

# REPORT ON STATUS OF SOIL MONITORING IN WB6

WP1-11 Depollution Soil: Monitoring of diffuse soil pollution

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## ABBREVIATIONS

ALB	Albania
BIH	Bosnia and Herzegovina
EC	European Commission
EPA	Environmental Protection Agency
EUROSOLAN	European and Eurasian Soil Laboratory Network
GLOSOLAN	Global Soil Laboratory Network
JRC	Joint Research Centre of the European Commission
LUCAS	Land Use and Coverage Area frame Survey
MKD	North Macedonia
MNE	Montenegro
SML	EU Soil Monitoring and Resilience Law
SOP	Standard Operating Procedure
SRB	Serbia
WB	Western Balkans
WB6	Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Serbia
WP	Work package
XXK	Kosovo

# 1. EXECUTIVE SUMMARY

The aim of this report within EU4Green WP1-11 “Monitoring of diffuse soil pollution“ is to provide an overview of the status of soil monitoring in the Western Balkans (WB), in particular on soil pollution in agricultural land, but not related to contaminated sites (see WP1-12). The report contains how the soil monitoring is evolved and which related laws, decrees or plans exist in WB6. It is mainly based on the information provided at the Joint regional workshop on Inventory of contaminated sites (WP1-12) and Monitoring of diffuse soil pollution (WP1-11), 16-17 October 2023, in Tirana, Albania and amended by information from the gap analyses carried out in 2022 and from some publications. This report can help each other in implementing soil monitoring in the WB6 economies.

Furthermore it forms a basis for the envisaged involvement of the WB6 in the next sampling survey of LUCAS Soil. LUCAS Soil samples and analyses the main properties of topsoil in the Member States of the European Union in order to build a consistent spatial database of the soil cover across the EU based on standard sampling and analytical procedures, with the analysis of all soil samples being carried out in a single laboratory. In 2015 samples were collected and analysed (pollutants were not covered) also from Albania, Bosnia-Herzegovina, North Macedonia, Montenegro and Serbia. So far the results of these additional samples are not published.

In Albania the National Environmental Agency based on DCM No 1189 of 18.11.2009 "On the rules and procedures for the design and implementation of the National Program for environmental monitoring" prepares and approves every year the National Environmental Monitoring Programme<sup>1</sup>. A soil monitoring network covering also trace elements is part of the Environmental Monitoring Programme, but it comprises only 26 sites. In addition the Ministry of Agriculture launched a soil survey on agricultural land. Background levels of heavy metals were determined in a study supported by the German Academic Exchange Service.

In the Federation of Bosnia and Herzegovina exists a Programme on Agricultural Soil Management including monitoring, but not all of the municipalities have adopted this programme. The monitoring of the state of contamination of agricultural land is carried out by the Federal Institute of Agropedology. In Republika Srpska soil monitoring is prescribed by the Law on Agriculture Land. But the Rulebook of soil monitoring methodology has not been adopted yet. Therefore, soil monitoring is conducted on project basis, not at economy level.

In Kosovo\*, a law on environmental protection exists, but no soil monitoring has been established up to now. Several studies on soil were carried out in parts of Kosovo. A domestic programme for Agriculture Land Inventory of Western Kosovo has the purpose to create a database on land and water including determination of soil pollution.

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<sup>1</sup> [https://akm.gov.al/ova\\_doc/programi-kombetar-i-monitorimit-te-mjedisit-2024](https://akm.gov.al/ova_doc/programi-kombetar-i-monitorimit-te-mjedisit-2024)

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

In North Macedonia a law on soil protection and a soil strategy is planned, but no soil monitoring is conducted so far. Studies on diffuse pollution of the soils were carried out.

In Montenegro, based on laws and rulebooks monitoring 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 an annual information by the Environmental Protection Agency.

In Serbia, soil monitoring legislation is in place which includes systematic monitoring of the status and quality of soil which applies to all soils regardless the use. Future plans are the establishment of the Soil Monitoring National Network and the adoption of the decree on the Soil Monitoring Programme. However, several institutions collect data on soil quality in Serbia.

## 2. STATUS OF SOIL MONITORING

### 2.1. Albania

In 2004, the Albanian Parliament approved the Law on Land Protection No. 9244 as a major piece of legislation. It set out the legislative framework for overall land protection and management, but the law did not pay too much attention to soil protection.<sup>2</sup>

A soil monitoring network is part of the Environmental Monitoring System Albania (EMSA) based on DCM No 1189 of 18.11.2009 "On the rules and procedures for the design and implementation of the National Program for environmental monitoring".

In EMSA Table 1 shows the parameters and indicators that needs to monitor and who is responsible for doing what. Table 1 point B "state environmental indicators" for soil foresees to monitor the

- a) fertility;
- b) salt content, Na, Cl, SO<sub>4</sub>- for saline soils; the content of nutritional elements - in peat soils; magnesium/calcium ratio – in magnesium rich soils; determination of acidity - in acidic soils;
- c) natural radioactivity of the earth

For point sources of industrial pollution it foresees to annually monitor the

- a) heavy metal content, according to area specifics (mercury, nickel, chrome etc.) and
- b) hydrocarbon content.

The point C "environmental impact indicators", soil and water for irrigation is foresees for one or in two years to monitor the indicators:

- a) the value of soil erosion and accumulation;
- b) the annual loss of land, as a result of erosion and rivers from drainage;
- c) the surface of the degraded land;
- d) the surface of barren land;
- e) the surface and location of soils contaminated with heavy metals;
- f) the surface and location of soils contaminated with hydrocarbons;
- g) the surface and location of soil contaminated with chemicals and hazardous waste;
- h) the degree of exposure of the population to soil pollution;
- i) exceeding the quality standards indicators of point B6.1 and B7.

Indicators: The parameters to be evaluated are temperature, pH (in sediment water and soil), composition of sand particles, morphological conditions (in situ), supporting root layer, permeability, water-bearing capacity, general atmospheric conditions (in situ), visual pollution (in situ);

Further indicators are: inorganic chemicals: electrical conductivity, N, P, K, cation exchange capacity (Ca, Mg, Na, K), trace elements, (Mn, Zn, Cu, Fe) assimilable inorganic nutrients,

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<sup>2</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. Soil management in the Western Balkans – gaps and recommendations. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

hydrogen carbonates ( $\text{HCO}_3$ ), heavy metals (Cd, Cu, Ni, Fe, Pb, Mn), erosion; organic matter: organic mass (MO), dry matter, total organic compounds (TOC), soil fertility (C/N), measurable pesticides aldrin, dieldrin, endrin, isodrin, dichlorodiphenyltrichloroethane (DDT), polycyclic aromatic hydrocarbons (PAHs) anthracene, phenanthrene, fluoranthene are measured; biological indicators: bio accumulators such as algae, water plants and animals for pollution from heavy metals, pesticides and indicators that evaluate soil erosion from lack of plant cover; monitoring the rate of erosion.

The soil monitoring network consists of 26 domestic stations but this is not a continuous monitoring due the lack of budget or the lack of the project proposal.

Sampling frequency:

- 1 time in 3 or 4 years for general physico-chemical indicators
- 1 time in 2 years for biological indicators

Sampling method: Sampling is done by drilling the soil with half cylinder within a 50m x 50m area.

Sampling type:

- T = Soil on the surface
- D = Earth at depth

As the 26 fixed sites are far too little for the whole economy the hope is that data coming from the LUCAS survey of 2015 could be included in EMSA<sup>3</sup>.

In 2003, the Ministry of Agriculture, under the Agriculture Land Inventory of Albania Programme launched a soil survey to collect new soil data. This extensive ongoing domestic programme intends to collect soil data and produce very detailed soil maps at a scale of 1:10,000 based on soil types and land suitability, along with creating a comprehensive digital soil database. So far the soil survey under the Agriculture Land Inventory of Albania Programme carried out by the Centre of Agriculture Technology Transfer (QTTB), the national center of soil information, has covered 425,541 ha or 62 % of the agriculture land. The digital GIS database established by QTTB contains a set of soil characteristics, including exchangeable sodium percentage (ESP), electrical conductivity (EC), cation exchange capacity (CEC), topsoil fertility (pH, soil organic matter (SOM), available P, exchangeable Ca, K, Mg and Na), topsoil and subsoil structure, slope, flood risk, soil depth, topsoil stoniness, topsoil and subsoil texture, natural drainage, total available water, and erosion risk. The Ministry of Agriculture, Rural Development and Water Management aims to complete this soil survey for all the agriculture land as soon as possible<sup>4</sup>.

In a study supported by the German Academic Exchange Service background levels of heavy metals (Cd, Cr, Cu, Ni, Pb, Zn, As, Co and Hg) were determined and are utilized for the assessment and monitoring of soil contamination caused by various human activities<sup>5</sup>. The

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<sup>3</sup> Zdruli, P.; Wojda, P. & Jones, A., Soil health in the Western Balkans, EUR 31163 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-55210-9, doi:10.2760/653515, JRC130276.

<sup>4</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. Soil management in the Western Balkans – gaps and recommendations. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

<sup>5</sup> Gjoka, F., Duering, RA. & Siemens, J. Background concentrations and spatial distribution of heavy metals in Albania's soils. Environ Monit Assess 194, 115 (2022). <https://doi.org/10.1007/s10661-022-09749-4>

database contains 278 topsoil samples from arable, pasture, forest and other land. The samples were categorized in 6 soil type classes and in 4 parent material classes. PCA analysis confirms the suitability of the database for determining background values for Zn, Pb, Cd, Cr, Ni and Cu. The background values derived for agricultural top soils (0-30cm) are related to the main soil types and parent materials. As no concentration in groundwater was measured it was not possible to distinguish between geogenic or anthropogenic influence. However, these background values are a good reference for further soil monitoring and assessing soil contamination.

During 2014, the National Environment Agency through the laboratory of the Agricultural Technology Transfer Center monitored heavy metals in a total of 65 samples for 12 industrial areas. The soil samples were analyzed for physico-chemical indicators and the content of heavy metals in total form<sup>6</sup>.

Pollution by pesticides (e.g. lindane) from communist time are still an open question. Soil monitoring should be improved, methods have to be exchanged for comparison and harmonization. In relation to the envisaged participation in the next LUCAS soil survey the experts will be figured out who carried out the LUCAS Soil sampling in 2015.

## 2.2. Bosnia and Herzegovina

Considering the complex administrative structure in Bosnia and Herzegovina, the soil management in general, is under the jurisdiction of entities and there is no state-level law regulating the issue of sustainable management and protection of land/soil. Both Federation of Bosnia and Herzegovina (FBiH) and Republika Srpska (RS) have Ministries dedicated to matters of various soil management, rural development and overall development of agricultural lands where the need for soil monitoring is identified.

In the FBiH jurisdiction on soil management belongs to the Ministry of Agriculture, Water Management and Forestry that is in charge of development of strategical and operational plans related to soil in accordance to the legislative framework. The Land Information System of the FBiH is a system for recording and monitoring the state of agricultural land, which, according to legal provisions, is established and managed by the Federal Ministry of Agriculture, Water Management, and Forestry, and the Federal Institute for Agropedology<sup>7</sup>. Currently, the monitoring of agricultural land is conducted on a limited scale, primarily due to the lack of permanently secured funds for these purposes. In the FBiH, it is necessary to adopt new, precise by-laws to establish an effective system for recording and monitoring agricultural land. Considering that the responsible institutions of the FBiH still need to fully implement systems such as IACS (Integrated Administration and Control System) and LPIS (Land Parcel Identification System), it is essential to ensure, through quality coordination, that the system

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<sup>6</sup> Location of soils contaminated with heavy metals for the year 2014. State of Environment Report in Albania (SoER), Republic of Albania, 2014.

<sup>7</sup> Institute of Agropedology performs the tasks of 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.

for recording and monitoring the state of agricultural land utilizes all the capacities of the IACS and LPIS once they are established.

Federal Institute for Agropedology submits the annual report that specifies activities conducted at various locations throughout the year. Monitoring results are also included in the report and continuously inputted numerically and graphically into a GIS database. Data on annual land monitoring for the Spreča<sup>8</sup> and Zenica<sup>9</sup> areas from 2011/2014 to 2018/19 are available on the Institute's official website. For the entire territory of the Federation of Bosnia and Herzegovina, the report on activities and operations is not available on official website while the annual report is available<sup>10</sup>.

Current strategical and legislative framework relevant to soil monitoring in FBiH encompass:

- Law on Agricultural Land<sup>11</sup> - regulates the issues of basic principles of land management, land protection, land use, land disposal and land records with further instructions for monitoring system development. The Law has not undergone any amendments since passing in 2009.
- Implementation of Law on Agricultural Land on lower levels of government is through two documents, the Cantons<sup>12</sup> through the "Strategy for Agricultural Soil Management", and local communities (municipalities and cities) through the adoption of the "Agricultural Soil Management Programme".
- Programme on Agricultural Soil Management - encompass regionalization, prescribing the procedure of soil management, monitoring, protection of agricultural land and habitats of wild plant and animal species that cannot be changed for use on local level. Out of 79 municipalities in FBiH, more than 30 of them have not adopted the programme. The Federal Ministry of Agriculture, Forestry and Water management prepares a document "Information on implementation of the Law on Agricultural land and Strategy for Agricultural Soil Management" on yearly basis. There is still the need to further implement the Programme on Agricultural Soil Management.
- Rulebook on Determining Permissible Levels of Harmful and Hazardous Substances in Soil and Methods of Their Testing<sup>13</sup> - determinates the substances considered to be pollutants of agricultural land, their permissible limit values in soil, sludge, and all products from wastewater, organic and mineral fertilizers, soil improvers, and plant protection products, and prescribe measures for preventing soil pollution and methods for determining permissible levels of harmful and hazardous substances, monitoring, as well as prevention, protection, and remediation of polluted soil. For the purpose of monitoring agricultural land pollution and entering data into the Land Information System (LIS) of the FBiH, authorized institutions and laboratories are obliged to submit data on performed pollution analyses for agricultural land to the Federal Ministry of Agriculture and the Federal Institute for Agropedology.

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<sup>8</sup> Available on the [link](https://agropedologija.gov.ba/monitoring-spreca/) <https://agropedologija.gov.ba/monitoring-spreca/>

<sup>9</sup> Available on the [link](https://agropedologija.gov.ba/monitoring-zenica/) <https://agropedologija.gov.ba/monitoring-zenica/>

<sup>10</sup> Available on the [link](https://agropedologija.gov.ba/wp-content/uploads/2023/04/IZVJESTAJ-O-RADU-2021.pdf) <https://agropedologija.gov.ba/wp-content/uploads/2023/04/IZVJESTAJ-O-RADU-2021.pdf>

<sup>11</sup> Law on Agricultural Land "Official Gazette of the Federation of Bosnia and Herzegovina," No. 52/09 / Zakon o poljoprivrednom zemljištu, "Službene novine FBiH," br. 52/09

<sup>12</sup> FBiH has 10 cantons and 79 municipalities

<sup>13</sup> Official Gazette of the Federation of Bosnia and Herzegovina No. 96/22

- Regulation on the Methodology for Monitoring the State of Agricultural Land<sup>14</sup>- defines the methodology for monitoring the state of agricultural land, a programme for systematic monitoring of soil quality, criteria/indicators for assessing the risk of soil degradation, and methods for developing remediation programmes are prescribed.
- Regulation on the Requirements that Scientific and Expert Institutions and Laboratories Must Fulfill for Conducting Tasks Related to the Development of Projects, as well as Measurements and Testing of Soil<sup>15</sup>

Already in 2013 a study was carried out by the Federal Institute of Agropedology in FBiH. 260 locations were tested regarding heavy metals and organic pollutants (PAHs)<sup>16</sup>.

The continuous monitoring of the state of contamination of agricultural land in the territory of the FBiH started in 2019 and is carried out by the Federal Institute of Agropedology. The plan is to sample 500 points in a four-year cycle covering all municipalities in the territory of FBiH with at least one locality per municipality for sampling and analysis. The first sampling cycle was completed in 2023. Beside general soil parameters such as soil texture, water permeability, pH, humus and calcium carbonate the content of nine heavy metals and several organic pollutants will be analyzed.

In the RS, jurisdiction on soil management belongs to the Ministry of Agriculture, Forestry and Water management that drafts and proposes draft laws, sub-legal acts and strategical documents related, among other, to sector specific soil management. The Ministry of Agriculture, Forestry and Water management elaborates the document “Basis for protection, arrangement and planning of land use” for the republic and municipal level. This document contains many data of land processed in GIS (pedological data, land cover/land use, erosion, risk of floods, degradations, soil nutrition and pollution with elements: Pb, Cd, Ni, Cr, Ni, Hg etc.). The document for the republic level was adopted in 2008, and for the municipal level it has been adopted for Gradiska, Laktasi, Samac and Doboje municipalities. The document for the republic level will be updated in 2024.

Current strategical and legislative framework relevant to soil monitoring in RS encompasses:

- Law on Agricultural Land<sup>17</sup> - defines planning, protection, regulation, use, and disposal of agricultural land, as well as other matters of importance concerning agricultural land as a public interest asset. Law defines permanent monitoring of agricultural land conditions, which includes specific soil parameters and aims to gather information on changes in soil conditions and characteristics, as well as to identify forms and intensities of soil damage. Soil monitoring is conducted by the designated institution authorized by the Ministry. The Minister, with the consent of the ministry responsible for environmental protection, shall enact regulations prescribing the methodology for establishing and monitoring the condition of agricultural land.

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<sup>14</sup> Official Gazette of the Federation of Bosnia and Herzegovina, No. 38/11

<sup>15</sup> Official Gazette of the Federation of Bosnia and Herzegovina, No. 39/10

<sup>16</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. Soil management in the Western Balkans – gaps and recommendations. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

<sup>17</sup> Official Gazette of the Republic of Srpska, No. 93/06, 86/07, 14/10, 05/12, 58/19, 119/21 and 106/22

- Regulation on Permitted Amounts of Hazardous and Harmful Substances in Agricultural Soil and Irrigation Water and Methods for Their Testing<sup>18</sup> states, as the title says, identified hazardous and harmful substances in Agricultural soil and prescribes continuous monitoring of the pollution status of agricultural soil, conducted according to the Program of the Ministry of Agriculture, Forestry, and Water Management for the purpose of protection of agricultural soil from pollution. The analytical methods for determining hazardous and harmful substances from Article 2, paragraph 3 of this regulation are defined by the regulation governing the field of surface and groundwater quality testing.
- Strategy for the Development of Agriculture and Rural Areas of Republika Srpska 2021–2027<sup>19</sup> - states that the Ministry, in collaboration with key land policy institutions, will develop an agricultural monitoring programme to inform the State Farmland Use Program. Protection of agricultural land will involve erosion control and other forms of degradation prevention, safeguarding against internal and external water sources and contamination by organic and inorganic materials, and increasing conservation tillage practices. Based on prior soil analyses, measures will enhance soil fertility linked to adopting good agricultural practices and financial incentive systems. The agricultural land monitoring programme involves sampling and assessing the soil quality (physical and chemical composition) and the presence of hazardous and harmful substances above threshold values, in accordance with a pre-agreed list of indicators. Local self-government units are primarily responsible for implementing and funding this measure, with co-financing from the Ministry of Agriculture in financially constrained municipalities. Continuous and systematic monitoring of agricultural land will result in the development of programmes for its protection and the utilization of state agricultural land.
- Document “Basis for protection, arrangement and planning of land use Republic of Srpska, 2008.” According to this document, monitoring of agricultural land should be an obligatory activity in the future.

In the RS the Programme on fertility control of agricultural land farms was carried out since 2014 with more than 7000 samples taken so far. As part of the Government’s Program on soil fertility control, Agricultural Institute of Republic of Srpska, Agricultural Faculty Banja Luka and Agricultural Faculty East Sarajevo have conducted research on the physico-chemical properties of soil for agrological and hydrological melioration and research in the field of erosion since 2014. Achieved results and data are stored in the GIS land data base in the Agricultural Institute of Republic of Srpska. However, as this is on project level and temporary needs, there is no continuous monitoring established.

The initial state of pollution in agricultural land has been investigated on a network of points in a mixed raster (2 x 2; 4 x 4; 8 x 8 km) since 2010. The Agricultural Institute of RS together with Environmental Protection and Energy Efficiency Fund of RS co-financed several projects (2009 – 2012) related to the establishment of a permanent monitoring of agricultural soil pollution in the north-western part of Republika Srpska (14 municipalities west of District

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<sup>18</sup> Regulation on Permitted Amounts of Hazardous and Harmful Substances in Agricultural Soil and Irrigation Water and Methods for Their Testing (“Official Gazette of Republika Srpska”, No. 56/16)/ Pravilnik o dozvoljenim količinama opasnih i štetnih materija u poljoprivrednom zemljištu i vodi za navodnjavanje i metodama za njihovo ispitivanje (“Službeni glasnik Republike Srpske”, br. 56/16)

<sup>19</sup> Ministry of Agriculture, Forestry, and Water Management of Republika Srpska. (2021). Strategy for the Development of Agriculture and Rural Areas of Republika Srpska 2021–2027

Brčko). According to the adopted methodology, the 138 samples were mainly taken in a 4 x 4 km grid. Depending on the method of use, soil samples were taken from 2 depths (cultivated areas) or 3 depths (natural meadows and pastures). The samples were analysed for acidity (pH), humus and the total content of heavy metals: Cd, Cr, Cu, Hg, Ni, Pb and Zn<sup>20</sup>. Meanwhile the monitoring area was extended to all municipalities west of District Brčko and five municipalities east of District Brčko.

In 2015 as part of the LUCAS Soil survey 250 locations were selected (all land cover types were included) in BiH and samples were taken from 246 locations (4 locations were unavailable). 40% were on woodland, 29% on grassland, 22% on cropland, 9% on shrubland and one location was on artificial land. Soil composite samples were taken to an approximate depth from 0-20 cm. As Federation of Bosnia and Herzegovina and Republika Srpska did soil monitoring according to LUCAS system the results are comparable. The analysis of the samples was carried out in one EU laboratory.

The EU4Green project could help to push up the collection of data as there are limited financial resources available for establishing enough data in RS. There is a big plan to carry out soil monitoring in the Federation of Bosnia and Herzegovina. The involvement of persons from the Ministries of Agriculture to collect data from both entities would be useful. It is envisaged that the Ministries of Agriculture are interested to monitor diffuse pollution by sampling agricultural soils. If a participation in the next LUCAS Soil survey is possible special focus should be given on monitoring heavy metals in order to see if there are problems in the economy.

### 2.3. Kosovo

For the first time, the Assembly of the Republic of Kosovo, regarding environmental protection, drafted and approved the Law on Environmental Protection in 2002. With No. 2002/8, this law, not meeting all the needs and legal gaps, was repealed, and a new law, Law No. 03/L-025 for environmental protection, was enacted in 2009, which is still in force. Within the framework of the law, an integrated system for environmental protection is regulated, aiming to reduce the risk of environmental pollution and promote sustainable development concepts.

Regarding soil quality analysis the Law No. 06/L-035 on hydro-meteorological activities was established in 2018. Article 16, Point 1.3, assigns the Hydro-Meteorological Institute the responsibility to conduct laboratory tests for soil quality control<sup>21</sup>. This action has not yet been activated due to a lack of resources in the laboratory and trained staff.

Law No. 02/L-26 on Agricultural Land in 2006 defines duties for the protection of agricultural land, both from human and natural factors. The Agricultural Institute, under the Ministry of

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<sup>20</sup> Predic et al. Introduction of Continuous Monitoring of Agricultural Land of Republic of Srpska, PROCEEDINGS The 1st International Congress on Soil Science XIII National Congress on Soil Science, January 2014, Soil Science Society of Serbia, Soil Science Institute, Serbia, ISBN: 978-86-911273-4-3, <https://www.researchgate.net/publication/261612402>

<sup>21</sup> MMPHI - Kosovo Environmental Protection Agency: Annual Report on the State of the Environment, 2021, Pristina

Agriculture, Forestry, and Rural Development, monitors soil quality, albeit with limited resources<sup>22</sup>.

Unfortunately, such legislation was unable to prevent soil degradation due to implementation gaps and policy enforcement. To date, no soil monitoring has been established in Kosovo. A future law is planned to outline how soil monitoring should function.

Between 2013 and 2015 a study on agricultural soil pollution funded by the EU was conducted in 17 municipalities with one sample per 0.7 km<sup>2</sup> or 0.5 km<sup>2</sup> (hotspots). Heavy metal concentrations were analysed and compared with the pollution standards (SNDH) of the 'Kosovo List'.

A pilot project on land inventory of Rahoveci municipality and a domestic programme for Agriculture Land Inventory of Western Kosovo aim to create an economy-wide database, based on the Geographic Information System (GIS) for land and water throughout the territory of the Republic of Kosovo. The objectives include determining organic matter and organic carbon in the soil, assessing soil biological activity, and studying heavy metal contamination in agricultural land.

Regarding soil the following actions are planned:

- Classification of agriculture land based on World Reference Base for Soil Resources 2022;
- Soil sampling using a 300 x 300 m grid and soil profil pits;
- Comprehensive analysis of physical-chemical parameters of soil samples;
- Determination of heavy metals and organic pollutants in soil;
- Assessment of microbiological activity in soil;
- Study of soil biology;
- Phytopathological and entomological analyses to identify plant pests in the soil.

Individual research projects have been conducted on soil pollution, such as one focused on the spatial distribution of heavy metals and the assessment of their bioavailability in Kosovo's agricultural lands in 2014. From topsoil 127 samples were collected which were analyzed for heavy metals (HM), by extraction with aqua-regia (pseudototal concentration), NH<sub>4</sub>OAc-EDTA (potential bioavailable) and NH<sub>4</sub>NO<sub>3</sub> (mobile fraction). The total heavy metal contents were compared with the permissible limits set by the European Union (EU)<sup>23</sup>.

In the Municipality of Kastriot, near the capital city of Pristina, Sallahu (2017) assessed total pollution concentrations of heavy metals in various soil types<sup>24</sup>. Soil samples were collected at a depth of 0-30 cm across approximately 5,000 hectares divided into three concentric circles (2, 4, and 6 km away from thermal power plants). A total of 40 geo-referenced samples were collected: 35 in the study area and 5 in the control area, located 25 km away

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<sup>22</sup> Law No. 02/L-26 on Agricultural Land

<sup>23</sup> Zogaj, M., Pacarizi, M., & Duering, R. A. (2014). Spatial distribution of heavy metals and assessment of their bioavailability in agricultural soils of Kosovo. *Carpathian journal of earth and environmental sciences*, 9(1), 221-230.

<sup>24</sup> Sallahu, S. 2017. Heavy metal contamination of soils in the Commune of Kastriot in the region of Prishtina. MS thesis CIHEAM Bari.

from the plants. The method for determining heavy metals was based on plasma spectroscopy – ICP – OES, EPA 12914: 2012. The results were compared to the EU's allowable threshold values.

A recent study on arsenic content and mobility in agricultural soils was carried out<sup>25</sup>. A total of 60 soil samples were collected in the agricultural soils of two regions of Kosovo known for pollution with heavy metals (Mitrovica and Mitrovica). Arsenic was extracted from the soil with aqua-regia (pseudo total concentration), NH<sub>4</sub>OAc-EDTA (potential bioavailable), and NH<sub>4</sub>NO<sub>3</sub> (mobile fraction).

In October 2023 a working group was formed including the Ministries of Agriculture, Environment, and Education looking for competent experts for soil pollution assessment. Kosovo is interested in participating in the upcoming LUCAS Soil survey, which would be the first time for this economy.

Due to past industrial impact, the areas with heavy pollution that require analysis are as follows:

1. Obiliq region and its surroundings – the culprits are thermal power plants.
2. Drenas region – Ferronickel Factory.
3. Hani i Elezit region – Cement production factory.
4. Mitrovica region – Industrial waste from Trepça.<sup>26</sup>

## 2.4. North Macedonia

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<sup>27</sup>. Responsible for the monitoring agenda would be the Ministry of Environment and Physical Planning in consultation with the Ministry of Agriculture, Forestry and Water Economy.

For North Macedonia it would be very important to be involved in the LUCAS monitoring programme to develop in parallel their own sampling and analyzing system enabling comparison with the results of LUCAS what could enhance their own development.

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<sup>25</sup> Zogaj, M., Bresilla, B., Maxhuni, A. (2023): Arsenic content and mobility in agricultural soils in two polluted areas in Kosovo. *Agriculture and Forestry*, 69 (3): 179-186. doi:10.17707/ AgricultForest.69.3.12.

<sup>26</sup> MMPHI-Institute for Spatial Planning. *Spatial Plan of Kosovo 2010-2020*. Page 47 Pristina

<sup>27</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. *Soil management in the Western Balkans – gaps and recommendations*. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

## 2.5. Montenegro

The competences, laws and procedures regarding environmental monitoring in Montenegro were presented. According to the Article 54 of the Law on Environment environmental monitoring shall be carried out which includes, inter alia, content of dangerous and harmful substances in the soil. Further legal framework is based on the Law on Agricultural Land as well the Rulebook on permitted concentrations of harmful and hazardous substances in the soil including methods for their testing. Screening values available for different land uses are contained in the rulebook on permitted concentrations of harmful and hazardous substances in the soil.

The aim of the monitoring is to determine the content of hazardous and harmful substances in the soil, in the immediate vicinity of landfills, roads, industrial zones, as well as in populated places, including children's playgrounds.

The Agricultural Land Act regulating agricultural land is in force. Consequently, for lands of other purposes (industrial land, children's playgrounds, parks, residential zones, etc.) there are no appropriate, legally prescribed, permitted concentrations of hazardous and harmful substances.

Monitoring 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 an annual Information by the Environmental Protection Agency<sup>28</sup>.

During 2022 determination of the content of hazardous and harmful substances in the soil was carried out in 13 locations in 7 urban settlements in Montenegro (Berane, Nikšić, Pljevlja, Podgorica, Tivat, Ulcinj and Žabljak). The results of the above-mentioned locations are available in the Environmental Information for 2022<sup>29</sup>. Soil monitoring has been improved by introducing additional methodological solutions and includes monitoring of the content of toxic and carcinogenic organic substances in the soil, i.e. long-term organic pollutants (POPs). The goal is sound management of waste, in particular regarding PCBs. So far 1050 t of PCB contaminated soil were removed.

An investigation was conducted to evaluate the sources of potential contamination and concentration of heavy metals (Pb, Cd, Zn, Cu, and Cr) in soil samples layer from coastal urban parks and kindergardens of Montenegro. 54 soil samples from the top 10 cm layer, within a 20 cm x 20 cm of surface soil, consisting of three sub-samples, were taken and mixed to obtain a bulk composite sample at each playground. Results were compared with background values<sup>30</sup>.

LUCAS Soil Monitoring is of interest for MNE. In relation to the envisaged participation in the next LUCAS soil survey the experts will be figured out who carried out the LUCAS Soil sampling in 2015.

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<sup>28</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. Soil management in the Western Balkans – gaps and recommendations. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

<sup>29</sup> <https://epa.org.me/informacije-o-stanju-zivotne-sredine/>

<sup>30</sup> <https://pdfs.semanticscholar.org/ff5a/9c7e0d42e055e6bc28fb92a8372111c365e1.pdf>

## 2.6. Serbia

Soil monitoring legislation is in place that includes systematic monitoring of the status and quality of soil that applies to all soils regardless the use. The Law on Soil Protection (Official Gazette of Republic of Serbia, 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 economy interest<sup>31</sup>. Although there is a legal basis, the National Soil Monitoring Programme has not yet been adopted in the Republic of Serbia.

The Programme of systematic monitoring of the status and quality of soil comprises:

- National and Local Monitoring Network defined by a decree on soil monitoring
- Polluter's Obligation for Monitoring every five years according to a rulebook
- Authorized Organization in line with the consent issued by the Ministry of Environmental Protection
- Soil Monitoring Report according to a rulebook on content and form
- Information System and Cadastre of Contaminated Sites

The Decree on systematic monitoring of the soil state and quality determines the following:

- content of the Soil Monitoring Programme
- methodology for the soil monitoring
- criteria for determining the number and positions of sampling points
- list of parameters, methods and standards
- frequency of profile opening
- frequency and depth of sampling
- indicators for the assessment of soil degradation risk
- manners and deadlines for submitting data

Currently 13 labs are accredited for soil monitoring. Seven indicators for the assessment of the risk of soil degradation are expected to be monitored in the domestic network.

Indicators for assessing the risk of soil degradation are:

1. Degree of soil vulnerability to erosion;
2. Degree of soil vulnerability to loss of organic matter;
3. Degree of soil vulnerability to compaction;
4. Degree of soil vulnerability to salinization and/or alkalization;
5. Degree of soil vulnerability to landslides, excluding landslides and rockfalls that may occur due to mining activities during their duration;
6. Degree of soil vulnerability to acidification;

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<sup>31</sup> Dragana Vidojevic, Pandi Zdruli, Hamdija Čivić, Mihajlo Marković, Stanko Milić, Duško Mukaetov, Mirko Knežević, Afrim Sharku. Soil management in the Western Balkans – gaps and recommendations. Standing working group for regional rural development (SWG), Skopje, 2022, ISBN 978-608-4760-41-2.

## 7. Degree of soil vulnerability to chemical pollution.

The selection of soil monitoring sites should be carried out as follows: For each soil type within a 16 x 16 km square, a representative terrain configuration is selected. A 25 x 25 m square is marked and divided into 25 smaller 5 x 5 m squares. A soil profile up to 2 m deep is dug at the edge of the 25 x 25 m square. Soil samples are taken from boreholes at the intersections of the diagonals of the 5 x 5 m squares.

Sampling is foreseen every 5 years, analyses of chemical, physical and microbiological parameters should be carried out according to ISO standards and methods from domestic guidance for soil testing.

Future plans are the establishment of the Soil Monitoring National Network, the adoption of the decree on the Soil Monitoring programme for 2025, further strengthening the capacities of all actors involved in soil monitoring and regional cooperation.

Two projects for determination of background values were carried out in Western and Eastern part of Serbia.

Several institutions collect data on soil quality: the Ministry of Agriculture, Forestry and Water Management, the Ministry of Environmental Protection and Environmental Protection Agency, the Secretariat for Agriculture of AP Vojvodina, the Soil Institute Belgrade, the Institute of Field and Vegetable Crops Novi Sad, and agricultural services (AS). For data collection purposes, the Environmental Protection Agency has developed a centralized information system for environmental protection, which contains soil data in addition to other parameters of environmental monitoring.

According to the draft State of the Environment Report for the Republic of Serbia for 2023, the following information regarding soil is available:

The degree of soil contamination in urban areas based on the exceedance of limit and remediation values of hazardous and harmful substances, in accordance with the Regulation on Limit Values of Polluting, Harmful, and Hazardous Substances in Soil has been examined. In 2023, the degree of soil contamination in urban areas was monitored in 12 local government units, and 295 soil samples were tested. Tested parameters are concentration of heavy metals in soil and concentration of organic contaminants.

Systematic control of agricultural soil fertility is conducted to determine the levels of nutrients in the soil, ensuring the proper use of mineral and organic fertilizers. The testing includes an analysis of the basic chemical properties of agricultural soil: exchangeable acidity (pH in H<sub>2</sub>O and nKCl), CaCO<sub>3</sub> (%), humus (%), N (%), and easily available forms of phosphorus (P<sub>2</sub>O<sub>5</sub> - mg/100 g) and potassium (K<sub>2</sub>O - mg/100 g). In central Serbia, a total of 23,878 agricultural soil samples taken from a depth of up to 30 cm were tested. In Vojvodina, a total of 3,049 agricultural soil samples (with data on land use) taken from a depth of up to 30 cm were tested.

The Ministry of Agriculture, Forestry, and Water Management – Directorate for Agricultural Land, in accordance with the Programme for the Protection, Improvement, and Use of Agricultural Land for 2023, conducted soil fertility testing in the area of the city of Kraljevo and the municipality of Raška, affected by an emergency situation due to a natural disaster-

flood. In total 451 samples were taken, 108 in Kraljevo and 343 in Raška. The testing includes an analysis of the basic chemical properties of agricultural soil within fertility control: exchangeable acidity (pH in H<sub>2</sub>O and nKCl), CaCO<sub>3</sub> (%), humus (%), N (%), and easily available forms of phosphorus (P<sub>2</sub>O<sub>5</sub> - mg/100 g) and potassium (K<sub>2</sub>O - mg/100 g).

The Ministry of Environmental Protection financed a project in 2023 titled "Investigation of Environmental Pollution due to the Spill of Flotation Tailings at Stolice", which concerns the examination of soil contamination due to the spill of flotation tailings during the catastrophic floods of 2014. In total 18 samples were taken on three depths (0-10, 10-20, 20-40 cm). The tested parameters are: basic chemical parameters, soil composition and concentration of heavy metals.

Between 2021 and 2024 an FAO Project on the enhanced quality and accessibility of data and information for the environmental and soil protection in Serbia was carried out<sup>32</sup>. The main goal of the investigation was the assessment of diffuse soil pollution originating from agricultural activities such as pesticide and fertilizer management in sensitive areas.

The conductors of this research were two prominent research institutions in the Republic of Serbia specializing in soil science: the Institute for Field and vegetable Crops, National Institute of the Republic of Serbia, Laboratory for Soil and Agroecology (IFVCNS) from Novi Sad and the Institute for Soil Science (ISS) from Belgrade. Additionally, the Serbian Environmental Protection Agency (SEPA) acted as an observer during sample collection and fieldwork.

Scope of investigation:

The research encompassed 15 individual farms in Serbia (5 from each location). The criteria for selecting farms were based on their mixed production (both crop and livestock) and their diverse land usage methods such as arable farming, horticulture, pastures, meadows, forests, orchards, vineyards, greenhouses, etc. Additionally, the farms were chosen based on their irrigated areas.

In the period 26 to 31 March 2022, the total of 151 soil samples, 6 manure and 11 irrigation water samples were taken from Bajina Bašta site.

In the period from 05 to 07 September 2023, the total of 62 soil samples, 5 manure and 5 irrigation water samples were taken from Palić-Ludoš lake site.

In the period from 13 to 15 September 2023, the total of 64 soil samples, 5 manure and 5 irrigation water samples were taken from Gruža lake site.

Laboratory analyses:

- Mechanical Composition of Soil
- Soil Reaction (pH)
- Content of Calcium Carbonate (CaCO<sub>3</sub>)
- Content of Macronutrients (NPK) in Soil
- Content of Total Nitrogen in Soil and the Content of Mineral Nitrogen (NO<sub>3</sub>-N) in Soil around manure landfill
- Content of Available Phosphorus (P<sub>2</sub>O<sub>5</sub>) in Soil

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<sup>32</sup> FAO Project: Enhanced quality and accessibility data and information for the environmental and soil protection in Serbia, 2024 based on the project TCP/SRB/3803/C3 "Increasing national capacities to assess the risk of diffuse agricultural soil pollution" in Serbia 2021-2022.

- Content of Available Potassium (K<sub>2</sub>O) in Soil
- Potentially Toxic Elements in Soil
- Concentration of Pseudo-total Potentially Toxic Elements in Soil
- Concentration of Available Potentially Toxic Elements in Soil
- Total Mercury (Hg) Distribution in Agroecosystem
- Diffuse Pollution Risk Assessment Based on Pollution Indices
- Soil Organic Pollutants
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Organochlorine Pesticides (OCPs)
- The Quality of Manure
- The Quality of Irrigation Water
- Risk Assessment According to Key Soil Indicators of Diffuse Pollution
- Soil Acidification
- Direct Input of Nutrients
- Gross Nutrient Balance
- PTEs Distribution in Agroecosystem
- PTEs Distribution in Agroecosystem via Organic Fertilizers and Irrigation Water
- Organic Pollutants

SRB has guidance, capacities and experts for monitoring, but needs action. Therefore, SRB is very much interested in participating in the next LUCAS Soil survey.

## 2.7. Overview of reported soil monitoring activities in WB6

The following table provides an overview of the reported soil monitoring activities in WB6:

Entity/Year	Parameters	Analysed area/samples
<b>ALB</b>		
since 2009	basic and chemical soil parameters, heavy metals, organic pollutants, biological indicators, erosion	26
2003	chemical and physical soil characteristics	62 % of the agriculture land
2014	physical/chemical parameters, heavy metals	65
2022	Cd, Cr, Cu, Ni, Pb, Zn, As, Co, Hg	278
<b>BiH</b>		
FBiH2013	heavy metals	260
FBiH2014-19	basic chemical parameters, Pb, Cd, Zn, Cr, Hg, Ni, Co, Cu, PAHs	25 locations
FBiH2023	heavy metals, PAH	125
RS2008	Pb, Cd, Ni, Cr, Ni, Hg	4 municipalities
RS since 2014	soil fertility testing: physico-chemical properties	7000
RS2010	Cd, Cr, Cu, Hg, Ni, Pb and Zn	138
LUCAS2015	physical/chemical parameters	246
<b>XXK</b>		
2013-2015	heavy metals	hotspots in 17 municipalities
2014	heavy metals	127
2017	heavy metals	40
2023	As	60
<b>MKD</b>		
no	information	available
<b>MNE</b>		
2016	Pb, Cd, Zn, Cu, Cr	54
2022	toxic and carcinogenic anorganic and organic substances	13 locations
<b>SRB</b>		
2023	chemical, physical and microbiological parameters	295
central SRB	soil fertility testing: basic chemical properties	23878
Vojvodina	soil fertility testing: basic chemical properties	3049
Kraljevo	soil fertility testing: basic chemical properties	108
Raška	soil fertility testing: basic chemical properties	343
Stolice	basic chemical parameters, soil composition, heavy metals	18
Bajina Bašta	basic chemical parameters, soil composition, heavy metals, organic pollutants	151
Palić-Ludoš	basic chemical parameters, soil composition, heavy metals, organic pollutants	62
Gruža	basic chemical parameters, soil composition, heavy metals, organic pollutants	64

### 3. OUTLOOK

In several economies of WB further soil monitoring is ongoing or planned. In order to support the endeavour to know more about the status of the soil resources and to improve the identification of areas for protection from diffuse soil pollution in WB6 it is envisaged that WB6 take part in the next [LUCAS Soil](#) sampling survey. After the survey in 2022 the next one will be most likely in 2027 or 2028, depending on the available resources of the European Commission and the adoption of the EU Soil Monitoring and Resilience Law (SML). In the current version of the SML it is foreseen that the LUCAS Soil module will support the EU Member States in their soil monitoring activities to assess the soil health in their territories.

In order to prepare for the envisaged participation a workshop is planned to be held on 19 November 2024 in Sarajevo, Bosnia and Herzegovina. In this workshop the requirements regarding monitoring design, soil sampling and parameters to be analysed for LUCAS Soil will be discussed. Those requirements will be compared with the survey in 2015, the status of soil monitoring in WB6 and the proposed SML. Furthermore the opportunities, capacities and challenges for a participation in the next LUCAS Soil survey will be identified and the costs for it estimated.

In relation to WP1-13 Status of environmental laboratories in Western Balkans opportunities for cooperation with the European and Eurasian Soil Laboratory Network ([EUROSOLAN](#)) as part of the Global Soil Laboratory Network ([GLOSOLAN](#)) will be explored. In addition to the soil samples that will be analysed in a centralized laboratory in the frame of LUCAS Soil soil material from those samples could also be taken for analyses in labs in WB6 according to national standards and if possible also according to Standard Operating Procedures (SOPs) of GLOSOLAN compiled in the [GLOSOLAN's Best practice manual](#). This would enable a comparison of economy, EU and global standards of soil analyses in order to foster the harmonization of analytical methods for soil in WB6. If transfer functions from one method to the other can be derived one can compare new data with previously generated data from previous soil investigations and assess potential changes of the soil status.

## 4. ANNEX – FURTHER INFORMATION RELATED TO SOIL POLLUTION IN WB6

### 4.1. Bosnia and Herzegovina

Further current strategical and legislative framework relevant to soil pollution in FBiH:

- Agriculture and Rural development Strategy of the FBiH 2021 – 2027<sup>33</sup> - recommends agroclimatic regionalization of the FBiH, the establishment of a monitoring and early warning system, and raising awareness among farmers about climate change, its impacts on agriculture, and the impacts of agriculture on climate change. Additionally, Strategy recommends improvement of legislation and caution regarding the usage of phytopharmaceutical products considering their effect on plants and soil. Quality and proper application of these products are overseen through a dedicated monitoring and control program covering inspection, storage, distribution, and use, with additional measures for monitoring residues in agricultural and food products, necessitating consistent support from competent inspection authorities.

Further current strategical and legislative framework relevant to soil pollution in RS:

- Regulation on the Conditions for Performing Tasks of Determining Hazardous and Harmful Substances in Agricultural Land and Irrigation Water<sup>34</sup> - prescribes conditions regarding workspace, technical equipment, and professional qualifications that institutions, and other entities conducting tasks related to determining hazardous and harmful substances in agricultural land must fulfill, including the procedure for authorization and oversight of their work
- Regulation on the Conditions for Trade and Use of Particularly Hazardous Plant Protection Products<sup>35</sup> - covers public interest related to plant protection products, including establishing the Plant Protection Products Commission, and addresses registration, trade, import, and use of these products in agriculture and forestry. It focuses on promoting good agricultural practices to manage land and reproductive material sustainably, minimizing residues and environmental impacts from plant protection products and agrotechnical measures.

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<sup>33</sup> Federal Ministry of Agriculture, Water Management and Forestry (2022). Agriculture and Rural development Strategy of the Federation of Bosnia and Herzegovina 2021 – 2027

<sup>34</sup> Official Gazette of Republika Srpska, No. 72/16

<sup>35</sup> Official Gazette of Republika Srpska, No. 27/22

## 4.2. Kosovo

According to a study by AMMK, various sources of soil pollution have been identified<sup>36</sup>

Agriculture	Municipal Waste	Sanitary Landfills	Chemicals and Hazardous Waste	Industry	Mining	Other Resources
Negative agricultural practices. Unregulated use of pesticides and fertilizers.	Inefficient management of hazardous waste. Disposal of them in soil without criteria and standards	The flow of polluted waters and the distribution of waste from poorly managed landfills	Inadequate storage of hazardous chemicals and waste.	Management of bad of leftovers from industrial processes applied on land surfaces without considering criteria and standards	Leaks of harmful materials from mining and from landfills of the mining remains	Warehouses, old cars and car services
In 2021, in Kosovo, 78,976,185 kg of various types of fertilizers were used, while 122,138 hectares of land were treated with pesticides	In 2021 in Kosovo, 763 illegal landfills were identified	Kosovo has 8 sanitary landfills that are not managed according to standards and criteria”	In Kosovo, there are 17 hazardous chemical and waste locations.	In Kosovo operate some big industrial companies which generate industrial remains	In Kosovo there are tons of mining and landfill remains which are not rehabilitated	Oils of used cars and other remains of cars

## 4.3. North Macedonia

Diffuse pollution of the soils in Macedonia is due to acid rains from different origin, such as from thermal power plants in MNE, as well as in neighbouring countries, like Greece, Bulgaria and Serbia, but also from the whole Europe. In the vicinity of mines in north-eastern parts of Macedonia (Zletovo, Toranica, Sasa), as well as in the central part of the economy

<sup>36</sup> MMPHI - Kosovo Environmental Protection Agency: Annual Report on the State of the Environment, Page 26, 2021, Pristina

(smeltery in Veles) lead, cadmium and zinc contamination is the strongest. Further contaminants are copper, chromium, nickel, arsenic, mercury, iron and manganese. Soil pollution also appears alongside highways<sup>37</sup>.

Soils may also be polluted by contaminated surface and ground waters in case it comes into contact with them. Due to the developed drainage, i.e. protection against flood of an area of close to 70.000 ha, contaminated river waters cannot come into contact with soil through floods. Exceptions from this include several hot-spots, i.e. soils along rivers carrying polluted wastewater from mines in the eastern part of Macedonia. Soils around the rivers Zletovo, Kamenica and Toranica are not protected against floods<sup>38</sup>.

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<sup>37</sup> <https://www.moep.gov.mk/wp-content/uploads/2017/07/Soil.pdf?lang=EN>

<sup>38</sup> <https://www.moep.gov.mk/wp-content/uploads/2017/07/Soil.pdf?lang=EN>