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DEUTSCHE ZUSAMMENARBEIT

South Eastern Europe
SWG RRD
Regional Rural Development Standing Working Group

Implemented by:

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GFA CONSULTING GROUP
General Agent BMEL
Berlin Office

SOIL MANAGEMENT IN THE WESTERN BALKANS – GAPS AND RECOMMENDATIONS

2022

CIP - Каталогизација во публикација
Национална и универзитетска библиотека "Св. Климент Охридски", Скопје

631.4:340.13(497-15)

SOIL management in the Western Balkans [Електронски извор] : gaps and recommendations / authors Dragana Vidojevic ... [и др.] ; illustrator Jelena Dimkovska. - Skopje : Standing working group for regional rural development (SWG), 2022

Начин на пристапување (URL): http://seerural.org/publications/. - Текст во PDF формат, содржи 115 стр., илустр. - Наслов преземен од екранот. - Опис на изворот на ден 30.12.2022. - Други автори: Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. - Библиографија кон главите

ISBN 978-608-4760-41-2

1. Vidojevic, Dragana [автор]
а) Почви -- Законски регулативи -- Западен Балкан

COBISS.MK-ID 59088645

SOIL MANAGEMENT IN THE WESTERN BALKANS – GAPS AND RECOMMENDATIONS

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"Support to the economic diversification of rural areas in Southeast Europe (SEDRA II)"

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Editor: Darko Konjevic

Proofreader: Ljubica Gavanski

Skopje, **2022**

FIRST EDITION

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SOIL MANAGEMENT IN THE WESTERN BALKANS – GAPS AND RECOMMENDATIONS

REGIONAL ASSESSMENT

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Regional Expert on Soil Management

1. Introduction

Soil is a limited natural resource, and its availability is decreasing. The soils of the Western Balkans are sensitive to pressures due to increasing demand for food, feed, and fuel supply, and as a result of the use of the ecosystem by a growing population. These pressures will only increase in the future. Soil degradation represents a transboundary issue where all stakeholders must engage responsibly to ensure that soils are managed sustainably and that the 2030 Agenda for Sustainable Development goals are met.

There is a number of initiatives that promote sustainable land and soil management. The United Nations defines sustainable land management (SLM) as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions".

FAO is working on several initiatives to share and enhance knowledge about sustainable land management practices and implementation processes and their use for informed decision making to prevent or reduce land degradation through the conservation, management, and restoration of soil, water, and biological resources and maintenance of ecosystem services.

EU and partner countries see sustainable agriculture as the key sector that ensures integration of land management into all programmes. This investment guarantees better resilience for all, with the final goal of zero soil degradation.

The European Green Deal sets out a strategy to tackle climate and environmental challenges. Soils play a crucial role in achieving the ambitious target of the European Green Deal on a climate-neutral EU by 2050. Soils are the foundation of agriculture and are essential in the EU Farm to Fork Strategy. Soils together with air and water are three elements to address zero pollution in the EU. The new EU Soil Observatory will collect policy-relevant data and develop indicators for the regular assessment and progress towards the ambitious targets of the Green Deal (Montanarella and Panagos, 2021). The new EU Soil Strategy states that making sustainable soil management (SSM) the new normal requires coordination and working together at local, regional, national, EU, and global level to promote and implement such practices. Playing its role, the European Commission will integrate the sustainable use of soils into relevant EU policies. The strategy defines actions to promote and strengthen the use of sustainable soil management practices to safeguard ecosystem services (namely by promoting agroecology and other biodiversity-friendly practices) and integrate soil preservation and restoration in different targets and indicators.

2. The importance of sustainable land management at the regional level

Main findings

- Land degradation is a serious issue for the society, as it can represent a major threat to food security, climate change mitigation, migration, and water scarcity.
- Agriculture is an important strategic sector for the economic development of the Western Balkans.
- Although agricultural land makes for around 40% of the surface of the region, productive agricultural land is very limited.
- The influence of the human factor in WB countries is crucial in relation to changes in the structure of land use. Serious threats to soil have been identified throughout the region. However, more evidence is needed to support a stronger soil protection policy and to target and monitor its implementation.
- Soil is a very vulnerable natural resource in the Western Balkan region, and it is necessary to carefully design and apply good management practices. Natural-based solutions are a way towards protecting and improving soil and its production capacities, thus increasing crop yield and intensifying measures countering climate change.
- Increased erosion, reduced land availability, and organic matter content in soil are the main expected impacts of climate change and extreme weather phenomena that contribute to the vulnerability of agricultural land in the Western Balkans.
- Organic production is an option for optimization of soil management by applying measures aimed toward the sustainable use of agricultural land.
- Investing in land restoration in all WB countries is critical for improving livelihoods, reducing vulnerabilities, and reducing risks to the economy.

3. General assessment of data available (conclusions and recommendations)

Land cover data in the Western Balkans – Key facts and figures

Land cover data are available for all Western Balkan countries, and this is the only database obtained by a unique methodology offering data analysis of soil pressures. The European Environmental Agency (EEA) provides the CORINE (CoORdinate INformation on the Environment) land database for all European countries, including WB countries.

An analysis of land cover data shows that the Western Balkans is a very rich and diverse region. The regional composition of the land cover mosaic is influenced by many biogeographical and socioeconomic factors. Natural and climatic factors form the basis for land cover by setting boundaries within which different land cover types coexist in regional patterns. Land cover is also the basis for socioeconomic activities and hence influences land use in the area. Land cover and land use are in constant interaction.

Some conclusions can be drawn from analysing land cover in the Western Balkans (Table 1, Figures 1, 2):

- Forest and semi-natural areas have the largest share of land in the region (55.5%), followed by Agricultural areas with 40.04%.
- Montenegro has the largest share of forest and semi natural areas in the region (79.17%), and Serbia has the largest portion of agricultural areas (55.13%).
- More than 2.8 % of WB land is used as artificial areas, which includes built-up areas and unbuilt surfaced areas such as transport networks and associated areas.

Table 1. CLC 2018 by country in WB (km² and %)

	1 - Artificial surfaces		2 - Agricultural areas		3 - Forest and semi natural areas		4 - Wetlands		5 - Water bodies		Total
	km²	%	km²	%	km²	%	km²	%	km²	%	km²
Total	**5,925**	**2.8525**	**83,182**	**40.0457**	**115,293**	**55.5049**	**609**	**0.2932**	**2,708**	**1.3037**	**207,717**
Albania	842	2.9237	7,985	27.7337	19,173	66.592	117	0.4062	675	2.3443	28,792
Bosnia and Herzegovina	890	1.7373	16,964	33.1222	32,965	64.3649	53	0.1033	344	0.6725	51,215
Kosovo*	517	4.7415	4,157	38.1156	6,208	56.9171	1	0.0117	23	0.2141	10,907
Montenegro	272	1.9607	2,231	16.0688	10,991	79.1688	125	0.8983	264	1.9035	13,882
North Macedonia	467	1.837	9,129	35.8906	15,278	60.0654	21	0.0836	540	2.1234	25,435
Serbia	2,937	3.7904	42,716	55.1285	30,679	39.5931	292	0.3768	861	1.1112	77,484

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.

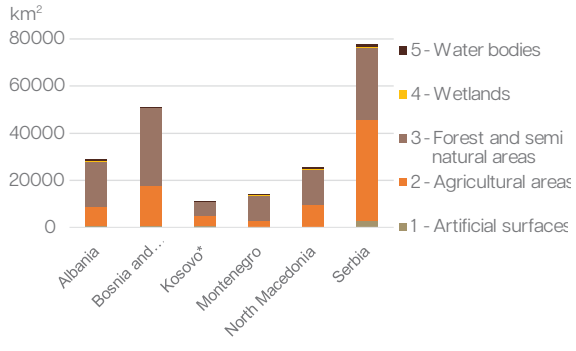

Figure 1. CLC 2018 by country in WB (km²)

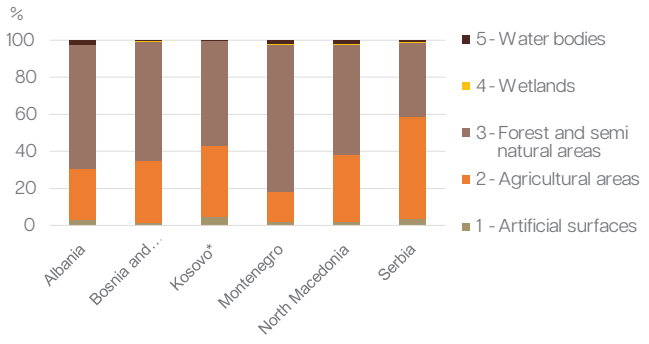

Figure 2. CLC 2018 by country in WB (%)

Assessment of data availability

Even though soil data availability differs from one WB country to another, there are specific conclusions and recommendations:

CONCLUSIONS

- The existing soil data sets, in most cases, are outdated and need to be updated and extended.
- Some soil datasets are in inappropriate format and have to be converted into a suitable (digital) format in order to connect with other datasets.
- Soil data or soil-related data generated within various projects are scattered and have to be collected and harmonized.
- There are no standard formats and protocols for data exchange.
- There is no unified information system on land and soil data in any WB countries.
- Land data are not publicly available in most cases.
- The problem also arises due to differences in analytical and field procedures.
- In most cases, soil monitoring programmes are not present.
- Interpretation of the results from the studies aimed to examine the chemicals that act as environmental contaminants in soil and which potentially cause risks to human health, and the environment are presented in annual state of environment reports in Serbia and Montenegro.
- In some cases, the lack of legal regulations makes it difficult to interpret monitoring results adequately.
- Serbia reported several positive developments in progress in terms of consolidating soil quality data and systematic monitoring, such as the establishment of a soil information system and the creation of a network of authorized laboratories for testing the fertility of arable agricultural land, entry into force of the Regulation on systematic monitoring of the condition and quality of soil, initiation of soil organic carbon monitoring, all of which will increase the scope of soil testing as well as regulate the validity and consolidation of data under the Environmental Protection Agency and the Ministry of Environmental Protection.

RECOMMENDATIONS

- There is an urgent need to draft a legal act related to soil protection, establishing inter-institutional arrangements, setting in place functional monitoring, reporting and verification (MRV) system for soils, as well as a long-term programme to support the implementation of SSM practices in all sectors acting as drivers of land degradation.
- It is recommended to identify contaminated areas and define a protocol in the process of exchange of existing databases between institutions.
- The need for training in data management in public institutions was identified.
- It is necessary to obtain more comprehensive data on applied agro-technical measures.
- It is necessary to simplify the Field Book and put it into a user-friendly format as a transitional model in order to collect at least the basic data of importance.

4. Legal framework for sustainable land management: gaps and recommendations for improvement

The main conclusions and recommendations based on the national assessment in the Western Balkans:

CONCLUSIONS

- No country in the region has a comprehensive legal framework that includes monitoring, protection, restoration, and sustainable land use.
- As a result, there is no organized approach to define and implement sustainable management practices, legally binding procedures and work protocols and the corresponding system of control in different sectors, which would act as drivers of land degradation.
- Even though certain legal and strategic documents address soil issues, it can be said that they are insufficient. They were adopted quite a long time ago and do not address global challenges related to climate change and the increasing importance of land.
- There are a number of problems in the implementation of legislation, primarily in terms of jurisdiction shared by different ministries and institutional entities, and lack of funding for the implementation.
- Development of legal acts related to soil protection and strategic decision-making processes often occur separately from the formal adoption of planning documents.
- The implementation and enforcement of the Law on Agricultural Land are very complex, and there are no complete mechanisms for the implementation and control of prescribed measures and activities to achieve the defined goals.
- It is challenging to control the implementation of laws, although there are inspection bodies at both national and local levels. However, the problem is the application of laws and their provisions, as well as the lack of financial resources to implement legally prescribed measures to protect land resources.
- In some cases, very few legal provisions are implemented in practice.
- Current legislation does not address the issue of reporting on the use of leased state agricultural land.
- A more intensive coordination and cooperation is needed between agriculture and environmental protection ministries.

RECOMMENDATIONS

- Legislative framework needs to be strengthened, and its implementation needs to be encouraged.
- The Law on Agricultural Land needs to be revised to transpose the best European practices primarily related to degradation processes, conservation, protection, and sustainable land management and to provide mechanisms for its implementation and control.
- The adoption of strategic documents on the national and local levels should be synchronized to ensure optimal implementation of strategic commitments and the implementation of vari-

ous international conventions and agreements.
- It is essential to harmonize the implementation of legal provisions related to the environmental protection system and agriculture in the context of climate change.
- Recommendations should go in the direction of finding potential donors to support the development of sustainable land and soil management strategies.
- Training and workshops for municipal and government staff should also be provided to inform decision makers about current EU regulations, the EU Soil Strategy for 2030 and the Green Agenda.
- A large part of the tasks must be delegated to a lower level to enable the best possible implementation of current regulations.
- An assessment should be made on whether the legislation in force should be updated or a law on soil protection should be prepared.
- Due to non-implementation of existing legislation, a concept paper related to land and soil protection needs to be drafted.
- When preparing strategic documents, countries should ensure preconditions for good soil health. Following European trends, strategies need to integrate the 'land take hierarchy' and prioritize reusing and recycling land, thus avoiding converting agricultural or natural land into a built environment.
- Immediate action is needed to gather all key stakeholders to define the needed institutional arrangements, working groups and action plans, reflecting the recently defined goals and requirements within the new EU Soil strategy.

5. The main soil degradation processes: gaps related to the assessment and management of degradation processes

Globally, soil and environmental challenges (climate change, pollution, desertification, water scarcity and biodiversity decline) are increasing dramatically (Hanjra and Qureshi, 2010). Regarding sustainability and resource use efficiency, it appears that many soils do not fulfil their function to the full potential (Panagos et al., 2020). Soil degradation is among the most crucial threats to ecosystem stability, and soils have recently gained more and more social and political visibility.

Soil monitoring, aimed at observing the characteristics of soil and soil quality indicators, coupled with environmental change management, helps identify specific regions/sites in the process of increasing degradation, where measures of restoration of soil functions can be applied.

Across many WB countries, existing sites for soil monitoring are insufficient. There is an adequate technical basis to implement a successful monitoring system for most of the threats to soil resources. Current methods are inadequate for assessing carbon stocks in peat soils, wind erosion and tillage erosion. A tiered approach to the implementation of soil monitoring is recommended.

Land cover change statistics 2000-2018 in the Western Balkans – Key facts and figures

Land cover and land use change in the Western Balkans is one of the most critical environmental change processes. Change analysis is the basis for further planning the region's sustainable development of terrestrial ecosystems. The European Environment Agency (EEA) has developed land accounts that allow for assessing changes in land cover types. Possible land cover changes are grouped into meaningful categories, the so-called Land Cover Flows (LCF). This system enables to address drivers of land cover changes. These changes can have environmental impacts, such as decline in biodiversity, reduced carbon stocks, or weakened capacity for food production and flood regulation. Understanding the implications of changes in land cover and land use is a fundamental part of planning sustainable development. Land cover accounts were derived from the CORINE land cover data series for 6 WB countries and presented for each country separately and for the entire region. Statistics were calculated for the entire period (2000-2018). The regional analysis of land cover changes in heterogeneous landscapes can be masked by spatial variations caused by both bioclimatic and socioeconomic factors.

Land and Ecosystem Accounts for the Western Balkans in the 2000-2018 period show that the forest internal land cover changes are the most prevalent, mainly in Serbia (present in 517.2km^2) and Northern Macedonia (505.9 km^2). These changes are present in all countries in the region except for Montenegro, where changes in land cover due to natural and multiple causes are present on 73.6 km^2. Agriculture internal conversions are the most present in Serbia, followed by Kosovo*. Of all countries in the region, urban residential expansion is the most prevalent in Albania on an area of 263.9 km^2, followed by Bosnia and Herzegovina, with changes present on 62.3 km^2 (Figure 3).

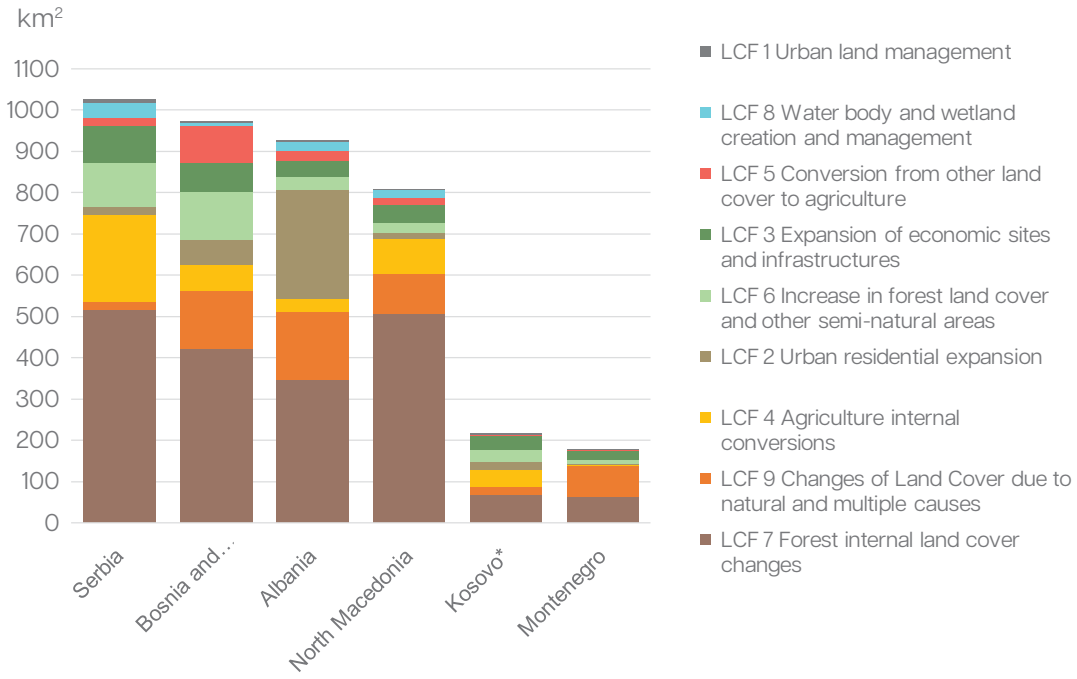

Figure 3. Land and Ecosystem Accounts for Western Balkans in the period 2000-2018.

An analysis of land cover consumption and formation in Land Cover Flows 2000-2018 in the Western Balkans has shown that the most changes are occurring in forests and transitional woodland shrubs related to internal land cover changes, followed by changes in artificial surfaces, where an area of 700 km^2 was formed, mostly in the framework of LCF urban residential expansion (378 km^2) and LCF expansion of economic sites and infrastructures (298 km^2), and 73 km^2 was consumed. The other significant

change is in the class of pastures and mosaic farmland, where 719 km^2 of the soil was consumed and 185 km^2 was formed. Regarding natural grassland, heathland, sclerophyllous vegetation – 316 km^2 of land was consumed, and 100 km^2 was formed. A lot more land in the class open space with little or no vegetation was formed before it was consumed. It can be observed that the most frequent changes in land cover in the Western Balkans are related to urbanization, and that mostly pastures and natural grasslands were consumed under agricultural areas (Table 2).

Table 2. Consumption (C) and formation (F) of land cover in Land Cover Flows (LCF) 2000-2018 Level 1 in the Western Balkans (km^2)

	Forests and transitional woodland shrub		Artificial surfaces		Open space with little or no vegetation		Arable land & permanent crops		Pastures & mosaic farmland		Natural grassland, heathland, sclerophyllous vegetation		Water bodies		Wetlands	
	C	F	C	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**	**C**	**F**
TOTAL	**2,362**	**2,228**	**73**	**700**	**211**	**484**	394	341	719	185	316	100	38	82	17	13
lcf1 Urban land management			24	24			0		0		0					
lcf2 Urban residential expansion	8			378	2		77		276		15		0		0	
lcf3 Expansion of economic sites and infrastructures	74		1	298	4		80		113		24		1		1	
lcf4 Agriculture internal conversions							207	304	204	129	27	4				
lcf5 Conversion from other land cover to agriculture	42		23		70			37		37	10	83	5		9	
lcf6 Increase in forest land cover and other semi-natural areas		306	22		100	4	20		92	10	80		5		2	
lcf7 Forest internal land cover changes	1,922	1,922														
lcf8 Water body and wetland creation and management	22		3		10	0	7		30		6		0	78	4	4
lcf9 Changes of Land Cover due to natural and multiple causes	294		0		27	479	2		5	8	155	12	28	3	1	9

Soil Indicators for Western Balkan policy support

Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The 17 Goals were adopted by all UN Member States in 2015 as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the goals (UN, 2015). Most SDGs depend strongly on soil and land.

SDG 15 Life on land, seeks to protect, restore, and promote the conservation and sustainable use of terrestrial, inland water and mountain ecosystems. This includes efforts and financial resources to sustainably manage forests and halt deforestation, combat desertification, and restore degraded land and soil. SDG 2 Zero hunger, seeks to ensure access to safe, sustainable and resilient food production.

The indicator for SDG target 15.3: Proportion of land that is degraded over total land area is a suitable metric for monitoring and reporting on restoration, combating desertification and achieving land degradation neutrality.

Today, progress is being made in many places, but, overall, action to meet SDGs is not yet advancing at the speed or scale required. Certain countries of the Western Balkans have shown progress in SDG reporting related to land. However, only Bosnia and Herzegovina reported on SDG 15.3.1. indicator: the share of degraded land in the total area was 4.0%.

Agri-environmental indicators

Agri-environmental indicators (AEIs) track the integration of environmental concerns into the Common Agricultural Policy (CAP) at the EU, national, and regional levels. The Statistical Office of the EU (Eurostat) makes a detailed overview of an updated set of 28 AEIs for the EU. The AEIs were set up through a Commission communication (COM (2006) 508 final). These AEIs track (a) farm management practices, (b) agricultural production systems, (c) pressures and risks to the environment, and (d) the state of natural resources. In the context of monitoring the status of natural resources, land-use change, soil cover, soil quality and soil erosion are included among the 28 AEIs. Some AEIs are also being monitored in the Western Balkans (Table 3).

Table 3. Threats, issues and indicators related to soil in WB countries

Threat/issue	Indicator
Soil erosion	Estimated soil loss by wind erosion Estimated soil loss by water erosion Estimated soil loss by tillage erosion
Decline in soil organic matter	Topsoil organic carbon content (measured) Soil organic carbon stocks (measured) Peat stock
Soil contamination	Heavy metal contents in soils Progress in management of contaminated sites
Soil sealing	Land take [to urban and infrastructural development]
Decline in soil biodiversity	Species diversity Soil microbial respiration
Soil salinization	Salt profile Exchangeable sodium percentage
Desertification	Land area at risk of desertification Land area burned by wildfire
Landslide	Occurrence of landslide activity Volume/mass of displaced material Landslide hazard assessment

In order to establish an indicator-based reporting system in the Western Balkans, it is necessary to consider the regional aspects that need to be taken into account when selecting a set of indicators for monitoring soil status.

6. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

The main conclusions and recommendations based on the national assessment in the Western Balkans are:

CONCLUSIONS

- Assessment of the capacity of WB countries to deal with sustainable land management varies. Only certain countries have reported having institutional and administrative capacities to adopt appropriate legal solutions that would oblige all subjects to comply with and implement SSM practices. However, it seems that there is not enough political will to adopt them at this moment. The same countries state that there are also technical preconditions for introducing sustainable land management in the region and monitoring its impact through measurable indicators.
- Other countries have assessed that there is a lack of human resources in relevant institutions, and inter-institutional coordination needs to be strengthened to establish effective SSM. Academic capacities and the syllabus related to soils at all levels of education is inadequate and outdated. Research capacities (human and technical) are very limited and can hardly respond to any form of monitoring and survey.
- Also, a lack of a body has been identified which would bring together all stakeholders and provide a platform for dialogue on sustainable land management, both horizontally and vertically.

RECOMMENDATIONS

- Strengthen capacities, knowledge and experience through a participatory approach as a precondition for efficient integration of the concept of sustainable land management into the legislative framework and policy and meaningful implementation at the local level.
- Educate end-users and farmers about all agro-technical and other measures, their benefits, how to apply these measures, etc., to achieve the ultimate goals that promote sustainable land

and soil management.

- Institutional capacities at all levels should have an appropriate format of organization and coordination, employing skilled staff with sufficient awareness and knowledge of the current situation in the country, lags and gaps in the sector and actions needed to reach land degradation neutrality and fulfil the requirements deriving from recent EU requirements.
- Academic capacities and current educational programmes should be strengthened with new and updated programmes, subjects and extra curricula, covering the most recent approaches in soil science, land degradation, soil conservation, modelling, etc.
- The soil research institutions' institutional, individual and technical capacities should be strengthened. Research institutions should pave the way for implementing new technologies, setting up standards of work in all aspects of soil management and monitoring programmes, and should serve as centres of excellence networked with similar institutions in the region and abroad.
- It would be of great importance to get international support and equip capital institutions with analytical equipment.
- The cooperation of state organizations, universities, research institutes, businesses and civil society organizations should be achieved within the soil societies as umbrella organizations.
- Develop projects that promote soil advocates through customized training and educational materials for primary, secondary and post-secondary school students could have long-term effects in the future.
- Introducing foreign soil advocates that would encourage the internalization of desirable agro-environmental standards and policies for promoting new approaches in soil management, climate change mitigation, the latest tools in agriculture, carbon sequestration, urban green spaces, recreation and conservation, green architecture, stormwater mitigation, etc. could have enormous effects on multifarious aspects in the region.

7. Regional assessment: conclusions and recommendations

The main conclusions and recommendations based on the national assessment in Western Balkans are:

- There are insufficient data on the soil status in WB countries, and investments are needed in soil monitoring.
- Land-use change, erosion and loss of organic carbon are severe threats to soil health, affecting agricultural production and resilience to climate change.
- Soil has been overlooked in environmental policy in recent decades. Enhancing policy coherence for the development of soil management practices is needed.
- It is necessary to harmonize the goals set within the strategic documents of Western Balkan countries with the requirements set in the new EU Soil Strategy for 2030.
- The low level of awareness is one of the issues that all national reports emphasized as one of the biggest obstacles to proper implementation of SSM practices.
- Capacity building is the issue with the highest consensus in the national reports. National ex-

perts and decision makers agreed that this was a very important issue. Capacity development refers to human capacities and technical capacities. There was an agreement that capacity building should be conducted for all stakeholders from policymakers to farmers.

- New chemical and waste management practices pose new regulatory challenges and environmental risks. The first step towards understanding the risks and challenges is soil monitoring and observing the ways in which it is changing.
- It is essential to demonstrate the benefits of improved soil and land management.

Table 4. Recommended activities at the national level to improve soil quality and support soil conservation

Albania
• Update the soil information system. • Raise awareness of new developments at the EU level regarding soils. Organize a meeting with the Ministry of Agriculture and the Ministry of Environment to explain the content and objectives of the Soil Deal for Europe and the repercussions Albania could face. • Prepare detailed studies to assess soil degradation processes. • Promote data sharing on soils. • Strengthen capacities at all levels to deal with soil management.
Bosnia and Herzegovina
• Adopt appropriate legal solutions that would be aligned with the EU legislation related to the protection and sustainable management of land. • Assist in the development of strategic documents. • Initiate procedures and define elements of the Law on Land Protection. • Develop special protocols for data exchange among individual institutions. • Intensify training for municipal and government staff and advisory services through scientific research institutions on various topics (database management, the importance of land management, etc.). • Develop schemes and protocols for transferring land management activities to municipal administrations for better implementation of applicable regulations. • Stop the processes of land degradation, and if possible, return the degraded lands to their original condition by implementing appropriate measures. • Maintain the fertility of soil and if possible, repair it using modern knowledge and technologies primarily related to soil cultivation, fertilization, and plant protection. • Promote existing and new initiatives to balance the carbon cycle in soil in a way that does not jeopardize food production. • Raise social awareness of the importance of soil through the education system.
Kosovo*
• Implement regular land monitoring at the national level. • Application of the Integrated Agricultural Land Management process. • Mandatory application of the Agro-Ecological Zoning process at the central and municipal levels. • Establish the State Soil Museum and the Regional Soil Museum / Western Balkan Soil Museum. • Develop a soil monitoring system at the regional level with indicators and thresholds for soil quality assessments.
Montenegro
• Establish a regional centre, where scientists from the region would deal with geostatistics and modelling. • Establish and harmonize methodologies for soil monitoring. • Establish the Regional Soil Platform. • Improve the legal and strategic frameworks related to land management and soil protection. • Capacity building and raising awareness of government officials, local communities and beneficiary communities for climate-responsive planning and development. • Support to implementation of agro-environmental measures.

North Macedonia

- Develop and adopt soil-related legal frameworks and strategic and planning documents outlining country needs and requirements deriving from signed UN conventions and EU strategies and legal acts.
- Reinforce administrative capacities at all levels with new organizational entities focused on soil and land management. Coordination among institutions should be established within a functional system. Individual capacities of employees in the sector should be permanently upgraded to enable the implementation of provisions in future national legislation and EU legal acts and strategies.
- Develop inter-institutional arrangements to establish a functional system for implementing in practice legal acts and strategies and monitoring the effects of their implementation, for monitoring, reporting and verification system and supporting the implementation of sustainable management practices in all sectors, with a long-term programme of work.
- Strengthen educational programmes at all levels of education, training programmes for farmers in the form of lifelong and vocational training programmes and retraining.
- Reinforce research capacities of research institutions by establishing a permanent and well-designed programme of work.

Serbia

- Increase the number of soil analyses and fulfil established soil monitoring, especially in terms of monitoring Soil Organic Carbon content and physical properties.
- Cross-sectoral networking.
- Raise awareness of the importance of land among all stakeholders.
- Revise the Rulebook on the type and content of measures which the user of agricultural land is obliged to apply.
- Afforestation and protection of natural areas.
- Prepare the erosion map.

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.

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ALBANIA SOIL REPORT

Prepared by

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1. The importance of sustainable land management at the national level

Albania is a country with a great diversity of soil types due to various forms of parent materials and climatic zones ranging from the typical Mediterranean along the coasts to almost temperate in the highlands, especially in the eastern part culminating with the Albanian Alps in the north. However, during the centuries, soils have been treated in different ways. Historically, Albanian farmers, no matter the low level of education, considered their soils as very valuable property and overall took good care of it. This was also facilitated by the low level of technologies that from one side offered relatively lower yields but was soil friendly in terms of disturbance.

A drastic change occurred with the establishment of the communist regime and the implementation of the centralized economy. On the positive side, this political change was followed by great investments mainly towards the increase of arable land through land reclamation of swamps and their conversion to cropland. There were also other reasons to do so: malaria. This resulted in creating of more than 50,000 ha of newly arable land put under cultivation.

The communist regime implemented an arduous collectivization process, and each parcel of agricultural land was included in state farms and agricultural cooperatives that were formally considered voluntary groups of cooperative members. Instead, they were forced to come together, even against their will. From a soil perspective, the farming system modernization also brought advantages. For instance, soil conservation and protection from erosion were considered equally important as crop productivity. The regime could impose fines on agricultural workers if soil erosion would accelerate due to unsustainable farming practices.

Another positive action of those times was that the month of December was considered the Month of Reforestation and Fight Against Soil Erosion. Hundreds of thousands of trees were planted around the country, many of them still covering extensive areas mostly on the mountain and hilly slopes.

Regarding soil fertility monitoring, the Soil Science Institute of Tirana conducted a detailed soil sampling programme once in five years, with thousands of samples collected at a depth of 0-30 cm at each cadastral parcel. In total, about 700,000 ha were monitored once in five years. There were 26 districts at that time in Albania, and each of them had a soil laboratory to conduct basic soil analyses for N, P, K and a few more for physical properties such as texture. From 1957 to 1990, two national pedological surveys were conducted on a scale of 1:250000, and furthermore, each state farm and agricultural cooperative had its own pedological survey at a scale of 1:10000. A practice that did not exist even in the most advanced Western countries. Unfortunately, this was lost after the change of the political system in the 1990s.

The communist regime also harmed soils. One of the terrible mistakes of that period was the conversion of natural pastures and shrubs into arable lands. More than 100,000 ha experienced such drastic change. This created enormous problems of soil erosion and landslides that are still visible. Ironically, this was in contradiction to proclaiming the month of December as the month to fight erosion only to, in the following months, force people to destroy pastures and shrubs.

After the change of the 1990s, soils underwent severe degradation, with urbanization expanding rapidly on the best fertile soils (please see photos below). Tirana is one example of it as well as the whole coastal area that was entirely transformed by the urban sprawl. Other degrading processes include soil erosion that was accelerated by extensive damage caused by illegal logging and fires. After the change, the use of chemical fertilizers rapidly declined, and the process of nutrient mining or the lowering of soil fertility was pointed out by several authors (Qilimi, 1996, Zdruli, 1997, Gjoka et al., 2021). Other processes include soil contamination with heavy metals from industrial sources (Gjoka et al., 2022), like those in the vicinity of the metallurgical complex of Elbasan and many mines around the country. In several cases, contamination was also caused by the oil extracting industry and incidental oil spills.

Photo 1. The state farm of Kamza, near Tirana, in 1989. One of the best producing farms in the country.

Photo 2. The same area in 2022

Is sustainable land management important for Albania? Everybody will say "YES". Is this being implemented in the country? Here are the main doubts.

2. General assessment of data available (conclusions and recommendations)

Soil data availability for the period before the 1990s that was well described in the previous section was lost. The only legacy of that is the knowledge accumulated during the process, but that too is getting lost as there is very little follow-up between the present generation of soil scientists and those of the past. The only entity with a mandate to conduct soil surveys in the country is the Centre for Agrotechnology Transfer (locally known as the QTTB of Fushë Krujë) which has surveyed until 2022 more than 425,541 ha or 62% of agricultural land. All soil samples are stored at QTTB, and the results of the analyses are available in digital format. QTTB has also established a GIS soil information system that contains soil-related data, such as soil type, land use, soil chemical and physical properties. The Agricultural University of Tirana (AUT) also has a very well-equipped soil laboratory, but they perform mostly analyses for research students, and to a lesser extent, for farmers.

Other sources of soil information include a first assessment (Zdruli, 1997) made in 1994-1996 by the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) in Washington DC that produced the first soil map of Albania at a scale of 1:250000 using the USDA Soil Taxonomy classification system, which was later converted to the FAO System.

In 2001, another soil survey was conducted in Albania with funding provided by the European Union under the Interreg Italy-Albania programme. This produced two new soil maps, one at a scale of 1:250000 for the whole country and another at a scale of 1:50000 for the western coastal plains. Soil maps were prepared according to the terminology of the World Reference Base for Soil Resources (WRB).

A few years ago, the LUCAS survey was also completed in Albania following the same methodology implemented in EU countries, but laboratory data are not yet available.

Albania urgently needs to update its soil information system; this requires adequate funding and qualified staff. While the financial resources somehow are made available by the Ministry of Agriculture, the main issue remains with a shortage of qualified staff, which is a severe handicap. Efforts should be made to attract the interest of AUT soil science students and prospective job opportunities.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

In 2004, the Albanian Parliament approved the Law on Land Protection No. 9244 as a major piece of legislation. Nevertheless, the law did not pay too much attention to soil protection but mostly set out the legislative framework for overall land protection and management. The issue is that since 2004, this law was weakly implemented and did not stop soil losses to urban sprawl and infrastructure development. However, some improvements have been noticed over the last decade in reducing the trends of land take, especially of arable land.

The main objectives of Law 9244 were: (i) to determine the principles, rules, and institutions relevant for sustainable protection and improvement of agricultural land, giving particular regard to soil fertility; (ii) to harmonize the rights and benefits of agricultural land ownership with responsibilities for its sustainable use; (iii) to protect and rehabilitate agricultural land from adverse effects caused by the harmful impact of climate and human factors. The law consists of the following six chapters: (I) General Provisions; (II) State Structures of Agricultural Land Protection, their Tasks and Responsibilities; (III) Agricultural Land Damage Prevention; (IV) Obligation to Inform on Agricultural Land Damage and Rehabilitation of Damaged Lands; (V) Administrative Offences and Sanctions; (VI) Final Provisions.

Further developments in terms of legislation dealing with soil protection and management derive from 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 SARDF 2021–2027 and implemented by GFA Consulting Group, Hamburg, Germany. It is clearly mentioned that "there were no agricultural practices promoting soil conservation identified at policy level in Albania". To overcome this, 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, Water Framework and Nitrate Directives, even though Albania has no legal obligations regarding them. Table 1 summarizes the legislation dealing with soil protection and management in Albania.

Table 1. Legislation on land and soil protection in Albania

Issue	Name of national acts (laws and by-laws)	Year	EU Legislation	Harmonized with EU regulation (Yes/No/ Partly)
Law 9244	Law on Land Protection	1994		Partly
Regulation 80	On the establishment, functioning, tasks and responsibilities of the agricultural land protection authorities	2005		Partly
Regulation 59	On the analysis of agricultural land indicators	2005		Partly
Law No. 69/2013	Amending and supplementing Law No. 9244 on agricultural land protection.	2013		Partly
Law No. 131/2014	Amending and supplementing Law No. 9244 of 2001 on agricultural land protection	2014		Partly

All Laws and Regulations are published in the Official Gazette.

The main aspects related to soil protection and management remain with their alignment with the recent EU legislation. Very few institutions and policymakers are aware of the new developments at EU level regarding soils. To overcome this, it is highly recommended that a special event be organized by the Ministry of Agriculture, with representation also from the Ministry of Environment, to explain the content and objectives of the mission A Soil Deal for Europe and the repercussions it could have for Albania.

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

In 1997, Zdruli made the first assessment of soil degradation processes in Albania, provided in Table 2. The processes were divided between human-induced and natural conditions to reflect the actual situation in the country. At that time, overgrazing appeared to be the major degrading factor that, along with deforestation, was degrading Albania's soils at a very fast rate.

Table 2. Major soil degradation processes in Albania in 1997

LAND RESOURCE STRESSES	Area	%
Human-induced		
Chemical pollution	165	0.6
Salinization	654	2.3
Nutrient mining	2,936	10.2
Deforestation	5,005	17.4
Overgrazing	12,201	42.4
Accelerated erosion	3,585	12.5
Natural processes and conditions		
Acidification	624	2.0
Flooding	461	1.6
Extremely stony or shallow	1,614	5.6
Low temperatures/poor accessibility	1,182	4.1
Water	320	1.1
TOTAL	28,747	100

Zdruli, 1997.

Soil erosion came third, followed by nutrient mining or the loss of soil fertility due to unsustainable farming practices and drastic reduction of chemical fertilizer use after the political change of the 1990s. It should be noted, however, that these data are primarily based on expert assessments with little verification on the ground. Unfortunately, this practice is still the rule rather than exception in Albania.

The country needs to embark on profound and detailed studies when it comes to assessing soil degradation. Erosion is still being assessed mostly based on modelling with little field evidence and checking, compaction and soil biodiversity losses or impacts are completely unknown, while data are available for acid and saline soils mostly due to former studies dating back more than 30 years. Some inputs are coming from recent soil surveys conducted by QTTB Fush**ë** Krujë, but they need to be updated continuously. It is not yet clear what the rate of soil sealing in the country is, also at annual level, what the Soil Organic Carbon stocks are and what the trend of carbon sequestration is. The situation could be very surprising if a detailed study were performed. For instance, there is a trend that despite fires during the summer period, the natural vegetation cover overall has a positive increasing trend throughout the country. This may have been a result of a drastic reduction of livestock, especially sheep and goats. Furthermore, there are at least 100,000 ha of land that is not used for agriculture and is otherwise abandoned. Could that indicate that these areas are left aside and could have increased carbon stocks?

These issues need attention and further research:

1. Update information on the actual extent of soil degradation in the country
2. Identify the driving forces of the soil degradation process by using an ecosystem-based approach considering both biophysical and socioeconomic indicators
3. Improve knowledge on soil quality indicators and their interaction with crop productivity, especially under the greenhouse horticulture systems
4. Identify better the sources of heavy metal contamination deriving from natural and/or human-induced activities

Information on SDG indicators is limited in Albania. Based on an expert assessment regarding SDG 2.4.1, 'Proportion of agriculture area under productive and sustainable agriculture', the total area of 417,000 ha was subdivided in cultivated field crops (mostly cereals and forages) and vegetables, includ-

ing those in greenhouses, as well as olives, fruit trees and vineyards. The first category covers 287,446 ha or 69% of the total agriculture area, while the second covers 129,554 ha or 31%. It should also be considered that "productive" and "sustainable agriculture" are not the same terms, especially when dealing with soil health. For instance, olives that cover 53,802 ha are producing less than their capacity due to lack of management, but overall, soil under olive groves is stabilized and less affected by degradation. On the other hand, despite the much lower surface area they cover, greenhouses occupying only 1,734 ha are intensively producing vegetables for exports. However, soil quality inside them has already been compromised by salinity built up due to higher use of chemical inputs, and in some cases, poor quality of irrigation water. This shows that the sustainability of this agricultural system is at risk. Based on these assumptions, it could be estimated that less than 50% of agricultural land meets the criteria of SDG 2.4.1.

Regarding SDG 15.3.1. 'Proportion of land that is degraded over the total land area' the most common platform endorsed also by UNCCD is Trends.Earth that considers the following indicators (i) land productivity trends, (ii) C stock trends, and (iii) land cover changes. Apart from the first indicator, it is estimated that the C stocks may have slightly increased in Albania. Instead, the land-use change shows a very different picture depending on the location. While fertile flat lands close to the major cities or along the coast have been heavily urbanized, the rest of the territory, especially mid-latitude hills, have experienced a growth of natural vegetation (Photo 3) that was also promoted by the rapidly decreasing number of small ruminants and the abandonment of remote areas. On the negative side, summer fires continue to damage natural vegetation of pastures, shrubs, and forests, but the overall burned surface area is still minimal compared to the whole surface area of 1,077,113 ha. It is estimated that the proportion of degraded land could be less than 20%.

Photo 3. Dense natural vegetation in Rubik, central Albania

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

The most prominent institution to deal with soil management at the national level is QTTB Fushë Krujë, which is well equipped with a good laboratory but needs to be strengthened with more staff qualified both in the country and abroad. There appears to be some form of increased interest from the Ministry of Agriculture regarding this.

The next important player is the Agriculture University of Tirana (AUT), which has established excellent cooperation with the Ministry of Agriculture regardless that AUT is not under the jurisdiction of the Ministry of Agriculture. Most recently, AUT was awarded a contract to establish a modern experimental precision agriculture farm that will, *inter alia*, also deal with sustainable soil management under irrigated systems. These activities will be supported by soil analyses conducted in the AUT laboratory, which will increase the soil database. However, there is a need for AUT activities to be coordinated with QTTB Fushë Krujë, which has the mandate to develop and update the soil database of the country. To this end, data sharing on soils should be promoted among AUT, QTTB, and any other public or private institution that may collect soil data.

6. Assessment, conclusions and recommendations

The following recommendations are considered necessary to further support soil management in Albania:

- Update the soil information system
- Raise awareness of new developments at the EU level regarding soils. Organize a meeting with the Ministry of Agriculture and the Ministry of Environment to explain the content and objectives of the mission A Soil Deal for Europe and repercussions it could have for Albania
- Prepare detailed studies to assess soil degradation processes
- Promote data sharing on soils
- Strengthen institutional capacities at all levels to deal with soil management

7. Good case studies on soil management practices

Saline soils cover at least 25,000 hectares in Albania, and their area is expected to increase for many reasons, either by abandoning management practices or climate change impacts.

However, a positive example comes from a private company called Agro Iliria, which is investing in the use and management of these saline soils. The farm is in the district of Lushnja near the village of Rremas, which was notoriously noted for the heavy clay soils and high salinity level. Sources of salinity come from salty underground water due to the vicinity of the Adriatic Sea and the merging of seawater with groundwater underneath the soils of Rremas.

Figure 1. Saline soils of Rremas in 2001

Is this snow in summer? No, it is salt on soil surface

Soil qualifiers in the WRB system		
Petrosalic Hypersalic Puffic Folic Histic Technic Vertic Gleyic Stagnic Mollic Gypsic Duric Calcic Haplic	Solonchaks 	Sodic Aceric Chloridic Sulphatic Carbonatic Gelic Oxyaquic Takyric Yermic Aridic Arenic Siltic Clayic Drainic Novic
Gleyic Vertic Hypersalic Solonchak (Clayic Sulphatic)		

The management of saline soils is a costly and long process that requires continuous investments; otherwise, salinity build-up can expand rapidly and nullify previous investments. This happened in Albania. On the other hand, present technologies offer good options for their recultivation. At the same site of Rremas, shown in Figure 2, at present, the successful Agro Iliria enterprise is growing salt-tolerant pomegranates and goji berry fruits, on a farm of 500 hectares, and the goal is to increase the cultivated area even more.

The farm is using a special technology that is based on three principles: 1. select the right salt-tolerant crop, 2. get rid of salts through soil management and leaching, and 3. collect rainfall water during the rainy season in winter and use it for irrigation through drip irrigation systems. The technology has been very successful, and the farm has already started exporting its products abroad.

Figure 2. Successful cultivation of pomegranates and goji berry fruits on the Agro Iliria farm

Credit: https://www.facebook.com/Agro.Iliria.Group

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BOSNIA AND HERZEGOVINA SOIL REPORT

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1. The importance of sustainable land management at the national level

Land is a natural resource and good of general national interest, which has many functions: food production, fibre, raw materials, ecological, construction, etc. The growing challenges facing humanity, such as climate change, population growth and soil degradation processes are already leading to greater human need and demand for food. Given that soil is a limited resource, solutions to the challenges ahead will need to be sought in sustainable land management and increased productivity.

The concept of sustainable land management can be defined as the use of land resources (soil, water, plants) for food production, which will meet basic human needs, ensure the long-term productive potential of soil and maintain environmental functions. Sustainable land management is the foundation of sustainable agriculture and part of a strategy for sustainable development and poverty alleviation (Alemu, 2016).

Soil productivity is actually its production capacity measured by biomass yield. Therefore, soil productivity is a broad term as opposed to soil fertility which is only one of the factors necessary for crop yields. Other soil characteristics, climate, disease pests, the genetic potential of plants and human impact through sustainable soil management are the main factors of soil productivity. In other words, *all productive soils are fertile, but not all fertile soils are productive*.

From all the above, it can be concluded that land is essential and invaluable for life on planet Earth. However, land and soil have been exposed to many pressures and degradation processes in recent decades that have significantly disrupted the above soil functions and seriously endangered the functioning and sustainability of the ecosystem as a whole.

It is estimated that about 25% of total soil globally is severely degraded, and about 50% of agricultural soils are moderately or severely affected by various forms of degradation. These facts are very worrying and the last alarm for all those in any way dealing with this issue to take concrete steps to adopt key strategic documents, laws and by-laws, action plans and measures to stop and protect soil from further degradation and remediate degraded soils. In this regard, the EU has already adopted several key strategic documents (Soil Deal for Europe, EU Soil Strategy for 2030, Soil Law, Green Deal) to bring these negative processes under control.

The situation in Bosnia and Herzegovina, when it comes to land cover structures and their trends, is best illustrated by CORINE data. According to these data for 2018, the total area of BiH is 51,215 km^2, of which 890 km^2 under Artificial surfaces, 1,892 km^2 under Arable land & permanent crops, 15,072 km^2 under Pastures & mosaic farmlands, 26,598 km^2 in Forests and transitional woodlands, Natural grassland heathland sclerophylls' vegetation 5,228 km^2, Open space with little or no vegetation 1,139 km^2, Wetlands 53 km^2 and Water bodies 344 km^2. Of all the above, 16,964 km^2 or 33.12% of the total area of BiH falls on Agricultural areas.

Comparing CORINE 2018-2000 for BiH, it can be concluded that the greatest pressure on land is from construction. Namely, in the mentioned period, there was an increase in artificial areas by 15.78% compared to the initial situation in 2000. In other words, it means that there has been an almost permanent

loss of this land for its productive, ecological and other functions, apart from the soil's function for construction. Open space with little or no vegetation comes next in the category of increased surface area by 1.71%. This is followed by an increase in water bodies by 0.93%, arable land and permanent crops by 0.80% an increase in areas under forests and transitional agricultural land by 0.05% compared to the initial situation.

On the other hand, the largest relative losses or reductions of areas were recorded as follows: wetlands by -8.21%, pastures and mosaic farmland by -6.81% and natural grassland, heathland, sclerophylls' vegetation by -0.86% compared to the initial year 2000.

From all of the above, a general conclusion can be drawn that the influence of the human factor in BiH is crucial concerning changes in land use structure. With the development of construction and expansion of urban areas, an average of 6.74 km^2 (674 ha) of land is lost annually in BiH. It can also be concluded that an even higher average annual loss of areas under pastures and mosaic farmland in BiH in the amount of 6.81 km^2 (681ha) is mostly due to population migration and leaving rural areas, with these areas mostly growing shrubs and low vegetation. Also, the increase in open space with little or no vegetation, averaging 1.06 km^2 (106 ha) per year, also indicates a negative trend in BiH regarding soil use.

These are real, and at the same time, most significant problems when it comes to changes in the cover structure of land in BiH, and it is clear that two processes dominate. One is related to a significant loss of soil under pastures. These areas mostly grow into neglected soils overgrown with low vegetation, shrubs and invasive crops, all as a result of outmigration and population abandonment in rural areas. The next most significant negative trend in terms of physical loss of land relates to the construction and expansion of urban spaces. In the post-war period in BiH, a significant expansion of unplanned and illegal construction was recorded. The state will have to stop these negative trends and find solutions to these problems as soon as possible.

If the following features of agricultural land in BiH are considered, then the situation becomes even more alarming. There is a need to take instant measures for the protection and sustainable management of land. The main characteristics of soils in BiH 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 north BiH: Lijevče field, Posavina, Semberija), excess water on about 14% of the territory, inadequate care of soil fertility management and its improvement, water erosion is 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 is classified as low quality (32%) and very low quality (30%) soils in total BiH land resources (see Table below).

Soil capability classes in Bosnia and Herzegovina	km^2	ha	%
High quality soils of I, II and III class	7,749.07	774,907	15.16
Moderate quality soils of IVa and IVb class	11265.20	1,126,520	22.03
Low quality soils of V and VI class	16,546.16	1,654,616	32.36
Very low-quality soils of VII and VIII class	15,568.57	1,556,857	30.45
TOTAL	51,129	5,112,900	100

The importance of sustainable land management in the Federation of Bosnia and Herzegovina (FBiH)

In the entity of FBiH, there is no significant difference in the state of land resources compared to what has been said for the state of BiH. The total area of FBiH is 26,608 km2. The relief structure is dominated by mountain relief > 1,000 m above sea level and amounts to 755,622 ha or 29%. Low and hilly relief up

to 200 m above sea level is the least represented (159,878.3 ha or 6.1%). Land at 200-400 m above sea level amounts to 490,189.2 ha or 18.8%, and at 400-600 m above sea level, 379,605.6 ha or 14.6% of the total land area of FBiH.

In terms of terrain slope, the class of very steep slopes with erosion processes is the largest, occupying 22.9% of the FBiH area. Almost equal representation is followed by classes that represent flat to almost flat terrain (16.4%) and moderately steep slopes (16.3%), followed by steep slopes (13.5%), very steep slopes (10.9%), moderately gentle slopes (9.4%), and the least represented are terrain classes with very steep slopes (5.7%) and undulating to slightly steep slopes (5.0%).

The land use method in FBiH was determined based on data from the Spatial Basis of the Spatial Plan of FBiH for the period 2008-2028, and based on the same source, data on agrozone boundaries within agricultural land were determined.

The first agrozone consists of agricultural soils/lands from the I to IV quality category; the second zone includes V and VI quality categories, and the third agricultural zone includes soils of VII and VIII creditworthiness categories. Within the agricultural land in FBiH, the second agrozone dominates with 553,510.7 ha (52.11%). It is followed by the first agrozone with 265,964.3 ha (25.04%), and the least represented is the third agrozone with 242,733.0 ha (22.85%). There are 1,546,379.0 ha or 59.28% of the total area of FBiH under forest vegetation, water surfaces and settlements.

From all of the above, it can be concluded that there are 1,062,208 ha of agricultural land in FBiH or 40.72% of the total area of FBiH. Of these, only one-quarter belongs to the first agrozone. They can be considered at the same time as the most productive soils on which a more intensive form of agricultural production can take place, while the rest of the agricultural area can be considered less productive. If the agricultural areas belonging to the first agrozone are divided by the number of FBiH inhabitants, estimated at 2.2 million, we get that the average size of this land per capita is about 0.12 ha. We should keep in mind that the world average agricultural land per capita is 0.24 ha, the European average is 0.45 ha, and in FBiH, it is 0.48 ha per capita. Data for FBiH do not look so good and optimistic if we consider the above, considering that in the structure of agricultural land there is still only one-quarter of the highest quality land.

There are several ways to improve soil productivity, strengthen its productive and ecological functions, and thus reduce its impact on climate change:

- Prevent or minimize the use of land for non-agricultural purposes
- Take preventive measures, prevent degradation processes and use technologies that do not lead to these processes
- Preserve soil fertility and protection against its loss (construction, contamination of the accumulation, landfills, etc.)
- Protect soil from negative impacts on physical, chemical and biological properties (use of heavy machinery and protection against deterioration of physical properties of soil, soil compaction, pollution with chemicals such as fertilizers, pesticides, heavy metals, sludge, etc.) preserve soil biogenicity and improve it, improve intake of organic matter, etc.
- Control soil fertility and fertilizer use to control environmental factors in plant production, also for the protection of soil, water, plants and food for human and animal use

The importance of sustainable land management in the Republic of Srpska

According to data from the RS Institute of Statistics, the total area of agricultural land in the Republic of Srpska (hereinafter: RS) in 2019 amounted to 1,008,000 ha (25.80% of the total territory), of which arable land occupies 816,000 ha (82% of total agricultural land).[1] Compared with the number of inhabi-

1 Institute of Statistics of the Republic of Srpska, Statistical Yearbooks, Agriculture and Fisheries Bulletin for 2020; available at: https://www.rzs.rs.ba

tants, there are about 0.83 ha of agricultural land per capita or 0.68 ha of arable land per capita. According to the World Bank (reference year 2016), the average arable land per capita in the world was 0.19 ha, and in the EU 0.21 ha.[2] Comparing these, one gets the impression that RS is relatively rich in land resources for the needs of agricultural production, because it has more agricultural and arable land per capita than most countries in the world. These statistical data are correct, but unfortunately, they do not represent the wealth in land areas but rather the large emigration from RS and depopulation.

When talking about land, it is not just an area. Vertical division (quality of land profiles) is much more important than spatial distribution. It is necessary to underline the importance of healthy and fertile land for obtaining good-quality and biologically healthy food. In recent years, in RS, there have been increasing discussions about the importance of organic production in the domestic economy and as an export item. In this regard, the importance of increasing healthy soil must be stressed. Unlike other resources, soil must be environmentally proper as well as fertile (rich in natural nutrients). In order to achieve this, it is necessary to pay more attention to this significant resource. In particular, the influence of the interconnectedness of four factors in the creation of microclimatic conditions: plant-air-water-soil should be noted. Therefore, land management and water management can never be separated, and all together can significantly affect adaptation to global climate change.

Farmers and food producers from RS are important stewards of our ecosystem and on the frontlines of climate change, and play an important role in developing and implementing environmental and agriculture solutions. They can help address water challenges and unearth sustainable alternatives to producing food. Farmers from RS are great drivers of Agriculture Nature-Based Solutions because they are mostly poor and have to combine their traditional knowledge with new skills thus protecting the ecosystems on which food production depends.

When deployed properly, Agriculture Nature-Based Solutions can provide triple benefits: improving the livelihoods of farmers and the resilience of agriculture, mitigating and adapting to climate change through soil, wetland and forest carbon sequestration, and enhancing nature and biodiversity. In order to sustain the future of food systems, agricultural producers are well-placed to lead the transition to production practices that regenerate and restore nature while enhancing efficient and sustainable food systems and this type of production should be applied in the future (contour tillage, sub-walls, wattles, planting of shrubs and woody fruits, etc.).

2. General assessment of data available (conclusions and recommendations)

Federation of Bosnia and Herzegovina

Records and data on land in Bosnia and Herzegovina are fraught with numerous problems. Thus, for example, the administration of geodata took place in analogue registers. Updating data in such conditions was slow and very often with errors. With the development of digital technologies, analogue registers were significantly translated into digital registers. However, a significant amount of data is still

2 The World Bank Development Indicators, available at https://data.worldbank.org/indicator/ AG.LND.ARBL.HA.PC?most_recent_value_desc=true

stored in analogue form. Problems are also related to the fact that in BiH, different institutions manage geodata, which are often not interconnected. Some of these problems have been resolved or are in the process of being resolved. Thus, the process of harmonization of land cadastre and land registers is currently taking place in BiH. It is a very common situation that the data in the records do not reflect the actual situation on the ground. Data search and update performance is poor, there are no standard formats for data exchange, etc. In addition to the above, unresolved ownership relations are common, a large amount of spatial data is missing, etc.

In order to be able to at least partially solve these and some other unlisted problems, it is necessary to achieve efficient access, sharing and exchange of cadastral data, and to create a domain model according to applicable standards in the field of cadastral data management and use. When it comes to agricultural soils and their use, there is no single database at the national level. These databases are maintained by the entity ministries of agriculture in FBiH through the Register of Agricultural Holdings and Clients.

Data on qualitative and other land properties are also kept by entity land institutes. Thus, in FBiH, the Institute of Agropedology in Sarajevo performs the following tasks: mapping and determining the creditworthiness of soil, soil fertility control, regulation of agricultural soils, monitoring of soil contamination, regionalization, monitoring, and establishment of the land information system.

Unfortunately, in Bosnia and Herzegovina, as well as in the Federation of Bosnia and Herzegovina, there is no unified information system on land data, nor are land data publicly available. This is a serious problem, because there is no adequate land database and the existing data are not publicly available. All this has influenced the fact that very little has been done in the past years to improve the situation related to the monitoring of agricultural land, its protection and sustainable management. Also, almost nothing has been done on the adoption of the law on land protection. The new strategy on agricultural land management has not been adopted. The last one was adopted in 2011. The current Law on Agricultural Land in FBiH was passed in 2009 and has not undergone any amendments since then.

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The main source of land data is taken from the basic map of BiH land in a scale of 1: 50000. Most of the old land maps were classified according to the modified Yugoslav classification system (1985) and scanned and digitized during the implementation of the FAO project, Inventory of the post-war situation in the land resources of BiH (2000-2002). All data is now available in GIS format. In this regard, data on land exist, but as they are based on research from the 1960s, they should be partially updated. Existing entity' data on organic carbon content are not useful for defining a baseline, as they are obtained from different analytical and field procedures and do not have a chronological sequence. Currently, global data and the European CORINE database are the only data sources that can be used to monitor land status and losses. Regardless of the poor situation when it comes to databases in RS, publicly available databases can be used in the analysis of the situation. According to the available data from the European CORINE database for RS for 2018, the situation in RS is as follows: forests cover about 52% of the territory (of which deciduous trees 34.6%, conifers 4.98%, and mixed deciduous-coniferous forests 7.51%). If the category of transitional and forest vegetation is taken into account, and the areas partially overgrown with vegetation, then the percentage of forest cover rises to 52.5%. Land under various types of agricultural production (irrigated and non-irrigated land, orchards, vineyards, complex areas under vegetation and agricultural land with significant areas under natural vegetation) occupies 7,986.8 km2 or 31.8%; pastures occupy 5.43% or 1,363.9 km^2, and meadows occupy 3.17%.

The lack of inter-institutional connections and of protocols in the exchange of existing databases is a big problem. Also, monitoring has not been established in RS, nor have cadastres of polluted areas

been identified. It is recommended to identify contaminated areas, establish a monitoring scheme and define a protocol for exchange of existing databases between institutions within RS, and then also outside RS. In addition, the need to introduce training for staff in public institutions for the use of existing databases was identified. The problem is that a very small number of employees have the necessary knowledge and skills to use available databases, and concluding recommendations should go in that direction.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

Federation of Bosnia and Herzegovina

In Bosnia and Herzegovina, there is no single law at the state level that would regulate the issue of sustainable management and protection of agricultural land.

The Federation of Bosnia and Herzegovina has the Law on Agricultural Land, which has been in force since 2009. This Law regulates issues of basic principles of land management, land protection, use, arrangement, disposal and land records. Also, this Law sets goals to preserve agricultural land, use it for its intended purpose, increase its productive capacity, and improve the management of this resource. This Law stipulates that the goals are realized through the Agricultural Land Management Strategy, adopted in 2011 and the Agricultural Land Management Improvement Programme adopted by lower levels of government in order to manage and protect agricultural land in their areas. At the level of FBiH, in 2011, a programme called Basics of Land Management was adopted: the Programme of Irrigation and Consolidation of Agricultural Land.

The FBiH Agricultural Land Strategy defines the problem, priorities, objectives, proposed ways and time to solve the problem. In drafting this Strategy, the European Soil Protection Strategy and the Water Framework Directive 2000/60/EC were analyzed. This document provides an overview of land areas, ownership structure, size of parcels, proposals for their consolidation, i.e., consolidating and managing land registers and cadastre, encouraging leases, granting concessions, the impact of urbanization and other types of land degradation. Furthermore, this document proposes land policy measures affecting land management. Management programmes are adopted by lower levels of government: cantons, cities and municipalities. Management programmes include regionalization, prescribing the procedure for soil management, monitoring, protection of agricultural land and habitats for wild plant and animal species that cannot be changed for use.

The strategic document on agricultural land management in FBiH also mentions the guidelines for land management and protection that are binding in EU countries and defined in the European Soil Protection Strategy from 2006. According to this Strategy, 8 main processes of soil degradation in the EU

are identified, namely: erosion process, reduction of soil organic matter, soil pollution, salinization, soil compaction, biodiversity reduction, soil coverage, landslides and floods. In this regard, risk areas that require specific actions and measures have been identified in the EU. Thus, for example, an inventory of polluted areas was performed, and registers were established. Also, the European Strategy for Soil Protection has taken into account some other regulations in force in the EU, such as the Water Framework Directive, the Nitrates Directive, and CAP measures, and incorporated all of these, which obliges all EU actors who in any way affect land degradation processes of to respect them.

As seen from the previous analysis of the legal framework for sustainable land management and protection, there is no single strategic document in BiH that deals with this issue. For sustainable land management and protection, it would be necessary to adopt such a strategic document as soon as possible, which would present an analysis of the state of land in BiH, define goals, guidelines and measures for land protection, measures to improve land quality, activities necessary for the implementation of measures, entities that would participate in the implementation, their rights, obligations and responsibilities, sources of funding for the implementation of strategic measures and the achievement of objectives.

In FBiH, despite the fact that certain legal and strategic solutions address this issue, it can be said that they are insufficient, as they were adopted quite a long time ago and do not meet global challenges related to climate change and the role of land in this process. The only law in FBIH that deals with this issue is the Law on Agricultural Land, which, as we have already said, was passed in 2009 and with certain by-laws adopted immediately after that. From then until today, no amendments to this Law, no new by-laws, or strategic and planning documents that would further regulate the problem of sustainable land management and protection have been adopted. In addition, all these documents deal only with agricultural land and not non-agricultural land such as forest land, which occupies close to 60% of the total structure of land in FBiH. This is a serious disadvantage if the land is viewed in a broader context and especially if its ecological function and potential impact on climate change reduction are taken into account.

An analysis of this Law in force in FBiH can also identify a number of weaknesses that make this Law non-functional, which is very easy to verify in practice. Namely, the system of implementation and enforcement of this Law is very complex because its enactor,in this case the federal level of government, does not have complete mechanisms for the implementation and control of proscribed measures and activities to achieve the defined goals related to the management, use, increase of land production capacity, land protection, etc. This is because it is a very decentralized system of management. Implementation and control over the implementation of this Law in which, in addition to the federal level of government and inspection, ten cantonal levels of government participate through their line ministries and inspection bodies. Local government levels have competencies related to the adoption of the Agricultural Land Management Programme. It should be noted that there is no single methodology proscribed by the federal level for the development of this Programme, the contents of which should be most directly related to entities at the local government level to implement measures and objectives defined by the Programme and other acts.

Due to the above, it would be necessary to adopt a unified strategy for sustainable land management and protection at the level of BiH, which would be harmonized with EU documents related to land protection, the Green Agenda, UN Convention on Land Protection, European directives on water and environment. At the entity level, and in cooperation with local governments, programmes on sustainable land management and protection should be adopted. These programmes would be in the function of implementing the measures and goals defined in the strategic plan. It should also define the activities for the implementation of measures, entities responsible for their implementation, the rights and ob-

ligations of these entities and lower levels of government to higher, such as submitting programmes and action plans for approval, and reporting on the implementation of measures.

In FBiH, it is necessary to amend the existing Law on Agricultural Land as soon as possible, eliminate its shortcomings and harmonize it with modern trends in Europe and the world, especially related to the degradation processes, conservation, protection, sustainable land management and provide mechanisms for its implementation and control.

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Looking at the legal framework in RS, we may notice that there is no law on land protection (it is not possible to talk about the term "land health," because the local language does not accept it). The current Law on Agricultural Land[3] covers the protection of agricultural land in RS. In the Law, Chapter III, Articles 17 to 36 cover the "protection of agricultural land". In addition, Chapter IV of the same Law defines the provisions relating to the arrangement of agricultural land (Articles 37 to 43). The Law on Forests[4] in RS specifies only the protection of forests and forest soil. Protections of forests and forest soil are defined in Articles 50-56, including measures and activities carried out to protect against biotic, abiotic and other factors that may cause harmful effects on them (suppression of plant diseases and pests, prohibition of the use of chemical agents and fire protection). The Law on Waters[5] covers the protection of water land (in Articles 57-85). Water land is defined as a set of land plots that make up riverbeds, lakes and reservoirs, as well as their shores to the level of hundred-year-old waters, i.e., to the level of the highest elevation for reservoirs. Also, the latest amendments to the Law on Environmental Protection (2020)[6] and Articles 16-16v have expanded the legal framework for the protection of soils that are not covered by the above-mentioned laws. By expanding the framework, the Law on Environmental Protection establishes the obligation of land users, whose activity may endanger and degrade the land, to take measures to remove and stop pollution, including soil remediation and reclamation of land. Also, a legal basis has been created for the adoption of a by-law on the limit and remediation values of pollutants and hazardous substances in the soil. Although several regulations define the obligation, manner and procedures on land management (reclamation) and its protection in RS, deficiencies have been identified. Very few legal provisions are implemented in practice. For example, the Law on Agricultural Land obliges the owners of plots of at least 1 hectare of arable agricultural land to control the fertility of agricultural land and the number of mineral fertilizers and pesticides at least once in four years, but there is no data that they do so, nor has any monitoring been established. In addition, the obligation of the municipal government to take anti-erosion biological measures every year on at least 4% of new areas of the total areas under, susceptible to or threatened by erosion is prescribed, but there are no indications that this is being done. In other cases, when inspection services are sent into the field, it is often found that property relations are unresolved with no clear ownership, so nobody can be punished. It is forbidden to burn organic residues after the harvest of crops, as well as other waste on agricultural land, but the same persists and causes fires and fire damage.

In RS, it is very difficult to control the implementation of laws, although there are inspection bodies at both national and local levels. However, the problem is the application of laws and their provisions, as well as the lack of financial resources for the implementation of legally prescribed measures for the protection of land resources. Also, in order to harmonize existing legislation on this topic with the EU standards and requirements, amendments to existing laws and secondary legislation should be made, in which land resources will be treated equally with other components of the environment. The adoption of strategic documents on the entity and local levels of government should be synchronized in

3 Law on Agricultural Land (Official Gazette of the Republic of Srpska, No. 93/06,86/07,14/10,05/12, 58/19 and 119/21)
4 Law on Forest (Official Gazette of the Republic of Srpska, No. 75/08, 60/13 and 70/20)
5 Law on Waters (Official Gazette of the Republic of Srpska, No. 50/06, 92/09 and 121/12)
6 Law on Environmental Protection (Official Gazette of the Republic of Srpska, No. 71/12, 79/15 and 70/20)

order to ensure the optimal implementation of strategic commitments of RS and the implementation of various international conventions and agreements in the field of land.

A cadastre of contaminated areas has not been established. The ministries in charge of agricultural and environmental policies have identified the need to develop a strategy for sustainable land management in RS and incorporated the development of this important document in the medium-term plan (if financial conditions are created). But it has been found that public administration officials are not familiar with the commitments from the Green Agenda and the content of the new EU Soil Strategy for 2030.

Recommendations should go in the direction of finding potential donors to support the development of the Strategy for Sustainable Land Management in RS. Trainings and workshops for municipal and government staff should also be provided in order to familiarize decision makers with current EU regulations, the EU Soil Strategy for 2030 and the Green Agenda. A large part of the tasks needs to be delegated to a lower level, in order to enable the best possible implementation of current regulations and to understand the importance and need to harmonize measures and activities with the Green Agenda and EU standards. Education, training and coaching should be strengthened through scientific research institutions and advisory services and the awareness of each individual raised, and not acted exclusively through inspection services.

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

Federation of Bosnia and Herzegovina

Excessive use of agrochemicals

The basic soil pollutants in BiH are primarily agrochemicals (fertilizers, pesticides, and heavy metals). This is especially in the areas where intense agricultural production is performed (Posavina, alluvial soils with river streams, Karst fields). Large amounts of mineral fertilizers and pesticides are often used in these soils and areas, and larger quantities of organic fertilizers are used.

Global production of mineral fertilizers in the world amounted to 246.5 million tons of active substance (2017), of which 58% is Nitrogen (N), 26% Phosphorus (P_2O_5) and 16% Potassium (K_2O) (Fertilizers Europe, 2019).

The European Union, with a production of 18.1 million tons of active substance, represents approximately 7% of world production, while total consumption for agricultural and industrial purposes is estimated at about 20 million tons per year (Fertilizers Europe, 2019). The largest exporters of mineral fertilizers to the EU are Russia, Egypt, Belarus, Morocco, Norway and the US. The most significant states that imports mineral fertilizers from the EU are Brazil, USA, China, and Ukraine.

The average consumption of fertilizers in the form of total active substance in kg/ha in some countries of the European Union is: Slovenia 251.7, Germany 241.9, Austria 168.5, Greece 152.8, and Croatia 148.2.

Generally, it can be concluded that the consumption of mineral fertilizers in the EU is stagnating and for the next period minimal growth is expected.

According to research conducted by Damjanović and Čivić (2021), the estimate of NPK consumption from mineral fertilizers in BiH for 2019 was 64,369 tons of nitrogen (N), 26,265 tons of phosphorus (P_2O_5), and 35,856 tons of potassium (K_2O). If the amount of NPK nutrients from mineral fertilizers is added to the amount of NPK nutrients from manure that is potentially produced in BiH on annual basis, this study showed that in BiH it is used about 40.50 kg N/ha, phosphorus 16.52 kg P_2O_5/ha, and potassium 22,56 kg K_2O/ha arable land.

According to FAO data, the consumption of mineral fertilizers in BiH from 1995 to 2019 was 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/ha (2004). The total consumption of this nutrient in the last measuring year (2019) was 8.95 kg K_2O/ha.

From these analyses and data, it can be concluded that fertilizer consumption in BiH is significantly smaller per unit of surface compared to some EU countries. This does not mean that there is no danger of pollution caused by excessive or inadequate use of fertilizers in BiH. This danger is very present in plain areas where intense agricultural production occurs, as well as on leaning grounds where orchards and vineyards are usually found. In addition to fertilizers, the soil can be polluted due to other factors including heavy metals, organic pollutants, microplastics, other pollutants from industry, traffic or floods.

Reports from EU countries show that heavy metals and mineral oils are the most common soil pollutants in the studied areas, while mineral oils and chlorinated hydrocarbons are the most common pollutants in groundwater. Other pollutants include polycyclic aromatic hydrocarbons (PAH), aromatic hydrocarbons (BTEX), phenols, and chlorinated hydrocarbons (CHC). When it comes to soils in BiH, in FBiH, systematic control and monitoring of the content of heavy metals and PAHs is carried out. The results of this monitoring indicate that there is no increased content of these substances in the soils of FBiH, except sporadically in soils near industrial plants and frequently flooded soils.

However, there is no systematically organized way of collecting data and analysing the number of farmers, use and consumption of fertilizers and pesticides, which would be a prerequisite for a more serious assessment of their impact on soil.

Soil erosion

Steep terrains in FBiH 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 FBiH, there is no official data on areas exposed to erosion nor an organized system for monitoring erosion.

According to estimates of soil erosion in Europe, data from the European Environment Agency (EEA), in Bosnia and Herzegovina, 0.5-5.0 tons of land per hectare is lost by water erosion. These quantities of erosive material depend on precipitation, terrain slope, soil type and land cover, agro-technical measures implemented, tillage, etc. Pre-war data (the period before 1992), show that the total average amount of sediment created in BiH was 16,518 per year (031 m^3 or 323 m^3/km^2).

Soil organic carbon

Carbon supplies in EU-27 soil amount to about 75 billion tons of carbon, of which about 50% are located in Ireland, Finland, Sweden and the United Kingdom (due to large peat areas in these countries).

The largest emissions of CO_2 from the soil are the result of organic soils conversion (drainage) and amount to 20-40 tons of CO_2 per hectare per year. The most effective carbon management option in the soil to alleviate climate change is to preserve the existing stock in soils, especially large supplies of peat and other soils with high organic carbon content.

Soils under lawns and forests are the abyss of carbon (estimated at 80 million tons of carbon per year), while soils under arable land are lower in carbon (estimated at 10-40 million tons of carbon per year).

About 45% of mineral soil in Europe has low or very low organic carbon content (0-2%) and 45% has medium content (2-6%). Low levels are particularly prevalent in southern Europe, where 74% of the land is covered with soils with less than 2% organic carbon in the topsoil (0-30 cm). However, areas with low organic carbon content can be found almost everywhere, including some parts of northern countries such as Belgium, France, Germany, Norway and the United Kingdom. More than 50% of the EU's organic carbon stocks are in peatlands.

Soil organic carbon levels are mainly determined by the balance between net primary production (NPP) from vegetation and the rate of decomposition of organic material. While climate change is expected to affect soil carbon in the long run, short-term change is more likely to be driven by land management and land-use change practices, which may obscure evidence of the impact of climate change on soil carbon stocks. The effects of climate change on soil are complex and rigorous supporting data sets are lacking. Keeping in mind the above, the general assessment is that the state of organic carbon in soils in FBiH should be at an enviable level if it is known that the structure of land cover is dominated by forest ecosystems, meadows and pastures and arable land is the least represented.

However, 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, which has been prepared for use by the JRC of the European Commission, it can be stated that the majority of soil in FBiH falls into two classes: class 2-6% organic carbon content and class 1-2% organic carbon content in top soils. Certain studies and research show that the organic carbon content in the soils of FBiH is mainly at the middle level. According to the International Soil Reference and Information Centre (ISRIC) data, 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, collapsing macropore density and reducing 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, monitoring soil compaction in FBiH is not performed. 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 (Murtić, et al., 2021., Murtić, et al., 2020.). Therefore, soil contamination prevention remains the best way to maintain healthy soils and food safety according to Sustainable Development Goals.

Areas in FBiH with a potentially high risk of contamination with pollutants consist of highly acidic soils with a pH below 4.5, with light texture, noncarbonated and 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 potentially medium risk of contamination with pollutants. These soils are of relatively lighter, loamy structure, medium humus, noncarbonated 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 Federation of Bosnia and Herzegovina territory 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 contamination processes are lands near industrial areas such as Tuzla and Zenica cantons, etc. (Čivić, et al., 2020; Sijahović et.al.,2020.). 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. The 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% of them 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 investigated, were contaminated with three elements (Cd, Ni and Mn). As for other locations, 53 or 20% of them were not polluted with any elements, i.e., they are 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, then 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.

According to Copernicus Land Monitoring Service from 2018, the population in Bosnia and Herzegovina was 3,424,031. Sealed Surface was 376.7 km^2, or 0.74 % of the total area of BiH (the European average of the same year was 1.86 % of the Sealing Area compared to total surface of Europe). Population Density in Sealed Area was 908,875 inhabitants/km^2 (European average of 573,975 inhabitants /km^2).

The degree of urbanization in BiH according to classes within the Sealing Area is 0.74%. Mostly uninhabited areas 0.07%, (European average 0.39%), dispersed rural areas 0.19%, (European average 0.46%), villages 0.10%, (European average 0.27%), suburbs 0.13 %, (European average 0.27%), towns 0.15%, (European average 0.29%), cities 0.09%. (European average 0.395%).

Soil acidification

Human-induced acidification of agricultural and forest soils is primarily associated with the 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 accordingly provides an appropriate measure to reduce it if necessary. About 25% of the 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 regarding biological diversity, 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 (Znaor, et al.,2014.).

Soil biodiversity

The soil is by far biologically a variety of material on Earth. It contains a large number of organisms that interfere with each other and contribute to many global cycles, including carbon and nitrogen cycles.

The soil provides vital habitats for microorganisms such as bacteria, mushrooms, as well as insects and other organisms. A teaspoon of the top layer of soil usually contains up to 6 billion microorganisms.

The variety of organisms that live inside the soil is critical for all earthly ecosystems because the soil organisms act as primary movements of nutrient circulation, regulate the dynamics of organic substances in soil, sequestration of carbon in soil and greenhouse gas emissions, modify the physical structure of soil and water regime, increase the amount and the effectiveness of adopting nutrients by vegetation and improve the health of plants (FAO). Soils that support natural, non-agricultural ecosystems usually have the highest soil biodiversity. In agriculture, soils that receive less produced inputs (e.g. chemical fertilizers and pesticides) generally have higher soil biodiversity. Grazing systems encourage plant diversity. Crop systems generally have low soil biodiversity unless they increase carbon and nitrogen input to the soil, which would increase the population of soil microbes. Crop management techniques that increase soil organic matter would also increase soil stability and biodiversity. Management techniques such as fruitful and reduced tillage increase the amount and quality of organic matter available to the soil organisms and develop a more stable environment that promotes greater soil biodiversity.

For soil to be healthy, land should be managed within its capabilities. It is necessary to encourage good agricultural practices of land management to increase the level of organic matter in the soil and its biodiversity. Examples of good management practices for strengthening biodiversity include steering pressure management to retain and improve herbal cover, using minimum tillage or soil processing procedures without soil cover and improve soil structure, maintaining and increasing perennial plants (including pastures), carefully using fertilizers, soil rehabilitation to targeted earthwork, water management and sowing. Soil biodiversity is increasingly under pressure due to soil threats such as erosion, contamination, salinization, and closure. These events threaten soil biodiversity by endangering or destroying the habitat of soil biota. Management practices that reduce the deposition or persistence of

organic matter in soils or bypass the biologically mediated nutrient cycle also tend to reduce the size and complexity of soil communities. However, it is noticeable that even contaminated or severely disturbed soils still support at least relatively high levels of microbial diversity. It has been observed that certain groups may be more sensitive to certain pollutants or stress than others (e.g. nitrogen-fixing bacteria that are symbiotic with legumes are particularly sensitive to copper). A recently published JRC article presents potential threats to three categories of soil biodiversity (i.e., soil microorganisms, fauna, and biological functions) in the EU and provides guidelines for identifying potentially endangered soils. The study showed that the potential risk for soil biodiversity is extremely high. According to the findings, intensive human use/exploitation is the biggest potential threat. Any biodiversity loss is certainly undesirable. However, given our limited understanding of the implications of soil biodiversity, further efforts will be needed to identify potential risks.

Unfortunately, in BiH and FBiH, there is no systematic monitoring of soil biodiversity.

Soil drought

The long-term, intense and frequent droughts cause habitat loss, migration of local species and spread of invasive foreign species and consequently loss of biodiversity. Droughts affect water resources and agricultural production, cause soil erosion, reduce carbon sequestration and generally contribute to land degradation (Čustović and Marković, 2014.).

According to the European Environment Agency, the impact of drought on total land area and land cover in BiH is 4,904 km^2. Average drought impact area per year is 258 km^2 or in 0.56% of the total land area. According to the above data, BiH is among the last countries in Europe in terms of the mentioned influence. After BiH, come Sweden, Norway and Iceland.

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 the abundance of water is one of the main characteristics of BiH.

Between 2000 and 2019, the EEA-39 region was affected by severe droughts with an annual loss of productivity of 3% in the affected areas. The last decade has experienced the most intense dry years. In particular, droughts in 2013, 2016 and 2019 showed strong influences on vegetation productivity. The influence of drought on forests was the worst, with annual productivity loss of 5%, followed by crops (4% annual drop), and heather/shrub (a decrease of 3.1 %).

Floods

Bosnia and Herzegovina is the richest country in the region regarding 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 are happening more and more due to man's irresponsible attitude towards nature.

At BiH level, Assessment of Natural or Other Disasters was adopted in 2013. This is a basic document developing a protection and rescue plan from natural and other disasters. Thus, in FBiH, there is a federal operating plan that determines the implementation of active defence and ice defence measures, at a time of immediate danger of the occurrence of large floods, during the duration of floods and eliminating the consequences of floods. Also, in FBiH, a preliminary flood risk assessment was made for watercourses based on available and collected information and data on areas with a significant risk of floods.

According to the European Environment Agency, the number of severe floods in Europe has a significant growth trend. For example, in 1980 their number in Europe was 99, of which 69 were medium, 18

high and 12 severe. In 2010, a total of 321 floods were reported in the EU, of which 204 were moderate, 46 high and 71 severe.

Agency for Statistics of Bosnia and Herzegovina has established an official portal for SDG indicators for Bosnia and Herzegovina (BiH SDG portal). The portal provides all users with data on the status of global SDG indicators for Bosnia and Herzegovina: https://sdg.bhas.gov.ba/.

SDG 15.3 defines that desertification should be combated by 2030, degraded soil should be restored, including soil affected by desertification, drought and floods, and a world-neutral soil degradation effort should be sought. The report for BiH from 2015 shows that the SDG indicator for the share of degraded soil in the total soil area was 4%. This information additionally obliges all actors in BiH in charge of land policy to pass appropriate laws as soon as possible. That would contribute to ceasing further processes of soil degradation as well as remediation of already degraded soils.

The Republic of Srpska

Drivers and pressures on land are multiple. According to the Land Degradation Neutrality Target Setting Programme 2018[7], there are numerous drivers of land degradation in RS, such as: construction of settlements on arable land, surface exploitation of various raw materials, landfills, water accumulations, construction of infrastructure (roads, railways, etc.), thermal power plants, industrial facilities, occurrence of water erosion and landslides, inadequate management of land and forests, presence of landmines and radioactive materials, floods, and droughts. What needs to be emphasized is the accelerated and aggressive urbanization of the northern parts, where the lands of the best classes are located. These are the areas of Semberija and Lijevče polje (expansion of Bijeljina, Laktaši and Gradiška towns). In addition to the permanent loss of soil, the expansion of settlements creates a huge amount of solid waste, which pollutes surrounding areas. In this regard, in addition to officially registered landfills, a lot of wild solid waste landfills can be found in the vicinity of populated areas , which have a very negative impact on biodiversity.

In the field of international obligations undertaken by BiH regarding land, the most important is the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (UNCCD), ratified by BiH in 2002 by the Decision on the Ratification of UNCCD (Official Gazette of BiH, No. 12/02) and entered into force the same year. The focal point for the UNCCD in BiH is the Ministry of Agriculture, Forestry and Water Management of RS. Regarding the reporting processes of land degradation, there are two important documents: the United Nations Environmental Programme (UNEP) Action Programme to Combat Land Degradation and Mitigate Drought Effects of the BiH (2017)[8] and the LDN Target Setting Programme for BiH, February 2018 (consisting of 3 individual reports). The UNEP Action Programme is a strategic document at the state level, for which the entity government gave consent and then was adopted by the Council of Ministers of BiH at the 102nd Assembly, held on 05 May 2017 (Notice No. 05-07-1-1236-17/17). During 2018, a document titled List of Selected Environmental Indicators in BiH was prepared. However, the problem with this document is that it was adopted by the Council of Ministers of BiH, without prior comments or suggestions from the RS Government, and as such is unacceptable and inapplicable. Its amendment was initiated in 2020, but the process of adoption is complicated due to political reasons.

The reporting process for BiH is currently based on global data and the European CORINE database, and in accordance with the above, the situation for RS in 2018 is presented in the table below.

7 Marijana Kapović-Solomun, "Land Degradation Neutrality Target Setting Programme", February 2018, (also available at https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mps/Documents/LDN%20TSP%20Report%20za%20Republiku%20Srpsku_470474363.pdf)

8 Čustović, H., Marković, M., 2017, The United Nations Environmental Programme (UNEP) Action Programme to Combat Land Degradation and Mitigate the Effects of Drought in Bosnia and Herzegovina

CORINE Land Cover class	km²	%
Artificial surfaces	1,616.32	6.44
Agricultural areas	10,144.68	40.42
Forest and semi natural areas	13,176.54	52.50
Wetlands	15.06	0.06
Water bodies	145.57	0.58
TOTAL	25,098.17	100.00

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

Federation of Bosnia and Herzegovina

In the last decades, soil has been exposed to various types of pressures and degradation processes that cause a number of negative consequences not only to soil, but also to other parts of the ecosystem and climate change. In order to reduce and stop these negative trends and improve the general situation, a different approach and human attitude towards this invaluable natural resource is necessary. One such approach is reflected in sustainable land management, which has become an integral part of the European Green Agenda 2030.

Bosnia and Herzegovina has accepted and signed certain international acts, and thus committed itself to work on the implementation and enforcement of certain obligations prescribed in these acts. One of them is related to sustainable land management. However, for its implementation, it is necessary to meet certain conditions, which relate primarily to administrative, technical, laboratory, educational, etc. As sustainable land management involves implementing a series of measures to preserve or improve not only the primary production functions of soil, but also its environmental and other functions. Sustainable land management also implies the implementation of a series of measures related to stopping soil degradation processes, as well as those that will return degraded soils to their original or zero state.

When it comes to sustainable land management in BiH, and thus in FBiH, it can be said that these processes are in the initial phase. There are realistic assumptions that sustainable land management in BiH could become a reality in the near future. For such a thing, it is necessary, first of all, to adopt appropriate legislation and stimulative measures that would contribute to achieve this goal. There are

institutional and administrative capacities both in FBiH and at the level of cantons to adopt appropriate legal solutions that would oblige all subjects to comply with and implement measures. However, it seems that at this moment, there is not enough political will to adopt them. There are also technical preconditions for the introduction of sustainable land management in FBiH and monitoring its impact through measurable indicators prescribed by the FAO Protocol, such as: soil productivity, soil organic carbon content, specific soil density, soil biological activity and other accompanying indicators. In FBiH, there are appropriate laboratories that are technically and professionally trained to conduct these and other analyses related to the implementation and monitoring of the impact of sustainable land management measures.

What could be a problem in the implementation of these measures is the lack of education of end users about the benefits of introducing these measures as well as the ways and techniques of their application. The recommendation could refer to the need to educate end users, farmers, about all agro-technical, technical and other measures, their benefits, how to apply these measures, etc., in order to achieve the ultimate goals that promote sustainable land management.

The Republic of Srpska

When considering the assessment of land management capacity in RS, the situation seems satisfactory. In RS, policy management institutions are established (Ministry of Spatial Planning, Civil Engineering and Ecology, Ministry of Agriculture, Forestry and Water Management – Sector of Agricultural Land), inspection supervision, training centres and laboratory facilities with equipment. However, the situation in land policy is still not at a satisfactory level, for the following reasons: insufficient connections between individual institutions, staff shortages and almost no data exchange. There is a large fluctuation of the workforce, which adversely affects the connectivity of institutions and staffing. Poor management practices (land, water, and forests) have also spread in the field. The reasons are low level of information/knowledge exchange, weak socio-economic situation and knowledge and awareness among stakeholders about the importance of land.

Recommendations should include the development of special protocols on data exchange between individual institutions and more education, training and workshops through scientific research institutions and advisory services.

In addition, to bring the concept of sustainable land management into life in the true sense of the word and become fully involved at all levels, 4 interrelated processes are needed:

1. Favourable institutional environment for the integration of sustainable land management, including: entities and territorial policies and regulations; intersectoral coordination and synchronization of legislation, and planning processes that respect and integrate sustainable land management at the entity and local levels
2. Functional financial and incentive mechanisms for the implementation of sustainable land management measures at the entity and local levels
3. Introduction and application of new technologies and practices for sustainable land management, and the dissemination of existing good practices that provide sustainability
4. Strengthening capacity, knowledge and experience through a participatory approach, as a precondition for efficient integration into legislative and policy framework, and meaningful implementation at the local level

6. Assessment, conclusions and recommendations

Federation of Bosnia and Herzegovina

Improving soil quality and its preservation in BiH, and thus in FBiH, can be achieved through a strategic and systemic approach that would primarily include the following activities:

- Adopt appropriate legal solutions that would be in line with the legislation developed in the EU, related to the protection and sustainable management of land.
- Stop the processes of land degradation, and if possible, return degraded lands to their original condition with the help of appropriate measures. This is especially true of land degradation caused by sealing, unplanned construction, and degradation of natural pastures as the most prevalent forms of degradation in BiH.
- Maintaining soil fertility, and if possible, repair it with the use of modern knowledge and technologies primarily related to soil cultivation, fertilization, and plant protection.
- In line with climate change agreements, it is necessary to promote existing and new initiatives to bring the carbon cycle in soil into balance in a way that does not jeopardize food production. Biomass production should be encouraged through improved access to water and other soil-related factors (soil structure, aeration, nutrient availability, pH, soil biological activity), extremely careful tillage, grazing and sustainable management of green areas, integrated agricultural production, including best practices from organic and conventional cultivation, such as crop rotation, legume cultivation, use of organic waste, composting and making winter cover for plants in the fields. Carbon-rich soils and grasslands must be cultivated in a sustainable way to encourage carbon sequestration in the soil and through plants.
- Raising social awareness of the importance of soil through the education system, education of the population and farmers and their awareness of soil and good agricultural practices.

The Republic of Srpska

1. Assist in the development of strategic documents: assist and support the development of the Strategy for Sustainable Land Management in RS and revise the document List of selected environmental indicators in BiH with all recommendations and suggestions of the RS Government
2. Develop special protocols on data exchange between individual institutions
3. Intensify training for municipal and government staff and advisory services through scientific research institutions on various topics (database management, the importance of land management, etc.)
4. Develop schemes and protocols for the transfer of land management activities to municipal administrations, in order to better implement applicable regulations
5. Initiate procedures and define elements of the RS Law on Land Protection

7. Good case studies on soil management practices

Federation of Bosnia and Herzegovina

In FBiH, more precisely in the Tuzla Canton and the municipality Ravno, in 2018, the FAO-GEF project Decision Support for Scaling up and Mainstreaming Sustainable Land Management (DS-SLM)was implemented The project was related to the application of good practices in degraded land management – WOCAT approach, and decision-making process for disseminating sustainable land management (SLM) practices. The World Overview of Conservation Approaches and Technologies (WOCAT) is a network established in 1992 to collect, document, assess, disseminate, and apply knowledge on sustainable land management (Čustović, et al., 2020.).

According to the WOCAT database from September 2018, 1,000 SLM technologies, 443 SLM approaches and 443 UNCCD PRAIS practices were registered and published in WOCAT. Research within this project established a review of the WOCAT database in May 2018, at least 133 SLM technologies and 48 SLM approaches applicable in BiH. These indicators were obtained on the basis of verification and analysis of 23 climate-comparable countries with BiH. Slovenia and Serbia were included among the surrounding countries , 4 types of SLM technologies from the WOCAT database applicable from Slovenia, and 1 type from Serbia. Examples of good practice for SLM from Slovenia that are applicable in BiH are:

- Conversion of arable land to pasture land. It is applicable for shallow soils with a lot of stone. In such lands, due to more and more frequent droughts, there is a decrease or loss of yield. An example of good sustainable management practices on such lands in such situations is the cultivation of more drought-resistant crops, such as sowing grass instead of maize, fencing and rotational grazing (paddocks), pasture for suckle cows.
- Integrated soil fertility management. Application of biochar and zeolite in stable, farm animal breeding. With this measure, it is possible to improve the health of animals, reduce unpleasant odours, improve the quality of manure, in addition, zeolite can be applied independently to improve soil properties. Similar results were obtained by Čivić et al. (2020) in their research related to the positive impact of zeolite and naturalite on reducing the concentration of heavy metals in some soils in FBiH.
- Organic agriculture, based on a 5-year crop rotation. No artificial means of protection and no inorganic nitrogen. Provision of nitrogen with organic fertilizers and plant residues.
- Fertilization with manure. Use of manure (excrement, grain straw) from dairy cow breeding for fertilization of arable land every 3 - 5 years. Very good effects of manure on productive soil properties.

An example of applicable SLM technology from Serbia from the WOCAT database refers to the newly patented technology for planting and growing forests and orchards. Technology of complete mulch with a special material (P 2013-0555 polyethylene) with a positive effect on the growth intensity of planted forest or fruit crops. This technology enables cultivation without irrigation in otherwise unfavourable conditions of habitats with high temperatures and insolation.

The project also promoted potential SLM technologies and affordable applications in BiH, such as the SLM approach to land consolidation in the municipality Ravno, and the development of a map of use values for several municipalities in the Tuzla Canton. Among SLM technologies in this canton, the following have been promoted: rehabilitation of landslides using the "fish bone" technique in the munic-

ipality Banovići; container cultivation (blueberries) on infertile soils and/or ore dumps in the municipality Živinice; contour soil tillage in the municipality Srebrenik; rehabilitation (stopping) of shallow landslides with wooden stakes in the municipality Kladanj; digging and using irrigation wells for vegetable growing in the municipality Gračanica.

The Republic of Srpska

Examples of best practices tested in the demonstration sites are:

- Irrigation of cropland belonging to the agricultural company Napredak in Pelagićevo: an SLM measure for drought control. Irrigation has increased yields by 35-40%.
- Reforestation of karst and bare land by planting tree seedlings in Trebinje.

Afforestation of karst landscapes in the Herzegovina region: an SLM technique aimed to increase infiltration and water holding capacity.

Successful afforestation of bare karst land.

The following SLM practices were implemented in agreement with national institutions:

- Intensive irrigation in the Pelagićevo municipality on the fields of the agricultural company "Napredak" was carried out on about 40% of the area (80 ha); irrigation measures have completely changed the structure of production and today it is focused exclusively on seed crops of corn, wheat, sunflower, and soybeans, as well as part on the production of vegetable seeds. The regime and structure of field production are completely different than in dry farming, and under the irrigation system they give much higher yields.
- Reforestation by planting seedlings in the pilot area of Trebinje depends on the entity budget (average 10-25 ha/year) and scaling up in Herzegovina (same ecological conditions: 130 ha/year). It was done annually, every year the Public Forest Enterprise Šume Republike Srpske a.d. Sokolac plans funds for afforestation of karst (between 10-25 ha), depending on the budget available for that year.

Installation of irrigation system in AC "Napredak"

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KOSOVO* SOIL REPORT

PREPARED BY

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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. The importance of sustainable land and soil management at the national level

According to population estimates for 2019, the population in Kosovo* at the end of 2019 was 1,782,115 inhabitants (KAS, 2021). Considering the total area of agricultural land used for agricultural production in 2019, which was 420,141 ha (MAFRD, 2020), about 0.23 ha per capita in Kosovo* was used for agricultural production in 2019, which fully corresponds to the global level with an area of 0.23 ha of cultivated land per capita of the world population, while high-income countries use 0.37 ha of cultivated land per capita (FAO, 2011).

The population in Kosovo* is increasing, and the demand and pressure on land use in the country on an annual basis are also increasing. It is noticeable, especially in the sectors of economy, construction, road infrastructure, tourism, recreation, use of raw materials, and other infrastructure (waste management, water treatment plants, etc.). Therefore, due to the pressure on land demand from the increase in urbanization, industrialization and economic exploitation, the land fund is constantly damaged, destroyed, and reduced. This requires urgent actions for sustainable soil protection and management.

The main challenges in agriculture land management are as follows:

- Loss of agricultural land due to change of purpose, especially due to unplanned urban construction
- Extreme fragmentation of agricultural lands
- Unfinished land consolidation from 1983 to 1989 and a lack of new consolidation projects
- Privatization of agricultural lands is carried out without a strategic plan for protecting and sustainable and planned use of agricultural land
- Lack of information and transparency on the land market
- Incomplete (up-to-date) data on land ownership, which poses a problem both in the allocation of subsidies and in the impossibility of carrying out the land consolidation process
- Poor land management system
- Permanent pollution of agricultural land from various sources of pollution
- The lack of a nationwide land-use management plan is reflected in unsustainable agricultural land use

Sustainable land management and protection from pollution is a standard that must be met by all levels of local and central institutions, and the private sector.

There is no doubt that access to and management of land resources needs to be significantly improved, as the envisaged food and agricultural production requirements need to be met. Therefore, sustainable agricultural land management requires closer policy integration, combined with increased investment and strategic plans for the protection, regulation and utilization of agricultural land.

Based on the current situation, policymakers in Kosovo* should take concrete steps toward the implementation of sustainable land management through:

- Capacity building at the central and local levels
- Implementation of the legal framework to effectively reduce the negative effects of soil degradation and challenges faced by agricultural land through Sustainable Land Management
- Establishment of a joint inter-ministerial and inter-institutional body, through which the responsibilities of all institutions for the use, management and supervision of agricultural land use should be precisely defined through the concept of Integrated Land Management
- Preparation of concrete projects for remediation of agricultural land degradation as a set of processes caused by human activity
- Application of good sustainable land management practices, according to the models of developed by European countries and EU standards

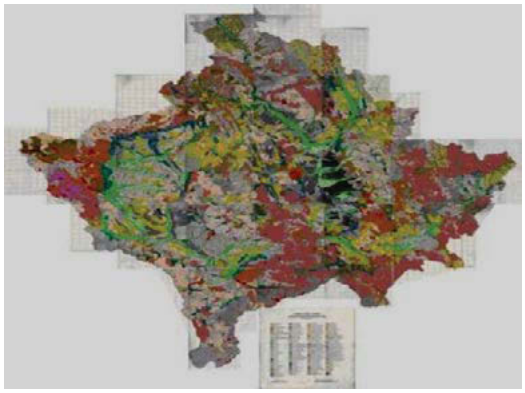
2. General assessment of data available (conclusions and recommendations)

The fundamental lack of data is an inherited problem. First studies of soil profiles were made during the preparation of the pedological map in 1974, at a scale of 1:50000, where 120 types and subtypes of soils were identified. The collected data remained in Serbia (Belgrade) and were never transferred to Kosovo*. Instead of producing a genuine pedological map from this study, Kosovo* inherited only an atlas of soil types and subtypes without data on the chemical, physical and mechanical properties of the types and subtypes of researched soils.

Therefore, it is more than necessary that the inventory project started by the Kosovo* Agricultural Institute in Peja finishes, and then to find the funds to start the inventory of the rest of Kosovo* soils. In this case, a unified digital pedological map for the whole of Kosovo* will be produced according to WRB 2014 (updated 2015), which will be simultaneously compatible and unified with the soil system according to EU standards. According to WRB 2014 (updated 2015), pedological maps should be accessible to all institutions, university representatives, and various soil researchers for projects that need data on soil types and subtypes.

The data that is needed for the classification of the suitability of agricultural land, for the determination of the creditworthiness of agricultural land, is based on the administrative instruction 02/2012 on the Classification of the Suitability of Agricultural Land, which emerged from the Law no. 02 / L-26 on Agriculture Land, Official Gazette of the Provisional Institutions of Self-Government in Kosovo*/Prishtina: year II / No. 13 / 01 June 2007. This data is divided into three groups; group I systematizes land data, including soil type, texture, depth, and drainage. All these data are provided by the Kosovo* soil atlas IDWE 1974. Group II systematizes terrain data, including terrain slope and altitude; group III systematizes climate data, including average annual atmospheric precipitation.

The agricultural land suitability classification methodology was prepared by the project Further Support of Land Use – EULUP , Project Number 2010 / 230-489, funded by the EU and managed by the European Commission Liaison Office (Palmer, R., Nordin, N., 2011).



Kosovo* Soil Atlas IDWE (1974)

This methodology is based on the physical characteristics of soil, and the relevant data were used, which were available from the Kosovo* Soil Atlas IDWE (1974), as other data sources at the country level were not available, and as such is used as the basis for implementing and managing policies in many areas such as agriculture, forestry, construction, environment, real estate market, taxation, spatial planning and development.

Given that this methodology is very deficient in basic land information, which is used in the methodologies of developed European countries and the UN FAO methodology for classifying lands according to suitability, then it is suggested that research on the land inventory of Kosovo* take into account the data necessary for the preparation of land suitability classification.

Kosovo* Hydrometeorological Institute (KHMI), which operates within the Ministry of Environment and Spatial Planning, does not regularly monitor and assess soil pollution because there are insufficient human capacities, even jurisdiction to soil.

Monitoring is carried out when there is an environmental accident or through a project, as was the case with the project Study of Agricultural Land Pollution (SNTB) in Kosovo*, which was part of the IPA 2010 Programme, and supported the Ministry of Environment and Planning Spatial Planning (MESP) and the Ministry of Agriculture and Rural Development (MAFRD). This project funded a detailed study on agricultural land pollution in 17 municipalities.

To obtain a clear picture of the land and soil situation in Kosovo* in terms of pollution, detailed studies on agricultural land pollution should be continued in all other municipalities where the study has not been conducted.

The local land and soil monitoring system should be kept under scrutiny, provide data on land condition, and suggest actions to maintain land functions.

The dynamics of monitoring and assessing the state of land use in Kosovo* should be applied according to EU policies and standards. They should focus on prioritizing the integrated approach to land use planning and management. This dynamic should focus on monitoring, documenting and evaluating the spatial model, extent and land cover in Kosovo*.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

To create a legal basis for the use, protection and regulation of agricultural land, the Assembly of Kosovo* has approved the Law no. 02/L-26 on Agricultural Land. This law defines the use, protection, regulation, and lease of agricultural land in order to permanently preserve and protect the agricultural potential based on the principles of sustainable development (GZIPK No. 13/01, 2007).

According to the Law No. 03/L-025 on Environmental Protection, land protection is an activity of general social interest. Based on that Law, the Administrative Instruction (GRK) No. 11/2018 on Limited Values of Emissions of Polluted Materials into Soil was prepared. This Administrative Instruction is partially in accordance with the Directive 2010/75/EU of the European Parliament, the Council of the European Parliament, and the Council of 24 November 2010 on Industrial Emissions/integrated pollution prevention and control (Official Journal of the European Union L 334/17, 2010). This Administrative Instruction aims to determine the emission and soil quality norms, i.e., the emission limit values of pollutants in the soil.

Based on this Administrative Instruction, the Ministry of Environment and Spatial Planning (MESP) identifies areas endangered by land degradation, identifies contaminated locations and prepares the programme for the protection of land function in cooperation with the Ministry of Agriculture, Forestry and Rural Development, Ministry of Infrastructure, the Ministry of Local Government Administration and Municipalities.

In accordance with the Law No. 03/L-025 on Environmental Protection, the Ministry of Environment and Spatial Planning must carry out continuous control and monitoring of the state of the environment and must determine the capacity of the land to fulfil its environmental, economic, social, and cultural functions and should determine land degradation.

However, because regular control and monitoring are not applied, we can conclude that the current legislation is not applied at the appropriate level.

Due to the non-implementation of the existing legislation, a concept document related to Land Protection should be drafted, through which the protection of land as a natural resource of national interest would be regulated, through systematic monitoring of the condition and quality of soil, application of rehabilitation measures, inspection supervision, etc. This concept document should have as objective the regulation of land protection as natural resources of national interest, addressing the systematic monitoring of the condition and quality of land, the application of rehabilitation measures, inspection supervision, etc. Based on the concept paper, a realistic assessment should be made on whether the legislation in force should be updated or the Law on the protection of land from degradation should be prepared.

Existing legislation and strategic documents in the area of land in Kosovo* are partially or fully in line with the laws, strategic documents and agreements of the European Union. Based on the 2015 European Union Preliminary Progress Report (Preliminary Progress Report Kosovo*, Year 18, 2015), the Environmental Impact Assessment Directive (2011/92/EU EIA) is 91% compliant. The Strategic Environmental Assessment Directive (2001/42/EC SEA) is 100% compliant, etc.

At the EU level, there is no comprehensive binding framework that strategically sets out policy priorities or parameters for land protection in the new Soil Strategy for 2030. The results of land protection in other laws are mainly due to the fulfilment of environmental objectives that are not explicitly focused on land, such as reducing pollution, compensating for greenhouse gas emissions and preventing other environmental threats *(https://ec.europa.eu/environment/soil/soil_policy_en.htm)*.

However, during the drafting of the Strategy for Environmental Protection and Sustainable Development 2022-2031 (which is currently being drafted by the Ministry of Environment, Spatial Planning and Infrastructure), the aim should to incorporate the objectives of strategic documents and agreements of the European Union that target land, such as:

- Soil Deal for Europe, with its primary mission – creating living laboratories as places where one can experiment with land in the field and special facilities, such as a farm or a park, where good practices can be displayed to lead the transition to healthy lands by 2030.
- Green Deal, which resets the European Commission's commitment to tackle climate and environmental-related challenges through a new growth strategy that aims to transform the EU into a fair and prosperous society with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.
- EU Soil Strategy for 2030 offers an overarching policy framework for soil restoration to assess the status of European soil and take action against its degradation.
- Soil Health Law, which is expected to be proposed by the European Commission in 2023, to improve the condition of the soil by 2050 significantly and protect soils on the same legal basis as air and water.

Implementation of the United Nations Sustainable Development Goals: SDG 2.4.1 Proportion of agricultural area under productive and sustainable agriculture is monitored by the Ministry of Agriculture, Forestry and Rural Development. Data on these areas are regularly reported in the annual Green reports (MAFRD, 2020). In addition, these areas are also reported through Land Coverage Reports (MMPH-AM-MK, 2019).

Implementation of the United Nations Sustainable Development Goals: SDG 15.3.1 Proportion of land that is degraded over the total land area is partially covered by the Ministry of Environment, Spatial Planning and Infrastructure. In this context, most of the locations of degraded lands have been identified, but the sources and total areas of degraded lands have not been identified.

Referring to the state of SDG 15.3.1, it is proposed that the Agency for Environmental Protection of Kosovo* prepare a cadastre of degraded lands, which will accurately reflect the location, resources, and areas of degraded lands and then propose measures to revitalize or rehabilitate degraded lands.

In terms of municipal competencies, Law No. 02/L-26 on Agricultural Land stipulates that the municipal body in charge of agriculture is obliged to keep records of uncultivated land, land given for use, records of land ownership, records of land that changed the purpose of use. However, 16 years after the law was enacted, 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 in force on agricultural land needs to be updated. The existing legislation does not have

clear provisions for central and local level competencies regarding the approval of draft development plans for changing the purpose of agricultural land (category I-IV) and forest land into land for non-agricultural-forestry purposes. Also, the current legislation does not provide provisions for the establishment of a fund for agricultural land, which is more than necessary for the consolidation process of agricultural land. On the other hand, the land consolidation process based on current legislation has proved to be limited or unsuccessful. Therefore, these and many other issues are issues that need to be addressed in the legislation that needs to be updated in the future by the Ministry of Agriculture, Forestry and Rural Development.

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

Use of mineral fertilizers - The use of mineral fertilizers in the last year has decreased mainly due to the high prices in the market. All mineral fertilizers in Kosovo* are imported. The quality of mineral fertilizers is controlled only when it is imported by the phytosanitary inspection. Soil degradation with mineral fertilizers occurs only in some intensive production crops such as in spice and tomato production. In general, although the science of agricultural production recommends the application of mineral fertilizers in optimal doses, farmers in Kosovo*, in most cases, do not use chemical fertilizers in preferred doses due to their high price. To avoid the high use of these fertilizers, farmers should focus on the use of organic and foliar fertilizers with lighter nutrient composition and use them in some treatments. The Ministry of Agriculture, Forestry and Rural Development should work on raising awareness of these actions through the implementation of various projects, organization of seminars and printing of brochures and leaflets. Also, this issue should be regulated by updating the Law no. 2003/10 on Artificial Fertilizers.

Use of plant protection products/substances - The authorization for registration and import of pesticides provided by the legislation of Kosovo* is 100% compatible with the Plant Protection Products Application Management System (PPPAMS) of Plant Protection in European Union and EU Pesticides Database.

However, the use of plant protection substances in Kosovo* is not controlled by state institutions. Farmers mainly use products preferred by agricultural experts for plant protection and those offered in agricultural pharmacies. Because they doubt the quality of plant protection products, farmers mostly use higher doses than those preferred by plant protection experts. To avoid uncontrolled use of plant protection substances, plan protection products should only be applied by persons that are certified to use these substances.

Erosion - Although there are data on the spatial extent of erosion and its intensity, there is still no erosion management plan within either the Ministry of Environment or the Ministry of Agriculture. The lack of erosion management plan and application of erosion protection measures is due to the non-application of existing legislation in force (Administrative Instruction MA No. 37/06, on the Protection of Agricultural Land from Erosion) and lack of staff in institutions responsible for this action. Forest burning appears to be an additional possibility for the occurrence of erosion in forest lands. Therefore, the Ministry of Agriculture, through the Kosovo* Forest Agency, should be oriented as much as possible to afforestation or reforestation of forest land.

Other measures against erosion of agricultural land should also be introduced, such as the application of organic fertilizers, planting and cultivation of fodder plants and other plants that enrich the soil with organic matter, ploughing according to isohypses, raising terraces on sloping plots, etc. The Ministry of Agriculture and the Ministry of Environment should work on raising awareness about issues related to erosion in the general population. In this regard, seminars and consultations should also be organized with farmers and all those who use agricultural and construction land.

Soil Organic Carbon - The increase in soil organic carbon content correlates with the increase in soil fertility which results in an increase in soil organic matter content. As a measure for raising organic carbon in the soil, it should be suggested to increase fertility by planting different types of plants, especially with a strong root system. Regarding the increase of organic carbon content in soil, special projects should be implemented for the awareness of farmers and the general population, as the lack of organic carbon in the soil directly affects the quality of soil in terms of chemical, physical and biological properties. Also, the Ministry of Agriculture must implement the by-laws in force, such as the Administrative Instruction MA No. 36/06, on the Recultivation of Agricultural Land and Administrative Instruction MA No.38/06, on the Control of Agricultural Land Fertility.

Contamination - Contamination represents a serious problem for Kosovo's agricultural land. Contaminated land is not subject to the process of recultivation and remediation, although this issue is regulated by the legislation in force. Land losses are permanent, and the inspectorate of the Ministry of Environment has a shortage of staff and still cannot withstand the pressure of contamination caused by the construction of residential buildings. The lack of staff in the Ministry of Environment, Spatial Planning and Infrastructure has, as a consequence, the non-application of the legislation in force for land protection.

To help reduce the impact of construction contamination, it is important to work with partners that can provide comprehensive solutions with cost-effective waste recycling and disposal plans.

In the current situation, work should be done on the digital cadastre of contamination of agricultural and construction land. This cadastre enables the authorities to identify all cases of contaminated land, its surface, intensity and sources of contamination. All this information should be digitized, and work should be done on the preparation of a digital map which at any time provides the necessary information on the possibility of applying remedial measures in accordance with applicable law and at the same time used to monitor contamination by inspectors and responsible staff.

But again, taking preventive measures to reduce or avoid the impact of contamination altogether is essential. In this regard, an integrated approach is needed for all central and local level institutions which are responsible for the planning, use and monitoring of agricultural and construction lands.

Floods - They pose a serious problem in Kosovo* and they are a consequence of improper land use, improper management of river beds and non-regulation of river banks. Therefore, each municipality should develop a strategy and measures to mitigate the increased risk of floods.

Environmental indicators for land/soil

Based on the Law on Environmental Protection (Law No. 03/L-025 on Environmental Protection), and according to Article 50 point 4 of this Law: "Environmental monitoring is performed through systematic measurements, research and evaluation of indicators of the condition and pollution of the environment".

The national list of environmental indicators is determined by the Decision of the Minister of MESP no. 90 dated 31 January 2018 for the approval of the national list of environmental indicators. Within this list there are two indicators – environmental Indicators for land (AMMK, 2020).

a. **Land use change -** The indicator shows land use change on an annual basis by land use categories, including changes in agricultural, forest, natural and semi-natural areas (CLC2-CLC5) and urban land (CLC1), respectively. The indicator is calculated through an analysis of maps based on satellite images and data obtained from the analysis according to the CORINE Land Cover (CLC) methodology, from the years 2000, 2006, 2012, and 2018, or taking into account the trend of increasing construction areas for a fixed time period (5-10 years).

b. **Erosion** - Through this indicator, the intensity of erosive processes is presented, as well as the representation of real and potential risk classes for soil erosion. The indicator is calculated by determining the risk to soil surfaces from erosion and erosion reports are available to the public.

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

The main challenge for sustainable management of agricultural land in Kosovo* is the lack of human resources in relevant institutions.

The lack of human capacity at the central and local levels to address issues and the mix of competencies between the central and local levels have caused non-implementation of the legislation in force. This has subsequently affected the management of agricultural land, which is reflected in the loss of

agricultural land and reduction of agricultural land area for agricultural production, fragmentation of agricultural land, degradation of agricultural land, degradation of socially owned pastures, non-application of land reclamation and other agro-technical measures, etc. The lack of staff to enforce the legislation in force has also paved the way for various misuses and degradations of agricultural land.

The Ministry of Environment, Spatial Planning and Infrastructure lacks human resources to update and complete the legislative framework in order to monitor the implementation of the applicable legislation.

The Kosovo* Hydrometeorological Institute (KHMI) as responsible for soil monitoring also lacks human resources for monitoring and assessing soil pollution. In this regard, this institution should be completed with human resources and then work on increasing the capacity of staff and supplying adequate equipment and software in order to apply the local land monitoring system and take measures to avoid agricultural land pollution.

The lack of staff is also reflected in the Division for Land Use, GIS, Registers and LPIS within the Ministry of Agriculture, Forestry and Rural Development. This shortcoming is particularly reflected in the lack of capacities of necessary inspections related to the change of purpose of agricultural land, which is the main source affecting the loss of agricultural land.

The Agricultural Institute of Kosovo* does not have sufficient human capacities either. Therefore, a way must be found to complete this Institute with the necessary human capacities in order to perform research and tasks, and fulfil the responsibilities according to the mandate defined by their Statutes. Completion of human capacities should be done as soon as possible, as this Institute should provide data for the development of projects and studies needed by the Ministry of Agriculture, the Ministry of Environment and other ministries dealing with the issue of agricultural land, data on soil fertility, land reclamation, recultivation, soil erosion, etc.

Private laboratories such as Agrovet in Fushë Kosovë and Sara & Meti in Prishtina, which deal with chemical, physical and mechanical analyses of soil, have professional staff engaged, and are equipped with the most modern equipment and have complete infrastructure for performing chemical, physical and mechanical analysis of soil.

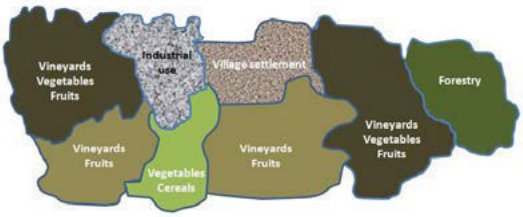
The Faculty of Agriculture and Veterinary Medicine is equipped with professional staff for soils, although the specialized department for soil science does not exist, but it is within the programme of crop production and other existing programmes.

Within UBT college, there is an Agricultural and Environmental Engineering study programme, where soil science and soil degradation are also taught. This college also has sufficient professional staff.

6. Assessment, conclusions and recommendations

In addition to regular land monitoring at the national level, other processes should be applied that will have significant impact on agricultural land conservation and sustainable land management, such as:

Application of the Integrated Agricultural Land Management process - In addition to the legislation in force, which needs to be updated, cooperation should be consolidated at the inter-ministerial level, respectively inter-institutionally at the central and local levels. This can be achieved through Integrated Agricultural Land Management. Integrated Agricultural Land Management 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 agricultural land properly and reduce losses, degradation, and other effects on agricultural land present in Kosovo*.



Mandatory application of the Agro-Ecological Zoning process at the central and municipal levels (low scale) - Low-level agro-ecological zoning should be conceived as a process of grouping agricultural land based on their quality, chemical, physical, mechanical and biological properties of land for agricultural production in order to predetermine them for agricultural production. Small-scale agro-ecological zoning should be used for spatial planning needs as an instrument for the conservation and protection of agricultural land. Agro-ecological zoning is included in the Administrative Instruction for the Municipal Zoning Map by the Ministry of Environment, Spatial Planning and Infrastructure, but unfortunately, as a non-mandatory instrument when preparing Municipal Zoning Maps. Therefore, municipalities do not consider it mandatory to apply this process, which can be used as a mechanism for protecting agricultural lands, especially those of categories 1-4 of creditworthiness.

Establishment of the State Soil Museum - The Soil Museum would be an attempt to bring together all living models of earth monoliths in one place. This museum can serve as a source of information on land to various persons and interest groups such as land scientists, various researchers, land management staff, students, planners, NGOs and the general public. The museum can serve as a source of communication and awareness of the general public and the community of scientists on the functioning and genesis of those lands and historical evolutions through which those lands have gone.

The soil monolith, which displays the vertical profile of the soil from the surface in depth, displaying genetic horizons, provides information on the taxonomy, physical and chemical characteristics of the soil, the type of forest or intact flora on the surface of that soil.

Establishment of soil monitoring system at the national and regional levels - At the regional level or in the Western Balkans, a system should also be applied, affecting the sustainable management of agricultural land.

This system should develop indicators and thresholds for soil quality assessments which should be compatible with European Union standards. The primary purpose of this system should be to protect the soil from degradation that may be reflected from one country to another and maintain soil quality at the regional level. This system should provide cooperation at the regional level through exchanging information and experiences.

7. Good case studies on soil management practices

Reforestation to prevent contamination, erosion and flooding

The Ministry of Agriculture, Forestry and Rural Development, through the Kosovo* Forest Agency, annually reforests forest lands to prevent contamination, erosion, and flooding. The following table highlights reforestation over the past 10 years in Kosovo* (APK, PPP, 2022).

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Reforestation (Ha)	538.00	368.80	97.24	511.10	299.50	289.98	296.65	419.14	380.60	309.00	3,510

The table shows that over the last ten years, a total of 3,510 ha has been reforested in Kosovo*, with an annual average of 351 ha.

Transformation of the former KEK ash landfill into a green oasis through the rehabilitation of ash storage spaces

Kosovo* Energy Corporation has completed the cycle of environmental investments amounting to over 50 million euros, mainly from its own funds, and the rest are investments from the World Bank. In this regard, in the former ash landfill of TC-Kosovo* A, which was not used for several years and had an area of about 243 hectares, ash had been accumulating since the early 1960s. Even though this former ash landfill was inherited, KEK, among the projects for improving the environment, finalized the treatment of this former landfill by recultivating it.

The entire surface of the ash dump Arbëria, which includes 243 ha, is covered with a layer of soil 1m high. No cultivated grass was planted in this area, but wild grass was allowed to emerge.

The area of 243 ha was divided into two landfills covered with soil. The first landfill covered with soil has an area of 80 ha, and the second landfill covered with soil has an area of 163 ha. This area was afforested by planting 5 different types of wood with 3,324 young trees (Simnica, S., 2022).

The following table shows the number and the types of wood planted:

Table. Arbëria Plantation

Nr.	Type	Number of young trees planted
1	Poplar tree	502
2	Fir tree	1,299
3	Chestnut tree	514
4	Maple tree	509
5	Linden tree	500
Total		3,324

Reconciliation and rehabilitation of landfills in Rahovec

Two landfills have been rehabilitated on the outskirts of the town of Rahovec.

The first landfill is located in the cadastral zone Rahovec and includes cadastral parcels no. 2427-0, 2429-0 and 2439-0. These three plots cover the total rehabilitated area of 1.05 ha.

This rehabilitation was carried out in two phases. In the first phase, waste and scrap metal were collected around the plots where the rehabilitation took place. In the second phase, the waste was flattened and covered with an additional surface of 1-1.5 meters thick, depending on the terrain. A sheep farm was set up in one part of the landfill, while the other part was ploughed and animal feed cultivated.

The project was implemented between 2007 and 2008, and the donor was the European Commission.

The second landfill is also located in the cadastral zone Rahovec and includes the cadastral parcel 2356-0 in an area of 2.96 Ha and is located on the road axis Rahovec-Malisheva. The plot is covered with a surface of 1.0-1.5 m thick, depending on the terrain. Ornamental trees were planted along the land plot, and the Municipality Rahovec designated it as a tourist destination. The project was implemented from the Municipal Budget of Rahovec in 2017 and 2018.

Establishment of the vineyard on the terraces according to the isohypses of the terrain in Rahovec

The terracing preparation project started in 1980 and was completed in 1981 when the vineyard was planted according to the isohypses of the terrain. Protecting potential erosion due to the landscape's slope was the primary purpose of planting this vineyard according to terrain isohypses. At the time of planting, the total area of 52 ha was covered by 28 varieties of table and wine grapes. For decades, this vineyard served as an experimental terrain and attraction for various visitors to the wine cellar in Rahovec which at that time was the second in Europe in terms of wine capacity.

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MONTENEGRO SOIL REPORT

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1. The importance of sustainable land management at the national level

Threats and pressures on soils. According to the LDN Report[9], the main threats and pressures on soil in Montenegro are urbanization and wildfires.

Urbanization is recognized as a significant factor in land degradation, especially if we have in mind that, very often, the highest quality agricultural land is used for housing construction facilities. In Montenegro, urbanization is particularly pronounced in rare lowland lands. In addition to urban development, the problem of unplanned construction is also expressed in rural areas, where, in addition to facilities intended for agriculture, other facilities for rural tourism and various services are built.

When land is urbanized, about 50% of it is covered with an impermeable layer, such as concrete or asphalt. Such a loss cannot be compensated, considering that when infrastructure is built on the land, its return to its original state is possible only at great expense.

Migration[10] from less developed parts of the northern region to the central and coastal regions, where living conditions are more favourable, has intensified over the past years. As a result of this migration, the pressure increased on resources, especially on land in the vicinity of urban settlements, which has been converted into industrial and residential zones. The negative impact is also present in rural areas, especially mountainous, since much land remains uncultivated and overgrown with weeds, shrubs, and trees. Demographic depopulation of rural areas in Montenegro has negative impacts preventing the valorization of pastures and meadows, which turn into forest land.

Also, *forest fires*, given the climatic factors and geographical position of Montenegro, represent the most serious threat to forest and forest land in Montenegro. Forest fires lead to the destruction of authentic landscape and soil structure, contributing to its erosion and land degradation. It is estimated that about 20% of areas of forests and forest land are inaccessible due to various natural obstacles, indicating limited opportunities to respond to forest fires.

Forests are most endangered in the coastal and central parts of Montenegro, where bioclimatic conditions, i.e., high air temperatures in summer and vegetation characteristics, favour the occurrence and development of fires.

Availability of productive soils against total land area and agricultural land in the country. Montenegro is one of the countries with a large agricultural area per capita and has significant agricultural potential. According to the new structure of agricultural land use aligned with EUROSTAT, the total utilized agricultural land is 0.41 ha per capita. However, the structure of agricultural land use is unfavourable, having in mind that over 85% of these areas are natural meadows (1,373.3 ha) and pastures (1,214.6 ha), mostly in karst, on steep slopes and high mountain plateaus, with shallow land, with limited and low fertility. The share of arable land, gardens, orchards, and vineyards with an area of 12,094.4 ha is below

9 Montenegro supported the UNCCD initiative Land Degradation Neutrality Target Setting Process (LDN TSP) in 2016 as a platform for promoting sustainable land management. LDN TSP resulted in a national report containing the identification of 15 hotspots and 25 measures with an aim to achieve LDN in Montenegro by 2030.

10 The migration rate in Montenegro is 8.0, which means that 8 people per 1,000 inhabitants have changed their place of residence within the borders of Montenegro

the European average and the average of all neighbouring countries.

Montenegro has 334,048.8 ha of total available agricultural land, which is about 24% of the territory of Montenegro. The area of used agricultural land is 257,469.6 ha.[11]

Why is the soil important for the country? Good-quality land is important for the development of agriculture which represents an important strategic sector for the economic development of Montenegro. The first priority sector in the Smart Specialization Strategy 2019-2024 refers to sustainable agriculture and the food value chain, and through the corresponding measures, intends to increase the number of entrepreneurs and companies in organic production, as well as the number of innovative and indigenous products in the agri-food industry. This should ultimately lead to a reduction in food imports and a possible increase in exports.

Agriculture is the basis for the whole food value chain, contributing to tourism development, sustainable development and mitigation of rural areas depopulation, as well as fight against poverty in rural areas.

The economic importance of agriculture is reflected in its high contribution to GDP. In 2020 the agriculture, forestry, and fisheries sectors accounted for 7.6% of GDP (In 2018, 6.7% of GDP).

What nature-based solutions can soil offer to increase crop productivity and tackle climate change? Accelerated erosion, reduction of the available land surface, and a decreasing content of organic matter in soil are the main expected impacts of climate change and extreme events that contribute to the vulnerability of agricultural land.[12] Montenegro LDN Report sets specific voluntary targets up to 2030[13], and 25 measures to achieve LDN by 2030. Some of those measures presented in the LDN Report have been proposed for implementation within LDN transformative projects and programmes (LDN TPP initiative launched within UNCCD) and will be part of the project application for the Green Climate Fund. Activities, inter alia, include support for the establishment of new orchards in a previously degraded area. Furthermore, the LDN TPP project will address the issue of combating forest fires by designing micro-accumulations and investing in water supply (wells, reservoirs). Special attention is given to organic agricultural production and change in manure management, which will lead to the reduction of N_2O emissions.

2. General assessment of data available (conclusions and recommendations)

During the period 1958-1988, a detailed soil map at a scale of 1:50000 was prepared in Montenegro by the Biotechnical Faculty (former Agriculture Institute), based on a soil survey involving the study of two thousand profiles.

Relevant data on the presence of certain types of land, lower systematic units, and their distribution, are provided in the Soil Atlas, with maps at a scale of 1:50000, and the monograph Soil of Montenegro Mountains (Fustic and Djuretic, 2000).

11 https://www.gov.me/clanak/zakup-poljoprivrednog-zemljista-u-drzavnoj-svojini

12 Background Report for the preparation of the updated NDC (2021).

13 (a) To avoid and minimize land degradation and redirect land use changes, (b) to increase land productivity, (c) to strive to protect natural ecosystems from wildfires, and (d) to improve soil monitoring system.

Most of the soils represented in Montenegro have a shallow soil profile and low contents of nutrients. Of the total area, not considering infertile lands (rocks, wetlands, lakes, rivers, roads, and urban settlements), the soils of Montenegro (Fustic and Djuretic, 2000) are grouped into five categories of effective fertility. The most represented is low fertility category land covering 46.2% of the total area. High fertility land covers only 1.5% of the total area.

Pedologic data are obtained through various laboratory methods. There are also data for several thousand soil profiles spanning over almost three decades, available in hand-written form in six notebooks. 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.

A pedological map in digital form with an appropriate database can be created with the digitization of data and their positioning. By using appropriate polygons (representing mapped soil types) and analytical data, an interpolation and spatial representation of physical and chemical characteristics of the 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 done.

The data from the book "Zemljišta Crne Gore" were almost entirely georeferenced.

Monitoring of the soil condition and testing of the content of hazardous and harmful materials in soil is being realized annually, and it is funded by the state. Monitoring results are presented in Annual Information on the state of the environment in Montenegro, prepared by the Environmental Protection Agency.[14]

Monitoring of potential soil pollution is hampered by a lack of an adequate legal framework. The current Law on Agricultural Land regulates only agricultural land, while for other purposes (industrial land, playgrounds, parks, residential zones, etc.), there are no appropriate, legally prescribed, maximum allowed concentrations of hazardous and harmful substances.

14 Determination of the content of hazardous and harmful substances in soil during 2020 was performed on 13 locations in seven Montenegrin municipalities.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

a) Strategic framework

A strategic framework for land protection was established by adopting the **National Action Plan (NAP) to Combat Desertification(2015)**. The main components of the Plan are an analysis of soil degradation in Montenegro (described through the pressures of individual sectors) and the activities to combat land degradation in Montenegro, including strategic and operational goals. NAP needs to be revised according to the **new UNCCD Strategy for the implementation of the Convention within the time frame until 2030**.

Furthermore, Montenegro supported the UNCCD initiative Land Degradation Neutrality Target Setting Process (LDN TSP) in 2016. **Montenegro LDN Report** should be embedded in the NAP by making an annex to propose actions to improve policy, legislative, institutional, and coordination framework. It could be a trigger to increase investments in land.

SDG 15.3[15] is recognized in the **National Strategy of Sustainable Development until 2030**, and a number of measures are recommended to be implemented in order to support the realization of this goal.

Montenegro has an obligation to **adopt a new Strategy for Agriculture and Rural Development**. The future Strategy has to focus on continuing the ongoing reforms and adjusting the policy with the new Common Agriculture Policy (CAP) for the period until 2027. It should follow the vision and objectives of the **EU Soil Strategy for 2030** and address the challenges of achieving climate neutrality. Montenegro is lagging behind the EU when it comes to Land Use, Land-Use Change and Forestry (LULUCF), and this issue should be further elaborated on within the Strategy. The Strategy should rely on *healthy soil* and ensure preconditions for good soil health. In Europe, there is an increasing interest in a *refined soil quality index and certificates of soil health* to be provided during land transactions to adequately inform the buyer. Following European trends, the Strategy should integrate the *land take hierarchy* and give priority to reusing and recycling land and, thus, avoid converting agricultural or natural land into a built environment.

b) Legislative framework

The *protection of land* is elaborated within the **Law on Environment** (Official Gazette of Montenegro, No. 052/16, 073/19), which states that the protection of land includes taking measures to improve its physical, chemical, and biological properties and land use shall be conducted in a way that best suits the natural characteristics of the land. The Law states that during the implementation of projects, be-

15 "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world "

fore and after their implementation (construction, exploitation of mineral resources), land protection shall be provided. Land damage remediation measures are proscribed within the **Law on Environmental Liability** (Official Gazette of Montenegro, No. 027/14, 055/16). The Law stipulates that, if there is no detailed spatial planning documentation for the contaminated land, the purpose of land is determined on the basis of the purpose of the wider area where the damage occurred and its planned development. If the purpose of contaminated land changes, the necessary measures shall be taken to prevent negative impacts on human health. **Law on Ionizing Radiation Protection and Radiation Safety** (Official Gazette of Montenegro, No. 056/09, 058/09, 040/11, 055/16) proscribes that systematic testing of radionuclide content (Cs 137) in arable and non-arable land shall be performed once in six months (April, October) using the γ-spectrometry method.

The issue of land use and land conversion is elaborated within the Law on Agricultural Land (Official Gazette of the Republic of Montenegro, No. 015/92, 059/92, 027/94, Official Gazette of Montenegro, No. 073/10, 032/11) and the Law on Spatial Planning and Construction (Official Gazette of Montenegro). The issue of spatial planning is centralized at the state level. Only two main planning documents are envisaged: the Spatial Plan of Montenegro and the General Regulation Plan of Montenegro, which determines, in particular, the purpose of areas, conditions for landscaping, construction, and use of space. In order to protect agricultural land, in case of its temporary use for non-agricultural purposes and change of purpose of arable agricultural land, a fee is paid.

The Law on Agricultural Land recognizes the possibility of conversion of agricultural land that is not used for agricultural purposes against a fee. However, this Law and other regulations governing this area do not define control mechanisms for conversion or the manner in which this fee is determined. The same Law prescribes the obligation for the competent municipal bodies to keep records on changes in land use, but such records have not yet been established.

In European practice, for example, in the context of agricultural land protection, in the Netherlands, urban planning envisages empty or degraded land in settlements for urban use, and agricultural land is intended for agriculture and recreation. In Denmark, if it is necessary to expand to agricultural land, the regional parliament decides on this request. In rural areas, any construction unrelated to agricultural activity is prohibited. Housing construction is focused exclusively on local urban centres.

The Law on Agriculture and Rural Development (Official Gazette of Montenegro, No. 30/17) defines the obligation of the Ministry of Agriculture, Forestry and Water Management to establish and maintain a register of entities, register of agricultural holdings, records of parcels (LPIS), records of requests for support and requests for payments through direct payments and rural development measures according to the reference parcel area.

A number of legislative acts elaborate on *the issue of state-owned agricultural land, land tenure, and sale procedure and conditions* (Law on Agricultural Land[16]; Law on State Property; Decree on the sale and leasing of state-owned property[17]). Agricultural land is leased exclusively for agricultural activity and cannot be used for other purposes. It can be leased by public bidding or on the basis of collected offers and exceptionally by direct agreement to registered agricultural producers, individuals, or legal entities interested in leasing land. Current legislation does not address the issue of reporting on the use of leased state agricultural land.

16 Article 11 defines that agricultural land can be leased, as well as that the lease agreement for agricultural land, which contains the code of cadastral culture and land class, lease duration and rent, must be entered into in writing and certified by the competent municipal authority

17 Adopted on the basis of Article 40, paragraph 4 of the Law on State Property, regulates the manner, procedure, conclusion of contracts and conditions of sale and lease of state property. The subject of the lease, the time of the lease, the amount of the lease and the method of payment, the manner of use, storage, protection and maintenance of leased items and other conditions and elements agreed by the contracting parties shall be regulated by the lease agreement.

This issue slightly differs from European practice. For example, in Austria, the farmer has the pre-emptive right of purchase. In Italy, priority is given to farmers whose land borders another farmer and who actively cultivate their land. In Slovakia, the seller can sell without limitation to a relative, co-owner, agricultural company or farmer who has been engaged in agriculture for at least 3 years. After that, a farmer from a neighbouring place can buy it, then any farmer from Slovakia, and only in the end any other buyer. Slovenia also enabled young farmers to lease agricultural land in a simpler way and under more favourable conditions and offers them land that is gradually being taken away from large tenants.

The legislative framework needs to be strengthened. In the coming period, the law on soil protection needs to be drafted by the Ministry of Ecology, Spatial Planning and Urban Planning. Law on Agricultural Land needs to be revised in coordination by the Ministry of Agriculture, Forestry and Water Management, in order to transpose the best European practice.

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

Direct main land degradation drivers in Montenegro are urbanization and infrastructure development, improper management of soil in agricultural production, conversion of land, deforestation, and removal of natural vegetation, soil sealing, industrial activities, waste disposal and mining activities, disturbance of the water cycle, and natural causes, such as water-scarce periods, extended rainfall events and temperature variations.

In addition, due to climate change, higher occurrence of forest fires, floods, droughts, torrents, and landslides is evident. Furthermore, the main indirect land degradation drivers in Montenegro are population pressure, migration from rural to urban areas, increase in touristic capacities, land tenure changes, poverty, labour availability and lack of financial inputs.

In Montenegro, around 80% of the degraded area was affected by wildfires, followed by urbanization.

Forest fires are by far the greatest threat to the degradation of forests and forest lands. Forest fires relate to the erosion of land, which represents the most severe form of degradation, causing the loss of huge amounts of land material and creating desolate landscapes where vegetation is impossible to be renewed. Also, the phenomena of aeolian erosion and water erosion are expected after the fire. According to the Third National Climate Change Report to the UNFCCC, from 2005 to 2015 in Montenegro, there were about 800 large forest fires, when more than 18,000 ha of forests and over 800,000 m3 of wood mass were damaged or destroyed. The fire season in Montenegro was the worst in 2017, when 124 fires were recorded on areas larger than 30 ha, covering a total of 51,661 ha, which is six times more than the area recorded in 2016. Lack of precipitation affected water resources and high temperatures contributed to the spread of the fire. The temperature of 43.9 degrees Celsius recorded in Podgorica on 7 August2017, was the second-highest measured temperature in the last 63 years. A similar situation repeated in 2021, when Montenegro experienced one of the driest summers with many fires.

In order to protect forest lands from degradation, it is necessary to work significantly on improving the system of forest protection against forest fires, especially in the areas defined as high-risk zones for forest fires, as well as on strengthening equipment in the technical and technological sense for extinguishing forest fires.

Urbanization is especially expressed in the central and coastal part of Montenegro. This is recognized in the National Action Plan to Combat Desertification and LDN Report, which highlights the importance of protecting the best quality soils from urbanization.

Drought became very common in Montenegro, resulting in reduced crop yields and final product quality, ground and surface water resources depletion, soil erosion, soil physical-chemical properties deterioration, the occurrence of wildfires, endangering overall flora and fauna.

Floods and erosions are also processes that can potentially endanger people's lives, their property, and natural resources. Montenegro has experienced three major floods (2007, 2009, and 2010). The damage and loss caused by floods in 2010 amounted to around EUR 44 million (1.4% of GDP). FAO estimated that these floods affected about 30,000 hectares of agricultural land. Total damage and losses in agriculture are estimated at over EUR 13 million, of which more than EUR 6 million in damages and over EUR 7 million in losses (FAO, 2015).

Furthermore, chemical degradation is also present and is caused by the use of inappropriate fertilizers, pesticides, and other chemicals of organic and inorganic origin. For Montenegro, there is no data on soil organic carbon change, compaction, soil sealing, salinization, acidification, and soil biodiversity. Collecting those data requires significant financial and human capacities, in order to conduct the necessary analyses.

Currently, Montenegro is preparing the project Application of agro-environmental measures for the purpose of sustainable land use, forest management, mitigation and achieving the goals of neutrality of land degradation (LDN), which will deal with the management of the different degradation processes.

The establishment and protection of forests is envisaged through project activities by afforestation, arrangement, and protection of forests and seedling production. Furthermore, investments include support for establishing new orchards in previously degraded areas. Attention is also given to organic agricultural production and change in manure management, which will lead to the reduction of N_2O emissions.

The main indicators for soil degradation processes are land cover, land productivity dynamic, and soil organic carbon.

The most important land use categories in Montenegro are pastures and meadows, forests, croplands, mosaic natural vegetation, water bodies, orchards and vineyards, mosaic agricultural land, artificial areas, marshes, and barren lands. Changes in land cover are the first indication of vegetation behaviour, habitat fragmentation, or land conversion. Land cover could be obtained from Earth observations, and land cover changes may be characterized as positive or negative. Negative critical transitions are generally considered as conversions from natural or semi-natural land cover classes to cropland or settlements, or from forest land to other land cover classes, as well as urbanization. European Space Agency land cover data for the years 2000 and 2010 indicate the loss of 800 ha of forests and their conversion to shrubs, and conversion of 1,700 ha of forests to croplands. In Montenegro, there is also a CORINE land cover dataset. Unfortunately, the use of these datasets is constrained by the possibilities of comparing land use/cover between two or more epochs (CORINE dataset and European Space Agency dataset).

Land productivity dynamics data indicate a decline in land productivity on 4,500 ha of croplands and

3,888 ha of shrubs, grasslands, and sparsely vegetated areas. Land productivity classes are: ''declining productivity'', ''early signs of decline'', ''stable, but stressed'', ''stable (not stressed)'' and ''increasing productivity''. Totally, 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%. Degradation has occurred on 8.5% of the total agricultural area and on 7.33% of the succession areas of forest vegetation, grassland, and areas with thinned vegetation.

An average SOC stock for the entire country is 125.1 t/ha. According to global data, SOC stocks are the highest in forests, 129.9 t/ha, followed by shrubs, grasslands, and sparsely vegetated areas, 124.9 t/ha, and croplands, 124.3 t/ha. Global data on SOC stocks do not represent the real situation, while national SOC stocks data should be systematized in order to be presented spatially and be confident.

SDG 15.3 is recognized in NSSD, and a number of measures are recommended for implementation in order to support the realization of this goal. SDG indicator (15.3.1) is the „Proportion of land that is degraded over total land area" (ECOSOC, 2016). NSSD states that this is one of the indicators that need to be introduced in the period 2018-2024 into the national framework.

As a party of the United Nation Convention on Combating Desertification (UNCCD), Montenegro is obliged to submit reports on the implementation of the Convention. The latest report on the implementation of the Convention was prepared within the UNEP-GEF umbrella project (GEF Support to UNCCD 2018 national reporting process, Montenegro) and submitted to the Convention Secretariat in 2018. Currently, Montenegro is in the process of reporting cycle 2021/2022, which will be realized through the new UNEP-GEF umbrella project.

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

In Montenegro, there are a number of institutions that deal with land from different aspects. Administrative capacities in different institutions are rather low, and inter-institutional coordination needs to be strengthened in order to establish effective sustainable soil management. The main ministries covering this issue are the Ministry of Ecology, Spatial Planning and Urban Planning from the aspect of spatial planning and implementation of the UN Convention on Combating Land Degradation, and the Ministry of Agriculture, Forestry and Water Management, responsible for 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.

The Ministry of Ecology, Spatial Planning and Urban Planning, in the context of the use of state-owned agricultural land, gives an opinion from the aspect of spatial planning and purpose of areas in relation to the subject locality.

Within the Ministry of Finance, the Directorate for Property and Legal Affairs is responsible for the disposal, use, supervision and management of state property, including state-owned land.

The Cadastre and State Property Administration assess the market value of state-owned land. Also, it is in charge of real estate cadastre and registration of real estate rights, as well as cadastral classification and rating of land and geodetic and agronomic work on land consolidation.

The Phytosanitary Administration, among others, performs activities related to the control of plant nutrition products and plant protection products.

The Forest Administration, among others, 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 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.

The Environment Protection Agency of Montenegro performs environmental monitoring activities, including land; analysis of the state of the environment, phenomena and events that may endanger the environment proposing and taking measures for their prevention and elimination; analysis of information obtained from monitoring, as well as information on the state of the environment, including land.

The Directorate for Inspection Affairs, among other things, performs inspection supervision in the areas of spatial protection, urban planning, 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 the 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 engineering-geological research and testing, as well as various projects in applied geology.

The Institute of Hydrometeorology and Seismology of Montenegro monitors the impact of meteorological conditions on the quality and quantity of yields, phenological observations and analyses, analysis of meteorological data for the needs of agriculture. It is also in charge of preparing agrometeorological studies, as well as agrometeorological bases for agricultural needs.

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 paedology, 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.

6. Assessment, conclusions and recommendations

The most important weaknesses are lack of an adequate legislative and strategic framework, lack of awareness about land degradation problems, insufficient application of agro-environmental principles, and insufficient human, technological, and financial resources. In order to improve soil quality and support soil conservation and sustainable soil management, the implementation of the following activities should be considered:

I 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 (SOC dynamics, land use and 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)
- Establishing and harmonizing methodologies for soil monitoring schemes as a long-term commitment
- Establishing the Regional Soil Platform

II Improvement of legal and strategic frameworks related to land management and protection

- Revision of National Action Plan (NAP) to Combat Desertification according to LDN and the new UNCCD Strategy
- Adoption of the new Strategy for Agriculture and Rural Development, focusing on vision and objectives of EU Soil Strategy for 2030, including LULUCF and preconditions for good soil health
- Integration of soil and land use management in river basins and flood risk management plans by deploying nature-based solutions
- Adoption of the law on soil protection and revision of the Law on Agricultural Land, in order to transpose the best European practices and to protect high-quality land from urbanization

III Capacity building and raising awareness of government officials, local communities and beneficiary communities for climate-responsive planning and development

IV Support for implementation of agro-environmental measures recognized within the project proposal Application of agro-environmental measures for the purpose of sustainable land use, forest management, mitigation and achieving the goals of neutrality of land degradation (LDN), referring to support for the establishment of new orchards on previously degraded area, designing of micro-accumulations and investing in water supply (wells, reservoirs) in order to combat forest fires, support organic agricultural production, and change manure management.

7. Good case studies on soil management practices

A case study of good soil management practice can be found in the activities conducted by Green Room Company, established for construction works and restoration of barren lands (Photo 1-4). Green Room Company is a construction company working mainly in and around the capital city of Podgorica.

This karst area faces severe drought periods and dry spells and lacks land resources. According to national soil classification, the dominant soil types in this area are Lithosols and Kalkomelanosols, which could roughly correspond to Nudilithic and Lithic Leptosols, or rarely Leptic Phaeozems, according to WRB. The terrain is characterized by the presence of rock outcrops (hard limestones) and mostly shallow soil cover. Moreover, soil depth is not homogenous, and not uniform.

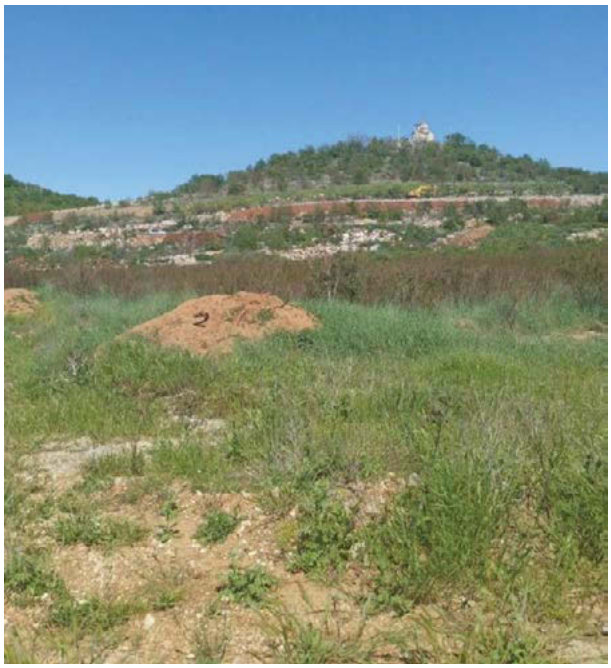
On one hand, bedrock exposures limit the use of modern mechanized agricultural equipment, whereas, on the other, where fine soil material covers the ground, effective soil depth for root penetration is unknown.

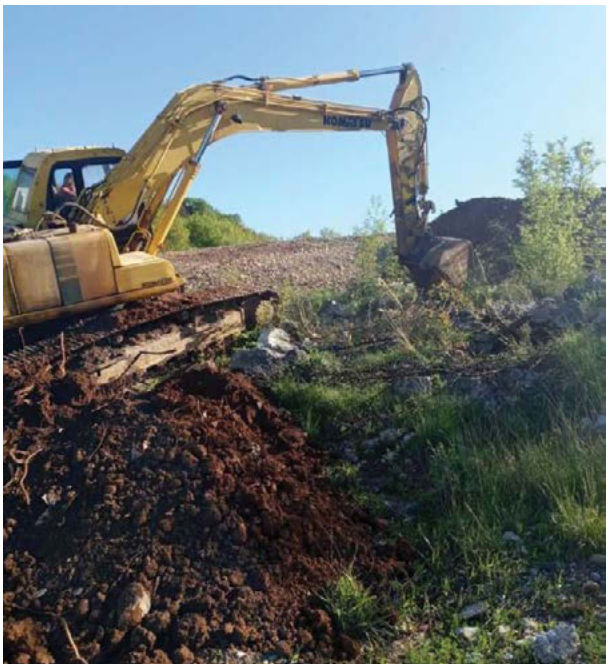
Therefore, Green Room's experience and current activities have resulted in measures to combat land degradation by increasing effective soil depth in the karst area. Green Room uses its facilities, trucks, and other construction and agricultural equipment, to transport material, often neglected in construction works, and deposited elsewhere, to locations where this material is lacking (photos attached).

Moreover, the activities did not stop with a simple increment of soil depth. A new pomegranate nursery was created in the village Kokoti with the idea to enhance and enlarge the production. This production site presents an ideal example of application of reclamation measures on low productive soils. The nursery was designed on very low productive and shallow calcareous soils with many exposed bedrocks on the top of the ground. The owner of the pomegranate nursery transports residual earthy material from a construction site in Podgorica. Earthy material was not deposited elsewhere but used to overlay the ground. This measure increased soil depth, and organized production on certain areas was initiated.

These measures have huge long-term environmental, social, and economic benefits and should be presented to the broader community and decision makers and mainstreamed into national policies.

Photo 1-4 Construction works and restoration of barren lands





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NORTH MACEDONIA SOIL REPORT

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1. The importance of sustainable land management at the national level

Soils of the Republic of North Macedonia are under constant pressure from various drivers such as urbanization, industry/energy, agriculture, forestry, transport, mining, tourism and climate change. In many cases, overall activities within the sectors mentioned above are causing pressures on soils, triggering various degradation processes and loss of their function in the ecosystem. The degradation processes are numerous and, in many cases, irreversible, meaning that the soil cover as a functional natural resource is permanently lost. The most important degradation processes in the country are soil erosion, soil organic matter depletion, soil sealing, soil contamination and salinization. The long list of pressures from different sectors of the country's economy causing numerous forms of degradation makes the issue of sustainable land management of utmost importance.

Putting sustainable soil and land management into practice is a complex process consisting of several steps. The first step is identifying unsustainable soil management practices in different sectors and estimating their negative impact on soils. In the next phase, the needed environment and capacities should be developed to support the process of shifting towards sustainable soil and land management. In the final stage, the monitoring system should be developed with indicators for estimating and quantifying the positive effects of sustainable soil management practices.

Sustainable soil and land management is particularly important for the country for several reasons: a) productive agricultural land is very limited, with 1,262 mil. ha or 49.08 % of the country territory (2.57 mil. ha), out of which 0.744 mil. ha are pastures, while fertile cultivated land occupies a bit less than 0.517 mil. ha (20.1%), b) abandonment of agricultural land as a result of depopulation of rural areas, c) a huge number of operators, especially in agriculture, d) soil management practices and their impacts are not well documented, meaning that there is no clear evidence for current soil management.

Although systematic monitoring of soils does not exist, some recent studies have outlined the current state of soil degradation processes to a certain extent. A recent evaluation and modelling of soil erosion processes, soil sealing and soil organic matter depletion showed retrograde processes in each of these three cases of land degradation. The most recent assessments for the areas affected by soil erosion processes show that more than 39% of the country is affected by the first three categories of soil erosion. Soil loss from agricultural land is estimated to be more than 4.1 t/ha/year. Soil organic matter in three pilot sites showed dramatic depletion of soil organic carbon, especially on agricultural land in the south and southeast part of the country, while soil sealing is very intensive around big urban centres.

Soil is a very vulnerable natural resource. Hence, proposed sustainable management practices must be carefully designed and implemented. Natural-based solutions are possible ways to protect and enhance soils and their production capabilities. Organic production is one option for optimizing soil management by applying measures for sustainable use of agricultural land. There is evidence of increased soil carbon levels in soils under organic production. Still, despite the intensive support by the Ministry of Agriculture, Forestry and Water Economy, areas under organic production are still very limited. In the past decade, according to State Statistical Office (SSO) data (SSO, Year book, 2021), areas under organic farming are small (2,174 ha in 2014 and 3,969 ha 2018). Cover crops in perennial plantations (vineyards

and orchards) are another good example of nature-based solutions, which significantly influence the level of soil organic matter. Moreover, if the produced biomass from cover crops is used as organic mulch, the intensity of soil erosion on sloping terrains could be significantly reduced. As a result of climate conditions and inappropriate forest management practices over the years, significant areas in the country are deforested, or the forests are heavily degraded. These areas, especially on hills and slopes that frame some valleys in the eastern part of the country, are suitable for agroforestry. Such conversion of the current land use will have an integrated positive effect, not just on the prevention of soil erosion and carbon stock depletion but on the social and economic aspects in these regions. However, despite organic farming, and to a certain extent, cover crops, all other nature-based solutions for increasing soil productivity and its resilience to climate change are still at a conceptual level in the country. There is a wide range of other possibilities that need to be supported and can be easily implemented, such as composting of on-farm organic by-products, use of charcoal, proper manipulation and application of manure, green manure, contour and strip cultivation, etc.

2. General assessment of data available (conclusions and recommendations)

Several major campaigns outline soil surveys in the country: a) long-term project for the preparation of the Soil Map of Macedonia on a scale of 1:50000 and the subsequent FAO-funded project for the establishment of a digital geospatial database containing all relevant soil data from the previous field survey; b) preparation of geochemical atlases for major hotspots and for the whole country territory on 5x5 km^2, that contain data for spatial distribution and levels of heavy metals in soils, c) long-term project for the preparation of the Land Productivity Map; and d) one soil sampling campaign for collecting soil samples over the country territory within the frame of the LUCAS initiative. Other soil data were collected within isolated ad-hoc soil surveys for various pilot projects and studies but did not aim at systematic and exhaustive monitoring of soil properties. All these projects and initiatives contributed to the overall soil survey and collection of soil data. However, there has been no active monitoring of soil properties for more than two decades.

Regarding existing data sets, specific gaps and shortcomings affect their use and integration with other environmental datasets.

The Soil Map dataset contains 4,300 geolocated soil profiles (more than 11,000 soil horizons) with data for the site and profile specifics and laboratory data (physical, chemical properties, and texture). A field survey was conducted from the late 1950s up to 1985. All soil data, field, laboratory data, and soil maps, were digitalized and stored in the Soil Information System (MASIS). This is the best organize d soil dataset in the country. However, MASIS soil dataset is outdated and needs to be updated with new field and laboratory data and upgraded with additional soil quality parameters. For some regions, soil data are more than 60 years old and do not reflect the actual situation and cannot be used for reliable evaluation and estimation of soil conditions.

Land productivity map was another long-term project aiming to produce a detailed survey of soil production properties. Soil properties within such soil survey are supposed to be examined on a small

scale, giving a detailed picture of soil production capabilities, which are needed for creating agricultural policies, land consolidation, land market, etc. After almost a decade, the project was ceased due to a lack of funds. A massive amount of soil data for basic soil properties has been collected. At the moment, it is archived in hard copy in the Ministry of Agriculture, Forestry and Water Economy (MAFWE) depot. The project has never continued, although only part of the survey programme was finalized. Existing data sets should be checked for quality and digitalized, while field activities should be continued.

Elaboration of geochemical atlases was not a state-supported and organize organized monitoring programme. This activity was accomplished within the frames of several scientific projects and with the enthusiasm of a group of experts and their associates. The editions contain statistically analyzed data for the content of heavy metals and their spatial distribution in the vicinity of several industrial hot spots and the whole country territory. Graphical and numerical data from datasets are in hard copy and are not publicly available in digital format. In addition, datasets contain information only for heavy metal contents and spatial distribution, with no other soil parameters or site descriptions and profile specifics. Heavy metals content in agricultural soil is directly related to food safety, human health, and welfare. For these reasons, more detailed monitoring is needed especially on agricultural land around industrial hot spots and urban areas identified as contaminated sites. Such investigations should be accomplished with multidisciplinary risk assessment for the possible impacts on human health, water safety, air quality and food security.

Conclusions and recommendations:

- Existing data soil datasets, in most cases, are outdated and need to be updated and extended
- Some soil datasets are in inappropriate format and need to be converted into a suitable (digital) format in order to connect with other soil and soil-related datasets
- Soil data or soil-related data generated within various pilot projects are scattered and need to be collected and harmonized in a soil resource centre
- A monitoring programme of any kind related to soil quality or land degradation is not in function and is not foreseen within the working plans of any of the responsible ministries or other authorities
- There is urgent need to draft legal acts establishing inter-institutional arrangements, putting in place a functional monitoring, reporting and verification (MRV) system for soils, as well as a long-term programme of work for supporting the implementation of sustainable soil management practices in all sectors that influence land degradation.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

In the past decade, several legal acts and strategic documents addressing sustainable soil and land management in a more general context have been drafted and adopted. However, unfortunately, legal acts directly targeted towards governing soil-related problems and soil protection have not been adopted. Regarding sustainable use of land and soil, several legal acts threaten these aspects, such as the Law on Organic Agriculture and the by-law on Procedures and rules in organic production, which define the allowed and recommended procedures and practices. Another by-law related to implementing the minimum standards of sustainable management practices on agricultural land is the Rulebook on cross-compliance measures. This document defines the minimum sustainable management practices fulfilled by farmers applying for subsidies or other financial aid forms. There are other legal documents that treat certain aspects of land management, like the Law on Mineral Raw Materials, which contains provisions for the procedures for storing/piling of waste generated during the exploitation of mineral raw materials, top-soil management and protection, etc.

On the other hand, the Law on Agricultural Land is more focused on the rights of use, land tenure and concessions. It briefly enumerates best practices for maintaining soil fertility, with only a few provisions related to protection from soil erosion and fires. Currently, a new version of the Law on Agricultural Land is in the phase of preparation. The development of a law on soil protection and a soil strategy is planned under the project Promoting Sustainable Land Management (SLM) Through Strengthening Legal and Institutional Framework, Capacity Building and Restoration of Most Vulnerable Mountain Landscapes.

One of the major gaps in the legal framework, is the lack of specific legal acts, strategies documents and action plans related to sustainable soil and land management. As a result, there is no legal basis for an organized approach to defining and implementing sustainable management practices, legally binding procedures and work protocols and the corresponding system of control in different sectors that influence land degradation. Another gap is the lack of more intensive coordination and cooperation between the two ministries (Ministry of Agriculture, Forestry and Water Economy and Ministry of Environment and Physical Planning) which are in charge for the governance of soil and land. Therefore, immediate action is needed to gather all key stakeholders and define the needed institutional arrangements, working groups and work programmes that will reflect the recently defined goals and requirements within the new EU Soil Strategy.

The Soil Strategy is one of the latest strategic documents of the EU related to soil, which is closely related to other EU strategic and planning documents. The Strategy outlines the mid- and long-term objectives, which are in many aspects in line with the objectives defined in the Green Deal. It is of particular importance for the legal framework of our country and future regional initiatives because the Strategy

highlights the necessity of addressing the transboundary impacts of soil degradation and promoting policy coherence at the EU and national levels. In addition, within the Soil Strategy the Commission commits to drafting a dedicated legislative proposal on soil health by 2023. This is another important reason for the necessity of drafting the national soil legislation in the country.

Main goals of the EU Mission A Soil Deal for Europe is to take action through funding an ambitious research and innovation programme, developing a harmonized framework for soil monitoring in Europe and raising people's awareness of the vital importance of soils in dealing with the primary degradation process which the Soil Deal is highlighting as its main objectives. This initiative is an excellent opportunity and example for establishing local and regional networks for harmonized monitoring and management of land and soil.

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

The term 'agrochemicals' generally encompasses two groups of chemicals used in the common agricultural production: mineral fertilizers and pesticides (insecticides, herbicides, fungicides, etc.). According to older data (NEAP, 1997), the use of fertilizers and pesticides in the transitional period (1982-1993) was significantly lower, primarily due to economic reasons. The awareness of the producers of the need for improvement of fertilization practices, and its importance for sustainable soil management, is still 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 quantities of fertilizers used in agriculture do not exist. Estimates for the common use of agrochemicals are based on direct contact with the producers and data collected within several field surveys. For instance, in the Bregalnica catchment, the total quantities of nutrients applied were estimated at 221 kg/ha/year/ pure nutrients (NPK), while the total quantities of pesticides were estimated at 7.4 kg/ha/year. In the Ohrid lake catchment, the total quantities of nutrients applied were estimated at 158.79 kg/ha/year and pesticides in the quantity of 4.66 kg/ha. In the past decade, a long-term project for implementing sustainable practices in orchards and vegetable production were conducted in two regions, aiming toward optimization of fertilizer management practices. Until recently, the Ministry of Agriculture, Forestry and Water Economy (MAFWE), through its programme on direct payments, supported a measure for laboratory testing of soil intended to be planted with perennial crops. Unfortunately, this measure is not supported anymore. Besides this, there is no other organize organized form to support the farmers and increase their knowledge of best practices in fertilization and plant protection.

Erosion is the most dominant process causing land degradation in the country. Natural conditions (climatic and edaphic factors) and bad management practices in agriculture and forestry deforestation are the main contributors to the high rate of water erosion, which is present in almost all parts 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. 1988). A new Soil Erosion Map has been prepared recently using the same

EPM model for the whole country territory and the RUSLE model for agricultural areas. The main findings are that almost 33.57% of the territory (834,130 ha) is affected by the first three categories of soil erosion. Results from the analysis of soil erosion on agricultural land (RUSLE method) showed that the mean annual soil losses on agricultural land are E= 4.1 t/ha. Combating soil erosion requires in-depth estimation of erosion processes and identification of prone areas, coordinated mobilization and action of all stakeholders on the central and local levels and radical changes in land management practices on catchment and parcel levels. At the moment, none of these elements are implemented in practice, except the model-based approach in the elaboration of soil erosion maps.

Soil organic carbon is part of the soil's natural capital, and underlies the majority of ecosystem services of soils. In essentially warm and dry areas, like South Europe, depletion of SOM can be rapid because decomposition processes are accelerated at high temperatures. Therefore, soils under intensive agriculture production in the country, especially those on sloping terrain with heavy texture and shallow soil profile, are the most vulnerable. In the process of elaboration for the Macedonian Soil Information systems, a high-resolution raster map for the spatial distribution of SOM in the topsoil was elaborated. These analyses helped in the identification of the 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 agricultural soils, especially those in the central and eastern parts of the country. However, all estimations have been made mostly on a quite outdated soil dataset. Keeping in mind that SOM content is a very dynamic category, a continuous and exhaustive monitoring programme should be put in place to monitor and preserve this precious part of soil.

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 a soil compaction map or to estimate the area affected by soil compaction.

According to the Ministry of Environment and Physical Planning (MoEPP), about 27 million tonnes of waste are generated annually. Of this, 66% is generated from mining and mine industry, 21% from agriculture, 8% is hazardous energy waste, 3% is municipal waste, etc. Soil contamination with heavy metals started with the intensification of the metal industry, mining and putting in function several smelters. In the past decade, a significant and intensive field survey over the whole country territory has been conducted to quantify heavy metal contents on 5 km^2. Separate studies for the most polluted soils around specific hot spots (Stafilov, T, 2010, 2011, 2013, 2014, 2015 and Bacheva, K. at all, 2014) were also performed. 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. However, the continuation of this monitoring and its extension with heavy metals risk assessment programme with a focus on food security, water contamination and air, is of essential importance. Furthermore, such monitoring should serve as basis for further sustainable management practices on contaminated land.

The most significant impacts of soil sealing are observable around the largest urban areas due to the migration of rural population to big cities and the country's economic development. Although the cities are uniformly distributed, the population density is not uniform. Such expansion is creating a conflict between the initiatives for the protection of high-quality arable land and the necessity of urban development. Soil sealing in the country has not been defined yet. According to some recent investigations, the most affected is the Skopje region resulting in radical sealing of agricultural land. The mean annual rate of soil sealing for the entire Skopje region is 0.14% (Trpcevska-Angellkovic, 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 must be found in order to overcome this conflict. The best way is for all stakeholders 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.

Drought is a serious climatic phenomenon that affects soils (soil drought) and agricultural areas (atmospheric drought), changes and alters levels of lakes and river flows (hydrological drought) in the country, especially in its central and south-eastern parts. Many studies and reports attempt to estimate the drought for specific areas and articulate its intensity through various drought indices. However, due to a lack of available long-term meteorological and climatological data and the needed capacities, the monitoring and impact assessment of drought in vulnerable zones have never been performed regularly. Moreover, the negative influences of drought are additionally worsened due to the increased impacts of climate change. The most recent analysis of aridity and drought indices has revealed that the central parts of the country, areas downstream Vardar River to the border with Greece and the south-east part of the country (Strumica valley) have the highest aridity index (Bagnouls-Gaussen Aridity Index I). Drought indices according to the same investigations show the most unfavourable values for the same area. For instance, the maximum length of consecutive dry days (>30 days) is detected for the same areas identified as the most arid zone, the central and south-east part of the country. Drought vulnerability based on spatial maps of different selected parameters (land use, climatic and edaphic factors) revealed that the most vulnerable areas to drought are: north-eastern part of Skopje and Kumanovo valley, the central part (Ovče pole, Štip and Tikveš) and the south-east part (Strumica valley).

Floods are another Bagnouls-Gaussen aridity index threat to soils and water resources in the country. Several regions can be identified as most prone to floods mainly along the more significant rivers especially their upper parts which are characterized by torrential flows especially in spring when the snow starts melting. In such conditions, a vast amount of torrential water containing suspended material, dragging mechanical elements, spills out of the river beds causing severe material damages. Recently, such conditions in the Skopje region caused human losses and substantial material damage. A similar situation is in the Polog region, Tikveš, Radoviš and Strumica valleys. In addition, in the lower parts of river courses, due to the high amount of dragged sedimented material in river beds during the periods of extreme hydrological conditions, rivers flood the adjacent agricultural areas and settlements. Either by wiping off the fertile topsoil in the upper parts of river streams, bearing fertile soils with rocks and sterile mechanical elements or waterlogging of flat valley bottoms, floods cause inevitable damage to soils. The most prone areas to floods in the country are: in the north-west – Polog plain, north and north-east – Skopje and Kumanovo valleys, in the central part – Ovče pole, Štip and Tikveš valleys, south-east Strumica and Radoviš valleys, and in the south – Pelagonija height. Several projects focusing on risk reduction and improvement of resilience to floods have been implemented in several critical regions in the past decade. In addition, river management plans for the country's most significant rivers have also been implemented. Among other studies, within some of these plans, a basin-scale analysis of flood risk and short- and long-term (systemic) flood risk mitigation options have also been prepared. Floods risk reduction, including its negative impact on soils, is a complex task which needs a systematic long-term approach with a set of legal and technical measures implemented at the central and local levels by multidisciplinary teams supported by all key stakeholders.

With regards to the assessment, reporting and management of degradation processes, despite the already elaborated, it is of utmost importance for all degradation processes to establish functional monitoring, reporting and verification system (MRV system), which should a part of the planning process and essential for determining successful outcomes, and evidence needed to demonstrate the success of implemented sustainable management of land and soil. This system should encompass the overall coordination of inter-ministerial working groups, give a clear purpose and demand for monitoring, enhance transparency and accountability of monitoring with the dissemination of the information produced to target specific audiences, involve stakeholders, monitor progress, evaluate outcomes, provide

adequate resourcing and planning for data providers, define the roles of data providers and ensure networking between data providers and data consumers for uninterrupted data flow. Such an approach can ensure the sustainability of the process of monitoring and sustainable management of land and soil.

The country, through its State Statistical Office, is reporting on some SDGs (SDG Country Profiles). Unfortunately, due to the lack of relevant data, SDG indicators 2.4.1 and 15.3.1 are not reported. With regards to SDG indicator 2.4.1, the only available data for land under sustainable agriculture are areas with organic production. In 2020, the areas under organic farming amounted to 3,957 hectares, and the share of organic production of the total cultivated area was 0.77% and 0.31%. of the total agricultural land.

Ministry of Environment and Physical Planning (MoEPP) is preparing an annual report on environmental quality. These reports outline the state for the most important aspects related to quality of the environment, like: air, water, waste, noise, and climate change. Soil and soil related issues are not covered by this report. Data for the state of the environment in the country are available from 2006. MoEPP is preparing biannual reports for the current state of selected environmental indicators and their trends. These reports are part of the reporting process to the European Environment Agency and the requirements arising from the relevant EU directives and regulations. In the most recent report from 2020, the country reported on a set of four indicators: soil take (sealing), land cover, management progress of contaminated sites, and soil erosion. The first reports (land take and land cover) were calculated using the Copernicus Land monitoring system (CORINE LC) spatial data. This database is updated at intervals of 6 years, which is why it is not suitable for biennial reporting periods. The other two indicators have not been updated for more than a decade for contaminated sites and more than three decades for soil erosion (Environmental indicators 2020). Due to a lack of legal regulations in the field of soil that will also cover issues related to contaminated sites, nor the existence of a suitable defined questionnaire on the basis of which progress in the management of contaminated sites can be monitored, this indicator cannot be produced in the future (annual report on the implementation of the spatial plan, 2018). The State of Environment (SOER) Report from 2013 (State of Environment – SOER, 2013) outlines that systematic monitoring of soil as a medium of the environment, does not exist. In addition, this report emphasizes the need of a law on soil protection which should treat many aspects of soil as a medium of the environment.

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

Administrative capacities related to sustainable management of land and soils are within the two responsible Ministries: Ministry of Agriculture, Forestry and Water Economy (MAFWE) and the Ministry of Environment and Physical Planning (MoEPP). MAFWE capacities related to sustainable land management are concentrated within the Sector for Land Consolidation and Exchange and Identification of Land Parcels, which is responsible for activities related to land consolidation and land use (LPIS), while the Sector for Rural Development and its departments, provides support to sustainable rural development, programming, evaluation, and implementing of IPARD funds. There are five employees who are directly responsible for implementing agroecological measures and the LIDER programme. Besides this, the Sector is responsible for supporting ANCs for agricultural production. MoEPP, Sector for the Environment, has a Department impact assessment on the environment and soil protection with a wide range of responsibilities, like preparation of strategic and legal documents, implementation of international and EU legal acts and protection measures from soil contamination and improvement of soil quality. The Department has seven employees, but only one senior adviser is directly responsible for land protection issues.

Educational capacities are situated with the state research and education institutions. Educational programme at the state universities is somewhat limited to traditional basic concepts of soil science and soil survey. The current curriculum of the universities lags behind the current advances in soil science. It should be enhanced with a new programme, reflecting recent modern approaches and concepts of soil management practices, soil survey and protection.

Technical capacities related to soil and soil monitoring are concentrated in the research and education centres of the universities. The Institute of Agriculture, has four employees in the Department for Soil Science and Plant Nutrition (three PhDs and one technician). The Department is in charge of field survey and cartography of soils, preparation of technical reports, fertilization programmes, laboratory testing of soil, fertilizer and plant material. This Department possesses modern equipment for laboratory soil testing and field surveys. Besides this, the Department possesses up-to-date hardware and software solutions for implementing digital techniques in soil surveys.

The Faculty of Agricultural Sciences and Food has two Departments related to soils. Irrigation Department with two PhDs and one technician with well-equipped laboratories for 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 a moderately equipped laboratory for educational purposes. The faculty has a department for soil and water 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.

Conclusions and recommendations:

- At the moment, institutional capacities related to sustainable land and soil management are very limited and cannot address all issues and challenges
- Legal frameworks and strategic documents and action plans do not exist, and a national policy related to soils has not been articulated
- Academic capacities and the actual syllabus related to soils at all levels of education is inadequate and outdated
- Research capacities (human and technical) are very limited and can hardly respond to any form of monitoring and survey
- Institutional capacities at all levels should be reinforced with an appropriate form of organization and coordination, occupied with skilled staff with sufficient awareness and knowledge of the current situation in the country, to address the lags and gaps in the sector and undertake the needed actions to reach a state of neutrality in land degradation and fulfil the requirements arising from recent and future strategic legal acts of the EU
- Academic capacities and current educational programmes should be reinforced with new and updated programmes , subjects and extra curricula, covering the most recent approaches in soil science, land degradation, soil conservation, modelling, etc.
- Institutional, individual and technical capacities of soil research institutions should be fundamentally reinforced
- Since soil research is a functional element of the future monitoring, reporting and verification system, research institutions should pave the way for implementing new technologies, setting standards of work in all aspects of soil management and monitoring programmes, and should serve as a centre of excellence networked with similar institutions in the region and abroad

6. Assessment, conclusions and recommendations

1. The country needs to develop and adopt legal framework, strategic and planning documents related to soil, outlining country needs and requirements arising from signed UN conventions and EU strategies and legal acts,
2. Administrative capacities at all levels should be reinforced with new organizational entities focused on soil and land management. Coordination among institutions should be established within a functional system. Individual capacities of employees in the sector should be permanently upgraded to enable the implementation of the provisions from future national legislation and EU legal acts and strategies
3. Establish a functional system for monitoring the effects of implementation
4. Create inter-institutional arrangements for a functional system for the implementation of legal

acts and strategies in practice, a monitoring, reporting and verification system, and support the implementation of sustainable management practices in all sectors, with a long-term programme of work
5. Adapt educational programmes at all levels of education, developing training programmes for farmers in the form of life-long and vocational training and retraining programmes
6. Reinforce the research capacities of research institutions by establishing a permanent and well-designed programme of work

7. Good case studies on soil management practices

In the past decade, several projects related to the improvement of soil management practices have been implemented. The goals of these projects were related to water resources preservation from diffuse sources of pollution and adaptation of agriculture to climate change.

A good case study for applying sustainable management practices is the project Support To The Introduction of Sustainable Farming Practices in the Prespa Lake Watershed Restoration. The project's main goal was to optimize management practices, especially those related to inputs of agrochemicals (fertilizers and pesticides) and water use. A significant area of Prespa lake watershed (more than 3,800 ha) is under apple and pear plantations. Such a large area of intensive agricultural production can be considered as a significant source of pollution of lake water with nutrients. Several gaps have been identified that prevent the implementation of sustainable soil management practices, such as: more than 7,000 producers are involved in the agricultural sector with different backgrounds and production systems. To convey sustainable management practices to such a large group is a cumbersome task. Primary producers have insufficient capacities or motivation for implementing proper management practices. The producers usually have insufficient awareness of the importance and benefits of implementing sustainable management practices, and, in some cases, are reluctant and sceptic about implementing new technologies and practices.

The project was accordingly designed to overcome all these gaps and bottlenecks. In the first phase, selection criteria were established, which were used to select the most prospective farmers. The idea was to select a group of farmers with sufficient experience and reputation in their communities that could further serve as a good example for others.

A comprehensive training programme was implemented for the selected group, and training manuals were also prepared. After the training programme implementation all trainees were tested, and the most successful candidates were selected for further collaboration. In the next phase, sustainable measures that would be implemented in practice were agreed. The equipment needed for implementing the selected measures, in the form of a grant scheme, was provided to the selected farmers. The provided equipment, included drip irrigation, fertigation, composting, cover crops and mulching, pheromonic traps, UV nets, equipment for the laboratory testing of chemical and physical soil properties with adequate programmes for fertilization, fertigation and irrigation. In addition, mini-meteorological stations were installed for the measurement of meteorological events and calculation of evapotranspiration and the risks of outbreak of certain plant diseases. To monitor soil moisture and estimate the right moment for irrigation, tensiometers with data loggers were installed on the parcels of selected farmers.

During the next two vegetation seasons, a group of experts was in close collaboration with the selected group of farmers. Field visits were regularly organized to give support and technical advice to the farmers. Two more cycles were organized in the next period for the selection and training of apple producers in the region of Prespa lake, or in total more than 80 farmers. After the second year of implementing sustainable measures, a new set of soil samples was collected to evaluate any positive influences of the applied sustainable soil management practices. In almost all cases, the level of nutrients was changed, soil organic carbon content on parcels applying compost or cover crops and mulching, were slightly increased. The farmers were satisfied with the programme of measures, since the yields increased and were of better quality.

A similar programme was implemented in another region in the south-east of the country for fruit (plums and apples) and vegetable producers (peppers and tomatoes).

Another good case study is the project implemented in the period 2013 to 2016 in the central and southern part of the Vardar River basin, a region considered most prone to climate change. The project's main objective was to reinforce agriculture's adaptation to climate change by demonstrating adaptive measures to a broad audience of regional farmers. For this reason, sixteen demonstration fields were established on farm holdings in the region. A comprehensive set of adaptation measures were applied in the area of fruit production, vegetable production, field crops, soil management, etc. These demonstration fields served as an example to the farmers of the effectiveness of measures for adaptation of agriculture to the negative effects of climate change and to demonstrate the methodology of its implementation. Two separates demonstrative fields were established to demonstrate a set of soil management practices for mitigating soil erosion and another for maintaining soil organic carbon contents. The main finding before the establishment of the demonstrative erosive fields was that soil management and, in particular, agricultural soil cultivation and crop cultivation pattern was becoming an important issue among farmers in the country. Basically, their attention on this issue was a result of suggestions of experts, agroecological measures subsidized by MAFWE and the farmers' increased inputs/expenses during the establishment and maintenance of modern plantations. However, applying of soil sustainable management practices among the farmers is still not a systematic, but more an incidental approach. In many cases, farmers that were implementing particular measures were not yet fully informed of the benefits of such measures. This is mainly due to a lack of specific evaluation of the positive influence of soil conservation practices and cost benefit analysis. Experience has demonstrated that farmers' motives for introducing some of the soil conservation practices are not guided by the genuine purpose of their application, but more by practical reasons, such as reduced number of cultivations, subsidies, etc.

The working hypothesis behind this programme of measures was that combating soil erosion and diminishing its negative impact by strengthening soil structure, enhancing soil organic matter and soil moisture conservation, were in the best interest of farmers, that are usually poorly informed about the advantages of the implementation of specific soil conservation practices.

To this end, the main objectives were to:

- Quantify the extent of the negative impacts of soil erosion under different types of soil cultivation and management practices
- Quantify the influence of soil erosion on soil properties under intensive influence of negative impact of CC and
- Show farmers the positive impact of certain types of soil cultivation and management practices on soil properties

For the achievement of these goals, a set of measures has been applied on two experimental sites in two different climate conditions and two soil types.

In the first erosive field, the influence of cultivation and land cover on the production of soil sediment was monitored. Downslope cultivation and contour cultivation were compared, with no vegetation. The result showed a 6 to 7 times reduction in sediment production, when contour cultivation was applied. Regarding the land cover, the effects of three variants: cereals cultivated as monocrops, spring crops and perennial grass on sediment loss and soil organic carbon content were compared over four vegetative seasons. Best results were obtained with the variant perennial grass. On the other experimental field with vineyards, the effects of cover crops and classic cultivation on soil sediment production and soil carbon content were compared (Picture 1-4). A significant reduction of sediment was detected in the variant with cover crops. The most important part was that a big number of producers were informed and convinced of the importance of proper cultivation and introduction of cover corps in the perennial plantations.

Picture 1 Perennial grass as cover crop

Picture 2 Eroded sediment under cover crops

Picture 3 Downslope cultivation

Picture 4 Eroded sediment – downslope cultivation

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SERBIA SOIL REPORT

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1. The importance of sustainable land management at the national level

Sustainable land management satisfies three aspects of development: economic, social, and ecological. Fertile and healthy soils are the limiting condition for the development of the whole agricultural sector and human wellbeing. Agricultural land represents more than half the territory of the Republic of Serbia . According to numbers, as well as confirmed analyses and expertise of the scientific and professional community, soil protection is crucial for sustainable development and prosperity in Serbia.

Agriculture is one of the most important economic sectors in Serbia, contributing to approximately 15-20% of GDP, 20% of employment, and more than 20% of total exports. The land fund of Serbia is rich in natural resources but endangered by intensive agricultural production. The main degradation process in the soils is the rapid loss of organic matter, which has effects on other degradation processes. This problem is global and also occurs on agricultural land in other countries around the world.

Loss of organic matter in soil causes side effects such as loss of fertility and yield decline, erosion, floods and landslides, vulnerability to climate change and pollution, acidification, etc. Land protection is in the focus of interest of the whole international community, which has recognized its importance and acts strongly to implement the goals of land protection from three aspects: stable food production, environmental protection and mitigation of climate change. Serbia is involved in these international initiatives and is signatory to several agreements in this area.

Small rural producers on fragmented plots own the largest area of agricultural land in Serbia. They are often affected by poverty with unfavourable age structure. They have to be strengthened and encouraged to stay in rural areas and contribute to the production of healthy food and preservation of the environment. The new concept of regenerative agriculture (to raise the content of organic matter in soil) is incomprehensible and distant to farmers and suggests that significant initial investments and knowledge are needed.

The Republic of Serbia has made significant progress in legislation in the field of soil and land protection and rural development. Now is the right time to implement activities to bring the adopted plans to life. Support for agricultural practices that raise the content of organic matter in soil will prevent desertification, reverse climate change, preserve biodiversity, forward food security goals, improve nutrition, increase water security, and slow down migration.

The scientific and professional community will steadfastly stand by decision makers in support as they enact policy to enhance the organic content of Serbia's soils to a minimum of 3-6%. This is an opportunity to make history by bringing our country back from the brink of soil extinction.

2. General assessment of data available (conclusions and recommendations)

Data on land use presented in different documents of official institutions vary widely, especially data on areas under forests, agricultural land, and the type of land use. It is, therefore, necessary to harmonize these key data on land resources and secure their uniform display.

The graphic design of the Serbian Pedological Map, including visualizations, needs to be improved to provide a broader view of the natural potential of land and the possibilities for soil protection and improvement to all interested parties. It is necessary to complete the Pedological/Soil Map of Serbia along with key messages shareable via e-portals because comprehensive maps are extremely rare and differ graphically among institutions.

Although there are different programmes for soil quality control, they are mostly short-term, incompatible, and lack continuity. Soil fertility parameters are more closely monitored from the aspect of agriculture, but potentially toxic elements are mainly monitored through various scientific projects, while organic soil pollutants are rarely monitored systematically.

There are several positive initiatives that are in progress regarding consolidating soil quality data and systematic monitoring, such as:

- The establishment of an information system (database) and the creation of a network of authorized laboratories for testing the fertility of arable agricultural land under the Directorate of Agricultural Land of the Ministry of Agriculture, Forestry and Water Management
- The entry into force of the Regulation on systematic monitoring of the condition and quality of soil, in January 2022, which will increase the scope of soil testing as well as regulate the validity and consolidation of data under the Environmental Protection Agency (SEPA) of the Ministry of Environmental Protection
- The initiation of the monitoring of organic carbon (C org)

Since agriculture is crucial to land resources in Serbia, both as the cause and the consequence of soil degradation processes, it is necessary to obtain more comprehensive data on applied agro-technical measures in addition to data on soil quality. According to the Law on Agricultural Land, each producer has an obligation to keep records of applied cultivation practices and relevant data in the Field Book. This rarely happens in practice, so there are no valid, essential data on quantities of applied agrochemicals, method of land cultivation, etc. The establishment of a unified data system has been in progress for a long time. In the meantime, it is necessary to simplify the Field Book and put it into a user-friendly form as a transitional model for Advisory Services to collect at least the basic data of importance.

It is necessary to find a better model for unifying existing data on soil quality at different levels: scientific research, systematic monitoring under the jurisdiction of different state entities, research within the projects of international organizations, etc. All this data is publicly available but often scattered and thus constantly re-collected within the framework of special studies. In addition, the existing specific data would be of great importance for improving thematic soil mapping. For example, data on pedological profiles collected in various studies could contribute to constant improvements and refinements of the pedological map, which has not changed in decades.

3. Legal framework for sustainable land and soil management: gaps and recommendations for improvement

Soil protection is generally well regulated in the Republic of Serbia, but the implementation of by-laws still needs to be encouraged. The **Law on Soil Protection** (Official Gazette of RS, No. 112/2015) regulates soil protection, systematic monitoring of soil quality, remediation measures, inspection supervision, and other issues of importance to the protection and maintenance of soil as a natural resource of national interest. The provisions of the law apply to all types of land within the Republic of Serbia as a natural resource, regardless of the form of its ownership, purpose, or use. The following by-laws have been adopted in line with the Law on Soil Protection: *Decree on limit values of polluting, harmful and dangerous substances in soil; Rulebook on the content of remediation and reclamation projects; Decree on systematic monitoring of the condition and quality of soil; Rulebook on the list of activities that may be the cause of soil pollution and degradation, procedure, data content, deadlines and other requirements for land monitoring; Rulebook on content and form of the soil monitoring report; Rulebook on the content and manner of keeping the cadastre of contaminated sites, type, content, forms, manner, and deadlines for data submission.*

All of the listed legal acts have been implemented, but the Decree on systematic monitoring of the condition and quality of soil has not been fully implemented. The Decree determines the contents of the Soil Monitoring Programme at the national and local network levels, methodology for systematic monitoring of soil quality and condition, criteria for determining the number and arrangement of measuring points, the list of parameters, methods and standards for soil sampling, sample analysis and data processing issues, including the scope and frequency of measurements, indicators for assessing the risk of soil degradation, and deadlines and manner of submitting relevant data.

Implementation of legal acts related to soil protection has had certain obstacles and gaps and further improvement is therefore necessary. In general, one of the issues for Serbia is the fact that key development and strategic decision-making processes often take place separately from the formal adoption of planning documents. Also, there is a number of problems in the implementation of legislation, primarily in terms of jurisdiction shared by different ministries and institutional entities, and secondly due to a lack of funding for programme implementation (for example, for remediation of contaminated sites caused by previous historical industry pollution). The listed problems are especially noticeable in the reporting obligations and the adoption and implementation of various strategies and action plans.

It is essential to harmonize the implementation of legal provisions related to environmental protection and agriculture in the context of climate change. Of primary importance is the revision of the Rulebook on the type and content of measures that the user of agricultural land is obliged to apply in order to establish economic models of permanent support for this method of sustainable production, which connects all three mentioned aspects. In addition, the applied sustainable measures would thus be

unambiguous and recognizable in the horizontal and vertical system of legislation, as well as enable their monitoring and reporting from all three mentioned crucial aspects.

Concerning the existing international and EU initiatives related to soil protection and sustainable use, such as the Soil Deal for Europe, the Republic of Serbia has to involve human and institutional resources in the defined programmes, rather than implement them independently.

Regarding the Green Deal, the Republic of Serbia is included in the framework of the Green Agenda for the Western Balkans, aiming to build a modern, climate-neutral and resource-efficient economy, supported by the EU. The European Parliament stressed the essential role of carbon sinks in the transition to climate neutrality for the Union and, in particular, the contribution of agriculture, forestry, and land-use sectors (European Parliament, 2021). These are the pressure points where Serbia must put more effort in the forthcoming period. Closing the loop – the EU's Circular Economy Action Plan has identified the Fertilizer and Waste Management Regulation revision as a key legislative proposal to boost the market for secondary raw materials. Since decrease in soil organic matter is one of the main degradation soil processes in Serbia, applying biogenic wastes and other secondary raw materials should be a priority of these programmes. The majority of waste materials rich in organic matter, especially from the food industry, can be recycled as organic (or organic-mineral) fertilizers with pre-treatment. This method requires additional research of potential waste materials, field experiments, and the development of machines for the production and application of new fertilizers, which the international community is occupied with. This research is currently conducted in Serbia within several projects in cooperation with the economic sector – the food industry. The first initiatives within the circular economy, which represents the use of biomass from agricultural harvested residues for energy purposes, should be carefully supported and promoted in Serbia, since our soils desperately need these harvest residues to increase soil organic matter.

The EU Soil Strategy for 2030 and the new Soil Health Law announced for 2023 are excellent examples Serbia should follow when creating and implementing its own strategies, plans, and calls/programmes at all levels. In addition, support should be used from the EU Soil Observatory (EUSO) policy, which underpins EU policies that concern soil. In the absence of a dedicated legislative framework, the EU soil protection policy is shaped by the EU Soil Thematic Strategy and provisions of a number of other policy instruments, such as the Industrial Emissions Directive, the Environmental Liability Directive, the EU Biodiversity Strategy, the EU Forest Strategy, and the Common Agricultural Policy (CAP).

4. The main soil degradation processes: gaps related to the assessment and management of degradation processes

Soils are largely non-renewable resources. Because soil formation is extremely slow and soil systems have a great resistance to change, the degradation of soils and its consequences can only be perceived with a considerable temporal delay. It takes 1,000 to 10,000 years to build up fully functional soil layers of 30 cm (European Environment Agency/United Nations Environment Programme, 2000). In the

EU Soil Strategy, the European Commission has already identified eight soil threats: soil erosion, soil contamination, floods and landslides, the decline in soil organic matter, salinization, soil compaction, soil sealing, and soil biodiversity loss (Commission of the European Communities, 2006). In light of the current situation in Serbia, besides the mentioned main degradation processes (decline in soil organic matter, soil erosion, soil contamination, floods and landslides, etc.), soil acidification and drought threats should also be added to this list.

In addition to natural factors (water and aeolian erosion, excessive rainfall, droughts), the reduction of the productive capacity of agricultural land in Serbia is under strong impact of anthropogenic factors, such as intensive tillage, waste disposal, as well as excessive and inadequate use of agrochemicals. It results in soil degradation in terms of decrease in organic matter and soil acidification, which further leads to continued deterioration of soil, and its chemical and physical properties, creating a closed circle of further soil endangerment that is extremely difficult to break.

Several institutions monitor the state of soil in the territory of the Republic of Serbia to review the soil state and define programmes for its protection. The adoption of the Law on Soil Protection in December 2015 provided a legal basis for the establishment of systematic monitoring of soil at the state and local level, which enabled more adequate monitoring of land conditions and pressures at the national and international levels, and planning of remediation measures and protection (SEPA, 2020).

The Government of the Republic of Serbia directly participated in the development and writing of the Sustainable Development Agenda. An Inter-Ministerial Working Group for the Implementation of SDGs was established in December 2015, while the national statistical office measures and monitors SDGs (https://sdg.indikatori.rs/en-US/).

Under the SDG2 Zero Hunger, 4 of 14 indicators were processed, while data for 10 indicators are being investigated. There are no official data for SDG indicator 2.4.1 Proportion of agricultural area under productive and sustainable agriculture. At present, it is possible to give a general assessment through pilot projects and the work of Agricultural Services which could provide data for smaller cadastral municipalities, all in accordance with the relevant FAO methodological documents (FAO, 2020, 2021). To successfully perform this work, it is necessary to provide expert support to the involved agricultural services as they do not have their own capacity to methodologically process the collected data.

Under the SDG15, Life on Land, 6 of 14 indicators were processed, while data for 8 indicators are being investigated. There are no official data for SDG indicator 15.3.1 Proportion of land that is degraded over total land area. This assessment could be provided based on the list of national indicators and the cadastre of contaminated sites and the land degraded due to pollution and erosion. The national list of indicators contains the indicator 'Degraded land area', code NLI 9.56, which is monitored. Within the scope of degraded agricultural land, it is possible to give a general assessment based on erosion processes and organic matter content.

Monitoring of these two mentioned indicators would significantly contribute to the protection of Serbian soils and lead to the fulfilment of international obligations, and they should be considered a priority given that there is little time left to reach all SDGs by 2030. According to the standard typology of indicators of the European Environment Agency, reporting indicators at the national level belong to one of the following categories: Pressures (P) and State (S). Indicators are based on the availability of data and the importance of assessing the status of soils in the Republic of Serbia. The indicators from the national list and the methodology for their development (Official Gazette of RS, No. 37/2011) are harmonized with the indicators of the European Environment Agency and other international organizations. The national list of indicators contains the methodology for data collection, ways and deadlines for the submission of data, information, indicators and reports generated by the Information System.

The national list of indicators includes the set of indicators on soil, which systematizes information on soil conditions, land-use changes and land degradation factors.

Since 2012, the following indicators have been monitored (http://indicator.sepa.gov.rs/):

No	Category	National code	EU code	Name of indicator
1	Pressures (P)	NLI 4.27	EEA CSI 014	Land use change
2	Pressures (P)	NLI 4.28	n/a	Soil erosion
3	State (S)	NLI 4.29	n/a	Soil organic carbon content

The National List of Indicators is well designed and comprehensive, but due to the division of the jurisdiction among several ministries, improvement needs to be made in order to provide a better mechanism for facilitated reporting on key indicators within the SEPA system. Fulfilling the obligation of national and international reporting (SDGs) would significantly contribute to the protection of soils in Serbia. Most national and international indicators are in line with each other, so full implementation of the national list of indicators should be considered a priority. Reports on the state of the environment are published once a year by the Serbian Environmental Protection Agency, providing information on the state of land and soil. Moreover, the report on the state of the soil is published bi-annually by the same organization.

Although the concept of land degradation neutrality (LDN) has not yet been explicitly defined under the current legislation of the Republic of Serbia, there is a clear tendency and effort to identify this approach in various development documents. In that respect, the publications Sustainable Land Management at the Local Level in the Republic of Serbia (2018) and Guide for Sustainable Land Management at the Local Level in the Republic of Serbia (SLMRS, 2018) are very important (MEPRS, 2020). Those publications represent the LDN approach and could be applied at different levels, from the national to the local level. "Visibility" of the LDN concept in the Law on Environmental Protection and the Law on Soil Protection would have major significance because these laws are explicitly related to the issue of land as a living medium which requires specific legislative, planning, and management solutions. Of course, the LDN concept has the potential to be identified in other laws, such as the Law on Agriculture and Rural Development, the Law on Forests, etc. The opportunity for implementation of land degradation neutrality might be recognized through the development of a new Spatial Plan of the Republic of Serbia and the identification of strategic priorities for the attainment of SDGs.

5. Capacity assessment of the country to deal with sustainable soil management (administrative, technical, laboratories, education, etc.), conclusions and recommendations

The importance of soil protection has long been unrecognized in the environmental protection system, both in the world and in Serbia. Thus, sectors in state bodies were strictly divided into those for air protection, water protection and waste management, while agriculture and forestry partially covered soil topics. Based on this traditionalism, the consequences of divided jurisdiction and parallel programmes are still visible. Since the whole world has changed its position on the importance of land and soil protection instruments, it is important that this shift is adopted in our country as well. The adoption of the Serbian Integrated Law on Soil Protection in 2015 has greatly contributed to this goal.

Serbia lacks a body that would unite all stakeholders and provide a platform for dialogue on sustainable land management, both horizontally and vertically. The Global Soil Partnership Model under the UN is an excellent example of such a platform. The Serbian Soil Science Society (SSSS), as a multidisciplinary team of scientists and experts, is involved in the global movement and would be the best body for connecting and networking with other actors (research institutions, government, private, NGOs and civil sector). In order to achieve this goal, it is first necessary for state authorities to recognize SSSS as a negotiating and advisory partner and involve it in all the processes of enactment and implementation of legislation as well as all actions relevant for soil protection. In this way, the cooperation of the state, science/expertise, economy and civil society, would be achieved within the Serbian Soil Science Society, as an umbrella organization.

Although the world focuses on soil protection as a key component of sustainable development, national projects and programmes for soil protection in the Republic of Serbia are not sufficiently supported and recognized. It is very important that the default topic in the area of sustainable land management is far more presented in all national programmes and calls/competitions (research programmes , calls for NGOs, etc.).

Although Serbia has a network of entities involved in soil analysis, these analyses are mainly fertility controls. There is professional capacity for more complex analyses in scientific institutions, but significant capital equipment is usually lacking or is worn out. It would be of great importance to establish national programmes with international support, and equip capital institutions with analytical equipment. In this way, the existing human capacities in domestic science, which has achieved international results and the necessary knowledge for the use of equipment, as well as valid processing of results, would be put into use.

Implementation and enforcement of soil advocates in the country (and other environmental or social goods threatened by human activities), aimed at changing the socio-ecological systems through laws and policies, could be beneficial and could provide the necessary policies (i.e., the governance sub-system), which would ultimately lead to better decisions for effective soil protection and soil restoration. Developing projects that promote soil advocates through customized training and educational material for primary, secondary and post-secondary students could have long-term effects in the future. Additionally, introducing foreign soil advocates that would encourage the internalization of desirable agro-environmental norms and policies for promoting new approaches in soil management, climate change mitigation, the latest tools in agriculture, carbon sequestration, urban green spaces, recreation and conservation, green architecture, stormwater mitigation etc., could have enormous effects on various aspects in Serbia and the region.

6. Assessment, conclusions and recommendations

The Republic of Serbia has a long tradition in soil research, a professional institutional sector and an institutional framework for soil protection and improvement, but a number of problems in the implementation of legislative framework are present, primarily in terms of shared jurisdiction of different ministries and institutional entities and a lack of funding for programme implementation. For this reason, urgent and comprehensive measures, such as strengthening institutional capacities, maintaining partnerships for joint actions and raising awareness of integrated and sustainable land management, are needed to release soil pressures.

The five key topics that should be considered in Serbia to improve soil quality and support soil conservation are as follows:

- **Increase the number of soil analyses and establish soil monitoring, especially in terms of monitoring Soil Organic Carbon content and physical properties**: valid data on soil quality and the degree of degradation are the most important basis for all further steps in soil protection and improvement; decreasing of soil organic matter presents one of the biggest threats on Serbian agricultural soils; obtained data will improve reporting obligations in terms of indicators (national and international).

  Implementation of the Regulation on systematic monitoring of the conditions and quality of soil would increase the scope of soil testing, as well as regulating the validity and consolidation of data under SEPA. Technical support to laboratories dealing with soil testing with analytical equipment. Support to national programmes/projects on the topic of systemic soil monitoring.
- **Cross-sectoral networking:** holistic land management from the aspects of agriculture, forestry, environmental protection, water resources management, urban and infrastructural planning, waste disposal, etc., results in successful land conservation.
- Gathering actors from different ministries in an open concept under the umbrella of the Serbian Soil Science Society. Raising awareness of the importance of soil for all parties involved by experts with strong communication skills. Moderation of dialogue and creation of a common insight of holistic land and soil management. Networking is needed, both at the level of national ministries and at the level of local self-government units (municipalities).

- **Revise the Rulebook on the type and content of measures which the user of agricultural land is obliged to apply in its use**: an urgent need for permanent application of agricultural practices that integrate the aspect of agriculture and environmental protection in the context of climate change; specific measures/practices must be equally named within equal terms from all three aspects. The applied sustainable measures should be unambiguous and recognizable in the horizontal and vertical system of legislation, as well as their monitoring and reporting from all three mentioned crucial aspects.

  Consolidate all national instrumental programmes of support and financial subsidies in these terms. Direct these measures primarily towards increasing organic matter in soils.

- **Afforestation:** healthy forests in large areas best preserve soil; increased protected natural areas significantly contribute soil conservation.

  Meet national afforestation targets through national capital projects, especially in the Vojvodina region. Data on land use vary widely in official institutions, especially concerning forest areas, so it is necessary to harmonize these key data on land resources and give them a unique display. Better monitoring of the implementation of the Law on Agriculture Land, where municipalities are obliged to provide wind protection of forest areas within agricultural land. Identification of areas with potentially protected natural resources. Increase protected natural areas on the basis of developed studies.

- **Erosion map preparation:** the last soil erosion map in Serbia was made in 1983, with only slight modifications after that; prepare an erosion map of the Republic of Serbia according to the Law on Soil Protection from 2015, which would identify the most endangered areas (from weak to excessive erosion).

  Help decision makers at the local and regional levels choose appropriate anti-erosion measures. Educate producers about anti-erosion measures that need to be implemented.

7. Good case studies on soil management practices

1. Use of organic waste material for the production of organic fertilizer

Institution: Company Compositing Smederevo D.O.O. and the Institute of Field and Vegetable Crops (IFVCNS), the National Institute of Republic of Serbia, Laboratory for Soil and Agroecology, Novi Sad

The pressure to increase crop production has resulted in the expansion of agricultural areas and intensification of cropland management through practices such as irrigation, fertilization, intensive tillage, and absence of favourable crop rotation. These practices have led to land degradation and amplified environmental impact of agriculture. A sign of land degradation is the loss of soil organic matter (SOM). This global issue is also present in Serbia, especially in the areas of intensive agricultural production. In addition to the factors above, the lack of application of organic fertilizers due to reduced livestock production in Serbia has accelerated this degradation process. Therefore, it is necessary to find alternative ways of returning organic matter to soil. Rebuilding SOM in agricultural lands for the improvement of soil fertility is promising, as SOM affects many properties of soils, including their ability to retain water and nutrients, provide structure promoting efficient drainage and aeration, and minimize loss

of topsoil via erosion (Reeves et al., 1997; Robertson et al., 2014). Also, there is vast scientific evidence affirming that maintaining current SOC stocks and fostering SOC sequestration, where potential exists, could greatly contribute to mitigating the impacts of climate change.

Since the decrease of soil organic matter is one of the main degradation soil processes in Serbia, applying biogenic wastes and other secondary raw materials in the absence of traditional organic fertilizers (manure) could be a great solution. The majority of waste materials are rich in organic matter, especially from the agricultural and food industries, and can be recycled as organic (or organic-mineral) fertilizers with the previous pre-treatment instead of becoming waste material.

Figure 1. Main elements in the composting process

In the period 2019-2021, the Laboratory for Soil and Agroecology (IFVCNS) and the company Composting D.O.O. have established cooperation in order to utilize organic waste originating from a chicken farm and organic residues from a mushroom farm for the purpose of producing organic fertilizer. The field of work of Composting company is related to waste management processes, and one of its activities is the composting of non-hazardous biodegradable waste by aerobic processes. For that purpose, the company designed and constructed several composters of different dimensions (Figure 1). The composting system Green Axle works on the principle of aerobic treatment so that no pollutants are created while biodegradable material is transformed and decomposed in a very short period (24-48 hours). The process of cooperation included the characterization of waste/raw materials for the production of fertilizers as well as monitoring the production process, adjusting the composting cycle, analysis of obtained materials throughout the production process. As a result of the cooperation, the produced organic fertilizer was registered for sale (Table 1), and it is now on the market. In addition, a multi-year experiment was set up on different types of soil in order to see the specific impact of this product in terms of increasing the content of organic matter and the impact on soil production capacity, as well as boosting the effect on maize production. The results of these activities are in the final phase and will soon be available to the public after the publication of the doctoral theses.

Use of similar products requires additional research of potential waste materials, field experiments, as well as the development of different machines for the production and application of new fertilizers. Since the high added value and support of a circular economy, similar research in Serbia has to be promoted and supported through national projects, especially in cooperation with the economic sector – food industry.

Table 1. Composition of the final product (organic fertilizer)

Active substance	Declared
Nitrogen (N) (total) [%] m/m	1.80
Nitrogen (organic) [%] m/m	1.80
Phosphorus (P_2O_5) (total) [%]	2.00
Potassium (K_2O) (total) [%] m/m	2.00
Calcium (CaO) (total) [%] m/m	11.00
Magnesium (MgO) (total) [%] m/m	2.50
Iron (Fe) (total) [%] m/m	0.500
Manganese (Mn) (total) [%] m/m	0.030
Zinc (total) [%] m/m	0.030
Organic carbon(C) [%] m/m	17.00
C/N ratio	<15
Humic acid content [%] m/m	4.00

2. Establishment of the Cadastre of Contaminated Sites in Serbia

Institution: Ministry of Environmental Protection, Serbian Environmental Protection Agency (SEPA)

According to the Law on Soil Protection, the Cadastre of Contaminated Sites is a set of relevant data on endangered, polluted, and degraded soil. The Serbian Environmental Protection Agency (SEPA) is responsible for the establishment and management of a national Cadastre of Contaminated Sites, which is an integral part of the information system for environmental protection in the Republic of Serbia. Upon its establishment in 2006, SEPA began with data collection and systematization of information on potentially contaminated and contaminated sites for the Cadastre. SEPA has constantly been working to improve the national methodology for the collection, analysis *and assessment of* data *on* contaminated *sites*. The main purpose of the Cadastre is to provide systematic data on sources of pollution, such as the type, quantities, methods and location of discharges of pollutants into soil, in order to implement preventive or remediation measures. Data collection is defined in more detail in the Rulebook on the content and manner of keeping the Cadastre of Contaminated Sites, type, content, forms, manner, and deadlines for data submission (Official Gazette of RS, No. 58/2019). According to data from 2015, the Cadastre database shows that 709 potentially contaminated sites and contaminated sites were identified and recorded on the territory of the Republic of Serbia. The largest number of registered causes of local soil pollution belongs to the following categories: municipal waste (45.48%), industrial waste (12.31%), industrial and commercial activities (33.92%) (SEPA, 2018). (Figure 2). However, according to the same source, reporting for 2020 (SEPA, 2021), on the territory of the Republic of Serbia, 213 locations were identified in the category of potentially contaminated and contaminated. The difference between the years is the result of the introduction of a new reporting system within the agency. The largest share in the identified locations were waste management sites – 71.83%, including non-sanitary landfills – landfills, managed by local self-governmental units.

Development of the Cadastre of contaminated sites was supported through the GEF-funded project: Enhanced Cross-Sectoral Land Management through Land Use Pressure Reduction and Planning, implemented by the United Nations Environment Programme (UNEP) in close cooperation with the Ministry of Environmental Protection and SEPA in the period 2015–2019. The significance of this project was enhanced by the investigation of industrial sites suspected to be contaminated. The main goals of the project were to provide the lacking methodologies, knowledge, and coordination mechanisms for sustainable and integrated management of soil as a natural resource. Additionally, the project also sup-

ported the identification of recipients of pollution and potential exposure routes, preliminary analysis, type and quantity of hazardous substances found at the location, soil and groundwater quality, as well as geological, pedological and hydrological features. The project enabled site-specific environmental monitoring data, the performance of comparative analysis and the application of preliminary risk assessment methodology that served to compile the relative risk-based priority list of contaminated sites. The project had a crucial role in the establishment and development of a Cadastre of Contaminated Sites and a policy framework for integrated land use management and its implementation at the governmental and local levels.

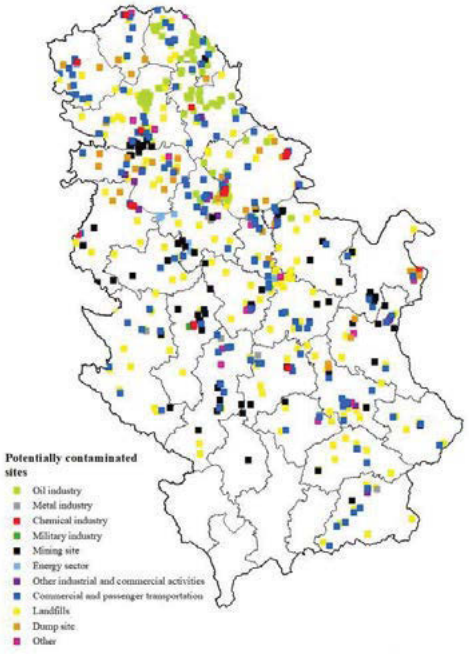

Figure 2. Map of potentially contaminated sites in the Republic of Serbia 2018-2019

3. Management of soil fertility data on the example of a technical solution SKUP

Institution: the Institute of Field and Vegetable Crops, the National Institute of Republic of Serbia, Laboratory for Soil and Agroecology, Novi Sad

The concept of integrating data on soil quality and open data is a global trend with the aim to protect and improve land management. The quality and applicability of soil information systems primarily depend on the quality of input data (surface representativeness, validity of laboratory and other input parameters), as well as the defined criteria for decision making. Applied information technologies are innovative tools for drawing conclusions about the state and forecasting the quality of soil and provide opportunities for an integrated view of the problem in a way that was almost unimaginable a few decades ago. Interpretation of data and drawing conclusions is a part that requires the participation of experts and expertise. This whole process requires a multidisciplinary approach with teamwork of experts from the agronomy and information technology sectors.

The development of SKUP solutions started from the existing data of 1,850 individual soil samples from the land area of 15,904 ha (Bački Petrovac municipality), based on previous research and projects of the Laboratory for Soil and Agroecology. After validation of the input data by laboratory re-analysis of each batch, 1,456 samples were considered for further processing. Each sample was accompanied by spatial components and data on fertility parameters. In addition, 124 samples contained data on the physical and pedological characteristics of the soil. GIS software was used for data processing. The geological, pedological and groundwater maps from the previous detailed studies conducted in 1996 were georeferenced as the basis. Digitization of the pedological map 1:25000 of the municipality of Bački Petrovac was made. Spatial interpolation of input data by the IDW method was performed and fertility maps were made. In the next step, modelling was done in order to define special criteria of the suitability of maps as output data (for hazelnut and sugar beet cultivation) by GIS tools (Figure 3). Defined criteria limits were set according to the principle that any limiting factor classifies the given area as an unsuitable zone.

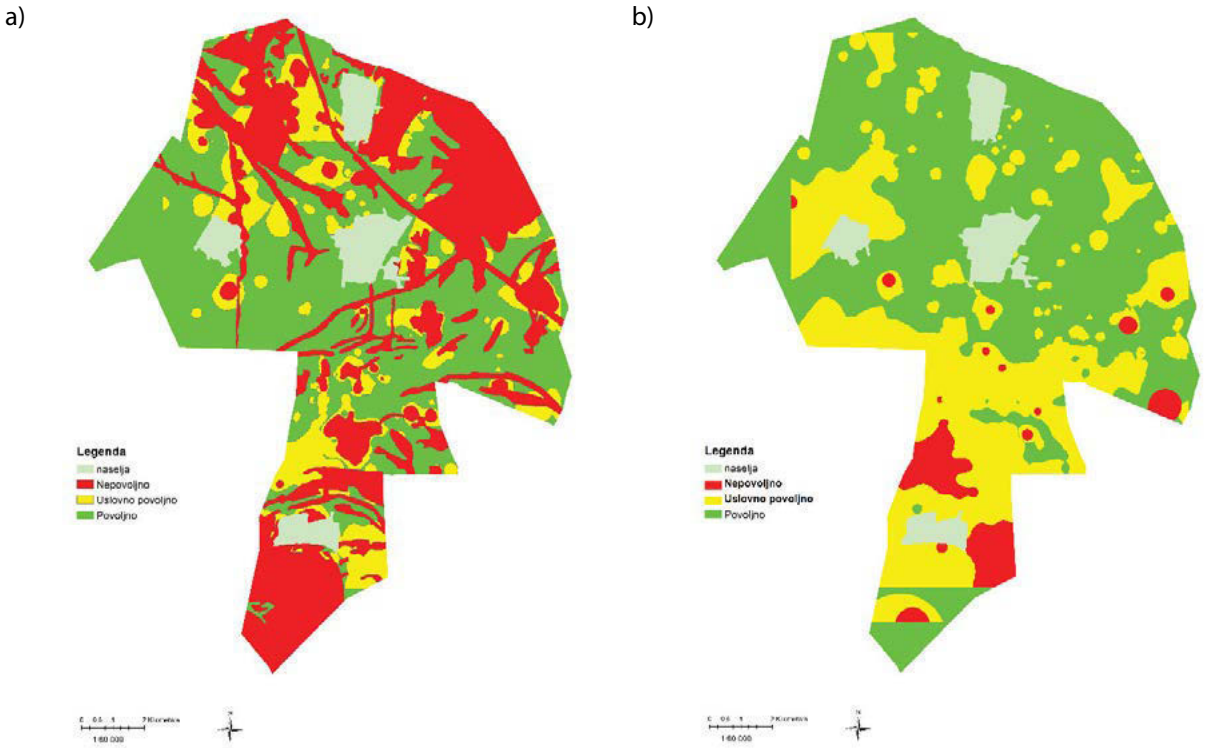

Figure 3. Maps of suitability for growing a) hazelnuts and b) sugar beets on the territory of the municipality of Bački Petrovac

The technical solution SKUP enables decision making on a documented basis, faster and easier identification of potentially unsatisfactory zones on agricultural land in the municipality of Bački Petrovac, sustainable management, reduction of land degradation and finally, improvement of the overall condition of soils and agricultural production of this local community.

There are numerous data on soil fertility from previous research (from the distant and recent past), as well as the knowledge of the scientific and professional community on how to organize and apply these data, since soil science has always been nurtured and developed in this area. What we currently lack is the integration of existing data and their sharing in the form of open data to the wider community. Integrating and opening soil fertility data within the public information system would greatly contribute to preventing further land degradation. As the awareness of the public, private and civil sectors about the importance of soil is raised, the need for further and more detailed study would increase and create new opportunities for organized land protection.

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Published by:
Regional Rural Development Standing
Working Group in SEE (SWG)
Blvd. Goce Delcev 18
MRTV Building, 12th floor
1000 Skopje
North Macedonia