Soil compaction
Available water content in soils

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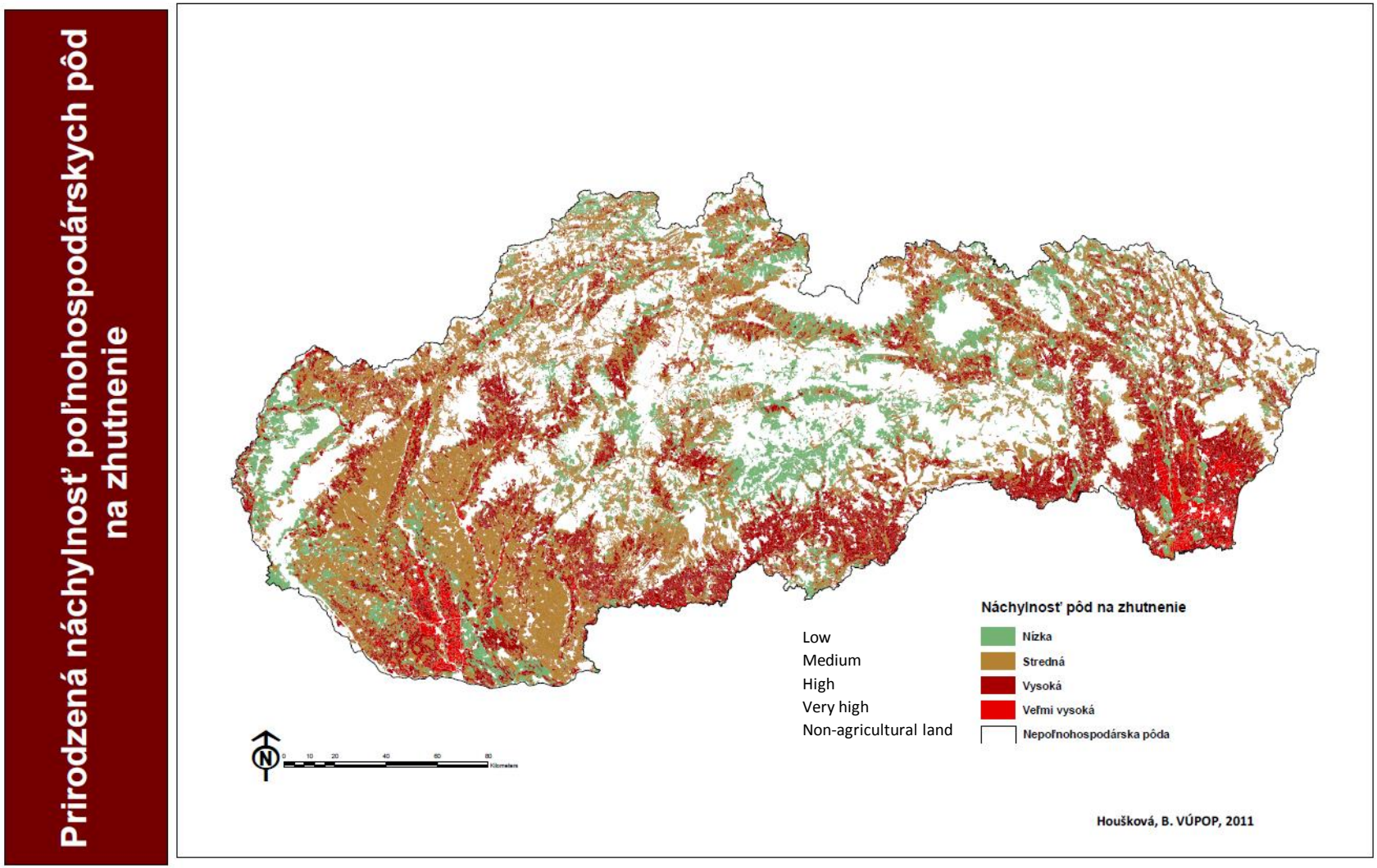
Natural susceptibility of soils to compaction



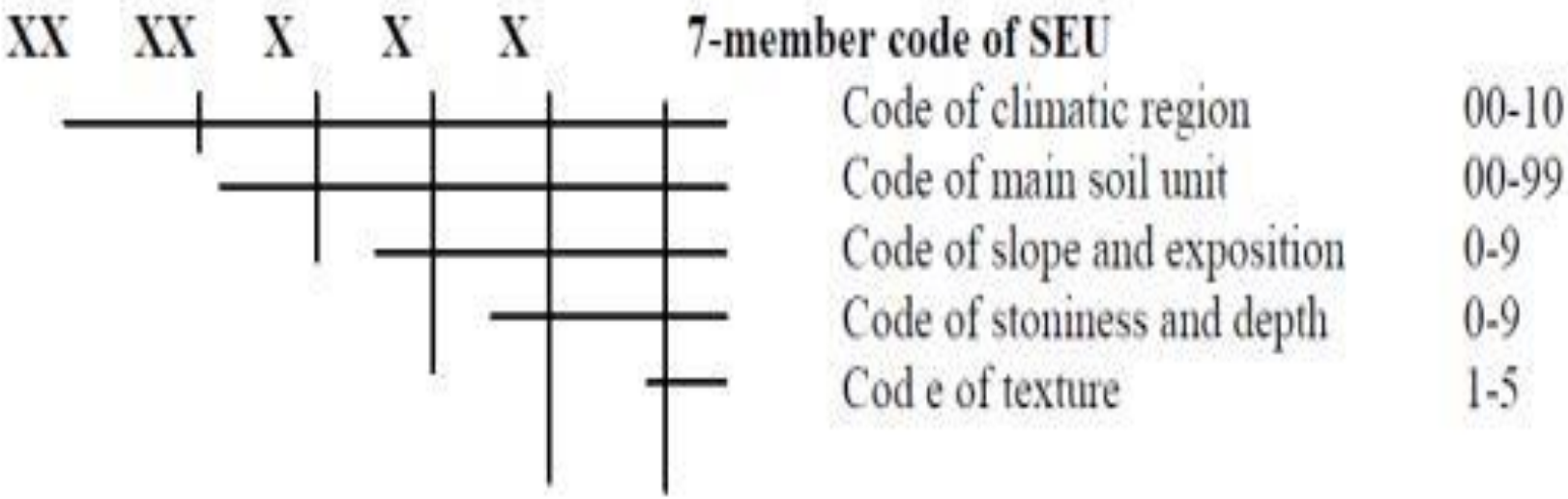
Principles of evaluation

- *Soil susceptibility to compaction* is the ***probability*** that soil becomes compacted when exposed to compaction risk. It can be low, medium, high and very high depending on soil properties and a set of external factors like climate, soil use, influence of the other threats, etc.
- There can be different reasons for soil compaction and soil susceptibility; thus they are divided into two main groups: *natural* – primary and *man induced* – secondary as well as one subgroup: *combined* which is the result of the two previous occurring simultaneously at the same place.

- Land evaluation units (LEU)

Land evaluation units (LEU)

- LEU code [5] is the combination of 7 numbers representing climate, main typological unit, slope, stoniness, exposition, soil depth and texture:



Evaluation of susceptibility to compaction on the level of main reference soil groups typical for Slovakia

WRB (1998)-GRP CODES AND THEIR MEANING / SUSCEPTIBILITY TO COMPACTION					
AB	Albeluvisol	H	LP	Leptosol	L
AN	Andosol	L	LV	Luvisol	H
AT	Anthrosol	NE	PH	Phaeozem	L
AR	Arenosol	L	PL	Planosol	H
CM	Cambisol	M	PZ	Podzol	M
CH	Chernozem	L	RG	Regosol	L
FL	Fluvisol	M	SC	Solonchak	H
GL	Gleysol	H	SN	Solonetz	H
HS	Histosol	L	VR	Vertisol	H

Evaluation of the susceptibility to compaction on the level of soil subunits (WRB_ADJ)

WRB (1998)_ADJ CODES AND THEIR MEANING / SUSCEPTIBILITY TO COMPACTION								
ao	Acroxic	L	rz	Rendzic	L	rs	Rustic	H
ab	Albic	M	fr	Ferric	H	sz	Salic	H
an	Andic	L	fi	Fibric	L	sa	Sapric	L
ar	Arenic	L	ge	Gelic	H	so	Sodic	H
ad	Aridic	NR	gl	Gleyic	H	st	Stagnic	H
ca	Calcaric	L	gs	Glossic	L	ti	Thionic	M
cc	Calcic	L/H*	ha	Haplic	NR	tu	Turbic	M
cb	Carbic	H	hi	Histic	L	um	Umbric	L
ch	Chernic	L	hu	Humic	L	vr	Vertic	H
cr	Chromic	NR	le	Leptic	NR	1	Town	NE
cy	Cryic	H	li	Lithic	NR	2	Soil disturbed by man	NE
dy	Dystric	M	lv	Luvic	H	3	Water body	NR
et	Entic	H	mo	Mollic	L	4	Marsh	NR
eu	Eutric	L	pe	Pellic	NR	5	Glacier	NR
pr	Protic	L	pi	Placic	H	6	Rock outcrops	NR

**LOW- in case of diffuse form of secondary carbonates; *HIGH – in case of cutans and nodules*

Evaluation of soil susceptibility to compaction according to soil texture

TEXTURAL CODES IN LEU [5]	DESCRIPTION	EVALUATION
1	Sandy and loamy-sandy soils	L
2	Clay soils	M/H*
3	Clay-loamy soils	M/H*
4	Clayey soils and clays	VH
5	Sandy-loamy	L/M*

*Explanations: * - final evaluation can be influenced by amount of organic matter and/or sand*
L – low, M – medium, H – high, VH – very high susceptibility

Soil texture plays a key role in susceptibility to compaction because it influences directly ground bearing capacity. Texture has also indirect influence through the determination of total organic matter content according to a generally valid rule stating that with the increase of clay content also organic matter content increases.

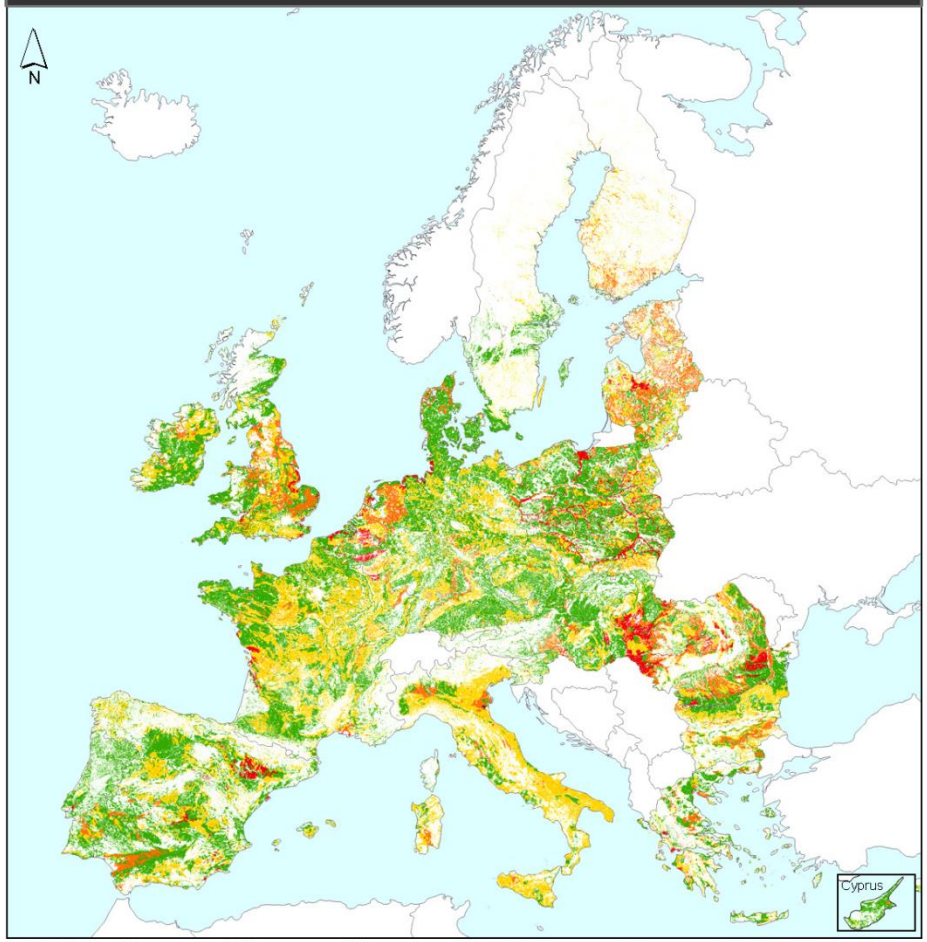
Limit values of soil properties according to soil susceptibility to compaction

Soil property	Soil textural categories					
	Clay	Clayey	Loam	Sandy-loam soil	Loamy-sandy soil	Sand
Bulk density ($g.cm^{-3}$)	>1,35	>1,40	>1,45	>1,55	>1,60	>1,70
Porosity (% objemu)	< 49	< 47	< 45	< 42	< 40	< 38
Minimum air capacity (% objemu)	< 10	< 10	< 10	< 10	< 10	< 10
Maximal capillary capacity (% objemu)	>35	>35	>35	-	-	-
Clay content(≤ 0,001 mm)	>30	>30	-	-	-	-

General soil moisture according to the textural category and proper soil moisture for cultivation; both in % of volume

SOIL TEXTURAL CATEGORY	SOIL HORIZON (m)	θ_s	θ_{FC}	PROPER SOIL MOISTURE for cultivation ($0.9\ \theta_{FC}$)
		(% of volume)		
Light soils	0 - 0.30	43.93	28.11	25.30
	0.31-0.80	44.26	27.71	24.94
	0.81-1.10	42.95	28.02	25.22
Medium heavy soils	0 - 0.30	45.35	34.09	30.68
	0.31-0.80	41.98	33.74	30.37
	0.81-1.10	40.47	33.25	29.93
Heavy soils	0 - 0.30	45.99	37.52	33.77
	0.31-0.80	43.83	36.91	33.22
	0.81-1.10	42.13	36.52	32.87
Very heavy soils	0 - 0.30	49.23	40.15	36.14
	0.31-0.80	45.15	40.9	36.81
	0.81-1.10	45.51	40.09	36.08
Clay	0 - 0.30	50.17	43.5	39.15
	0.31-0.80	50.06	45.44	40.90
	0.81-1.10	50.54	47.87	43.08

The natural susceptibility of soils to compaction



0 250 500 1,000 1,500 2,000 Km

Natural susceptibility to compaction

- No soil
- Low
- Medium
- High
- Very high
- No evaluation

This map shows the natural susceptibility of agricultural soils to compaction if they were to be exposed to compaction. The evaluation of the soil's natural susceptibility is based on the creation of logical connections between relevant parameters (pedotransfer rules). The input parameters for these pedotransfer rules are taken from the attributes of the European soil database, e.g. soil properties: type, texture and water regime, depth to textural change and the limitation of the soil for agricultural use. Besides the main parameters auxiliary parameters have been used as impermeable layer, depth of an obstacle to roots, water management system, dominant and secondary land use. It was assumed that every soil, as a porous medium, could be compacted.

MAP INFORMATION

Spatial coverage: 27 Member States of the European Union where data available.

Pixel size: 1km
Projection: ETRS89 Lambert Azimuthal Equal Area

Input data - source
Soil data - European Soil Database v2
Land Use - CORINE Land Cover 2000

BIBLIOGRAPHIC INFORMATION

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Digital datasets can be downloaded from
http://eusoils.jrc.ec.europa.eu/

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Soil as third water source

- *Amount of water in soils of Slovakia*
  - Agricultural soils: 5,06 mld.m^3
  - Forest soils: 3,56 mld.m^3

Springing water in Slovakia: 12.49 mld.m^3 (100%)
Water in soils in total: 8.62 mld.m^3 (69%)

Main soil properties influencing WHC

- Soil texture
- Soil mineralogical composition
- Soil type (kind and arrangement of soil horizons)
- Soil depth

Typical values of soil water holding capacity acoording to textural categories

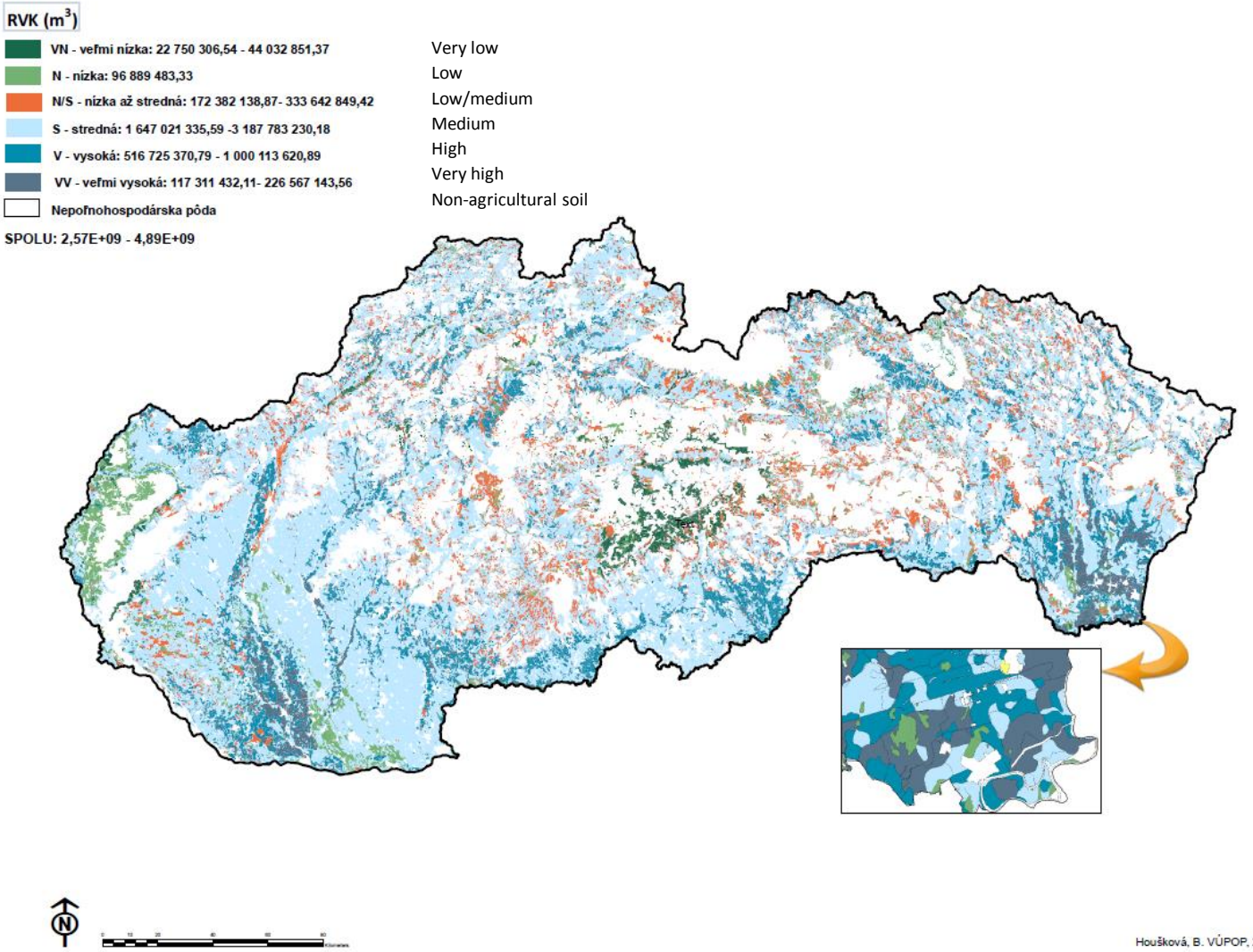
Textural code	Soil texture	WHC	WHC (θ)
1	Sandy, L/S	Very low	10
5	S/H	Low	20
2	Loam	Medium	35
3	C/L	High	40
4	Clay	Very high	45

Soil depth evaluation

Soil depth code	Soil depth	Evaluation
0	Deep soils	>60 cm
1	Medium deep soils	30 - 60 cm
2	Shallow soils	<30 cm

Water holding capacity of soils

Retenčná vodná kapacita (RVK) poľnohospodárskych pôd Slovenska v závislosti od zrnitosti, hĺbky a plošného výskytu



Houšková, B. VÚPOP, 2011

Improvement of water holding capacity of soil due to agri land-improvement to the depth of 0,6 m

Soil type	Compacted soil		Non-compacted soil		Compacted soils	Non-compacted soil
	ρ_d (g.cm^{-3})	θ_P (% obj.)	ρ_d (g.cm^{-3})	θ_P (% obj.)	RVK (m^3.ha^{-1})	RVK (m^3.ha^{-1})
Clay	1,5	43	1,35	49	2 322	2 646
Clayey soil	1,6	40	1,4	47	2 160	2 538
Loamy soil	1,65	38	1,45	45	2 052	2 430
Sandy-loamy soil	1,75	34	1,55	42	1 836	2 268
Loamy-sandy soil	1,8	32	1,6	40	1 728	2 160
Sandy soil	1,9	28	1,7	38	1 512	2 052