Република Северна Македонија
Министерство за животна средина и просторно планирање

Republika e Maqedonisë së Veriut
Ministria e Mjedisit Jetësor dhe Planifikimit Hapësinor

Database Development of Soil Sealing Rate and Loss of Soil Organic Matter on 3 Pilot Sites in Macedonia and Analysis of Their Impact to Biodiversity

2020

By

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Project

"Achieving Biodiversity Conservation through Creation and Effective Management of Protected Areas and Mainstreaming Biodiversity into Land Use Planning"

Project component 3.1.1.2.:
"Database Development of Soil Sealing Rate and Loss of Soil Organic Matter on 3 Pilot Sites in Macedonia and Analysis of Their Impact to Biodiversity"

Required citation:

Mukaetov D., Poposka H., Andreevski M., Mincev I., Trendafilov B., 2020, Database Development of Soil Sealing Rate and Loss of Soil Organic Matter on 3 Pilot Sites in Macedonia and Analysis of Their Impact to Biodiversity*,*

Cover photo: Mukaetov D., 2020

A view on an area of experimental location - village Vrbjani, Prilep municipality

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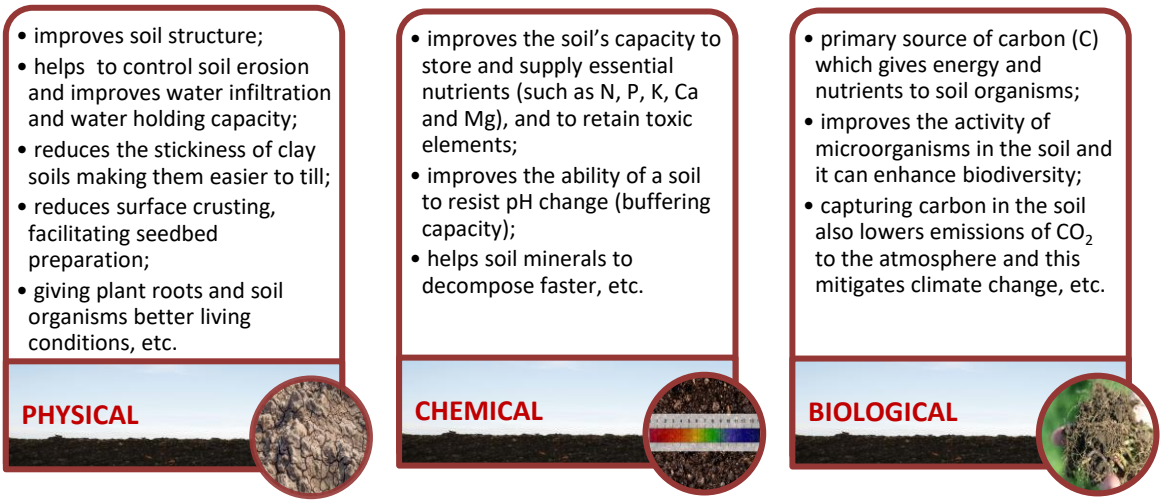
INTRODUCTION

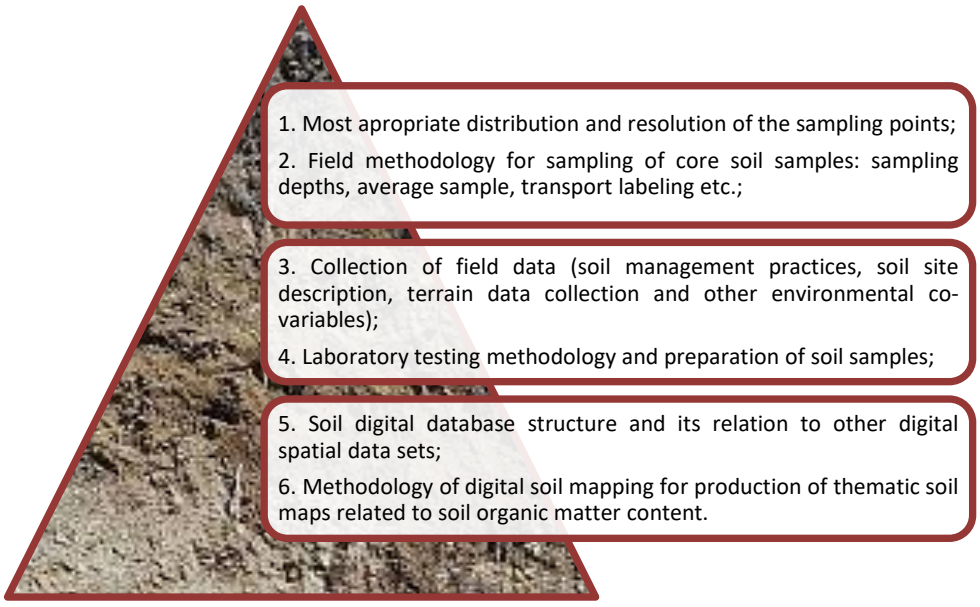
Soil organic matter (SOM) plays a central role in maintaining soil functions and preventing soil degradation. Most of our agricultural soils have between 1 and 3 % organic matter.

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). There are numerous benefits to having a relatively high stable organic matter level in an agricultural soil. These benefits can be grouped into three categories:



Intensive depletion of SOM through unsustainable management practices will lead to intensive degradation of this vital natural resource and loss of its fertility and ecosystem service potential. For these reasons, permanent monitoring of SOM on fertile agricultural and forest soil is of vital interest for the community.

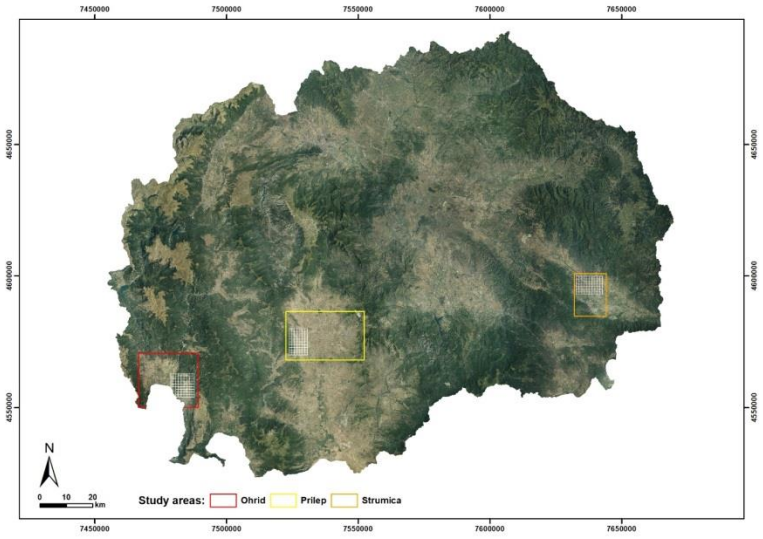
SCOPE OF WORK, GENERAL METHODOLOGY AND APPROACH



MONITORING of SOIL ORGANIC MATTER (SOM)

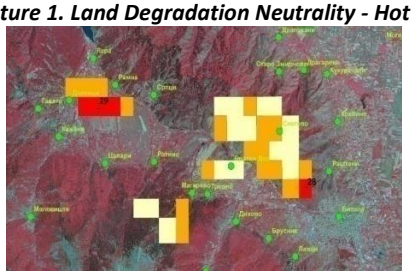
The overall activates related to setting up of best methodologies for monitoring of SOM were based on activities performed in three pilot sites. The most appropriate pilot sites were for monitoring of SOM were identified on the base of the previous analysis (Picture 1[1]).

1. Field survey and sampling of core soil samples



Picture 1. Land Degradation Neutrality - Hot spots

Test region in Ohrid valley

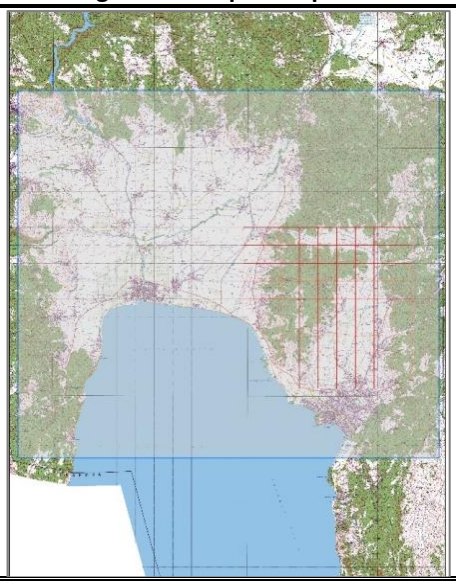
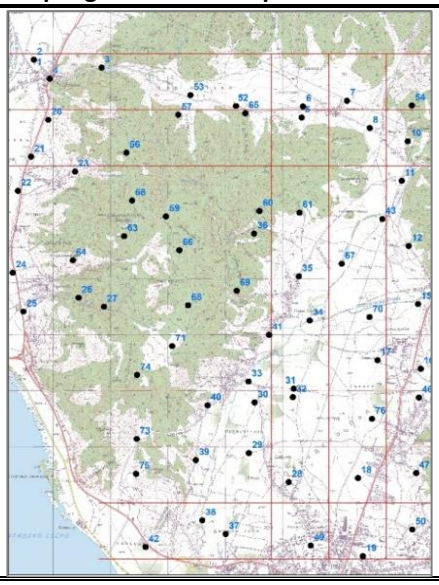
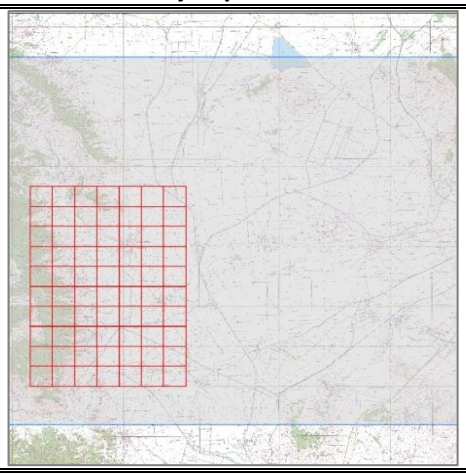
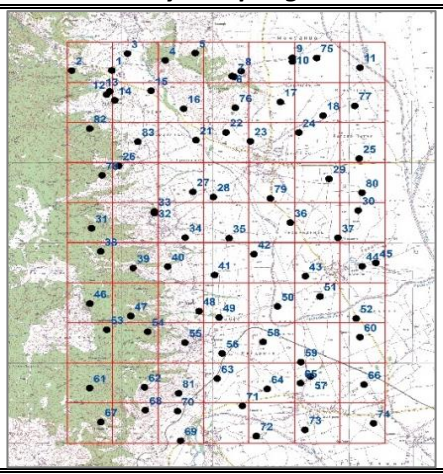
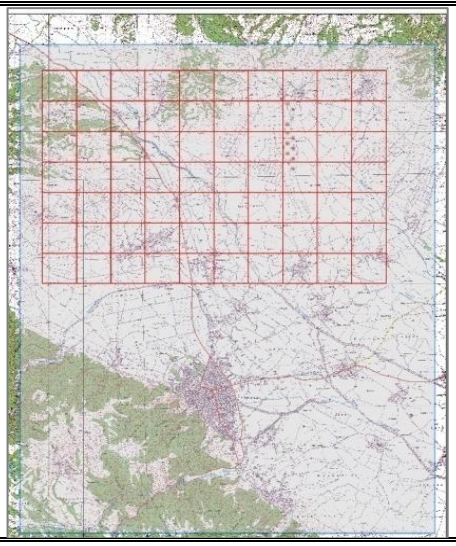
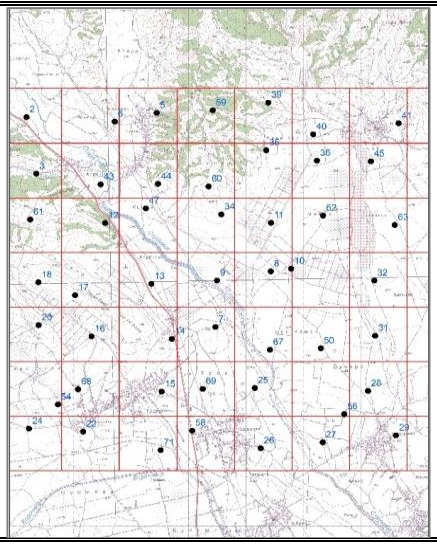


Test region in Prilep valley

Test region in Ohrid valley

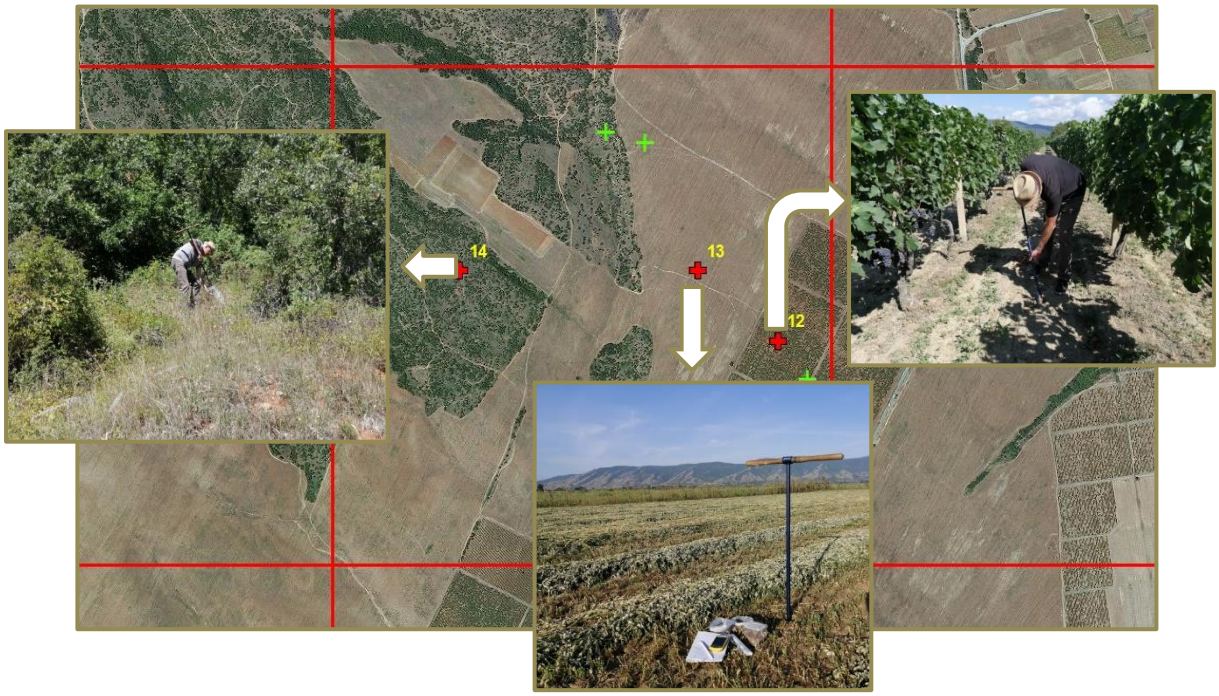
Support to the Land Degradation NeutralityTarget Setting Process - UNCCD[1]

a. Development of field survey methodology for monitoring of SOM

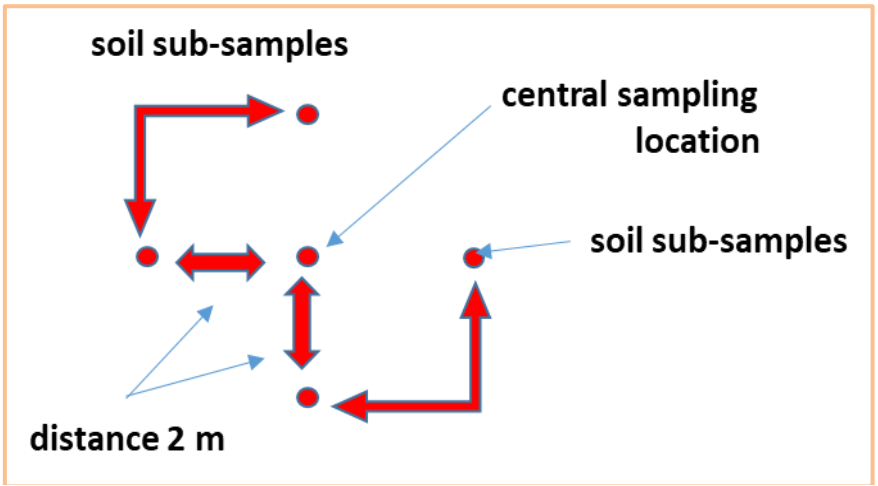
Pilot working areas and pilot experimental sites	Sampling locations in experimental sites
	
Ohrid Valley Experimental Site	***Ohrid Valley Sampling Locations***
	
Prilep Valley Experimental Site	***Prilep Valley Sampling Locations***
	
Strumica Valley Experimental Site	***Strumica Valley Sampling Locations***

b. Methodology for collection of soil samples and other environmental co-variables

Sampling of the soil samples from the selected locations, has been performed according themethodology used in LUCAS Project, for monitoring of surface soil parameters on EU level.



Picture 2. Selection methodology of soil samples



Picture 3. Sampling scheme

Picture 4. Soil sampling procedures

2. Laboratory testing of the collected soil samples

Soil samples in the laboratory were accordingly prepared and analyzed,following the standard methods adopted in the accredited Soil Testing Laboratory of the Institute of Agriculture in Skopje.

3. Collection of land management data related to SOM dynamics and soil sealing

During the filed survey, attention has been payed to collect samples from various land types, like forest, range land, pastures, agricultural land – perennial crops (orchards and vineyards) and annual crops – cereals, industrial crops and vegetables. From each sampling site, data for the natural co-variates, which might influence SOM content, were collected, like: soil type, drainage, erosion intensity, soil depth altitude, aspect etc. In many cases whenever possible) effort has been made to collect data about management practices applied on the selected sampling sites.

MAIN FINDINGS AND RESULTS

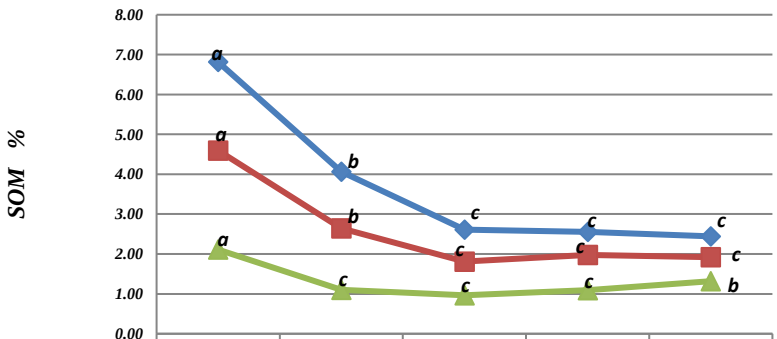
1. Mutual digital data

After finalization of the laboratory examinations, laboratory data, together with the other field data and environmental co-variables of the test area, were integrated into mutual digital data base, using

GIS technology. The geographical coordinates of the sampling points were organized as a shape file (QGis).

2. Soil organic matter content from the three pilot regions

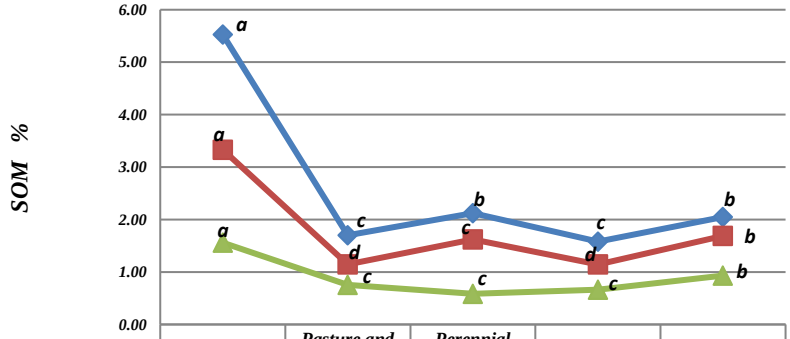
Figyre 1. Content of SOM at Ohrid region



	Forest	Pasture and natural land	Perennial crops	Field crops	Forage crops
0-20 cm	6.81	4.07	2.61	2.55	2.44
20-40 cm	4.60	2.64	1.81	1.98	1.92
40-60 cm	2.11	1.10	0.97	1.10	1.32

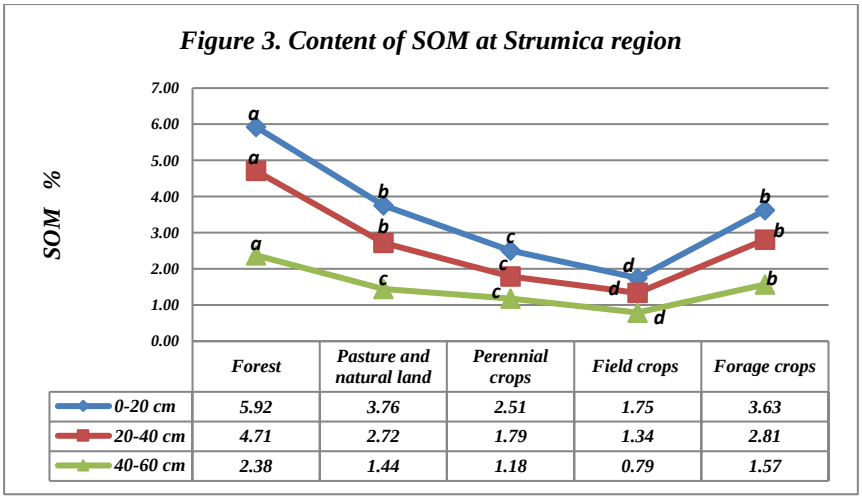
*Different letters (a, b, c …) in the same line indicate statistically significant among land use at the probability level p <0.05

Figure 2. Content of SOM at Prilep region



	Forest	Pasture and natural land	Perennial crops	Field crops	Forage crops
0-20 cm	5.53	1.70	2.12	1.58	2.05
20-40 cm	3.33	1.15	1.62	1.14	1.69
40-60 cm	1.56	0.75	0.59	0.66	0.93

*Different letters (a, b, c …) in the same line indicate statisticallysignificantamong land use attheprobabilitylevelp <0.05



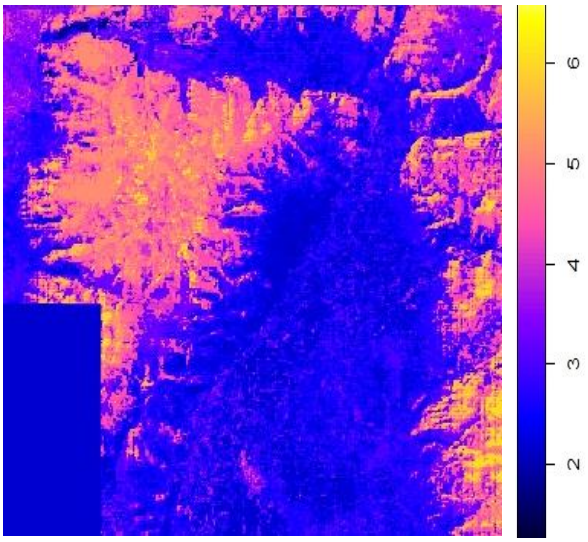
	Forest	Pasture and natural land	Perennial crops	Field crops	Forage crops
0-20 cm	5.92	3.76	2.51	1.75	3.63
20-40 cm	4.71	2.72	1.79	1.34	2.81
40-60 cm	2.38	1.44	1.18	0.79	1.57

**Different letters (a, b, c …) in the same line indicate statistically significant among land use at the probability level p <0.05*

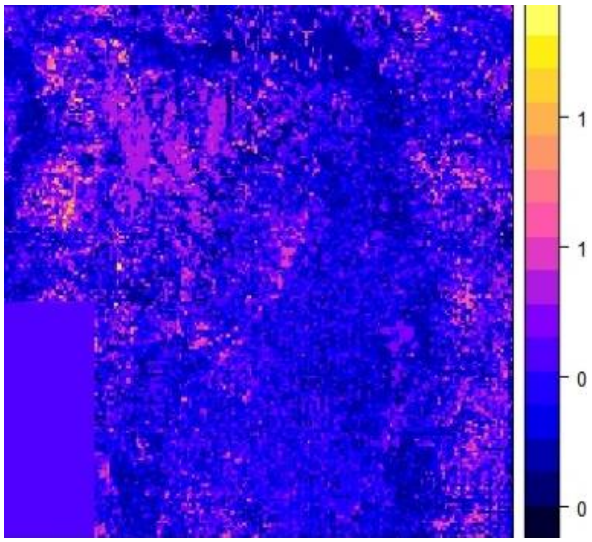
3. Digital soil Mapping

Ohrid experimental site

Total number of sapling points for this region is 120 locations with corresponding spatial references (longitude, latitude, and altitude).



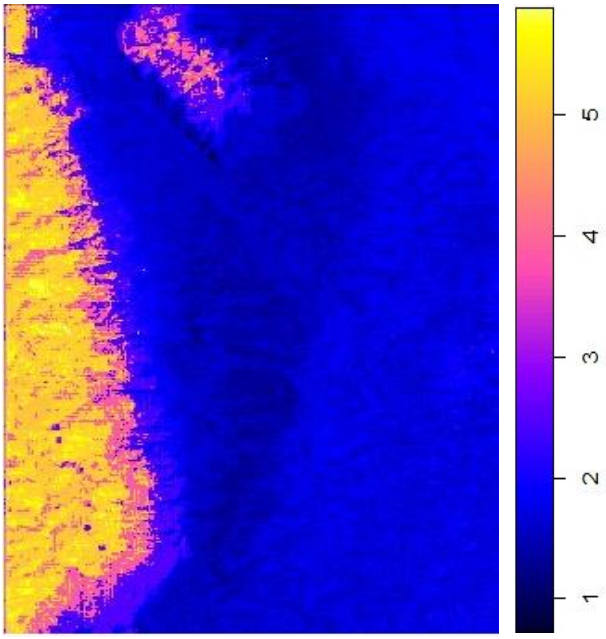
Map 1. Soil organic matter map-Ohrid



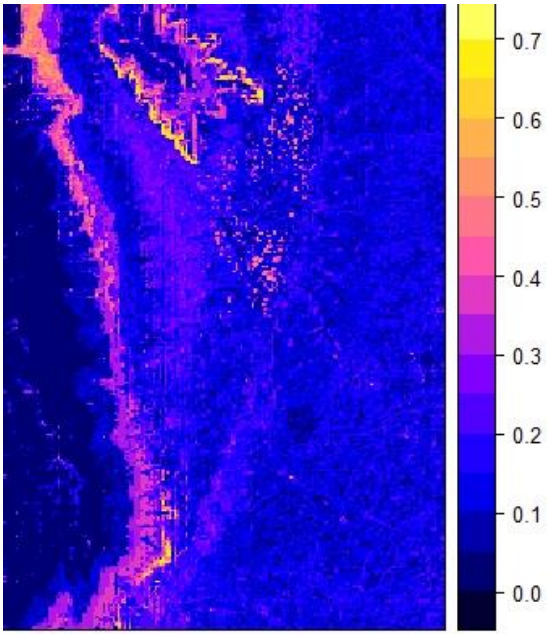
Map 2. Uncertainity map of SOM -Ohrid

Prilep experimental site

Prilep experimental site was covered with 234 soil sampling locations, following the predefined grid for that pilot site.



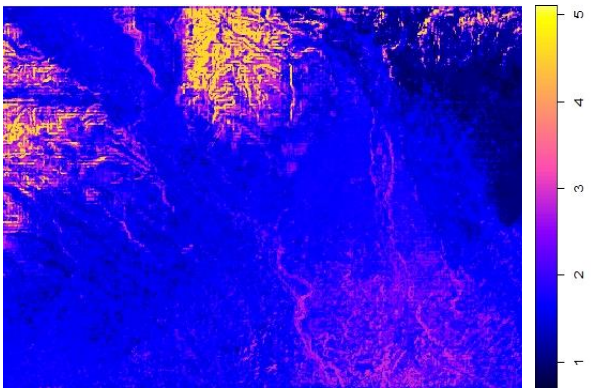
Map 3. Soil organic matter map-Prilep



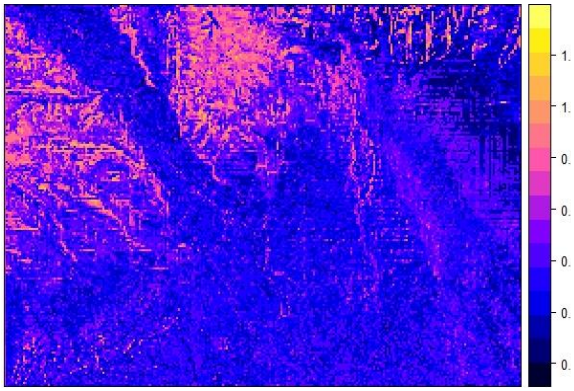
Map 4. Uncertainity map of SOM -Prilep

Strumica experimental site

For modeling of SOM on Strumica experimental site, 142 locations were sampled and tested for the exact contents of SOM.



Map 5. Soil organic matter map-Strumica



Map 6. Uncertainity map of SOM -Strumica

SOIL SEALING

As per the EC Soil sealing is defined as the covering of the ground by an impermeable material – and as such is one of the main causes of soil degradation in the EU. Soil sealing often affects fertile agricultural land, puts biodiversity at risk, increases the risk of flooding and water scarcity and contributes to global warming.

1. **Soil sealing estimate based on CLC comparison**

The methodology for performing of the comparison was to use the CORINE Land Cover GeoTIFF from the year 2000 and 2018 (100 meters spatial resolution). Thereafter, the two datasets were reclassified into three categories:

- Artificial surfaces (code 100)
- Vegetative areas where agricultural land was included (code 200 and 300)
- Other surfaces (code 400 and 500)

2. **Soil sealing estimate based on satellite imagery**

One of the objectives of the study was to increase local and global consciousness for the problem of soil sealing and appointing the true value of the soils as a medium for food production, diluter of pollutants or water retainer for flood protection. In order to achieve a more detailed map, the expert team had decided on producing even more detailed maps with higher spatial resolution, which in turn will result in the creation of maps with details presented in meters rather than larger patches of land.

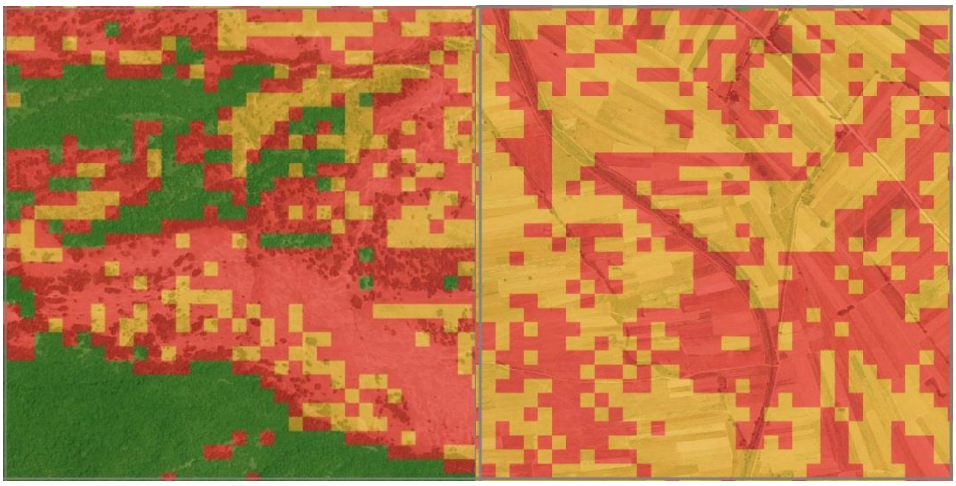
<u>Ohrid experimental site</u>

Map 7. Supervised classification (MLC) results for the Ohrid valley. L7 2000 left image, L8 2020 to the right

Table 1. Results of the supervised classification for the Ohrid valley

L7 2000 Ohrid		*Class*	*L8 2020 Ohrid*	
Area (ha)	*Percent (%)*		*Area (ha)*	*Percent (%)*
4303,29	50,67	**Agriculture**	4564,47	53,75
2634,83	31,03	**Forest**	2197,63	25,88
1097,57	12,92	**Urban**	1243,73	14,65
456,72	5,38	**Water**	486,57	5,73

Prilep experimental site

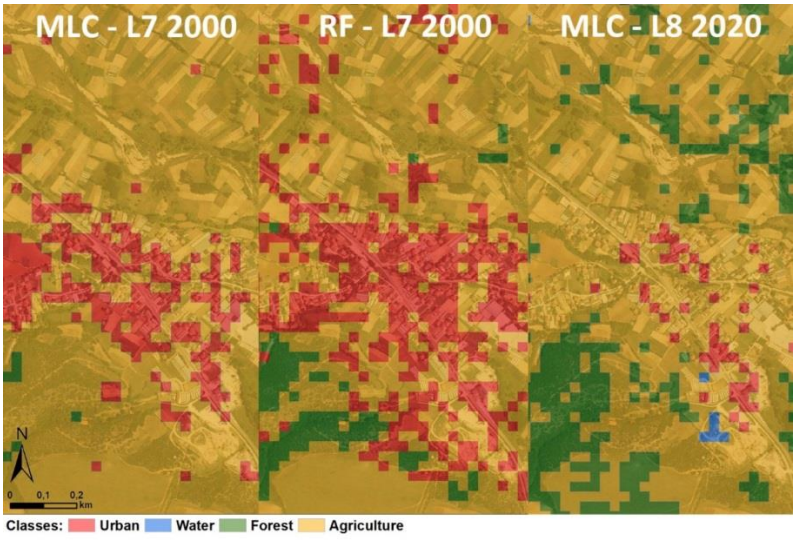


Map 8. Misclassified land cover/use (MLC) for the Pelagonia valley for the Landsat 8 2020 image

Table 2. Results of the supervised classification and corrected classes for the Pelagonia valley

L7 2000 Prilep		*Class*	*L8 2020 Prilep*		*L8 2020 Prilep Corrected*	
Area (ha)	*Percent (%)*		*Area (ha)*	*Percent (%)*	*Area (ha)*	*Percent (%)*
5761,32	76,98	**Agriculture**	3786,28	50,59	5618,28	75,07
1199,47	16,03	**Forest**	1196,50	15,99	1201,73	16,06
523,50	6,99	**Urban**	2501,52	33,42	664,30	8,88

Strumica experimental site



Map 9. Comparison of MLC and RF results for the Strumica valley region

Table 3. Results of the supervised classification and corrected classes for the Strumica valley

L7 2000 Strumica		*Class*	*L8 2020 Strumica*	
Area (ha)	*Percent (%)*		*Area (ha)*	*Percent (%)*
5913,71	80,47	**Agriculture**	6257,20	85,15
22,06	0,30	**Forest**	902,38	12,28
1412,46	19,22	**Urban**	185,43	2,52
0,45	0,01	**Water**	3,69	0,05

CONCLUSIONS

There is a evident decline of SOM in experimental sites, especially on agricultural land, which is result to the improper management practices applied;

There is a significant difference in SOM content depending to the actual land use, (forest>pastures>agricultural land);

SOM content on agricultural land is highly dependent to the actual management practices (soil cover period, residue quality factor, farmyard manure, tillage practices and irrigation);

Within this activity, a proper and contemporary methodology approaches for all segments of the SOM monitoring program was defined and tested;

In order to estimate the overall situation with SOM content and to identify the most vulnerable areas and design a measures for combating this process of land degradation, of particular importance is to replicate this activity on the overall country territory.

RECCOMENDATIONS

Soil organic matter (SOM) plays a key role in the improvement of soil physical, chemical and biological properties;

Livestock manure is an excellent source of nutrients and SOM.Regular applications combined with forage-based rotations are the envy of crop producers when SOM levels and soil resilience are considered;

,,*How much organic matter am I adding to the soi*l?,,: depending from soil texture, existing SOM, cropping practices such as rotation and use of cover crops, tillage, residue management, etc.;

Generally the most favorable period for manure application is the period from *15th March to 15thOctober*;

While animal manure shortage, it may be necessary to use other soil improving practices such as conservation tillage (limited till or No-till); cover crops; residue management; and nutrient saving manure application methods to enhance the soil building process;

Soil sealing must be implemented by employing the following recommendations into legislative acts;

Implementation of urban and rural zones based on the soil types which will be mandatory in spatial planning not only on national but on local municipal level since the latter are the ones living the ill effects of losing patches of soil;

Taxation rate for sealing soils which have been categorized as very fertile or essential to regulating inner city micro-climate. Such taxation systems are already widely adopted throughout the European Union of which North Macedonia strives to become a member.