and the LPIS system must be implemented in order to monitor and make decisions related to agricultural production, subsidies and environmental protection accurately.

Shelterbelts have a great impact on most areas of agriculture, water management, transport, protection of soil from erosion, development of desirable microclimatic properties while protecting the environment and biodiversity. In the northern part of Serbia – AP Vojvodina, composed of about 1.7 million ha of agricultural land, afforestation was recorded at about 7% of the area, mostly concentrated in larger areas (Fruška Gora, Vršačke planine, Deliblatska peščara, etc.). What makes the Vojvodina plain stand out in relation to all other plains in Europe is the lack of wind protection belts. Erosive processes in Vojvodina are expressed by the removal of the finest particles from the surface (arable) layer with the highest fertility level. Raising windbreaks in agricultural zones must become a priority as well as building wind farms in the energy sector.

7. Capacity assessment of the country to deal with sustainable soil management

Numerous institutions in the Republic of Serbia are partially or fully engaged in the study, management and use of land resources. Main institutions which perform administrative and technical control and carry out activities related to the implementation of legislation are the Ministry of Agriculture, Forestry and Water Management, specifically Directorate for Agricultural Land, the Ministry of Environmental Protection, the Environmental Protection Agency and the Secretariat for Environmental Protection and Urban Planning in the Autonomous Province of Vojvodina. Land management is also carried out by local self-government units. Within the Ministry of Agriculture, Water Management and Forestry, there are 34 state-funded agricultural advisory services engaged in advisory and professional work in agriculture and distributed across administrative municipalities and regions. The activities of these services are aimed at raising the knowledge of agricultural producers and giving advice and recommendations on rational land use. Some advisory services have laboratories for soil testing. Authorized laboratories of advisory services for determining the basic parameters of soil fertility are located in Novi Sad, Kikinda, Zrenjanin, Subotica, Kikinda, Ruma, Bačka Topola, Sremska Mitrovica, Užice, Tamiš Institute, Senta, Kragujevac, Kraljevo, Kruševac and Smederevo.

The analysis of wider physical and chemical properties of soil is also done by two scientific institutions: the Institute for Soil – Belgrade and the Institute for Field and Vegetable Crops Novi Sad – Laboratory for Soil and Agroecology. These Laboratories are in the process of submitting documentation for obtaining the authorization of reference laboratories, which is expected at the beginning of next year.

In addition to state institutions, soil analyses are carried out by private laboratories. Currently, two private laboratories – Eko-Lab LLC, and the Miphem LLC are registered in the Ministry of Agriculture, Forestry and Water Management, with a possibility of registration of other private laboratories. Several institutes in the field of soil management, agriculture and education are registered in Serbia, most important of which are the Institute for Biological Research, the Biosense Institute, the Institute for the Application of Science in Agriculture, the Institute for Multidisciplinary Research.

Institutions that provide education on soil science are mainly state universities – faculties of agriculture (Zemun, Novi Sad, Čačak, Kruševac), the Faculty of Forestry, and the faculties of natural sciences. In addition to state universities, there are also private universities and faculties: Educons University, Faculty of Ecological Agriculture – Svilajnac, Faculty of Biofarming – Bačka Topola. In a broader or narrower scope of their program studies, master's and doctoral programs, these faculties provide education in subjects related to soil science: pedology, geodesy, geology, agrochemistry, irrigation and land reclamation and environmental protection.

Although soil science is present in most faculties, specialized study programmes are very rare. Only at the Faculty of Agriculture in Belgrade, there is a study programme (Management of Soil and Water) that deals a bit more with soil research. However, despite the real need for experts in this field, there is a declining response of students enrolling study programmes that imply soil management. A great contribution to the transfer of scientific and professional knowledge in the field of land is given by the Serbian Soil Science Society, which is the legal successor of the Yugoslav Society for Soil Research and operates within the International Union for Soil Sciences.

Also, educational staff problems in state-owned institutions persist because decision-makers are not experts on soil or agriculture science. Moreover, inter-institutional connection – between the relevant entities and decision-makers – is loose, while equipment utilized to determine more complex soil chemical and physical parameters is outdated and too expensive to purchase. The application of new technologies and software solutions relies on the current trends of modernization on annual level.

8. How can the problems be overcome regionally?

Failure to comply with the basic principles of environmental protection often results in not only pressure but also violence against the soil. Once the function and quality of the soil is impaired, its regeneration is costly and time-consuming. For this reason, urgent and comprehensive measures, such as the development of science and technology, strengthening institutional capacity, maintenance of partnerships for joint actions and raising the awareness of integrated and sustainable land management, are needed to release soil pressures. The most important measures to be implemented at all levels of government include improvement of land management, development of mechanisms for integrated land use, prevention of soil degradation, strengthening institutional capacity and establishment of a cadastre of contaminated sites through the collection of data on soil pollution levels. It is also necessary to educate people about anti-erosion measures that need to be implemented. Some of the measures that must be implemented are an obligatory introduction of ploughing by isohypses, prohibition of excessive grazing on pastures and forest land, planned deforestation, afforestation of degraded areas, etc. It is necessary to promote sustainable management of forest and land resources and improve the protection policy in the plant-soil-water concept.

Currently, the countries of the Region do not have enough economic strength to undertake strategic capital national projects for soil protection and improvement. Therefore, short-term and achievable goals could be considered. Now, the most important actions are initiatives for changes in the perception of soil importance, both in the environmental protection system and in agriculture, as well as in the context of climate change. By involving, at this moment, as many actors as possible in the concept of healthy soil, more significant desired goals will be achieved in the medium/long term period.

Effective increase in the number of actors (from interest groups, public policy actors, stakeholders, decision-makers, all the way to the public) should be achieved – by raising awareness of the importance of soil for living on our planet and highlighting the benefits to potential investors for achieving soil health. This would mean that in addition to farmers, foresters, landowners, governments etc., banks and other actors from the financial, industrial and private business sectors will also be included.

Some ideas for engaging new and strengthening existing actors for regional protection and improvement of soil:

Increase the number of soil analyses and establish soil monitoring in the region

Goal: Valid and long-term decisions for soil protection and improvement are made on the basis of valid data on the condition and present processes of soil. Valid data on soil quality and the degree of degradation are the most important basis for all further steps in soil protection and improvement.

State: Although there are different programs for monitoring soil quality, they are mostly short-term,

without continuity and incompatible with each other. Soil is monitored more widely on fertility parameters from the aspect of agriculture, potentially toxic elements are monitored mainly through various scientific projects, while organic soil pollutants are rarely monitored systematically. The countries of the region apply mostly the same analytical methods for determining fertility parameters due to the common past and standardization of methods by the former Yugoslav Society for Soil Science. Institutions and laboratories dealing with soil analytics need to be strengthened. This is most often a network of state laboratories with institutes, faculties, agricultural professional services with old outdated analytical equipment. Support is needed to establish a systematic continuous monitoring of land quality at a number of locations.

Proposal of actions:

Technical support to laboratories dealing with soil testing in the form of analytical equipment. Exchange of experiences in soil analysis in the region. Exchange of experiences in systematic monitoring of soil quality. Support to regional projects on the topic of systemic soil monitoring.

Harmonization of pedological maps in the region

Goal: Harmonized cartographic units on pedological maps in the region and its visualizations will provide a broader picture of the natural potential of land and the possibilities for its protection/improvement.

State: In the past, most countries in the region used the same methodology and classification to make pedological maps in former Yugoslavia. In the later period, these maps were refined and harmonized with the WRB international classification. The availability and graphical display of pedological maps in the region are different.

Proposal of actions:

Create individual pedological maps of the countries in the region in accordance with the WRB classification in the same graphic processing (in the form of high-resolution images/infographics with listed areas of predominant soil types). Make these maps visible and downloadable on e-portals.

Improve reionization of agriculture

Goal: Improve reionization of agriculture by exchanging knowledge and experience in the region, as the best measure for planned land use and contribution to the protection of the geographical origin of agricultural products.

State: In the Republic of Serbia, reionization was done for viticulture and fruit production, as agricultural sectors that carry large initial investments with many years of exploitation. Through the EU project, the experiences of Serbia in the reionization of wine-growing areas in Montenegro were transferred. This model could be extended to other countries in the region.

Proposal of actions:

Networking and support to groups working on the reionization of agriculture in the region. Transfer of experiences. In addition, it is possible to work together on the reionization of other agricultural crops. The system of reionization implies extensive research of climatic, relief, edaphic, biological, socio-economic and other factors, and the exchange of knowledge and experience is very valuable for this process.

Promotion of innovations in agriculture in the region

Goal: The promotion of existing and encouraging the creation of new innovations in agriculture in the region significantly contributes to sustainable land use.

State: There are a number of national, regional and larger innovation programs. Products and solutions that have already been developed are not significantly visible in the region. Also, research teams in the region are not sufficiently networked.

Proposal of actions:

Networking of research teams of the Region at the level of scientific research institutions, scientific societies, and producer associations as well as individual innovation teams. Promotion of ready-use solutions in agriculture that are applicable in the region. Strengthening teams for joint project applications and/or supporting the opening of new innovative projects in the region on the more specific topic of soil protection and quality improvement.

Presentation of realistic facts about irrigation possibilities in agriculture

Goal: By presenting real facts about irrigation possibilities in agriculture to all actors, better decisions and plans will be made.

State: The prevailing opinion of target groups at all levels is that irrigation is an optimal agro-technical measure in the context of climate change, and that only a large initial investment is needed for this measure. The fact is that the countries in the region do not have enough water supplies in all their parts, and the quality of water for irrigation is especially questionable. Although there is a legal framework, irrigation water is rarely controlled in practice in terms of quality.

Proposal of actions:

Create unified and key messages about the available quantity and quality of irrigation water in the countries of the region. In this way, all stakeholders will make better decisions and turn to other climate-smart agro-technical practices. It is especially important, in order prevent land degradation, to increase the quality control of irrigation water as well as institutional supervision for the implementation of this control.

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Summary of soil and land data availability: Serbia

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Pedological map	National soil survey	- Directorate for Agricultural Land, Ministry of Agriculture Forestry and Water Management, - Environmental Protection Agency, Ministry of Environmental Protection	Soil types (WRB)	Decades	Country/region/ municipality	1:200000 1:50000	Yes	Yes
Land use	CORINE LAND COVER, Copernicus	- Environmental Protection Agency, Ministry of Environmental Protection - Republic Geodetic Authority	Cropping pattern	6 Years	Country/region	Medium		Yes
Land cover	CORINE LAND COVER, Copernicus, Orthophoto	- Environmental Protection Agency, Ministry of Environmental Protection - Republic Geodetic Authority	Land cover categories	6 Years	Country/ region/ municipality/ parcel	Orthophoto for the entire territory of Serbia with 10/20/40 cm resolution		Yes
Basic Geological Map of Serbia	National soil survey	- Geological Institute of Serbia - Faculty of Mining and Geology, University of Belgrade - Republic Geodetic Authority - Geological Information System of Serbia	Geological categories	Decades	Country/region	1:100000	Yes	Yes
Basic Geomorphological Map of Serbia	National soil survey	- Geological Institute of Serbia - Faculty of Mining and Geology, University of Belgrade - Geological Information System of Serbia	Geomorphological categories	Decades	Country/region	1:300000	Yes	Yes
Map of Protected Areas of Serbia	National biodiversity survey	- Institute for nature conservation	Protected areas in Serbia	Yearly	Country/region	Vector format	Yes	Yes
Soil chemical properties	Laboratory analyses	- Directorate for Agricultural Land, Ministry of Agriculture, Forestry and Water Management, - Environmental Protection Agency, Ministry of Environmental Protection - Institute for Soil Science, Belgrade - Institute of Field and Vegetable Crops, Novi Sad - Agricultural Faculty, University of Belgrade - Agricultural Faculty, University of Novi Sad	- Frequent: topsoil fertility (pH), lime content, soil organic matter (SOM), available P and K, - Sporadic: exchangeable Ca, K, Mg and Na, Exchangeable sodium percent (ESP), electrical conductivity (EC), cation exchange capacity (CEC)	Sporadic	Country/region	Depends on location Medium/ Low	Yes	Yes

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Erosion	Method 1 EPM Method 2 USLE	- Faculty of Forestry, Belgrade - Institute for Soil Science, Belgrade - Institute for Biological Research Siniša Stanković	Destructiveness category Ton/ha/year	Decades Sporadic	Country Region	Medium/ Low	Yes	No
Soil organic carbon loss	Field survey	- Directorate for Agricultural Land, Ministry of agriculture forestry and water management - Environmental Protection Agency, Ministry of Environmental Protection	SOM g/kg and SOC g/kg of soil converted in %	Sporadic	Country/region	Medium/ Low	No	Yes
Compaction	No data							
Contamination	Field survey	- Directorate for Agricultural Land, Ministry of Agriculture Forestry and Water Management - Environmental Protection Agency, Ministry of Environmental Protection - Institute for Soil Science, Belgrade - Institute of Field and Vegetable Crops, Novi Sad	Dangerous and harmful substance	Sporadic	Regions	Low	No	Yes
Soil sealing	CORINE LAND COVER	- Environmental Protection Agency, Ministry of Environmental Protection	Land take by urbanization	6 Years	Country/region	Low	No	Yes
Salinization	Field surveys	- Institute of Field and Vegetable Crops, Novi Sad - Agricultural Faculty, University of Novi Sad - Institute for Soil Science, Belgrade	EC and/or salt content	Sporadic	Vojvodina Region, salt affected areas	Low	Yes	Yes
Acidification	Field survey	- Directorate for Agricultural Land, Ministry of Agriculture Forestry and Water Management - Environmental Protection Agency, Ministry of Environmental Protection - Institute for Soil Science, Belgrade - Agricultural Faculty, University of Belgrade	pH	Sporadic	Region	Low	Yes	Yes
Soil biodiversity	Estimates	- Faculty of Biology, University of Belgrade -Faculty of Science, University of Novi Sad, Biology Department - Faculty of Science, University of Kragujevac, Biology Department - Institute for Biological Research Siniša Stanković	Soil fauna	Sporadic	Country/region	Low	Yes (Descriptive)	No

Name of the parameter	Data source/ method	Institution in charge	What is measured	Frequency of monitoring	Data gathering level *Country/ Region/Municipality/Parcel*	Resolution or scale	Availability of data	
							Hard copy	GIS
Drought	Estimates	Republic *Hydrometeorological Service of Serbia*	Moisture conditions **on the basis of Standard Precipitation Index**	Monthly	Country/region	Medium	No	Yes
Floods	Flood hazard and flood risk maps	Ministry of Agriculture, Forestry and Water Management, Republic Water Directorate	Areas inundated in ha, areas at risk of flooding	Sporadic	Region	Low	Yes	Yes
Desertification	No data							

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