SETOF Soil Erosion and TOrrential Flood
Prevention: Curriculum Development at the Universities of Western Balkan Countries

WP1 – Analysis of soil erosion state and torrential floods in WBC - regional aspects -

Reference Number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP

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SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Introduction

- The Western Balkans is a neologism coined to describe the countries of "ex-Yugoslavia (minus Slovenia and Croatia) plus Albania".
- The region includes: Albania, Bosnia and Herzegovina, Montenegro, Macedonia, Serbia (Kosovo** United Nations Security Council resolution 1244, adopted on 10 June 1999,)

Analyzes in this chapter (Introduction) cover all WBC while in other chapters are focused only on Bosna & Hercegovina, Serbia and North Macedonia

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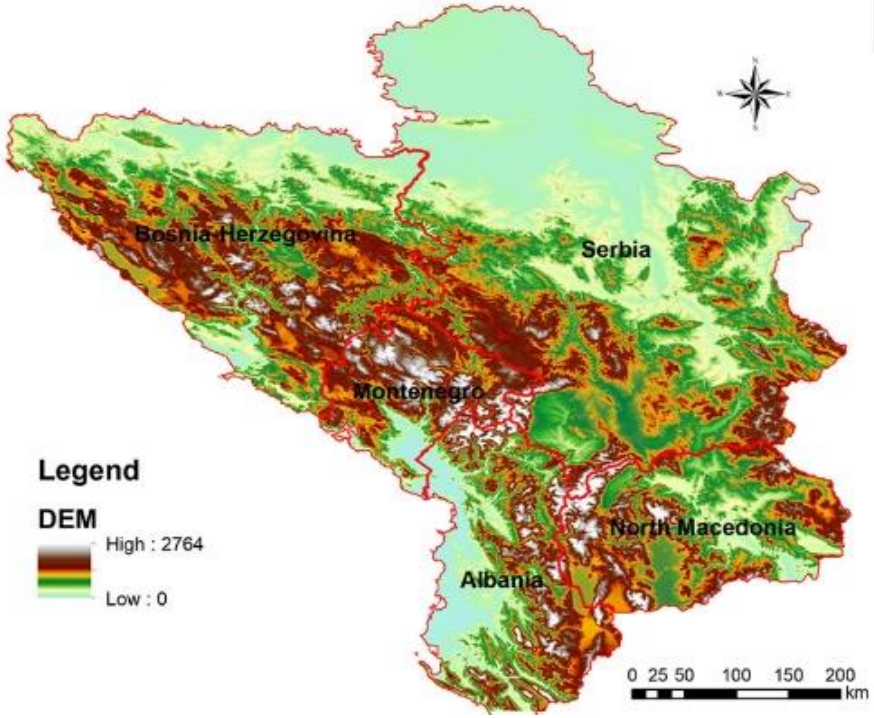

- **Relief** of the WBC is dominantly hilly, hilly mountain and mountain. Most of the area is covered by mountain ranges running from the northwest to the southeast.
- The main ranges are the Dinaric Alps in Bosnia and Herzegovina, Montenegro and Albania, the Shara-Pindus massif which spreads along the border between Albania and North Macedonia and Stara Planina in Serbia

- There is a dense **drainage network** in the region. Water resources from the WBC belong to: a)Adriatic, b) Black Sea and c)Aegean basin i.e Albania (a), BiH (a,b), North Macedonia (a,b,c), Montenegro (a, b), Serbia (a,b,c),
- The main river in the region considered is Danube that belongs to the Black Sea basin. The Danube receives water from the following rivers from WBC: Sava (BiH), Drina (BiH, Serbia, Montenegro), Morava (Serbia, N. Macedonia) and Tisa (Serbia). The source of water from the rivers Neretva (BiH), Drim/Drini (Montenegro, Albania, Serbia, North Macedonia) drain into Adriatic Sea, as well as all the other rivers in Albania .
- The river Vardar and Strumica (North Macedonia) are flowing to the Aegean Sea.

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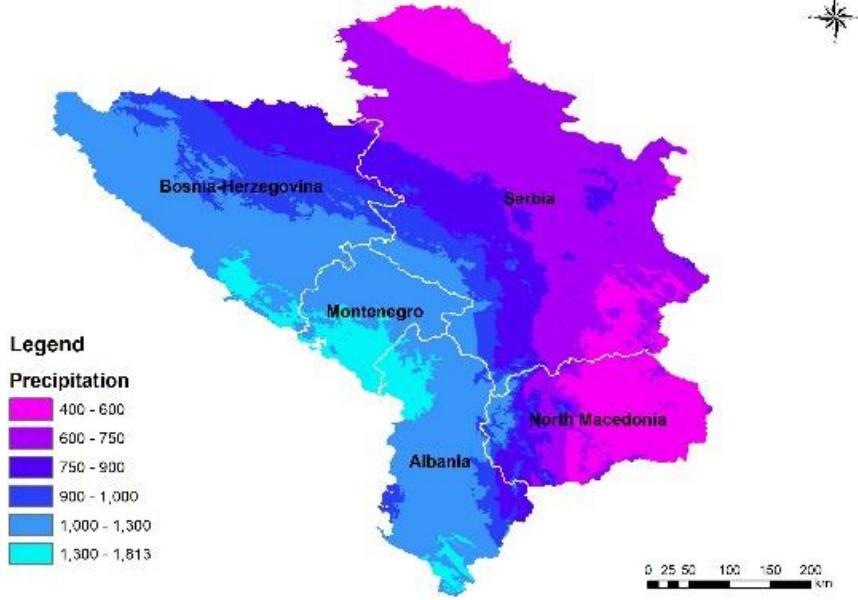

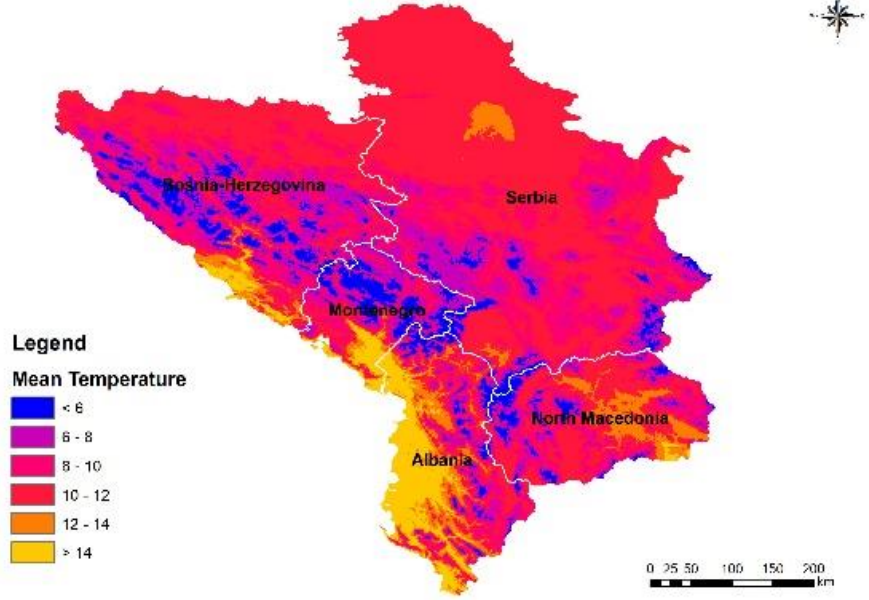

- The WBC experiences a range of **climates** in accordance to of the size of their geographic area. Mediterranean climate with mild, wet winters and hot, dry summers occurs in the coastal and lowland areas of Bosnia and Herzegovina. The climate in the remaining areas of Bosnia and Herzegovina ranges from temperate continental to alpine. The climate of Serbia varies from temperate continental in most areas, to continental in the mountains and warm continental in the south-west. The climate in North Macedonia varies from sub-Mediterranean, moderate continental/sub-Mediterranean to continental and alpine on the highest mountains.
- The mean temperatures vary between 0-14°C. Only the mountain ranges have mean annual temperatures below 6 degrees and on the other hand, the continental valleys varies between 10 and 14 degrees and the coastal areas have temperatures above 14 degrees. The mean annual precipitation of this region is also quite diverse and it can vary from 450 mm (North Macedonia) to more then 1500 mm (BiH)

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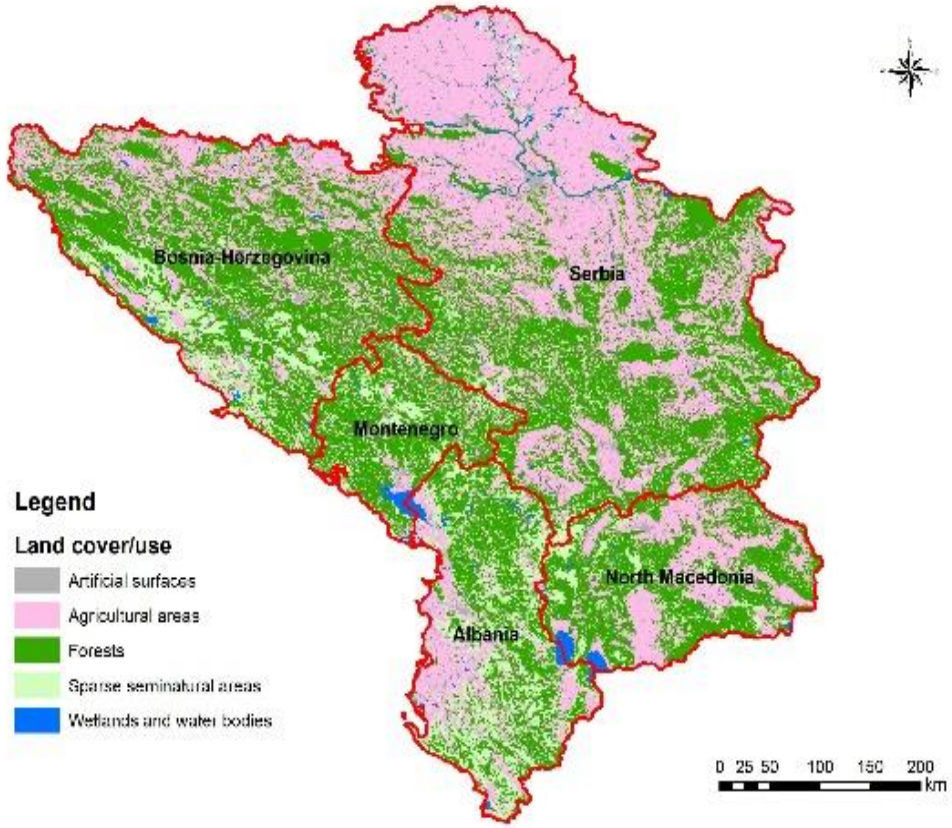
LC per country [%]

Country	Area (km²)	forest	Semi-natural areas	pastures & mosaic	arable land & permanent crops	other
BiH	51,129	53	8	31	4	4
North Macedonia	25,713	50	9	24	12	5
Serbia	88,385	38	4	27	25	6



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Status of soil data

- In the past was developed a Soil Map of Yugoslavia in a working scale 1:50 000 according to the methodology by Škorić A., Ćirić M. and Filipovski G (1964) - SCF. Soil mapping finished in the 80's and in 1985 was published a book "Classification of soils in Yugoslavia".
- Later after 2000, in each country, all sheets of Soil Map were scanned and digitized. The same was done for the analytical data (physical and chemical properties) from all annexes containing soil profiles. After digitization, the old classification was translated into the official nationals soil classification system as well as into the current FAO classification (World Reference Base for Soil Resources). Only the soil database for North Macedonia is available free on internet.

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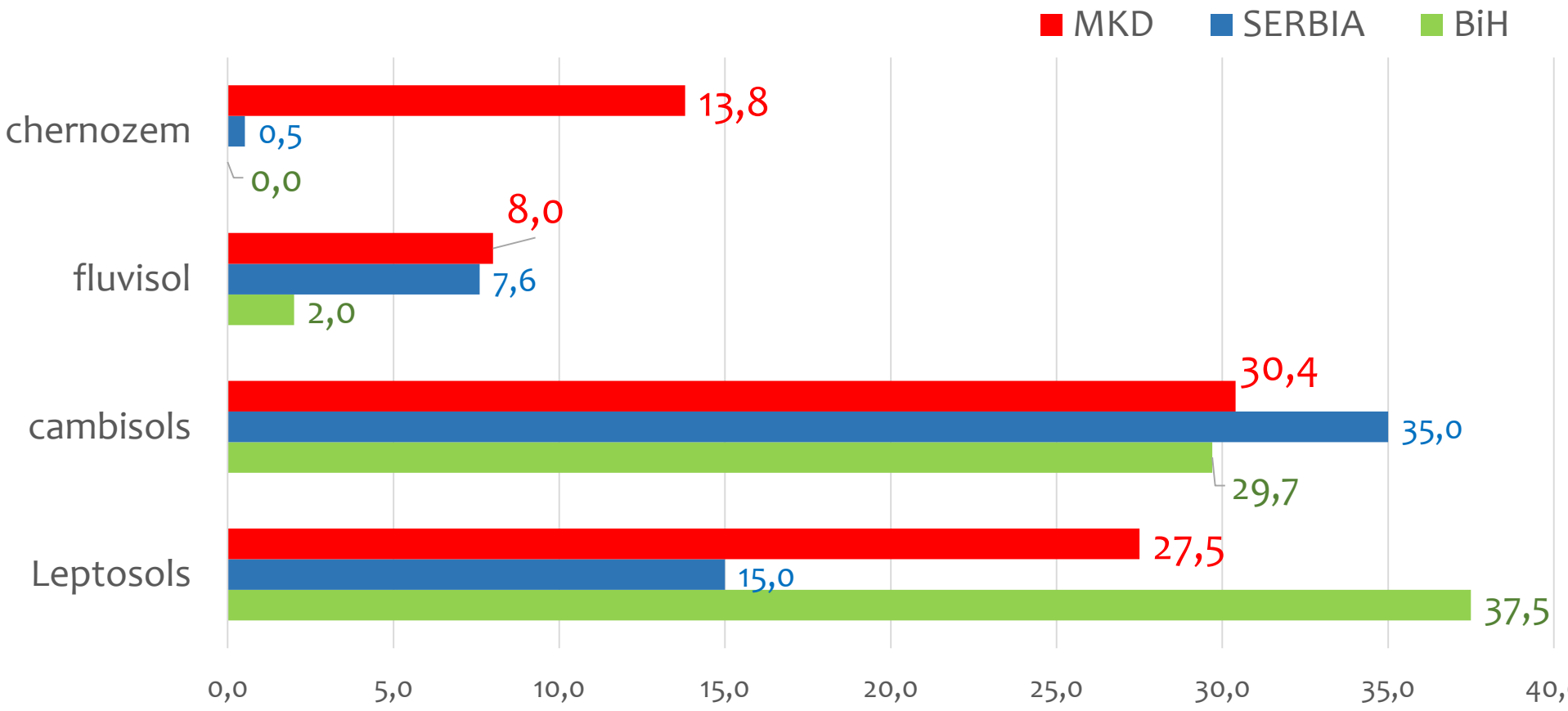
Distribution of main soil types per country [%]



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Land and Soil degradation

- **Land** is "the terrestrial bio-productive system that comprises **soil**, vegetation, other biota, and the ecological and hydrological processes that operate within the system" (Article 1 of the UNCCD).
- **Soil** is he upper layer of earth in which plants grow, a black or dark brown material typically consisting of a mixture of organic remains, clay, and rock particles.
- **Land degradation** is a process in which the value of the biophysical environment is affected by a combination of human-induced processes acting upon the **land**.
- **Soil degradation** is the decline in **soil** condition caused by its improper use or poor management, usually for agricultural, industrial or urban purposes.

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Land Degradation Neutrality baseline indicators

- **Land cover changes** data express loss of productive land in the period 2000-2012 in all 3 countries. In ***Bosnia and Hercegovina***, in this period 8658 ha agricultural land were converted in artificial land, 2330 ha in forest land and 318,7 ha in water areas, and on the other hand in the period 2000-2006, 946 ha of forests are converted into artificial land. LC changes in ***Serbia*** in the period 2006-2012 show loss of productive land and per LC type are as follow: arable land and permanent crops (-17 km^2), pastures and mosaics (- 26 km^2), forests (+12 km^2), seminatural vegetation (-5 km^2) artificial land (+18 km^2), open spaces and bare soils (+ 6 km^2), wetlands (-4km^2) , water bodies (+7 km^2). In the ***North Macedonia***, comparison of data from 2000 and 2012 express significant loss of forest (365,8 km^2) and almost the same value (334, 2 km^2) increase of shrubs, grassland and sparsely vegetated areas that is a result of forest fires in 2007;
- **Land productivity dynamic** data for BiH indicate unacceptable changes (decline, early signs of decline, stable but stressed) on 2,49% of the territory. in Serbia 5.4% in North Macedonia 2,35%.
- Total ***soil organic carbon loss*** for the period 2000-2010, according to the global data are estimated as: Bosna and Hercegovina (102 393 t), Serbia (33 678 t) and North Macedonia (3951 t)
- **Total land area with trend of degradation** in the period 2000-2010 (as degraded area is as follow: Bosna and Hercegovina (1366 km^2), Serbia (4757 km^2) and North Macedonia (589 km^2)

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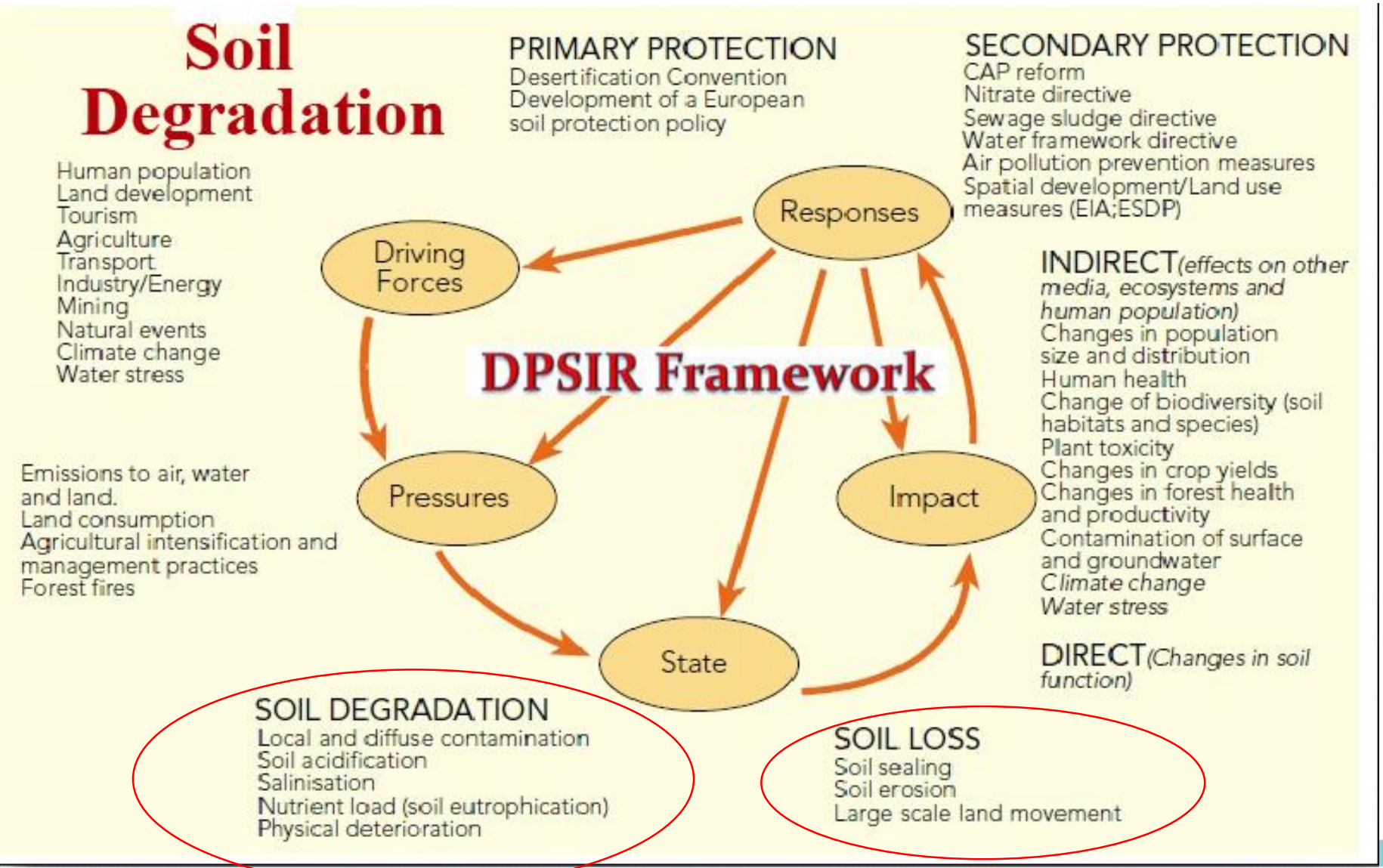
Soil Degradation



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- ***Soil alkalization and salinization*** are not recognized as wide spread
- ***Depletion of organic matter*** *is* very important for soil fertility and yield. In dry areas, depletion of SOM can be rapid, because the processes of decomposition are accelerated at high temperatures. There is initial general data in all 3 countries that should be improved through proper monitoring system.
- ***Physical deterioration of soil*** is significant type of soil degradation but there is no data.
- ***Soil sealing*** is a type of soil degradation which become more important with the process of industrialization, expanding of settlements and traffic network. There is no enough data for soil sealing and it should be studied in the future.

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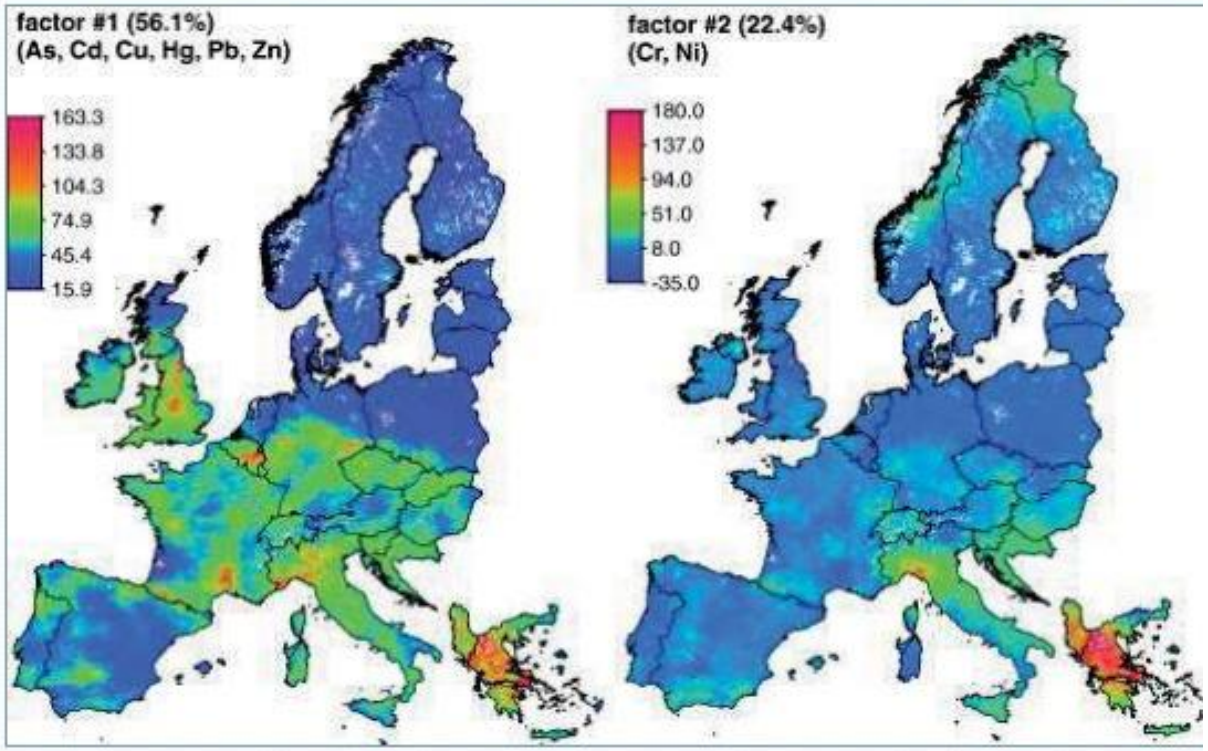
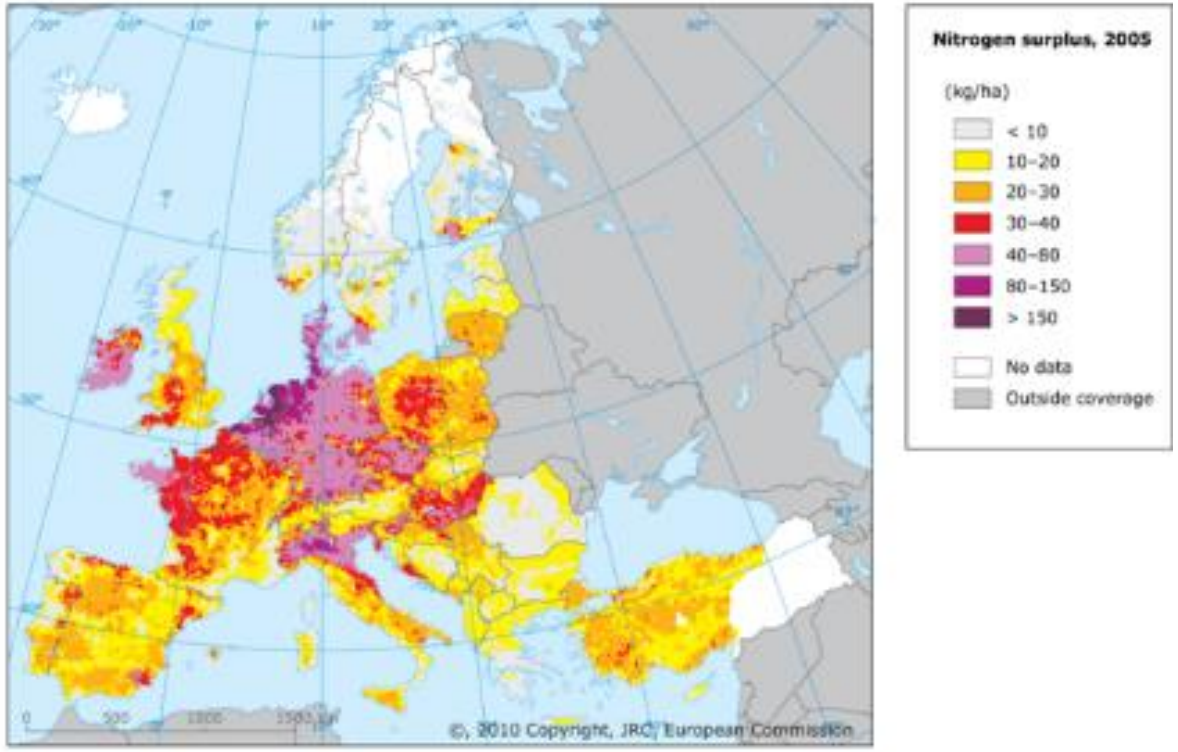
Soil pollution

SOIL POLLUTION IN EUROPE



Heavy metal content in European soils (Lado et al. 2008).



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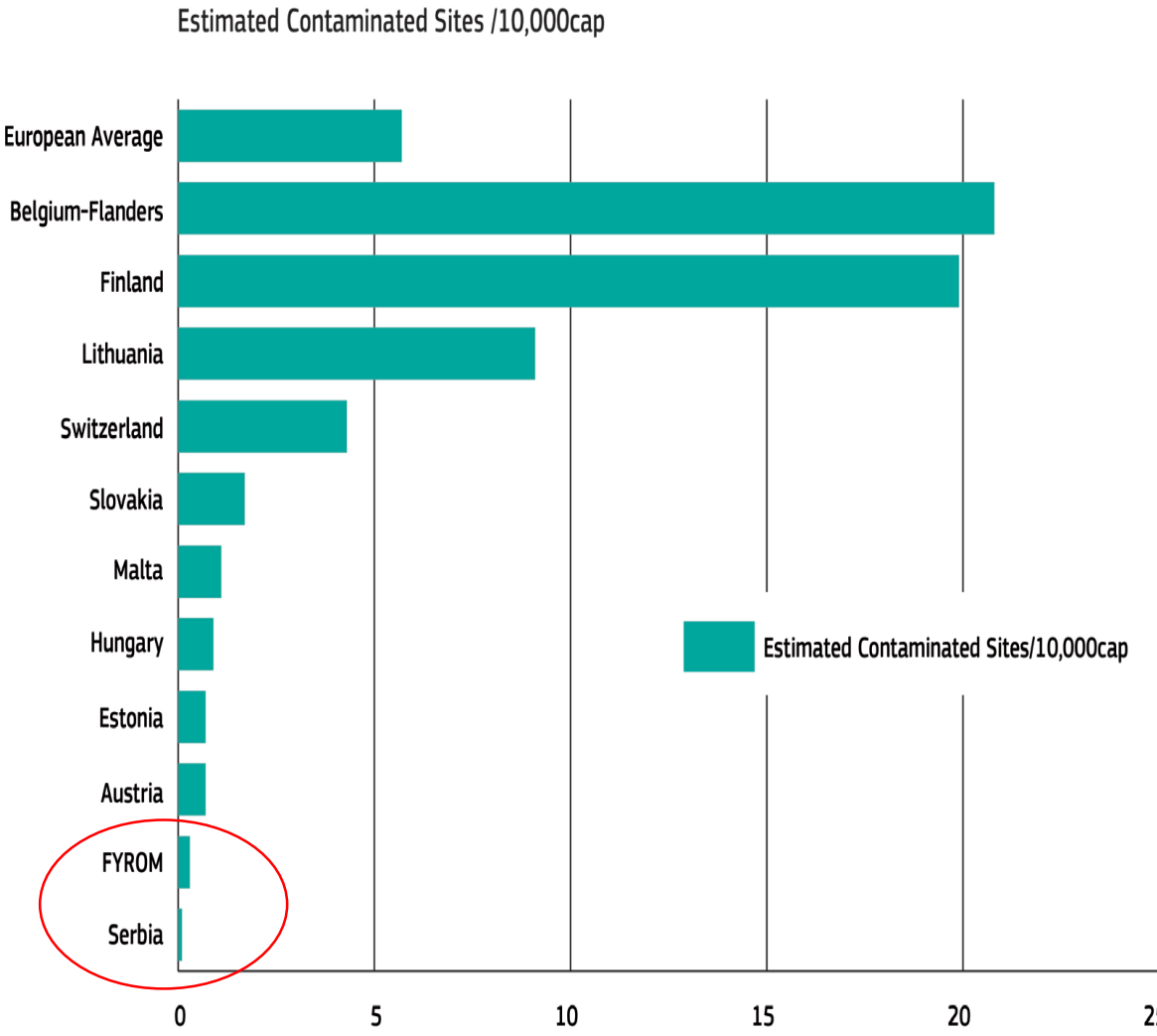
- ***Soil pollution*** with nitrates, phosphates, sulphates, pesticides, organic pollutants, heavy metals, oil is a wide spread problem of soils in the region. The highest number of contaminated sites (422) is monitored in Serbia, but in other countries/territories, this number ranges from, 91 (Bosnia and Herzegovina), to the large number which refers only to the landfill (Macedonia). A particular problem in BiH represent landmines and other residual explosive materials contamination.
- On average about 4.2 Potentially Contaminated Sites are estimated to exist per 1,000 inhabitants and about 5.7 Contaminated Sites per 10,000 inhabitants in EU. (in Belgium-Flanders and Denmark this value is about 20 CS)
- **On the other hand in Serbia is 0,14 CS/10000 cap , in North Macedonia is 0,3 CS/10000 that are the lowest values in Europe. (Marc H Van Liedekerke et al, 2017)**



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- A functional system for **soil monitoring** in these countries, however, has not yet been established.
- Reporting systems of soil quality monitoring in BiH are in process of being established in accordance with EEA indicators and EIONET requirements.
- No soil monitoring system does exist in Macedonia. A methodology for monitoring carbon stocks and organic carbon contained in the soil was developed in Serbia, but the measurement is not carried out systematically and values are not relevant for the entire territory of the country

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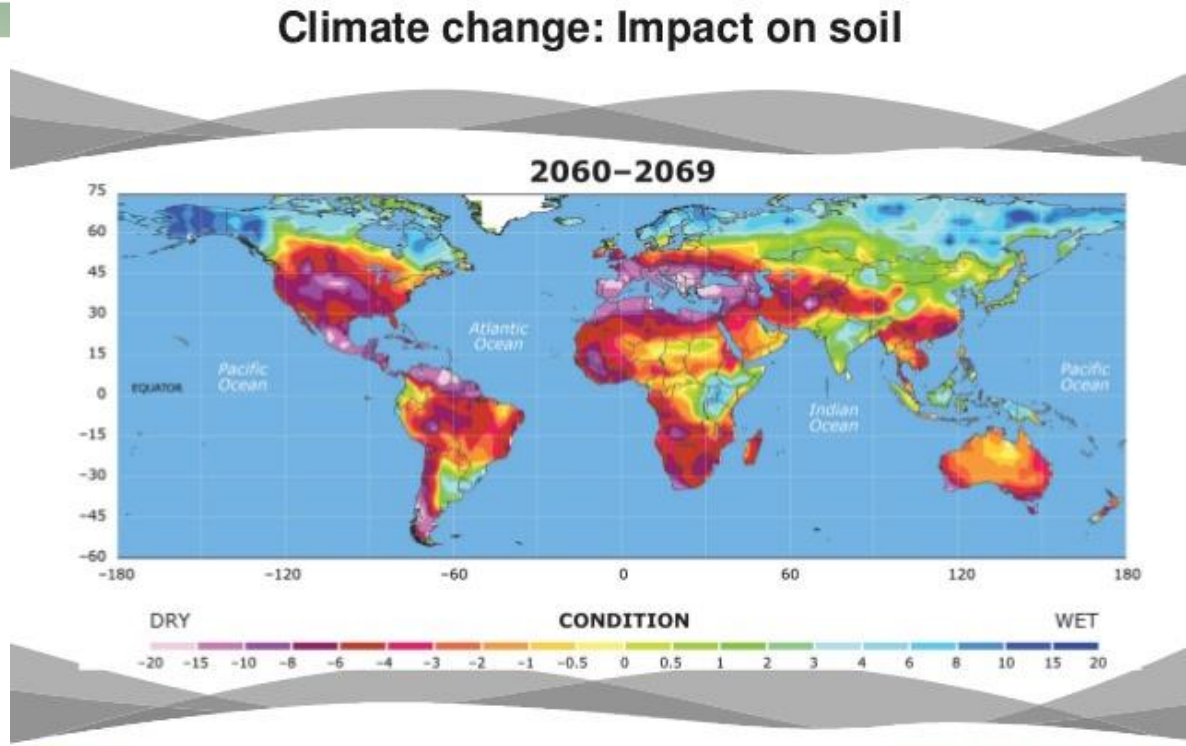
- **Desertification** is a new recognized natural hazard. Drylands cover great part of North Macedonia and northern part of Serbia (Vojvodina where arenosols exists). Climate conditions are the main reason for desertification. According to the calculation almost 1/4 of the North Macedonia is vulnerable to desertification.
- On the other hand unfavorable climate scenarios up to 2100 for the region (decrease of annual precipitations, increase of frequency of high intensity rainfalls and increase of temperature) indicate that this problem will be more intense even in near future and should be payed more attention on it.



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SOIL EROSION

- **Soil erosion** is considered as one of the major threats to European soils, particularly in the Mediterranean areas (CEC, 2002). Erosion is understood to be a physical phenomenon that results in the displacement of soil and rock particles by water, wind, ice and gravity.
- The South and Southeast region of Europe is significantly prone to water erosion. In parts of the region, erosion has reached a stage of irreversibility and in some places erosion has practically ceased because there is no soil left. With a very slow rate of soil formation, any soil loss of more than 1 t/ha/y can be considered as irreversible within a time span of 50–100 years. Losses of 20 to 40 t/ha in individual storms, that may happen once every few years, are measured regularly in Europe with losses of more than 100 t/ha in extreme events (Morgan, 1992).
-

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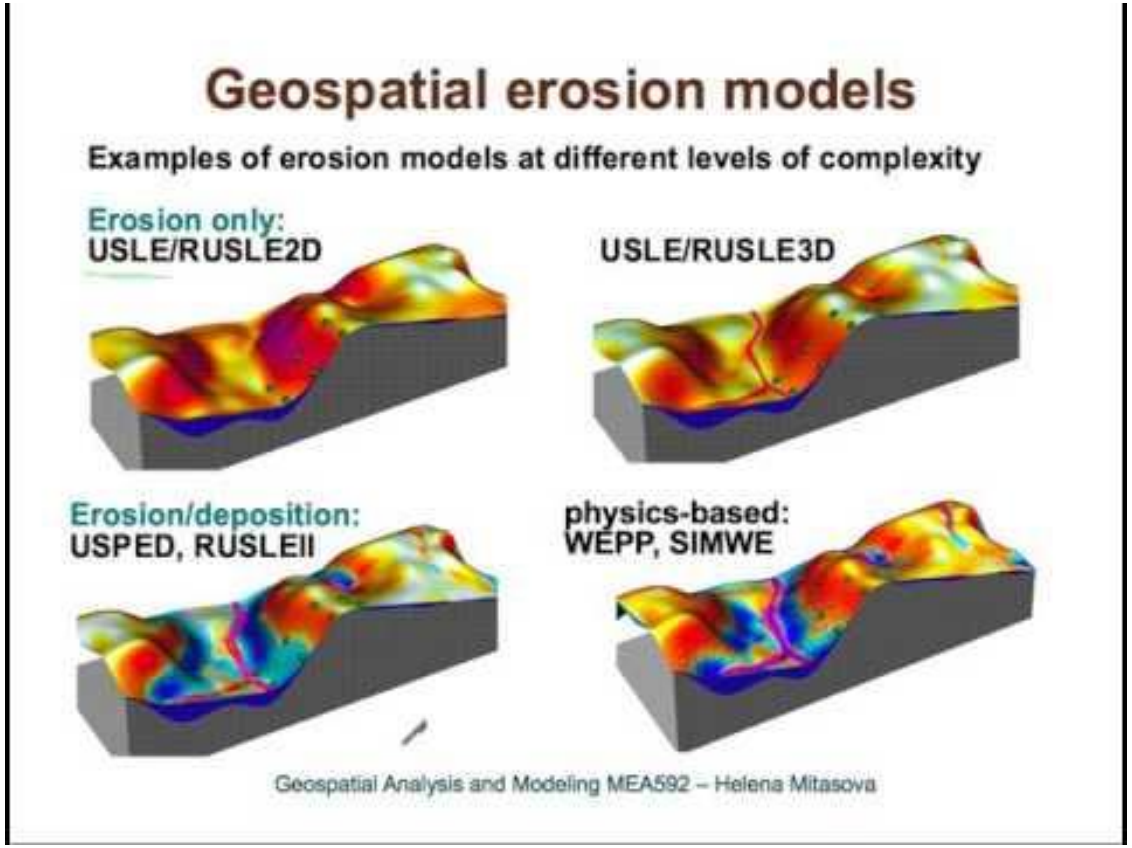
SOIL EROSION

- Various methods, models and approaches to erosion risk assessment are used by various countries in Europe.
- There is a significant difference within the scientific community in several erosion related issues, including the definition and acceptance of erosion, erosion intensity measurement, erosion intensity modeling, and they particularly depend on a scientist's provenience (various schools, various professions etc.).
- At the European level, there is no unified classification of erosion or a unified model for erosion intensity (hazard) and erosion risk



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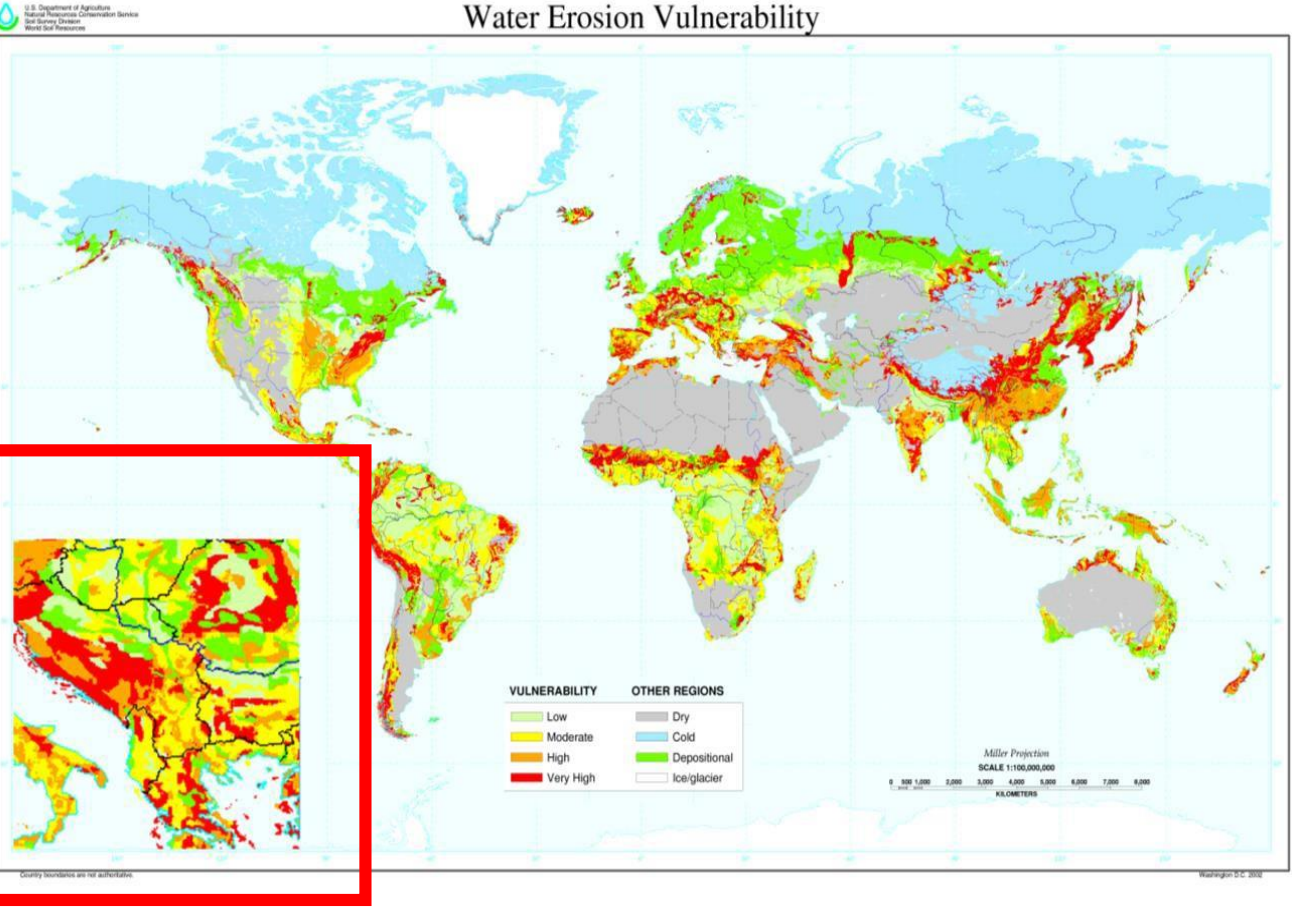
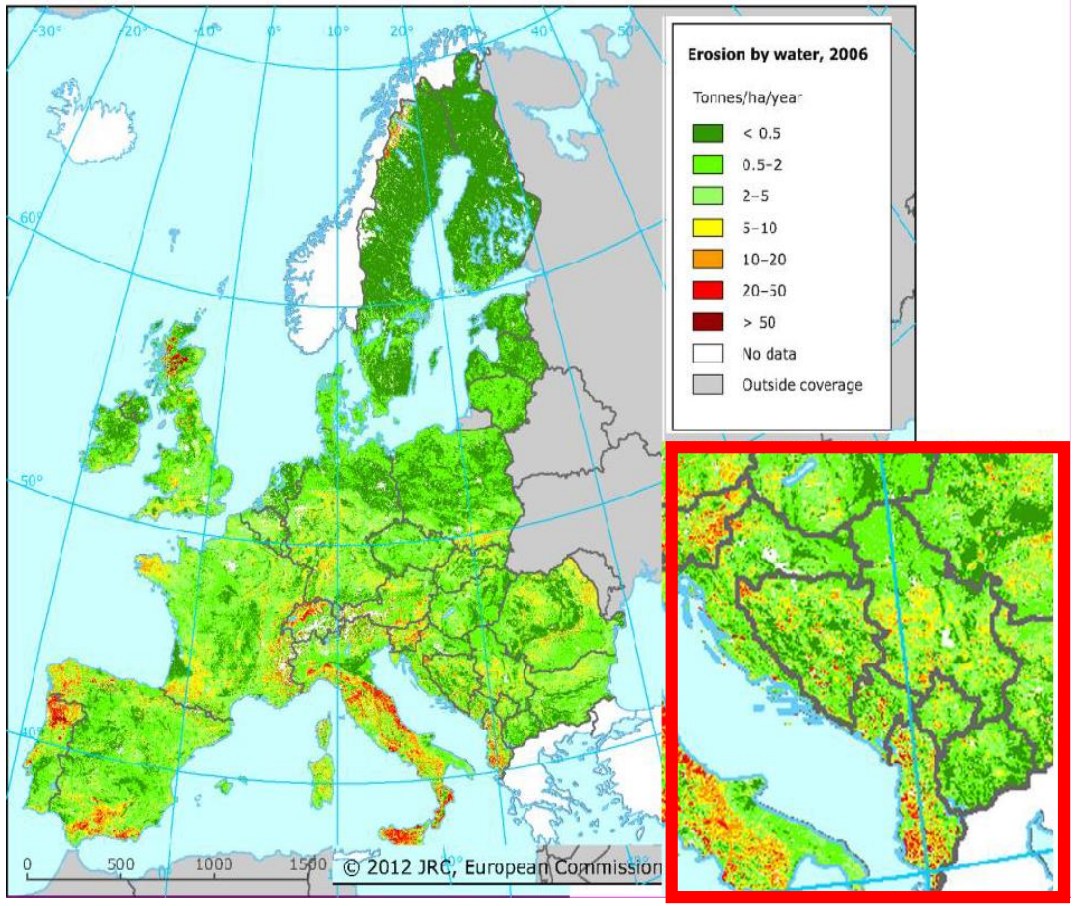
Soil erosion – global and WB



http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_054006



http://www. eea.europa.eu/data-and-maps/figures/estimated-soil- erosion-by-water

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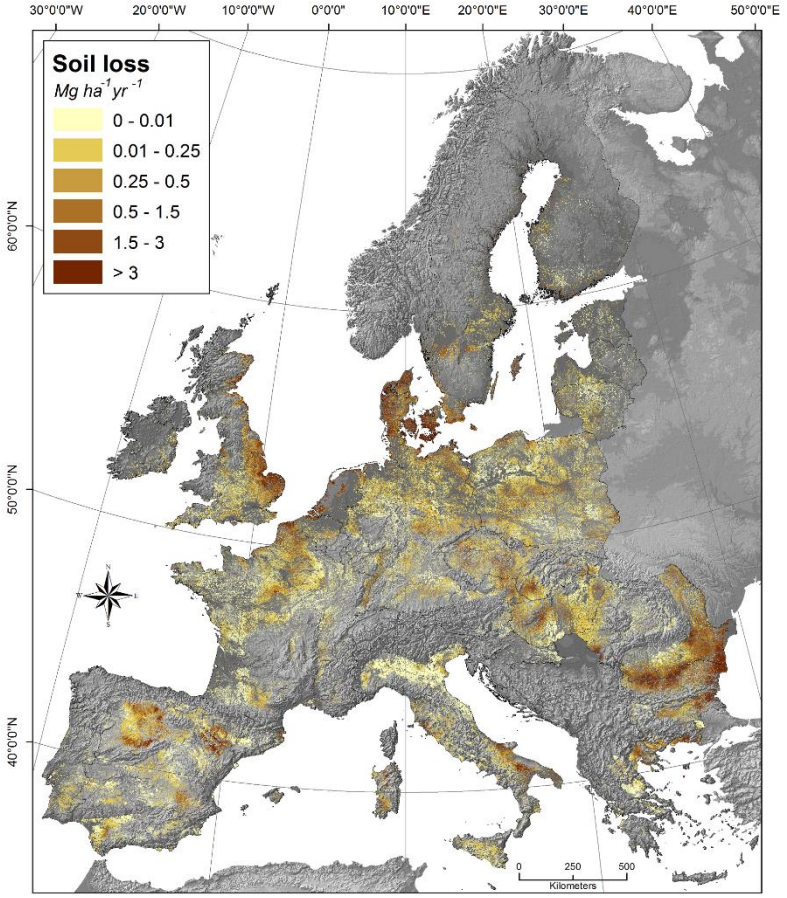
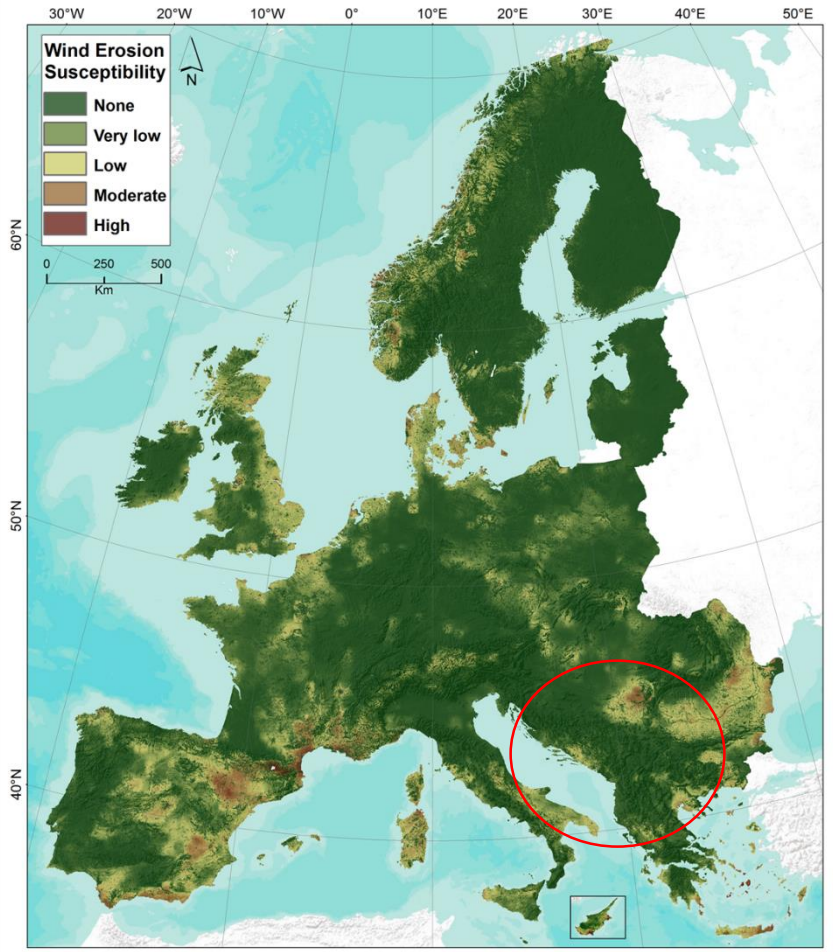
Wind erosion

https://esdac.jrc.ec.europa.eu/themes/wind-erosion



Soil loss by wind erosion in European agricultural soils. Work performed by a modified version of RWEQ. Spatial resolution: 1km. Spatial Coverage: EU-28



Index of Land Susceptibility to Wind Erosion (ILSWE) predicted for 36 European Countries (at spatial resolution 500m)

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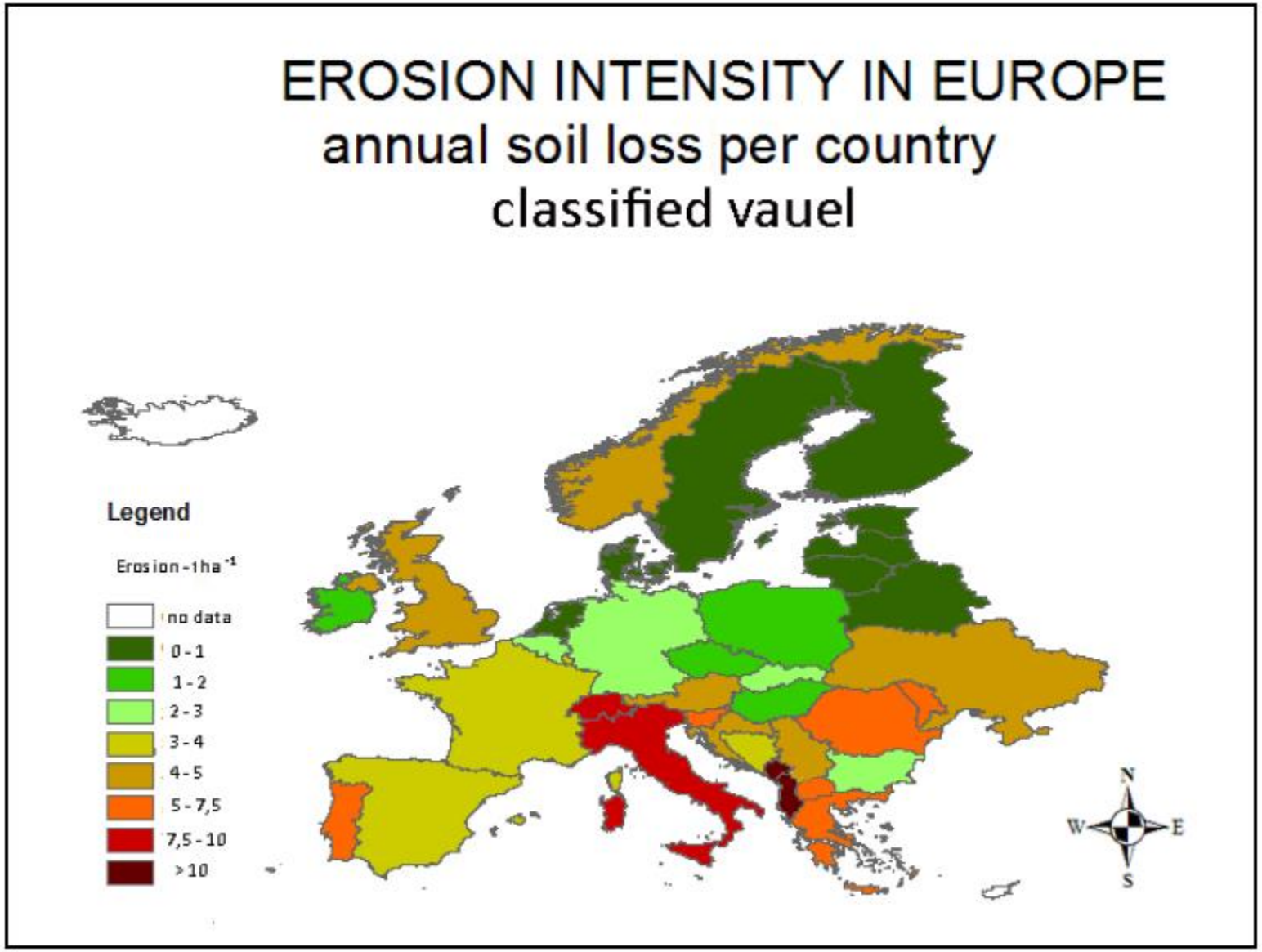
- The mean calculated annual erosion intensity of European states is 3.18 th^{-1}. The total soil losses (produced sediments) are $1973*10^6$ tones.
- The Balkan countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia and Slovenia) cover 765891 km^2 or 12.85% of the territory of European states.
- The mean annual erosion intensity in the Balkans is 5.48 th^{-1} and varies from 2.3 (Bulgaria) to 18.7 th^{-1} (Albania).
- The total annual soil losses are $419.9*10^6$ tones. It means that 21.28% of the total annual sediments (erosion production) in Europe originate from the Balkan countries. (*Blinkov I., 2015*)



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Erosion mapping in some WBC

- Generally, official data about erosion intensity of the WB countries was developed in the 70,s - 80's of the XX century. The common characteristics of former SFRJ countries is that erosion maps were created using the EPM – Erosion Potential Method. All maps were created using expert judgment approach through direct on-field mapping of erosion processes on a scale of 1:50 000. These data were later digitized (scanned, georeferenced and vectorized) in a GIS environment.
- The latest research on soil erosion in BiH dates from 1985, when a Map of Soil Erosion of BiH was developed by Lazarević (1985). Unfortunately, that map has not been updated and moreover, data disappeared during the conflict period in Bosnia (Tošić, 2007; Tošić, 2008). Since 2004 part of the erosion map was reconstructed, but only for the Republic of Srpska territory (Tošić et al., 2012).
- Erosion Map od Serbia is also developed in the 1973 and updated in 1984 using EPM (Kostadinov S. 2006).
- The Erosion Map of the North Macedonia was prepared by the team from Water Development Institute led by Gorgević M. in the period 1981 – 1993. Erosion potential method (EPM) by Gavrilović was used with direct on-field mapping. Team was firstly trained for subjective assessment of processes during on-field mapping. Team used maps in a scale 1: 50 000. A summarized report was produced in 1993. Later, in 2002, the working maps were scanned, georeferenced and vectorized.
- . In the last 15 years there are a lot of studies where erosion intensity was calculated using modelling in a GIS environment using EPM, RUSLE or any other method, but those studies were launched only for some parts of the countries and not for the whole country

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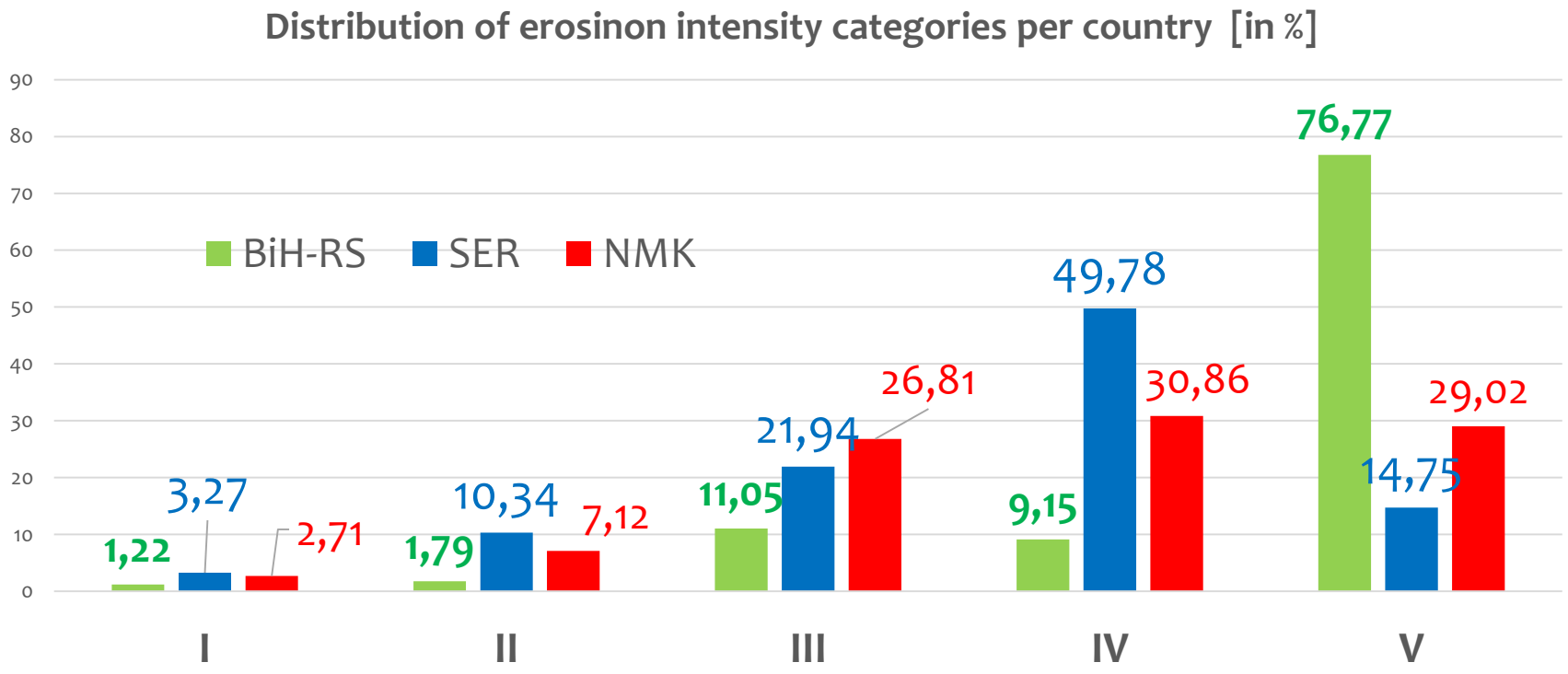
	Erosion process intensity	Erosion intensity	BIH (Republika Srpska)		Serbia		North Macedonia	
		(m^3 km^2 yr^{-1})	km^2	%	km^2	%	km^2	%
I	Excessive	> 3000	263	1,22	2888	3,27	698	2,71
II	High	1500 – 3000	386	1,79	9138	10,34	1832	7,12
III	Moderate	1000 – 1500	2385	11,05	19386	21,94	6893	26,81
IV	Weak	500 – 1000	1975	9,15	43914	49,78	7936	30,86
V	Very weak	70 – 500	16568	76,77	13035	14,75	7463	29,02
							891	3,47
	Total		21851	100	88361	100	25 713	100.00



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Country	Area	Annual Erosion intensity		Map scale	Source
	km^2	$10^6\ m^3$	m^3/km^2		
Bosna and Hercegovina	51,129	16.5	323	1:25,000	Lazić Z. (2012)
North Macedonia	25,713	17.0	661	1:50,000	Gorgević et al. (1993)
Serbia	88,385	37.0	419	1:50,000	Kostadinov S. (2007)
Total /*average*	165,227	70,5	*431*		

- On a level of Bosna and Hercegovina, the total average amount of sediment, created on territory of SR BiH per year is 16.518,031 m^3, or 323 m^3/km^2.
- Total average annual gross erosion in Serbia amounts to 37,249,975 m^3, specific annual gross erosion amounts to 421.57 m^3/km^2, annual sediment transport is 9,350,765 m^3 and the specific annual sediment transport is 105.80 m^3/km^2.
- The total annual erosion production for North Macedonia is about 17,000,000 m^3 or 685 m^3/km^2,. An amount of $7.5*10^6$ m^3 or 323 m^3/km^2 of sediment are transported from the site where it is eroded.

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Description of erosion processes

- Hilly terrain and a relatively huge quantity of precipitation in BiH means that a significant proportion of the BIH territory is exposed to water-induced erosion.
- Geomorphological features of the Serbian territory are strongly related to water erosion predominating in the southern region and wind erosion in the northern plain. As a consequence of such natural conditions, practically all of the territory of Serbia is under erosion processes of different intensities (from low to the excessive erosion).
- Due to the natural conditions as well as human activities, various type of erosion processes can be defined in North Macedonia as follow: water erosion (dominantly), wind erosion (mostly in central part), karstic and glacial erosion (on the high mountains). By type are presented sheet erosion, rills, shallow and deep gullies, streambank erosion, mass movement erosion (landslides and landfalls). Rock weathering are significant in the mountain region and are significant contributors of sediment. In different parts of the country various erosion processes per type are present.

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- **Wind erosion** as phenomenon is represented in all 3 countries but mostly in Serbia in plane Vojvodina lowland.
- Research on intensity of wind erosion exist only in Serbia (Jevtić, 1975; Letić, 1989; Savić, 2000; Velojic, 2016). According to Letic 2011, over 86% of the areas are in the category of disturbed and very disturbed land. Researche show wind erosion intensity about 20 times the annual production of eolic sediments from unprotected cultivated land (erosion intensity from 1.3 to 43.2 on average 6.9 kg / m per year) compared to land in forest vegetation protected area (0.1 to 0.6 average 0.36 kg / m per year)

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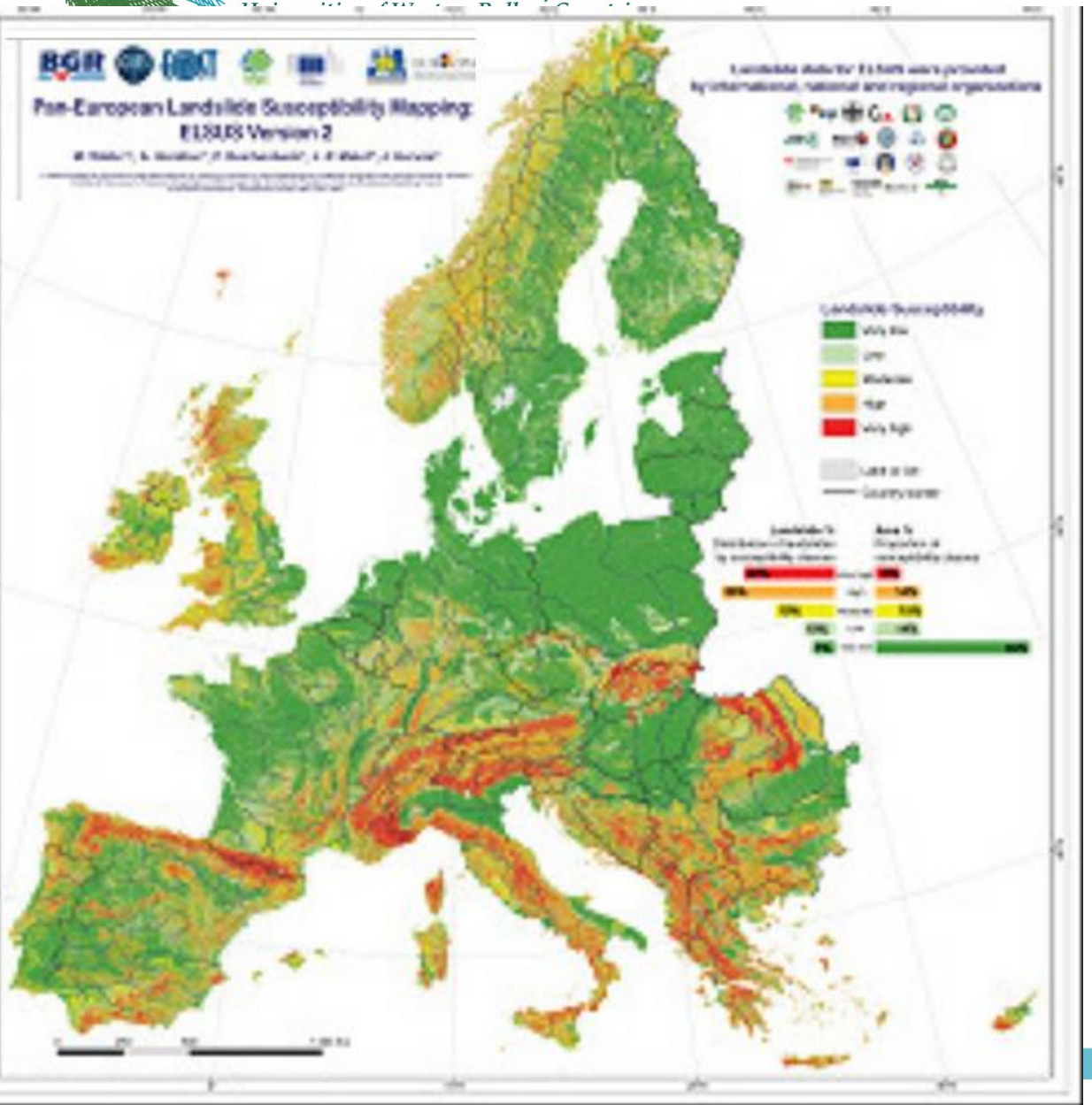

LANDSLIDES

- Landslides in the SEE region commonly occur due to increased amounts of precipitation, high levels of groundwater and the unplanned construction of houses and road infrastructure on slopes, uncontrolled cutting of forest and mineral resources exploitation.
- For example, 30% of Serbia's territory is threatened by landslides or some kind of mass earth movements which affects more than 40,000 locations.
- Landslide risk is very high in BiH too.
- In North Macedonia landslixe risk is lower then in BiH

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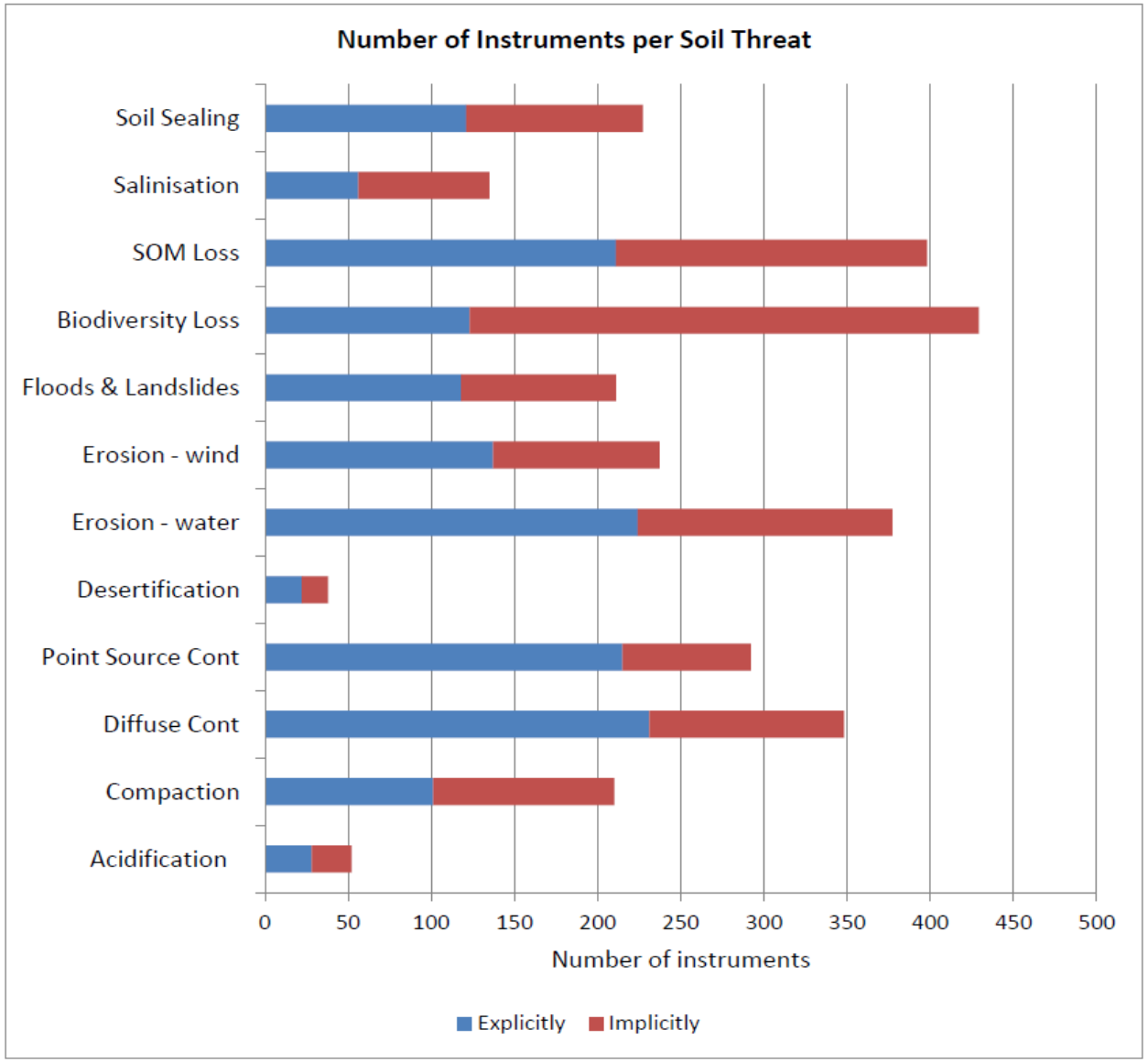
Institutional set-up concerning soil management, legal and policy governance

- There is various world commonly accepted (FAO world soil charter, RIO conventions, Millennium development goals, Global Soil partnership, Sustainable development goals, etc.) and EU instruments that are aimed directly or indirectly to soil.
- Exact 35 policy instruments were identified as being relevant for soil protection on EU level. A total of 671 Member State instruments or an average of 24 instruments per Member State.



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Organization of soil management

- In North Macedonia and in Serbia organization is similar because the main Governmental institutions responsible for various issues related to soil and land are the Ministry of Environment and Physical Planning (MOEPP) and the Ministry of Agriculture, Forestry and Water Economy (MAFWE) in North Macedonia and Ministry of |Environment and Ministry of Agriculture, Forestry and Water Economy in Serbia. There are other governmental bodies (agencies/directorate, independent or as a part of the ministries) that are indirectly included in soil protection as those responsible for rural development, hydro meteorological affairs, spatial planning etc.
- On the other hand, in Bosnia and Hercegovina, taking in consideration the state organization and decentralized political and administrative structure: 3 entities (Federation of Bosnia and Herzegovina, Republika Srpska and Brčko District), as well as cantons and municipalities. On a state level, The Sector for Natural Resources, Energy and Environmental Protection within the Ministry of Foreign Trade and Economy Relations (MoFTER) was appointed as a coordination body for land issues for the purpose of common operation at the international level, but only with prior consent of Entity Ministries. Beside this, each of 3 entity has various organizational structure regrading soil and generally environment protection.
- However, for general land policy is competent the Ministry responsible for agriculture, while for protection of soil as medium is competent the Ministry responsible for environment.

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Legal framework

- The existing legislation regulating the issues of land and soil, its spatial planning and use is in line with the Entity legislation according to the Constitution of BiH. Entities are mandated for land related matters, namely the ministries and administrative organizations. There is no land or environmental legislation at the national level.
- The laws which regulate the area of land resources in Serbia are primarily the Law on Land Protection (OG of RS, No.112 / 15), the Law on Agricultural Land (OG of RS, No. 112/15), and the Law on Environmental Protection (OG of RS, No 43/2011). The National List of Indicators includes a set of indicators related to land, which support the systematization of information on the condition of land, land use changes and factors regarding land degradation. Contaminated site management is regulated by the regulation on the establishment of criteria for assessing the status of the endangered environment and priorities for rehabilitation and remediation (OG of RS, No. 22/10).
- No specific legislation for soil exists to date in North Macedonia. Soil protection is regulated by several laws: for environment. Nature, agriculture, forest, water, spatial planning..

- The most relevant documents for soil protection adopted in all 3 countries are: "National Action Plan to Combat Land Degradation and Desertification" and "Land Degradation Neutrality Target setting programme".
- Other adopted national documents relevant for soil protection are those related to: The National strategy for Sustainable Development; The National Water Strategy, The National Rural Programme, 2014 - 2020; The National Strategy for Land Consolidation of Agricultural land; The national communication on climate change; National Spatial Plan; The National Strategy for Sustainable Forestry Development; The National Strategy for Biodiversity Protection; Waste Management Strategy etc.

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Erosion and erosion control in legislation

- This matter is mostly regulated within the Law on Waters. Provisions that refer erosion controls are almost the same in all 3 countries.
- Within the Law on Water in all 3 countries there is a chapter about Adverse impact of water (where erosion and torrents are completely regulated) i.e in BIH (Ch. VII. Regulation of rivers and other water bodies and protection form adverse impact of water art.80-97), Serbia (Ch.4 – Water management activities – 4.1.1.2 – Protection from erosion and torrents art.61-65) North Macedonia (Ch.5 – Protection from adverse impact of water art.125 – 141).
- In all 3 laws there are provisions about: establishing erosive areas, responsibilities for proclaiming erosive areas, forbidden activities within it, obligatory measure and activities for erosion control etc.

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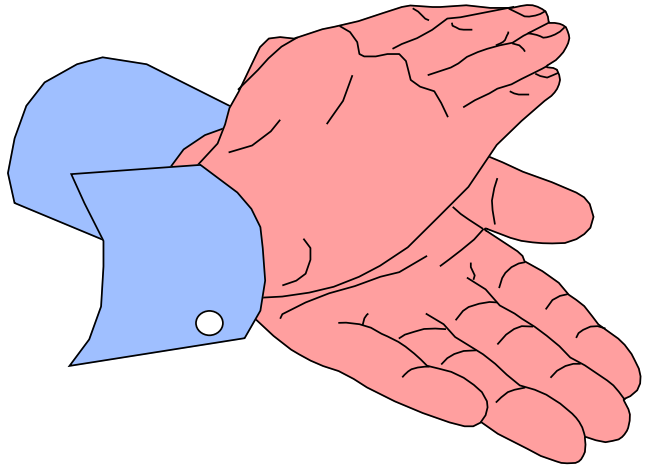
Blagodaram na vnimanieto



Thank you for your attention

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