

Jak se pečeje o zemědělskou půdu v České republice?

Bořivoj ŠARAPATKA

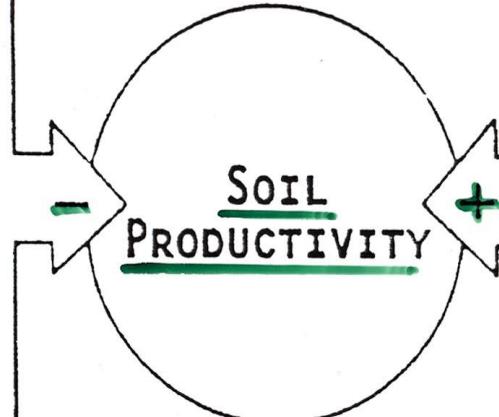
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SOIL DEGRADATION PROCESSES

SOIL EROSION
NUTRIENT RUNOFF
WATERLOGGING
DESERTIFICATION
ACIDIFICATION
COMPACTION
CRUSTING
ORGANIC MATTER LOSS
SALINIZATION
NUTRIENT DEPLETION
BY LEACHING
TOXICANT ACCUMULATION



SOIL CONSERVATION PRACTICES

CONSERVATION TILLAGE
CROP ROTATIONS
IMPROVED DRAINAGE
RESIDUE MANAGEMENT
WATER CONSERVATION
TERRACING
CONTOUR FARMING
CHEMICAL FERTILIZERS
ORGANIC FERTILIZERS
IMPROVED NUTRIENT CYCLING
IMPROVED SYSTEMS TO MATCH
SOIL, CLIMATE AND CULTIVARS



SOIL

THE SURFACE LAYER

A SURVEYOR "FOOTPRINT"

This imprint of a footpad of the U.S. unmanned Surveyor 3 spacecraft was photographed on the Moon by Apollo 12 astronauts who had landed their lunar module near the Surveyor. Surveyor 3 had landed on the Moon 31 months before it was visited by the astronauts. The Surveyor had bounced upon landing, leaving the footprint.

Television images of the footprint and other lunar features had been transmitted to Earth by the Surveyor after it landed. These images showed that men and machines would be able to move about without sinking deep into the soil.



ORANGE SOIL

Apollo 17 astronauts discovered an area of orange soil on the rim of Shorty crater, in the Valley of Taurus-Littrow. A trench was dug to obtain samples of this material. Subsequent study of the orange soil indicates that it was formed during volcanic eruptions 3.7 billion years ago.



LUNAR ROVING VEHICLE TRACKS

The wheels of the lunar roving vehicles used for transportation on the Moon by the crewmen of Apollo 15, 16, and 17 were specially designed to provide support and traction in the soft lunar soil. Studies of the wheels' performance and the tracks they left have improved understanding of the mechanical properties of lunar soil.

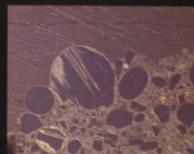


SOIL PARTICLES

Lunar soil contains fragments of the major lunar rock types: breccia (A), anorthosite (B), and brecchia (C). In addition, round glass particles (D) are present. The materials that make up these particles are the products of the continuous bombardment of the Moon by meteoroids which smash and grind rocks into soil and weld soil into new rocks.

ORANGE GLASS

Orange glass spheres, like the green glass spheres, originate in the same source. The glass in the orange spheres here has begun to crystallize into dark, needlelike crystals.



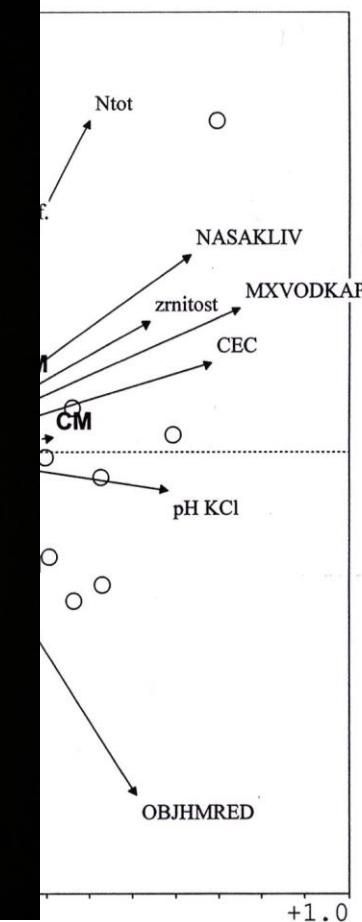
BOOT PRINT

Apollo 11 astronaut Neil A. Armstrong left this footprint in the lunar soil at Tranquillity Base, July 20, 1969. The impression, about 2.5 centimeters (1 inch) deep, demonstrates the fineness and cohesiveness of the lunar soil.



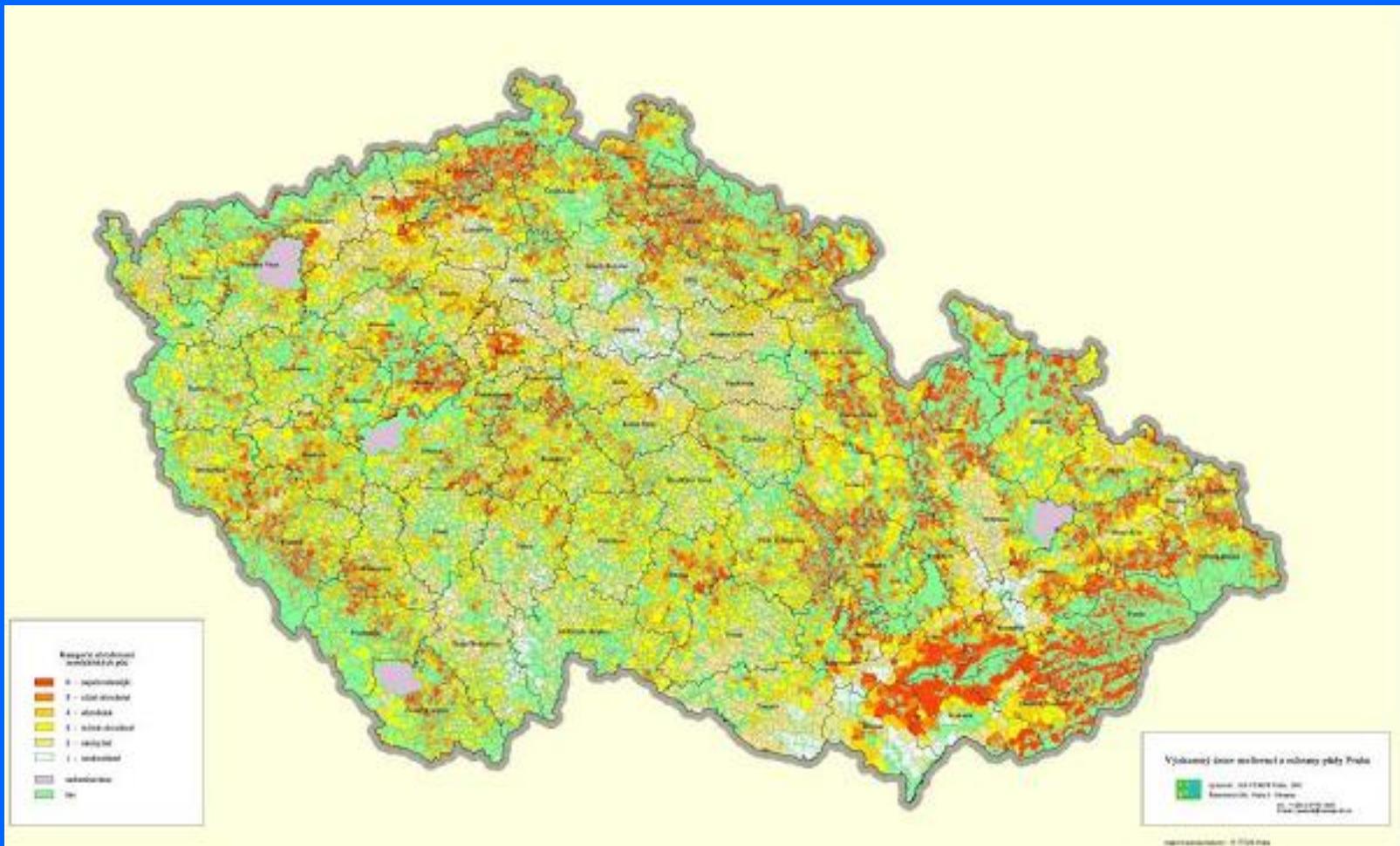
LUNAR SOIL TEXTURE

The texture of undisturbed lunar soil can be seen in this photograph. It requires the soil enlarged about 35 times. This soil is composed of aggregates, clumps of small particles 0.1-0.6 millimeters (4/1000-24/1000 inch) in diameter.

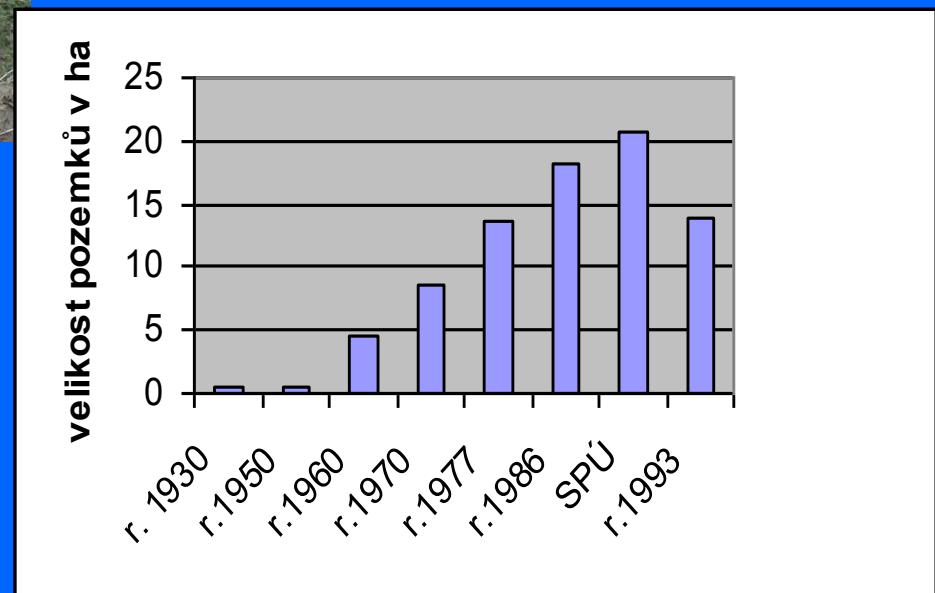


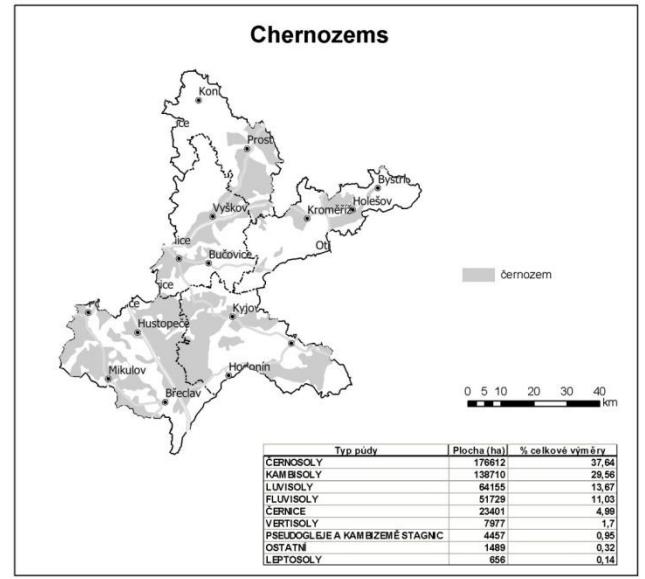
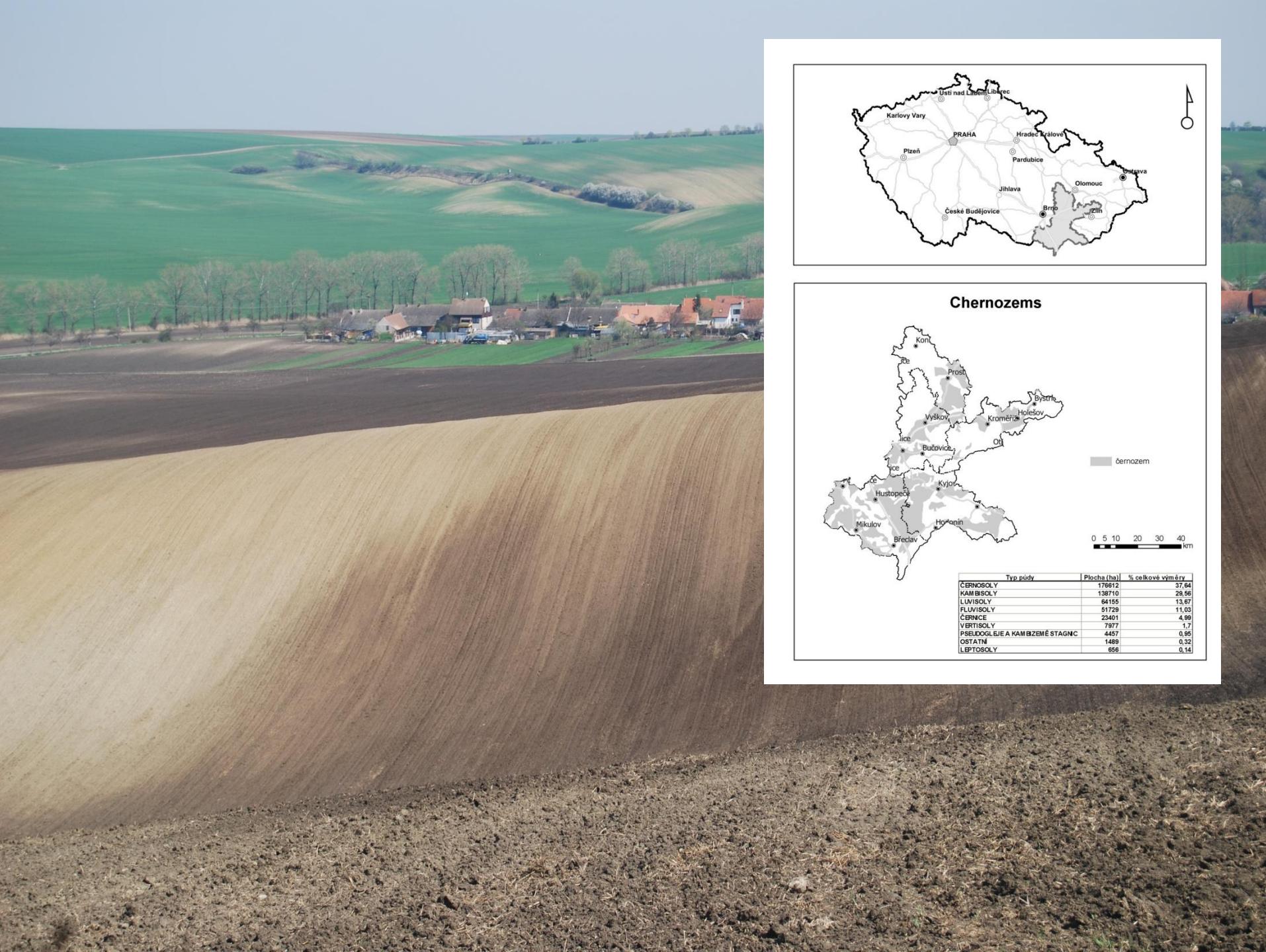


54 % of arable land - problems with water erosion



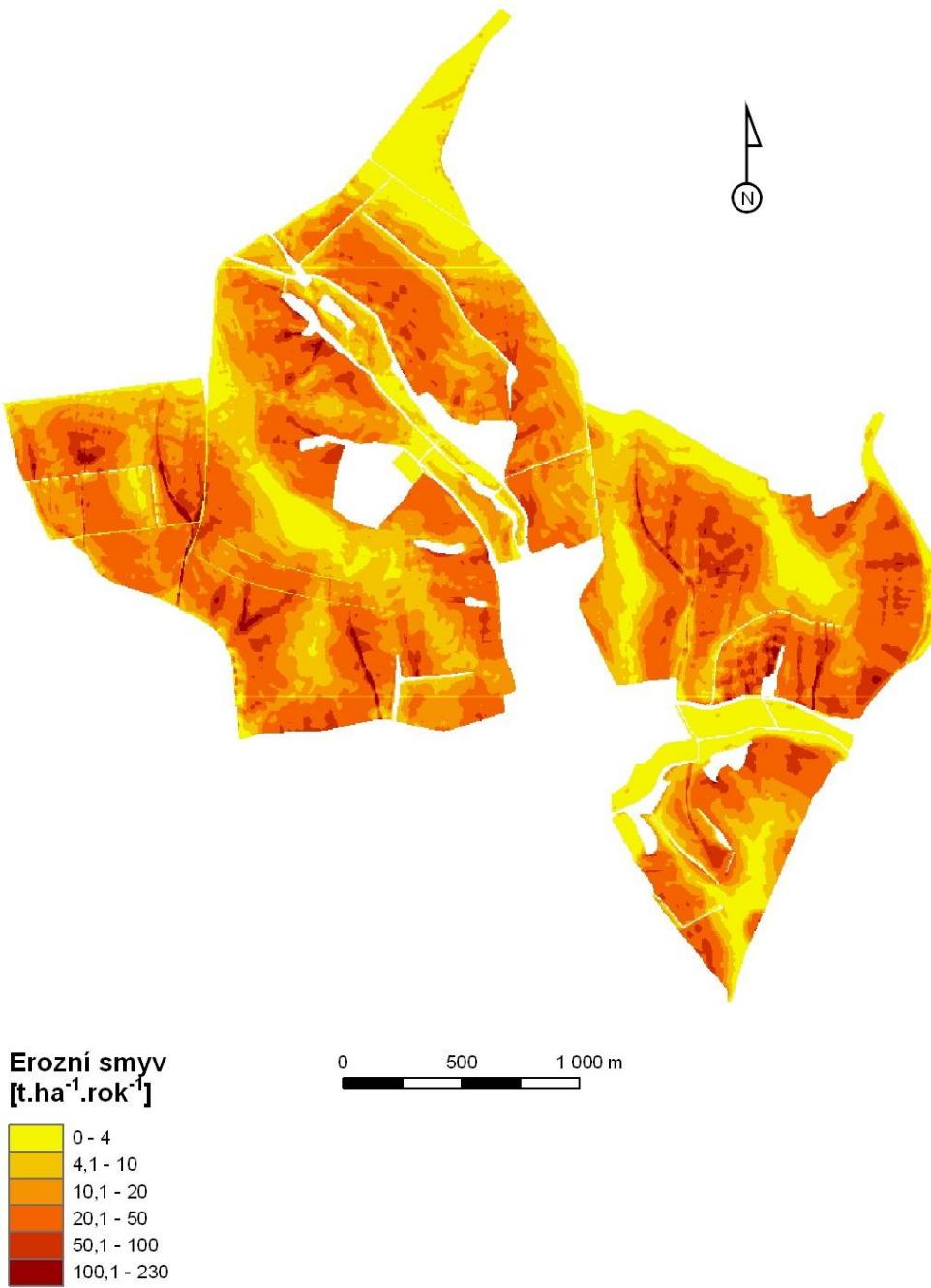
Soil erosion vs. average size of fields (in hectares)

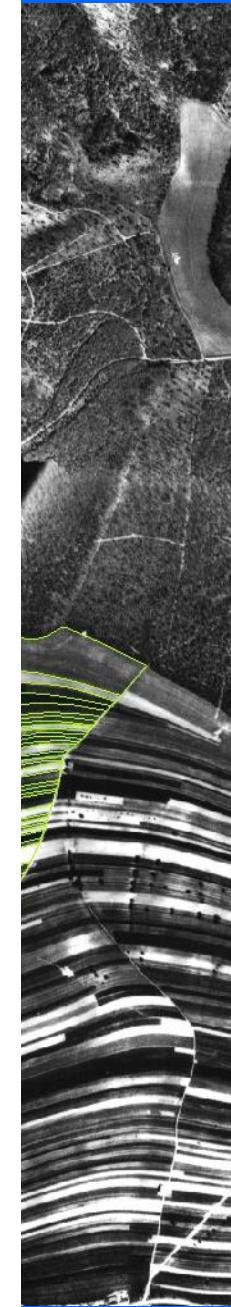
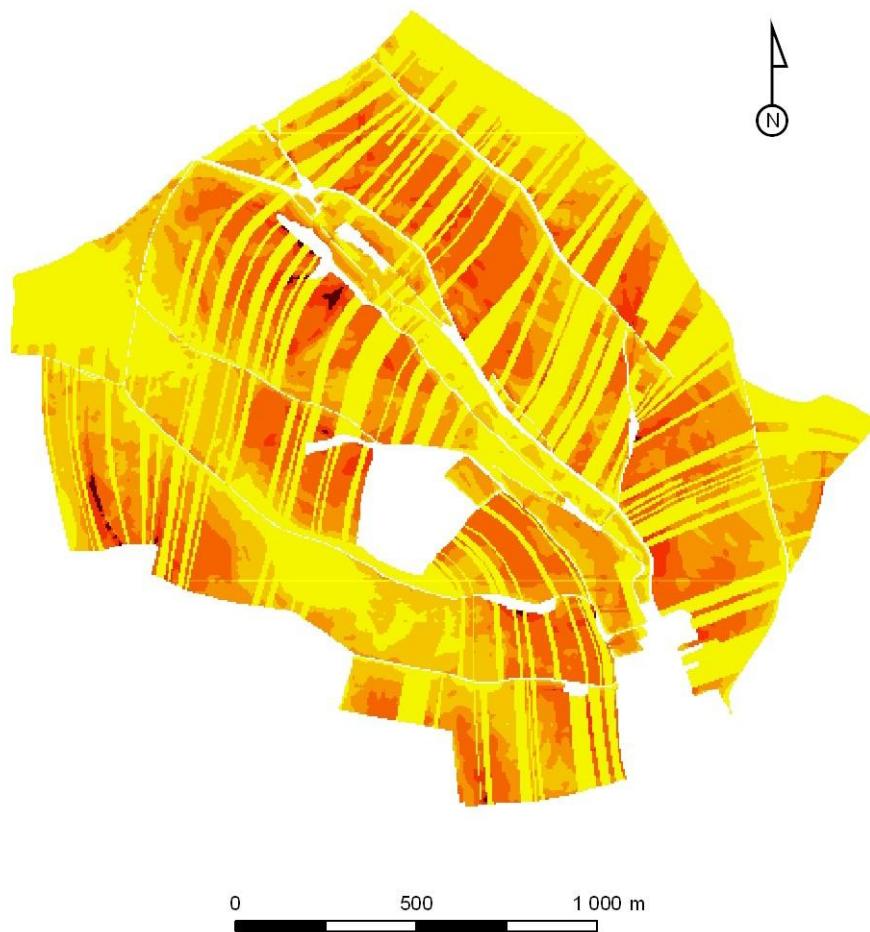




Typ půdy	Plocha (ha)	% celkové výměry
CERNOZOLY	176612	37,64
KAMBIOSOLY	138710	29,56
LLUVISOLY	64155	13,67
FLUVISOLY	51729	11,03
LEPTOSOLY	20301	4,06
VERTISOLY	7977	1,7
PSEUDOGLEJU A KAMBZEME STAGNICKY	4457	0,95
OSTATNI	1489	0,32
LEPTOSOLY	656	0,14

South
Moravia –
very
productive
region

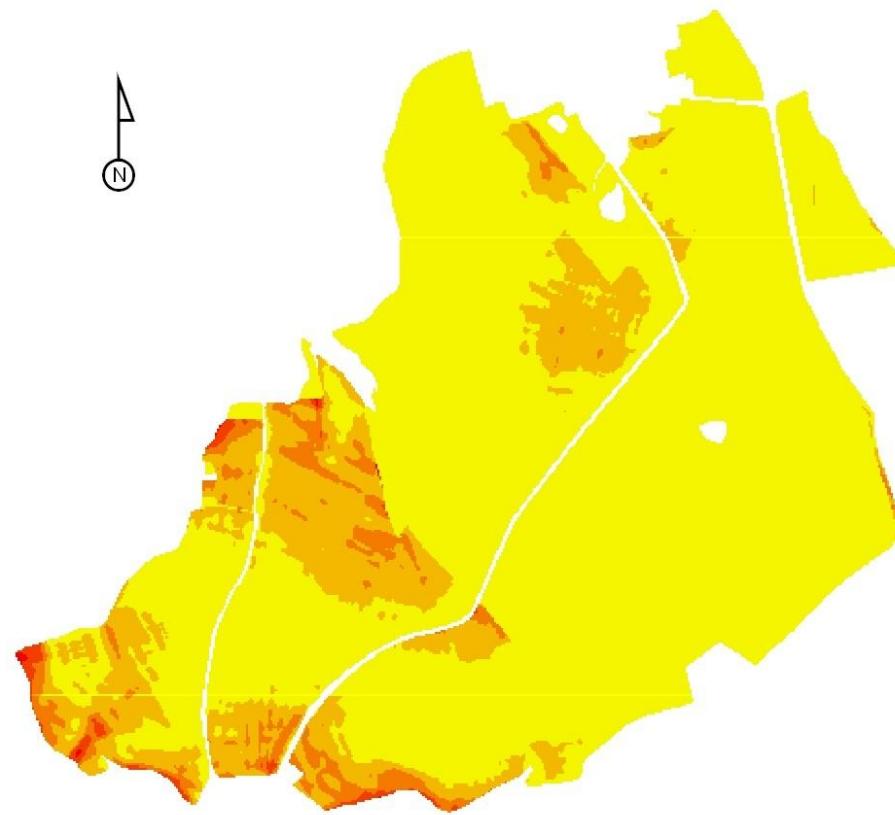




Erozní smyv
[t.ha⁻¹.rok⁻¹]

0 - 4
4,1 - 10
10,1 - 20
20,1 - 50
50,1 - 100
100,1 - 217

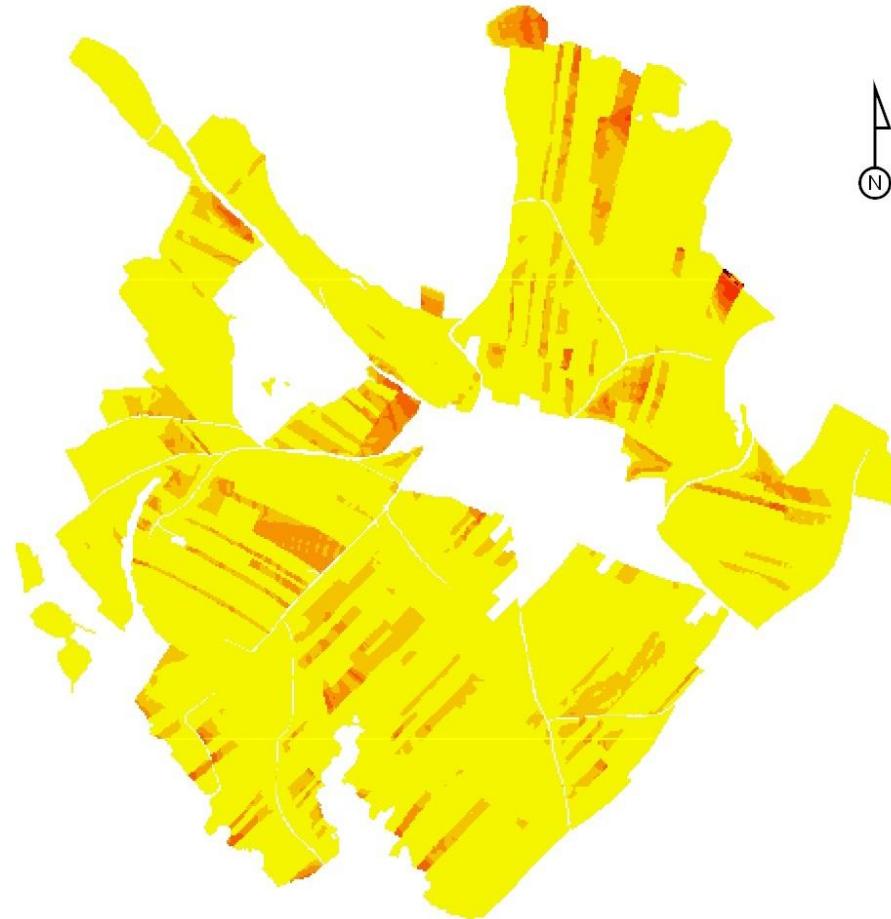
Submountain areas



Erozní smýv
[t.ha⁻¹.rok⁻¹]

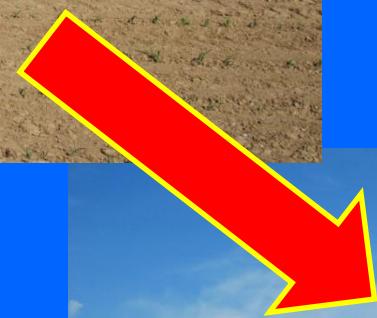
0 - 4
4,1 - 10
10,1 - 20
20,1 - 50
50,1 - 80





Erozní smyv
[t.ha⁻¹.rok⁻¹]

0 - 4
4,1 - 10
10,1 - 20
20,1 - 50
50,1 - 100
100,1 - 130





Assessment of soil erosion and deposition using ^{137}Cs

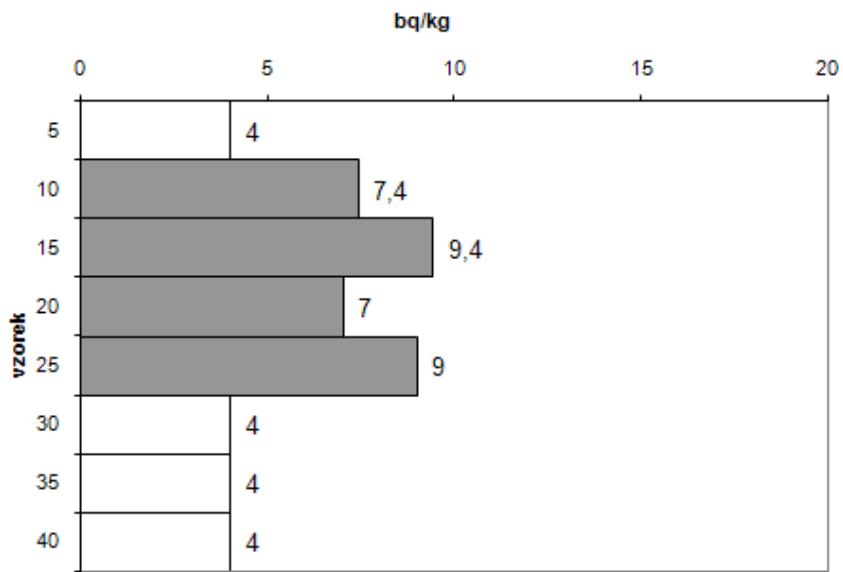
The key assumption to use caesium-137 radionuclide as a erosion tracer is finding of significant relationship between soil loss and radionuclide loss. Then the spatial distribution of these radionuclides in the field can determine areas of net soil loss (erosion) and net gain (deposition).

The assessment of ^{137}Cs redistribution is based on a comparison of measured inventories (^{137}Cs total activity per area) of a individual sampling point in the field with an reference inventory (stable site, without erosion/deposition).

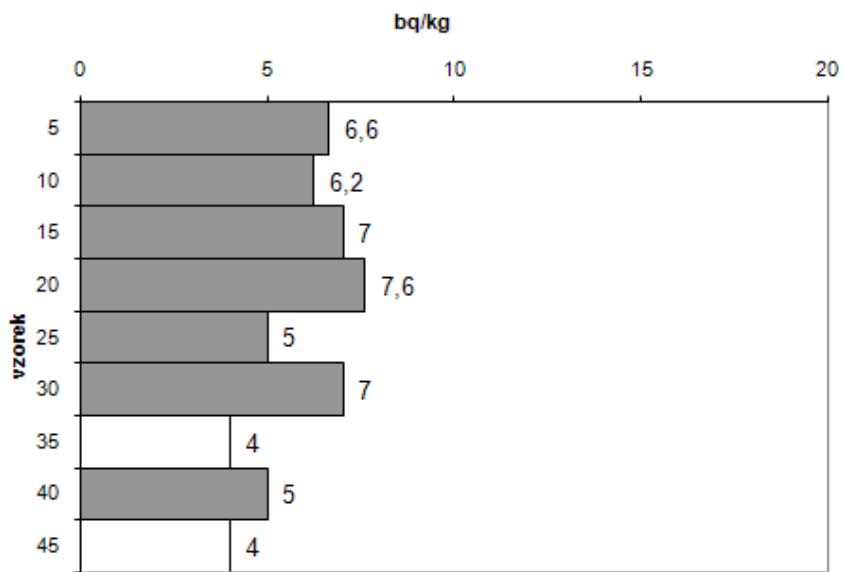




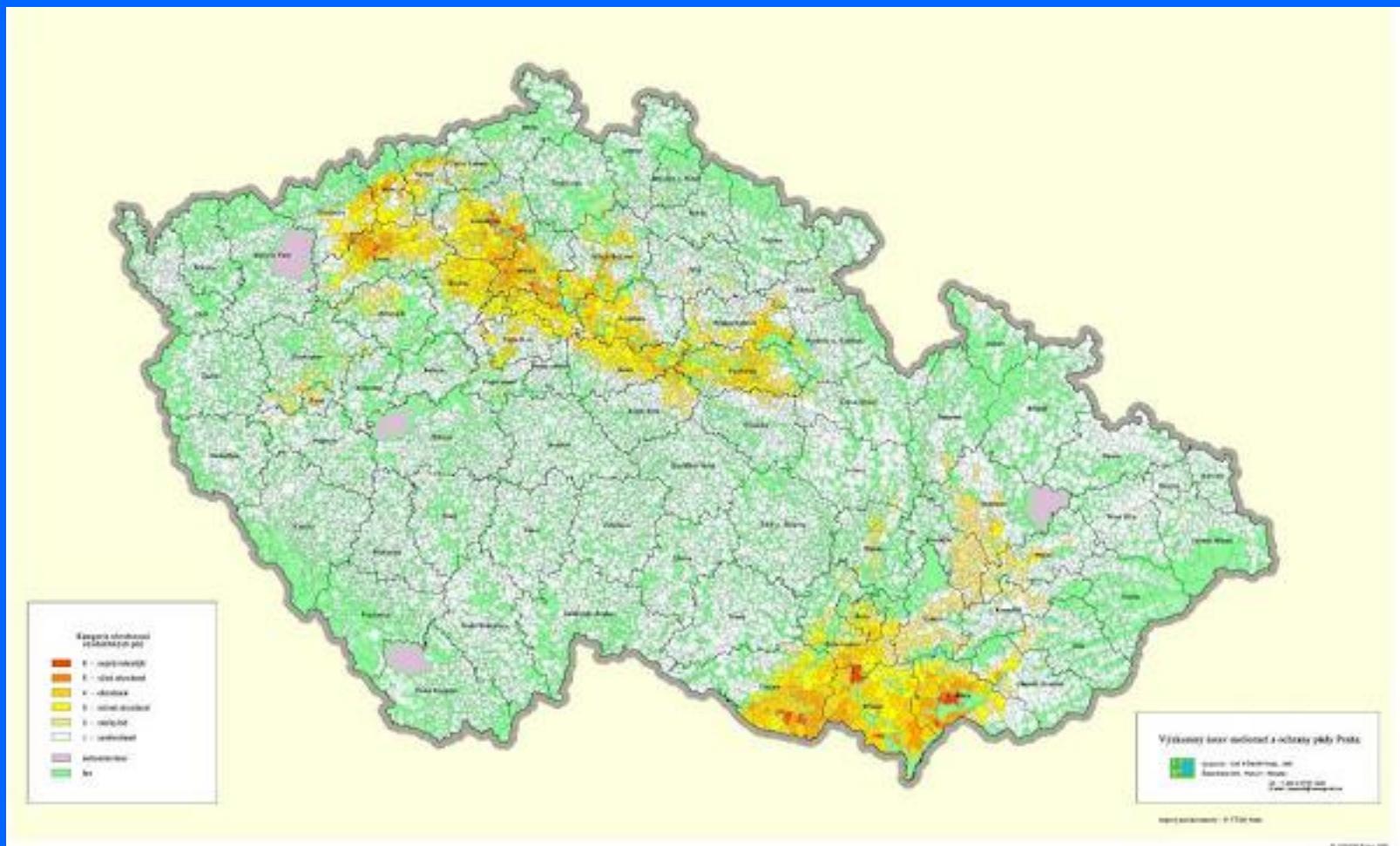
Čejkovice - eroze



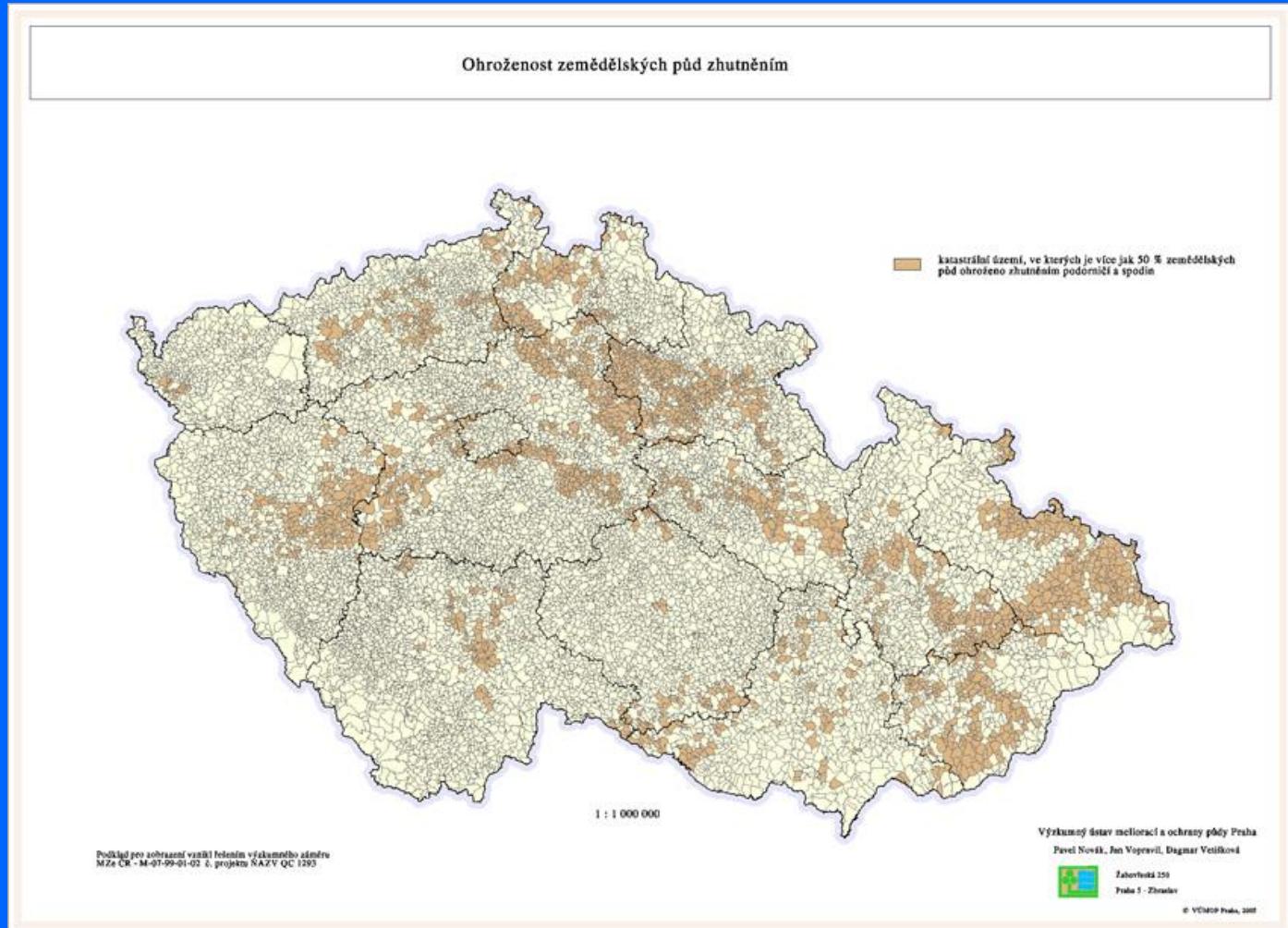
Čejkovice - akumulace



10.4 % of arable land - problems with wind erosion

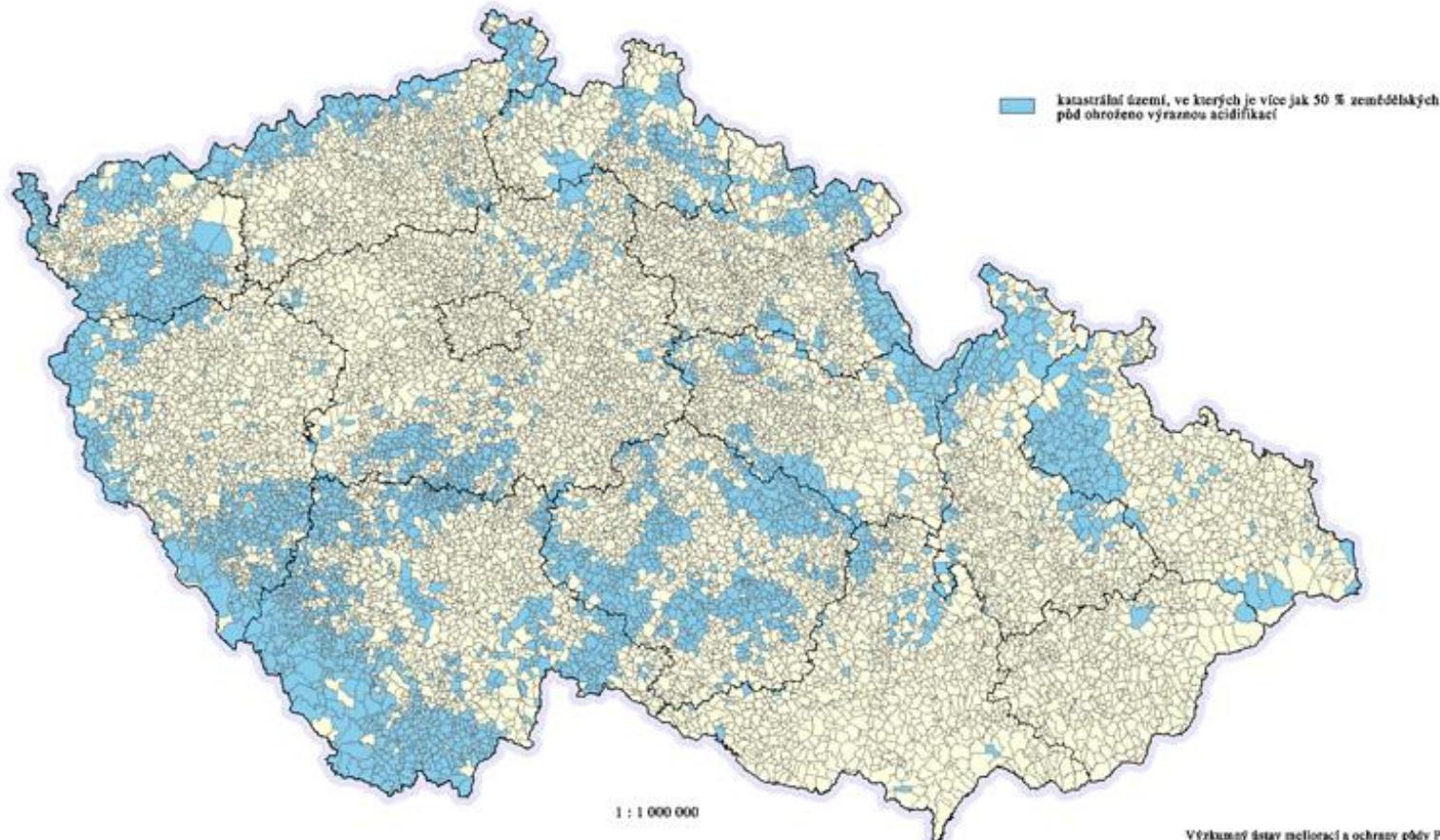


45 % of agricultural land - problems with compaction



Acidification

Ohroženost zemědělských půd acidifikací



Loss of organic matter

Ohroženost zemědělských půd dehumifikací

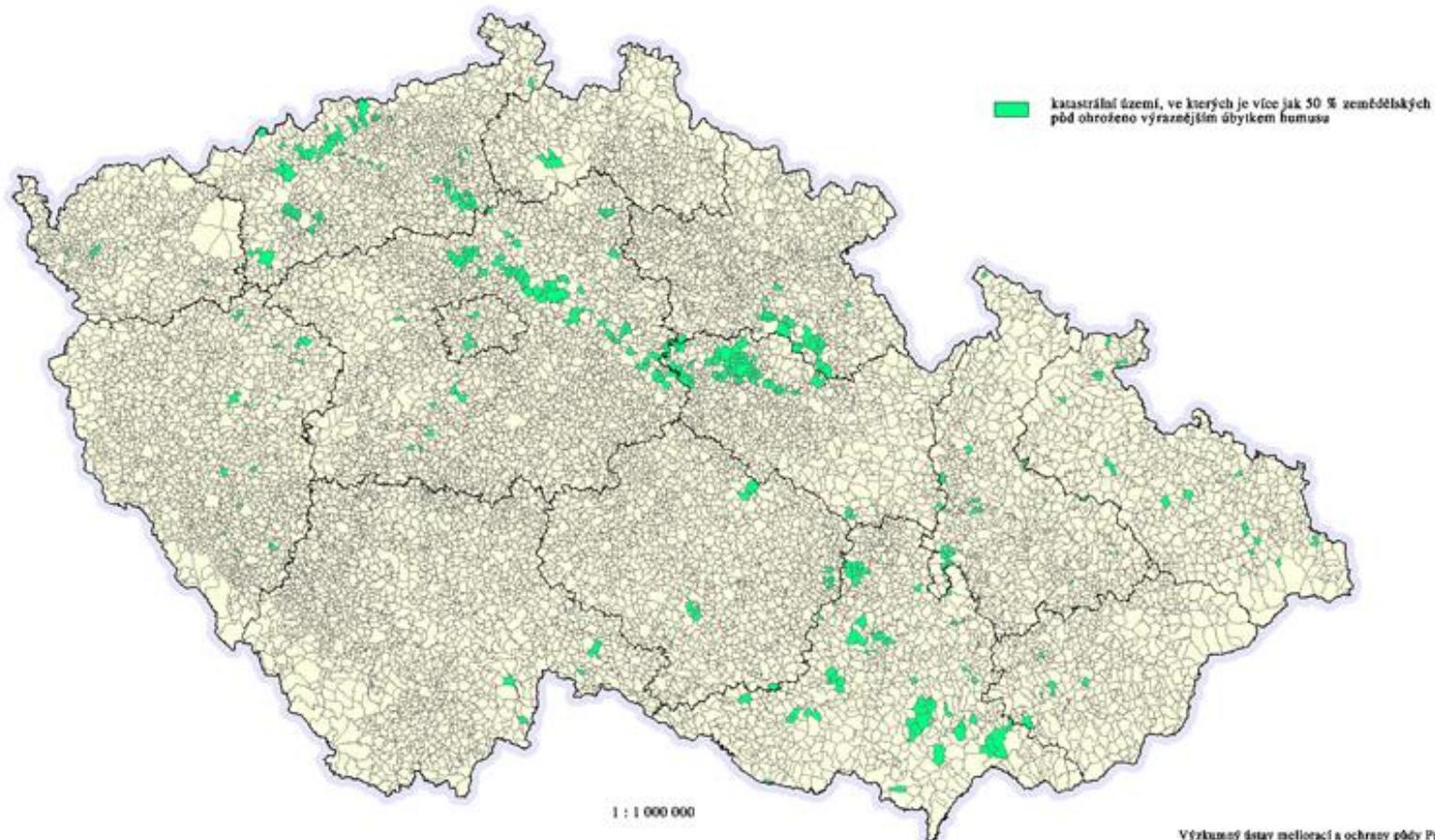
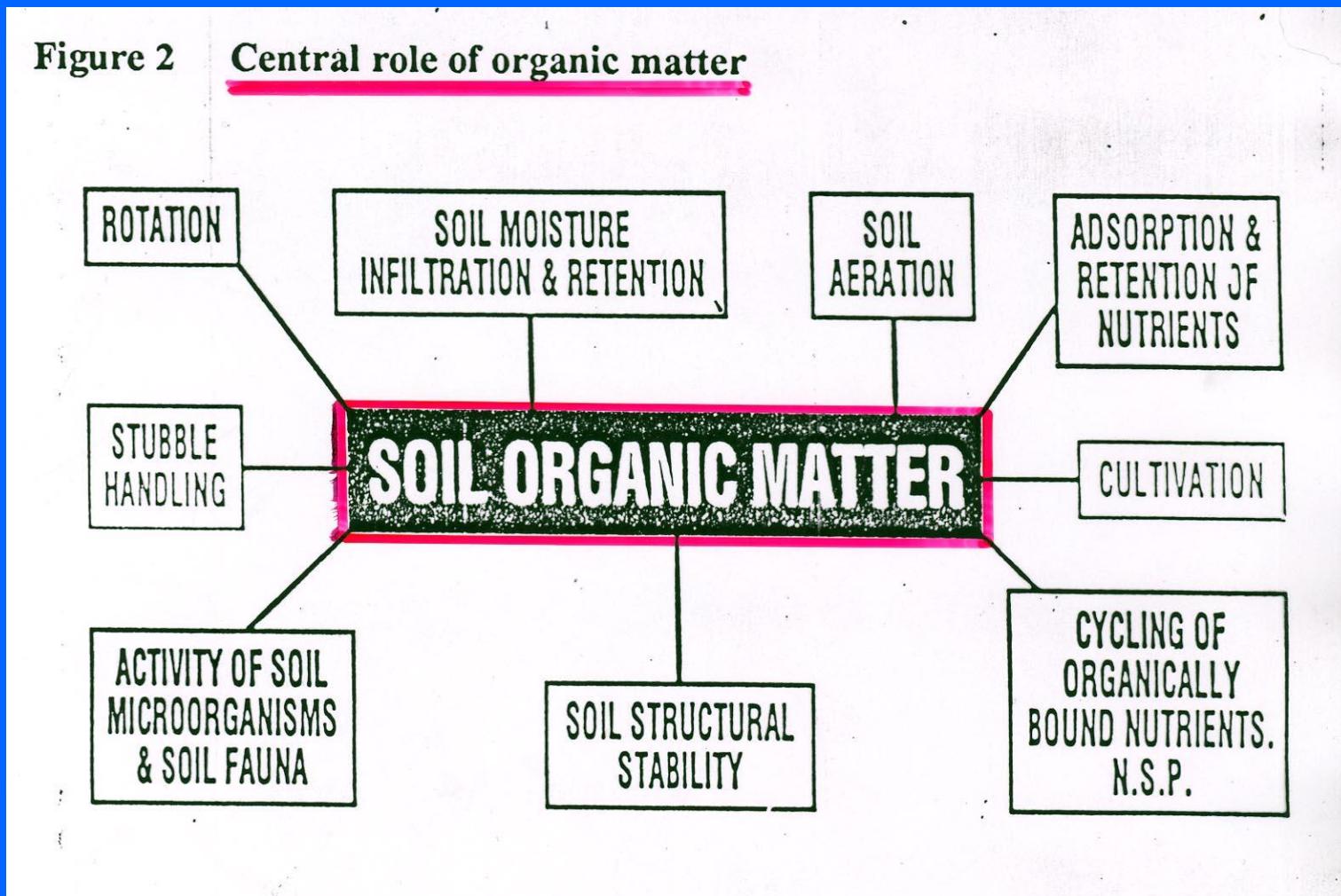
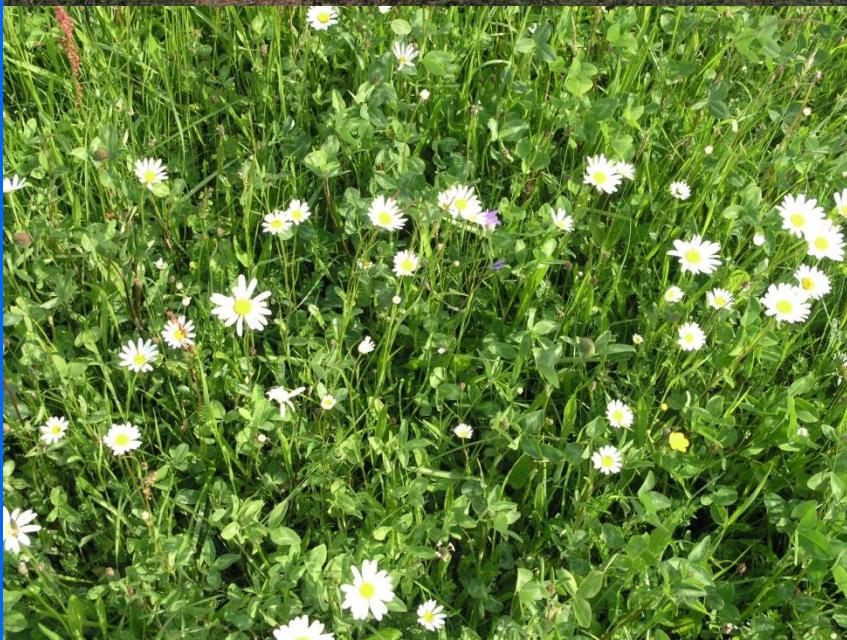


Figure 2 Central role of organic matter

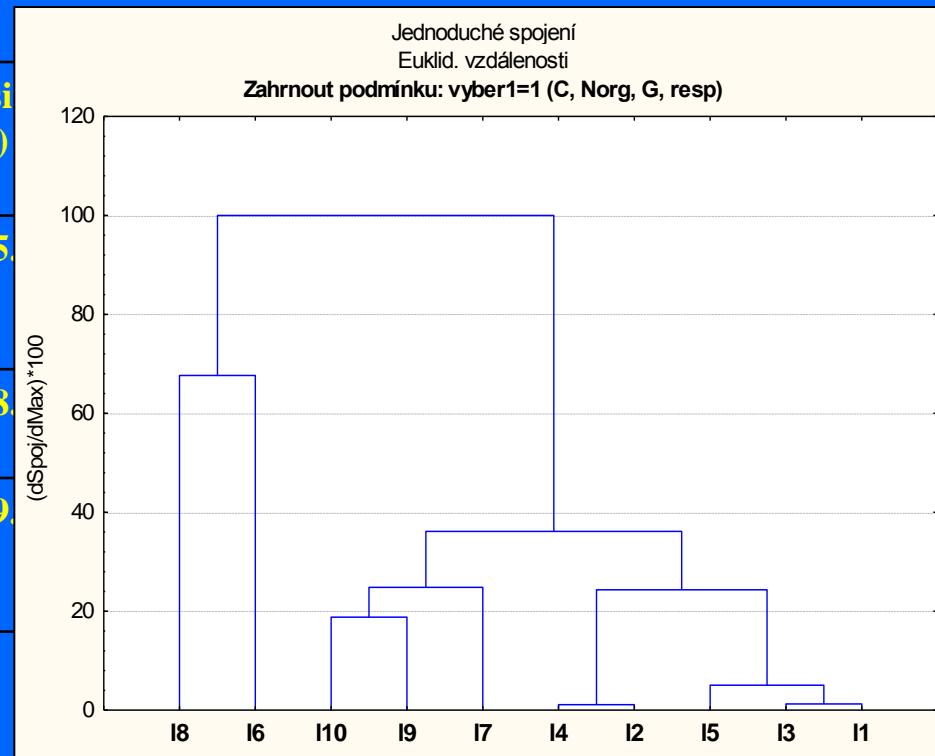




Different types of grassland ecosystems:

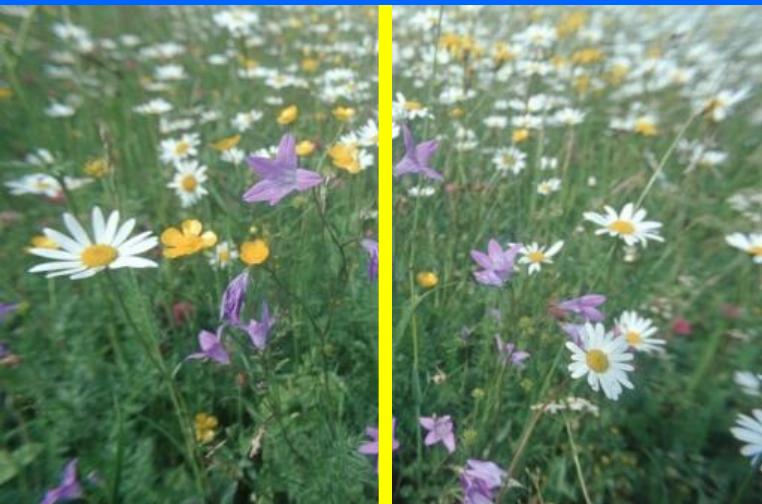
- newly established grassland
 - average 16 plant species
- species-rich communities
 - average 33 plant species

	Conduct.	Bulk density (Mg/m ³)	Porosity (%)
Temporary grassland - newly established grassland	70.25	1.46	45.2
Temporary grassland - older re-cultivation	54.15	1.36	48.1
Seminatural grassland- species reach communities	39.95	1.35	49.1



	C (%)	Norg. (mg/kg)	HA:FA	respiration
Temporary grassland - newly established grassland	2.02	2069.90	0.244	3.99
Temporary grassland - older re-cultivation	2.76	3167.13	0.282	2.51
Seminatural grassland- species reach communities	3.93	5704.15	0.363	6.12

Seminatural grassland



Species reach communities



$C = 106,1 \text{ t/ha}$

Temporary grassland

Older re-cultivation



Temporary grassland

Newly established grassland



$C = 58,9 \text{ t/ha}$

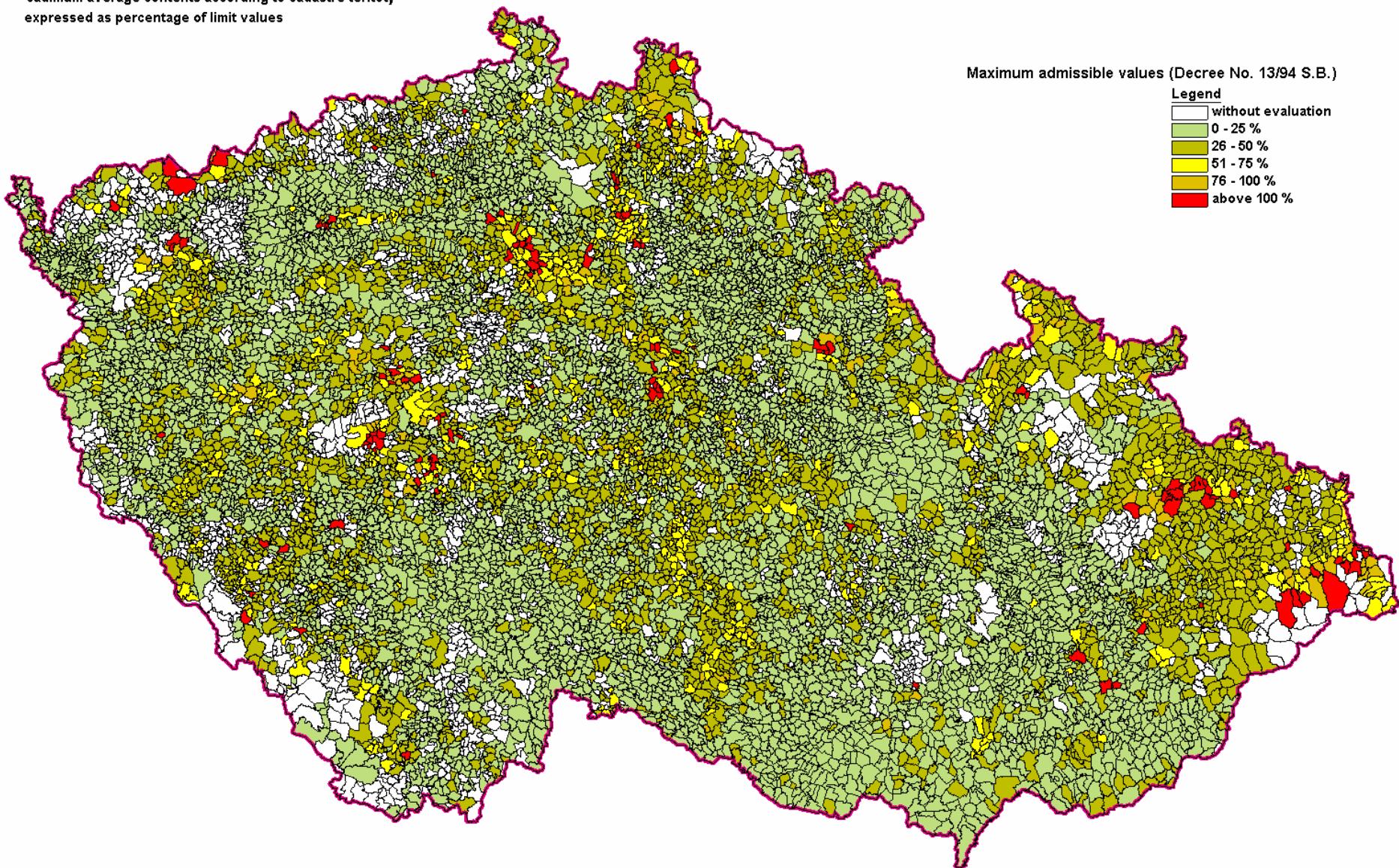
$C = 75,1 \text{ t/ha}$

Contents of risk elements in agricultural soil in the Czech Republic

Map 2

Cadmium (Cd) 2M nitric acid

cadmium average contents according to cadastre territory
expressed as percentage of limit values



The process model functions were specified as:

$$CHM = a_1 \cdot LOM + a_2 \cdot A + a_3 \cdot HMI$$

$$PHD = b_1 \cdot WIE + b_2 \cdot WAE + b_3 \cdot ES + b_4 \cdot SC + b_5 \cdot DI$$

$$RDM = c_1 \cdot CHD + c_2 \cdot PHD$$

$$DSM = d_1 \cdot WIE + d_2 \cdot LOM + d_3 \cdot DI$$

LOM Loss of organic matter

A Acidification

HMI Heavy metal intoxication

WAE Water erosion

WIE Wind erosion

ES Extreme soils (clay soils)

SC Soil compaction

DI Dryness impact

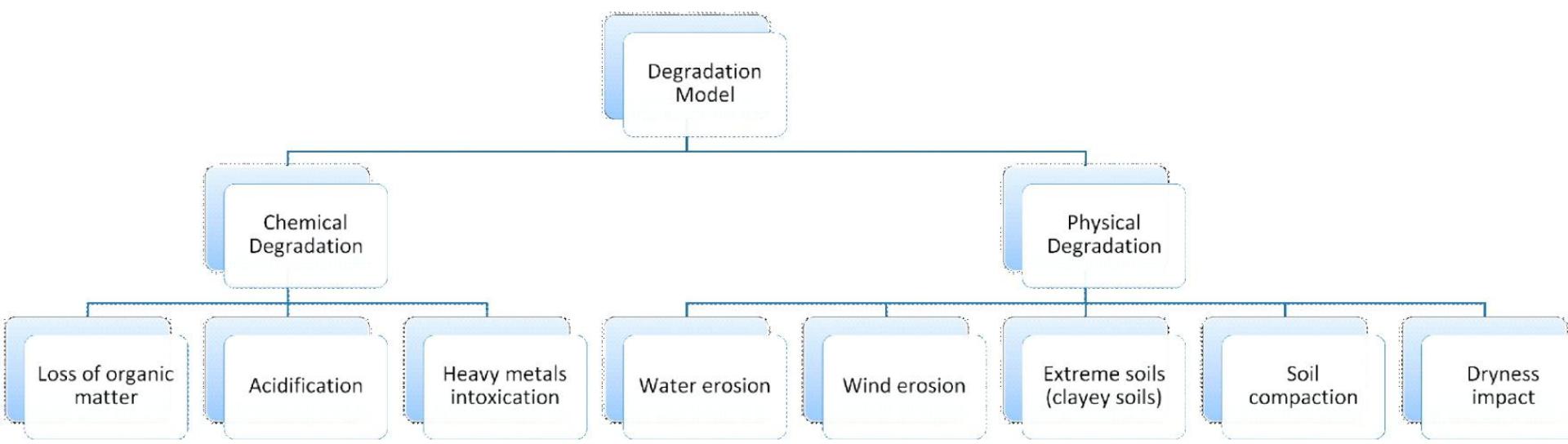
CHD Chemical degradation

PHD Physical degradation

RDM Resulting Degradation Model

DSM Desertification Model

Individual weightings $a_1, a_2, a_3, b_1, b_2, b_3, b_4, b_5, c_1$ and c_5 were specified by judgment of an independent agricultural specialist.



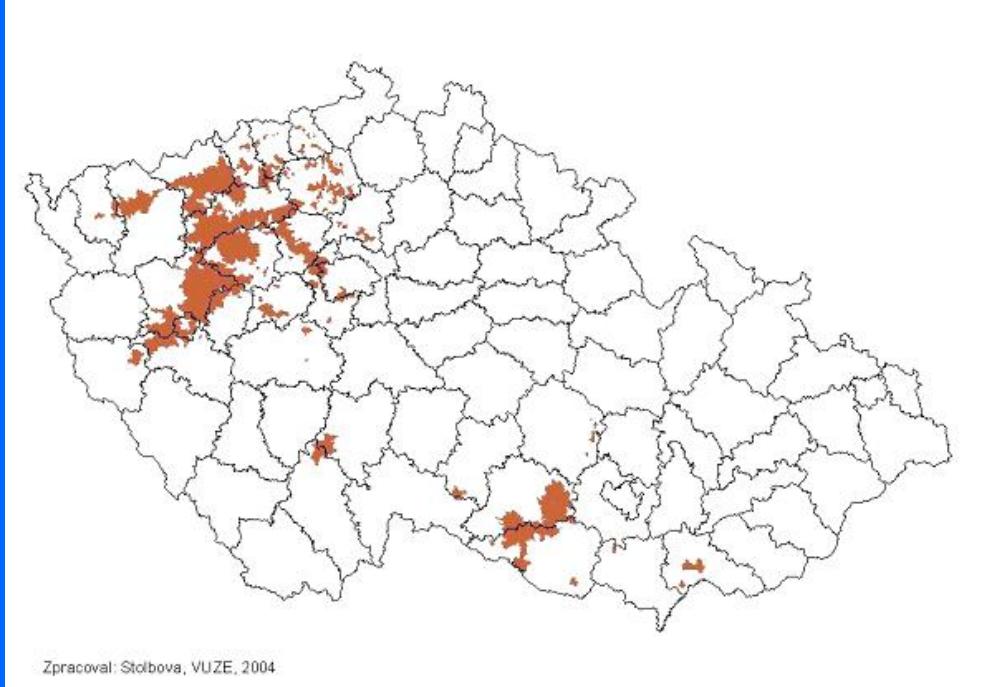
Desertification

Wind erosion

Loss of organic matter

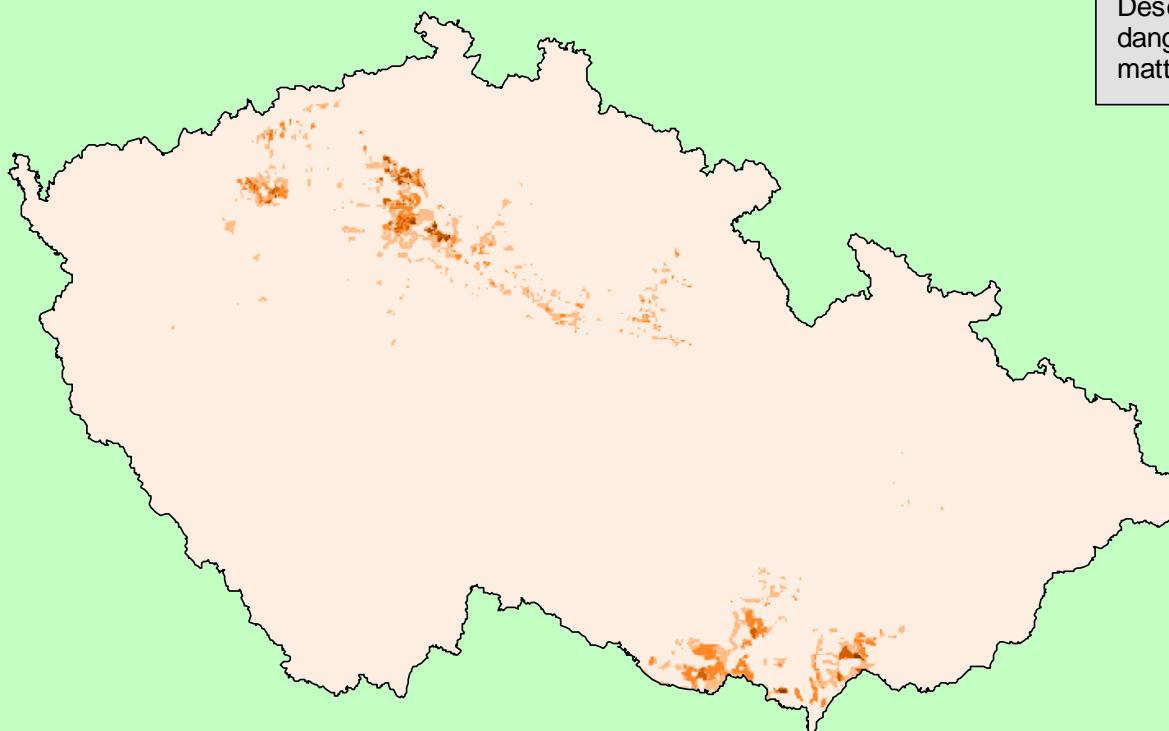
Dryness impact

1



Desertification

Czech Republic



Desertification consists of a set of potential dangers which are: wind erosion, loss of organic matter and dryness impact.

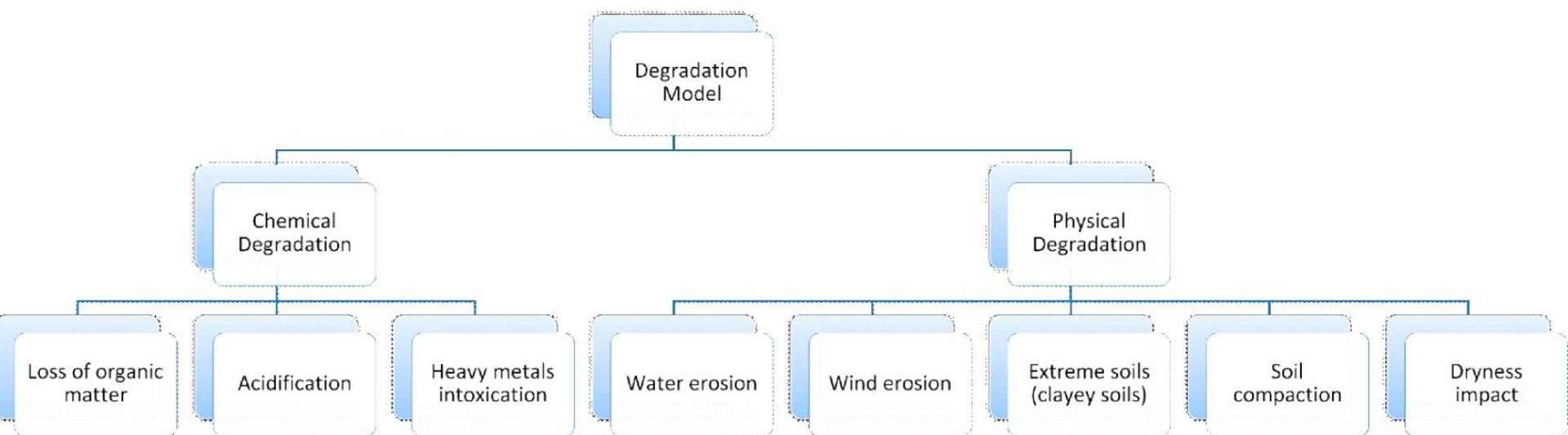
Desertification Threat

safe
low
middle
high
extremely high

0 25 50 75 100 Kilometers

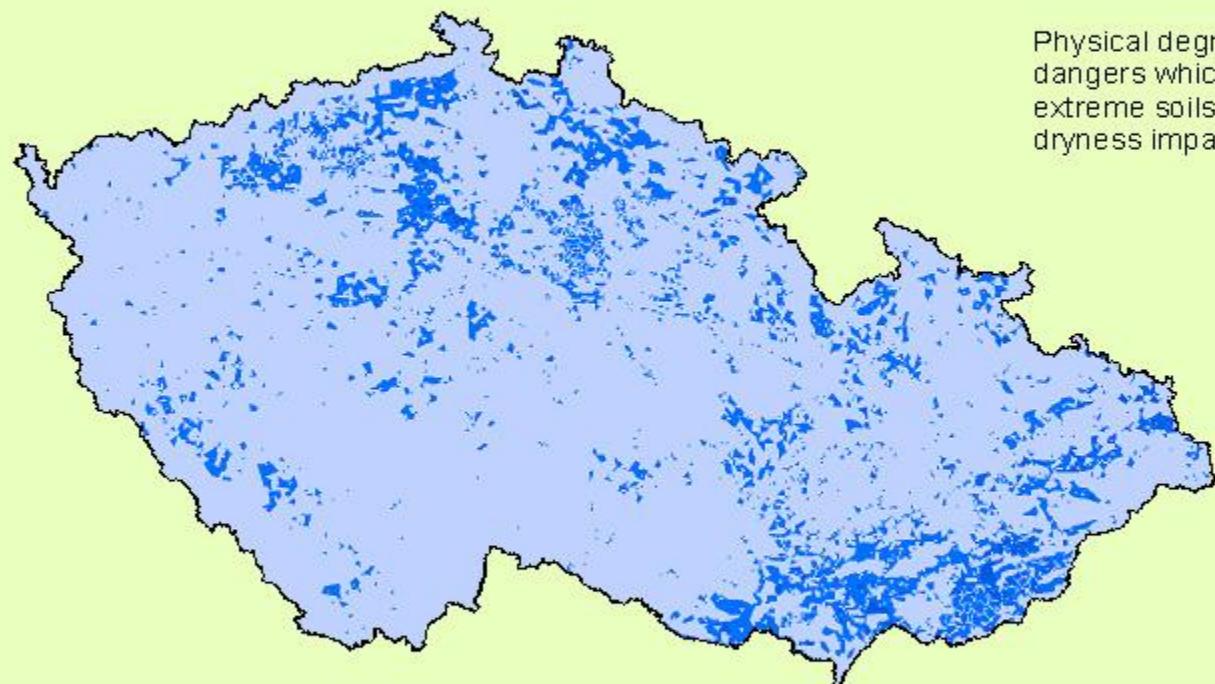
Projection coordination system:
S-JTSK

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From the sources of Research Institute of Ameliorations
and Soil Conservation, Prague



Physical Degradation of Soil

Czech Republic



Physical degradation consists of a set of potential dangers which are: water erosion, wind erosion, extreme soils (clayey soils), soil compaction and dryness impact.

Physical Degradation Threat

- safe
- low
- middle
- high
- extremely high

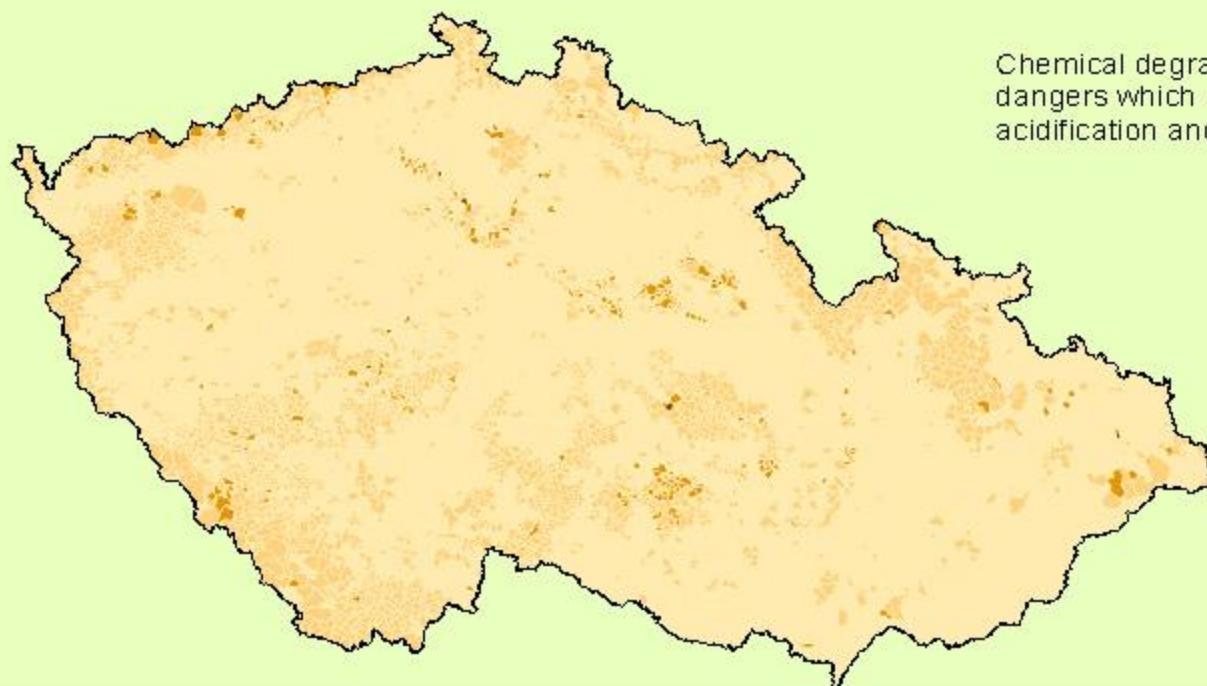
0 20 40 80 120 160 Kilometers

Projection coordination system:
S-JTSK

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Chemical Degradation of Soil

Czech Republic



Chemical degradation consists of a set of potential dangers which are: loss of organic matter, acidification and presence of the heavy metals.

Chemical Degradation Threat

- safe
- low
- middle
- high
- extremely high

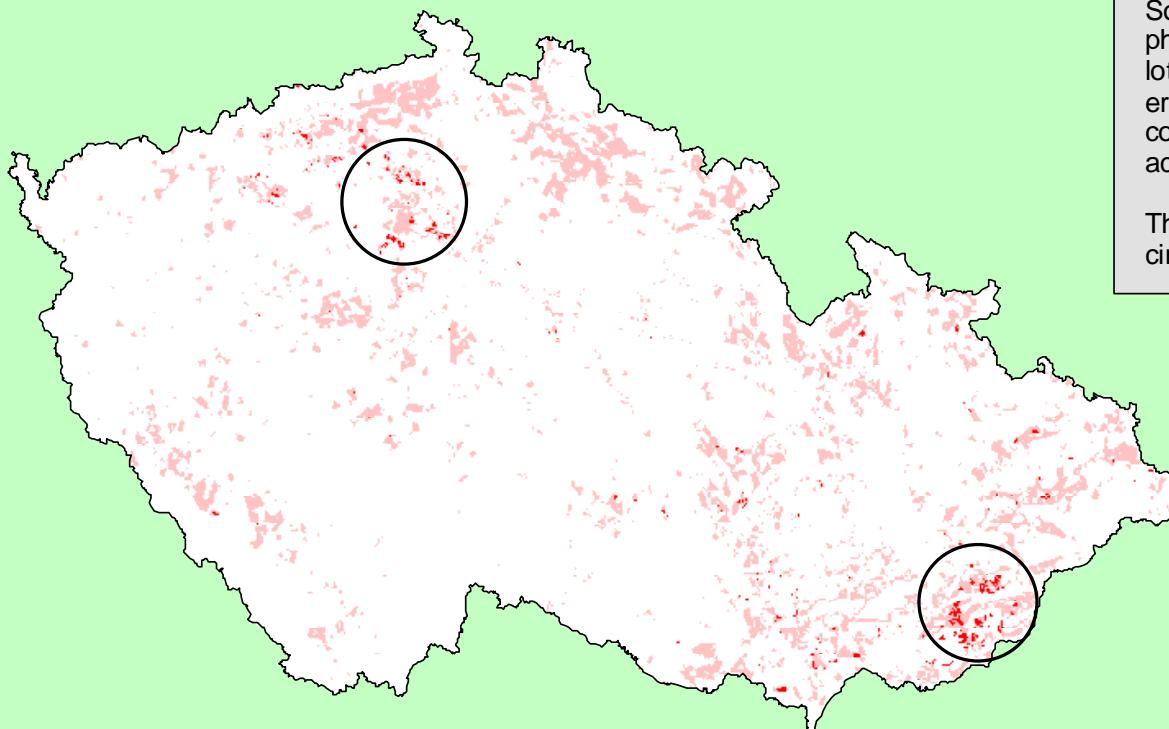
0 20 40 60 80 100 120 140 160 Kilometers

Projection coordination system:
S-JTSK

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Soil degradation model - results

Czech Republic



Soil degradation model is the sum of chemical and physical threat degradation models. Consists of a lot of dangers including: water erosion, wind erosion, extreme soils (clayey soils), soil compaction, loss of organic matter, dryness impact, acidification and intoxication by heavy metals.

The places with the biggest threat are rounded by circle.

The result of degradation model (potential threat)

white	safe
light pink	low
medium pink	middle
dark red	high
maroon	extremely high

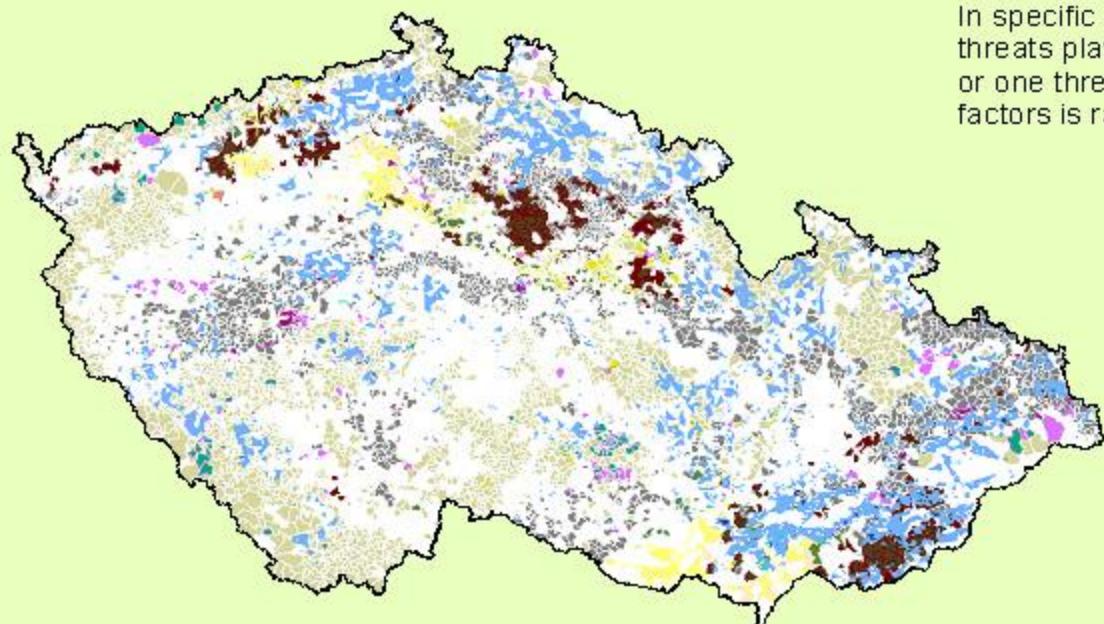
0 25 50 75 100 Kilometers

Projection coordination system:
S-JTSK

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UP Olomouc

Degradation Threats Distribution

Czech Republic



In specific area one or some combination of degradation threats play the critical role. Combination of two threats or one threat cover nearly all area. Combination of more factors is rare.

Critical Degradation Threats

safe	HeMSoC	AciSoC
WiE SoC	HeMExS	AciHeM
WiE ExS	HeMDrl	AciExS
WiE Drl	HeM	AciDrl
WiE	ExSSoC	Aci
WaEWiE	ExSDrl	LomWE
WaESoC	ExS	Lom HeM
WaE	DrlSoC	Lom ExS
SoC	Drl	Lom Drl
more fact.	AciWiE	Lom Aci
HeMWME	AcMWAE	Lom

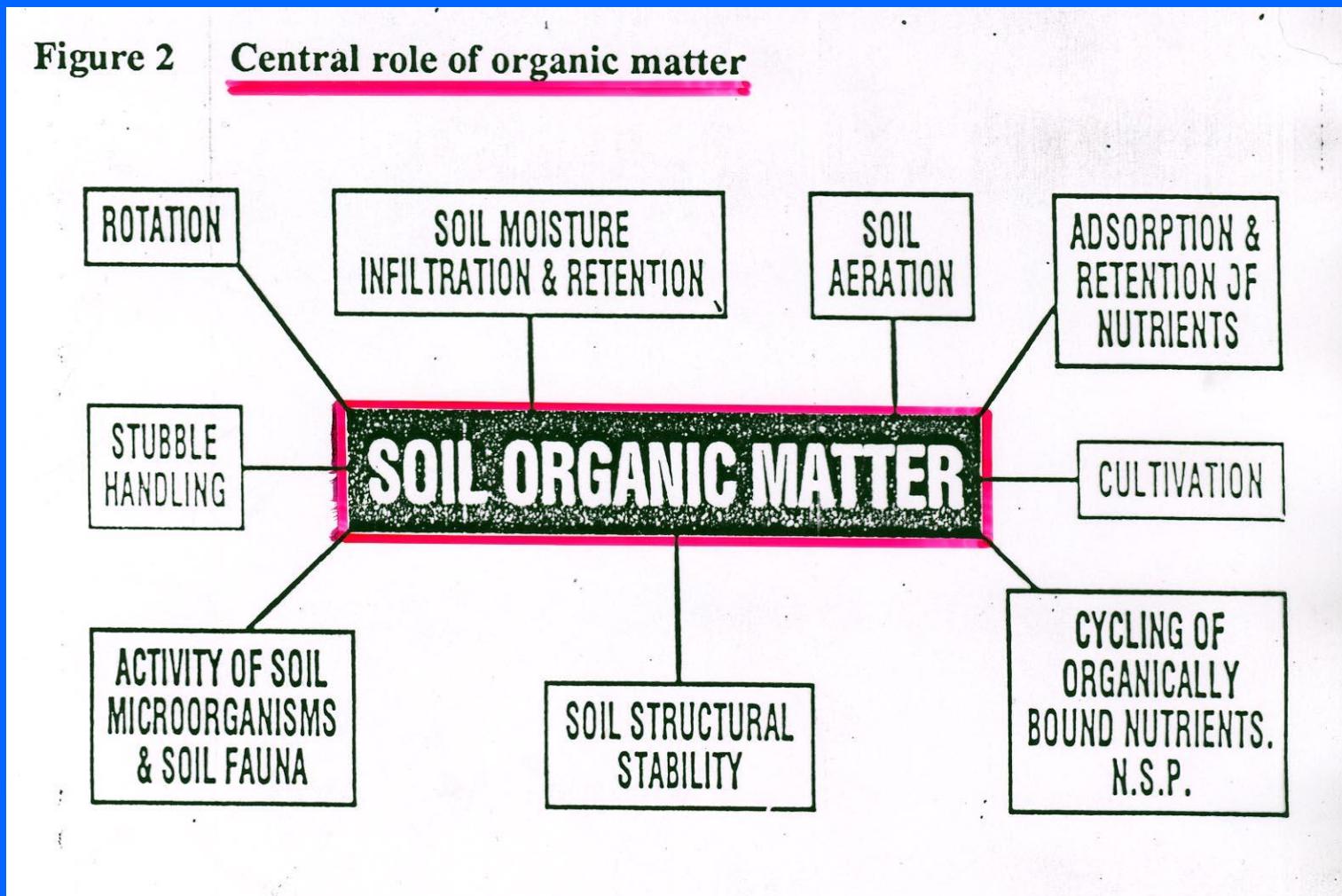
WiE - wind erosion, WaE - water erosion, SoC - soil compaction, HeM - heavy metals, ExS - extreme soils, Drl - dryness impact, Aci - Acidification, Lom - loss of organic matter

0 15 30 60 90 120 Kilometers

Projection coordination system:
S-JTSK

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Figure 2 Central role of organic matter



Jednoduché spojení
Euklid. vzdálenosti

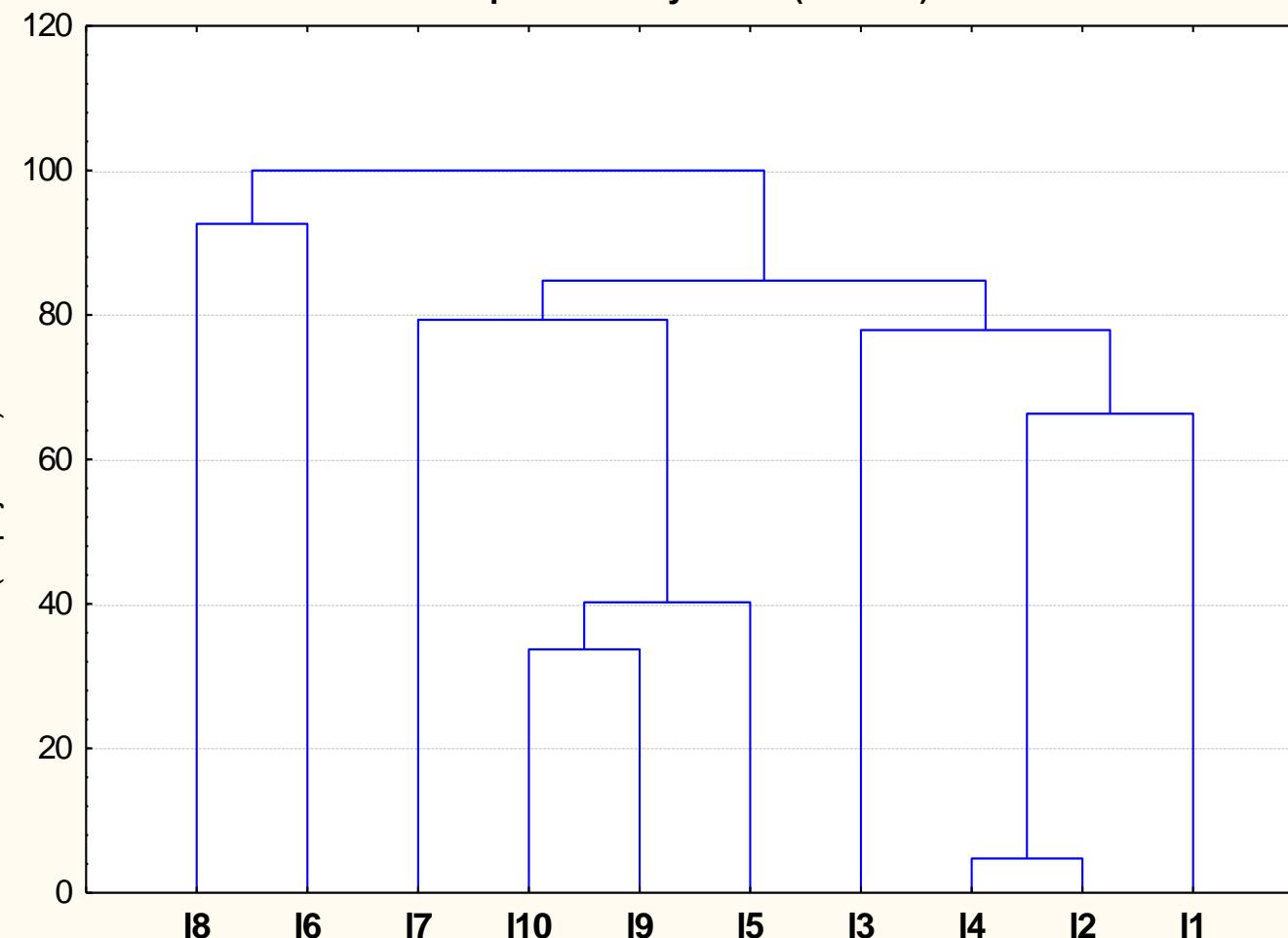
Zahrnout podmítku: vyber2=1 (mail 1.3.)

Detailed description of the dendrogram:
 - **Y-axis:** Labeled '(dSpoi/dMax) * 100', representing the normalized distance between data points.
 - **X-axis:** Labeled with Roman numerals I8, I6, I7, I10, I9, I5, I3, I4, I2, I1, representing different groups of environmental parameters.
 - **Clustering:** The dendrogram shows the hierarchical merging of clusters. At the top level, I8 and I6 merge into a cluster labeled 'I8+I6'. This cluster then merges with I7 to form 'I8+I6+I7'. This pattern continues down the tree, with I10 merging with I9, then with I5, then with I3, then with I4, then with I2, and finally with I1 at the bottom level.
 - **Blue Bars:** Blue vertical bars are placed at the base of each main cluster, indicating the point where two clusters merge. The height of these bars corresponds to the distance value on the y-axis.

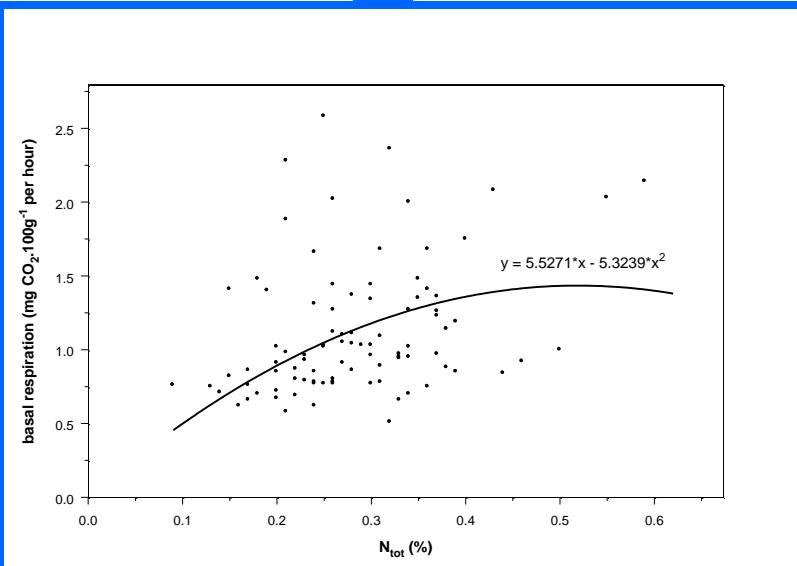
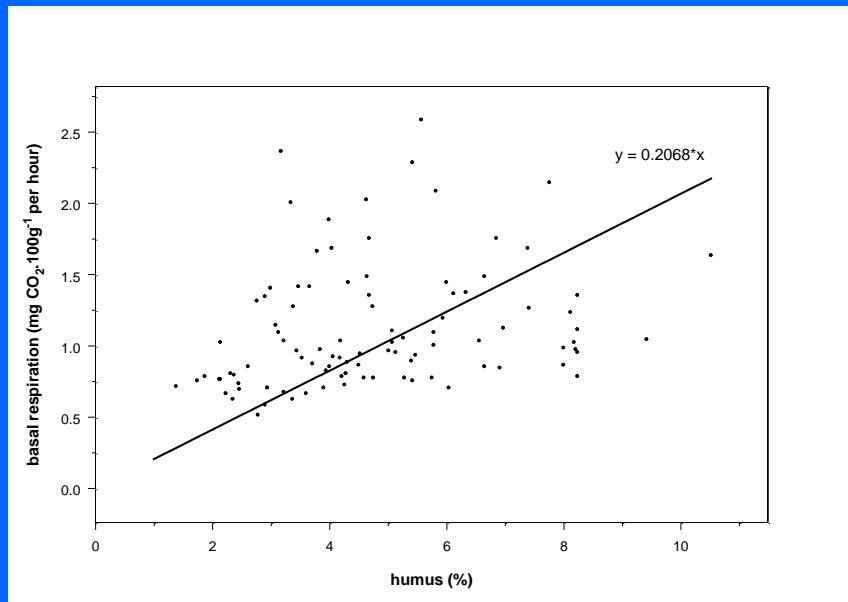
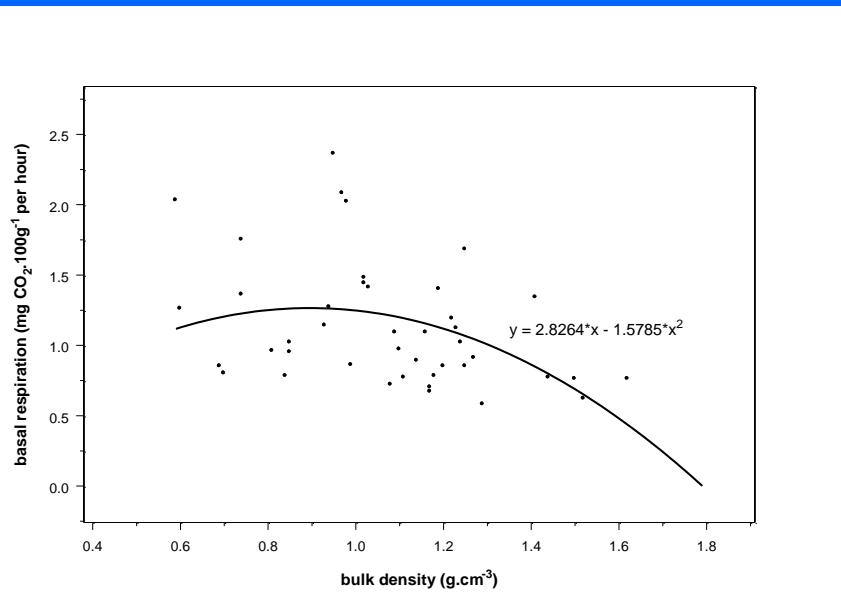
1. jednoduché spojení

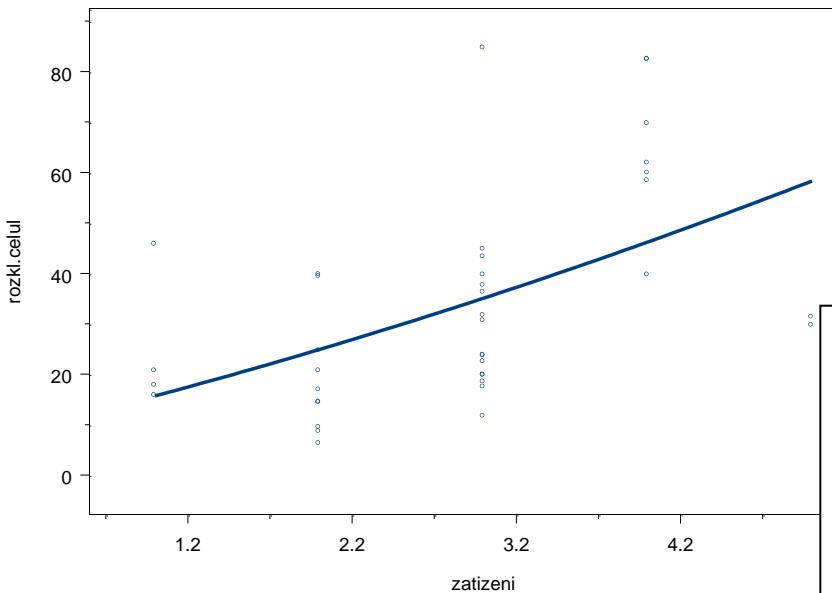
Euklid vzdáleností

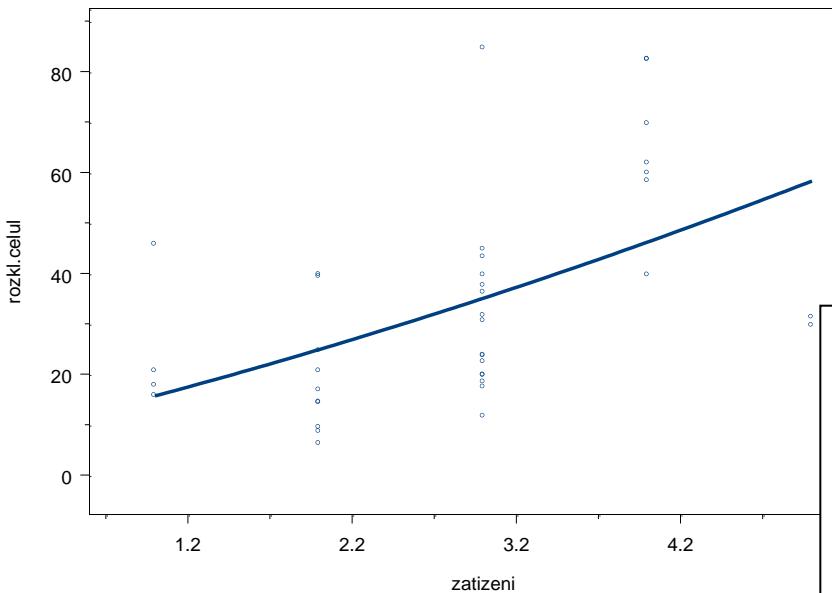
Zahrnout podmínyku: vyber2=1 (mai 1.3.)

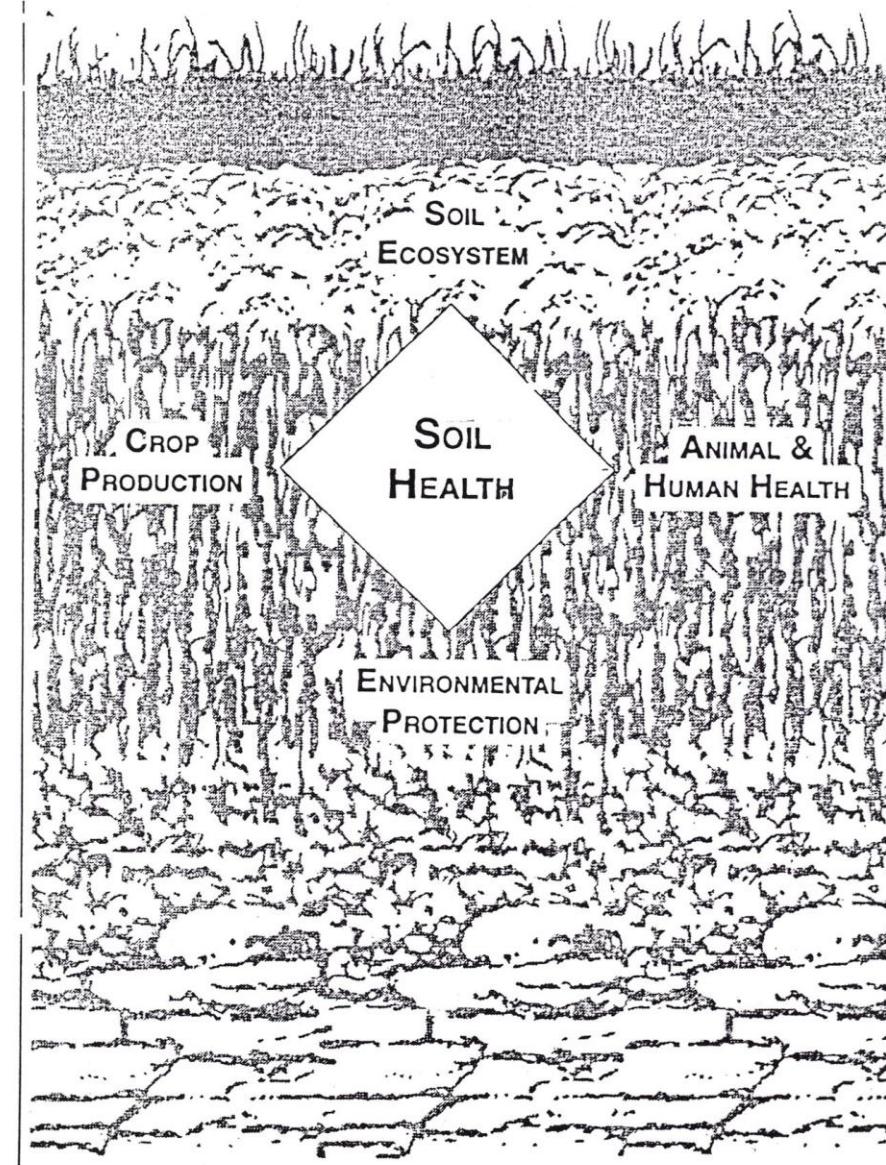


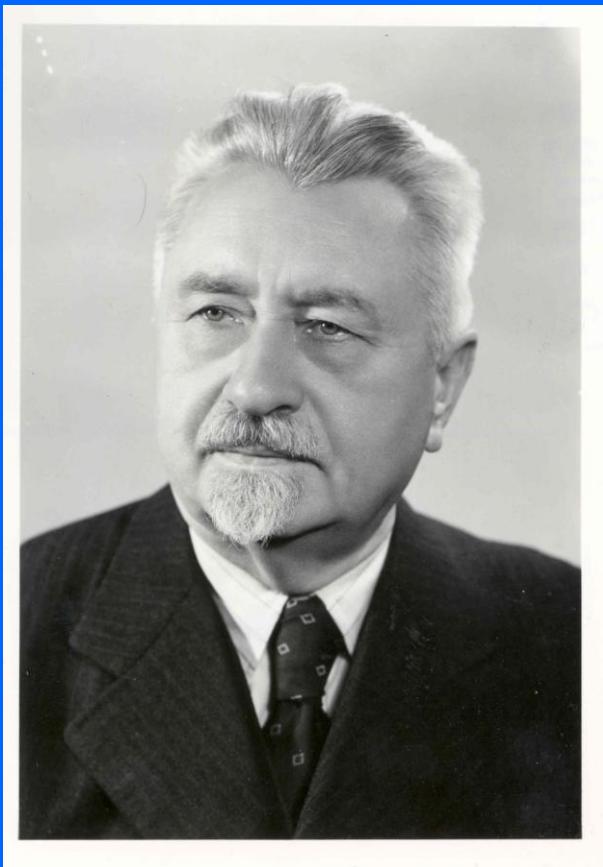
The respiration test yielded important results in all variants. It has correlated well (5% significance level) with several physical and chemical soil properties.











March, 1998

Methods for Assessing Soil Quality

Dr. Václav Novák

Best regards, John W. Doran

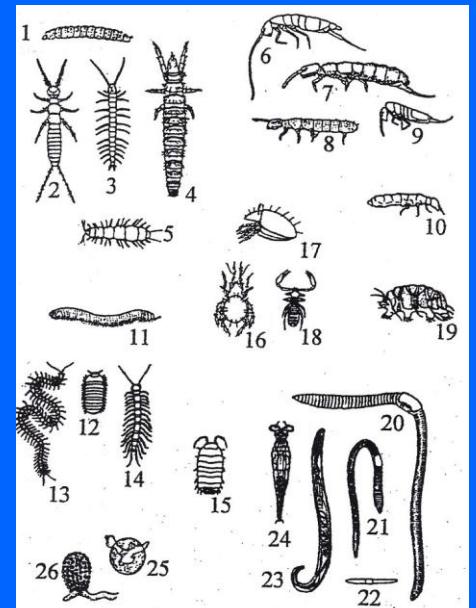
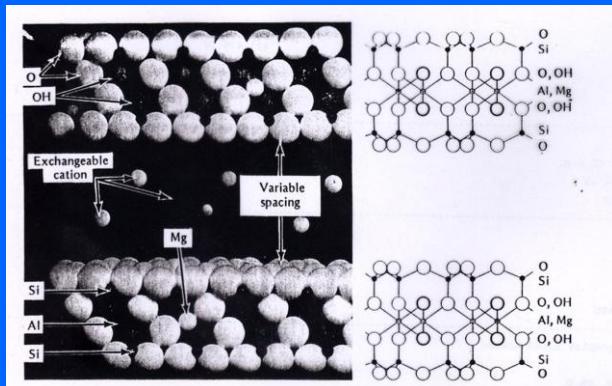
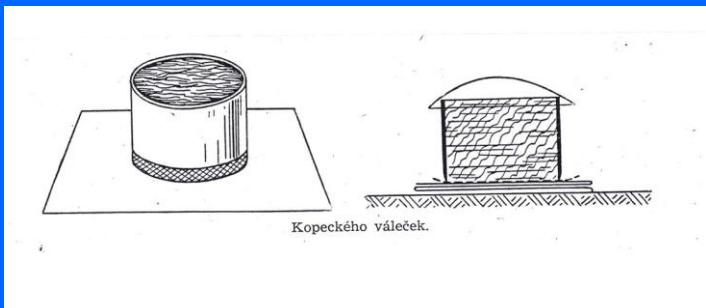
John W. Doran

Table 2-2. Proposed minimum data set of physical, chemical, and biological indicators for screening the condition, quality, and health of soil (after Doran & Parkin, 1994; Larson & Pierce, 1994).

Indicators of soil condition	Relationship to soil condition and function; rationale as a priority measurement	Ecologically relevant values or units; comparisons for evaluation
	Physical	
Texture	Retention and transport of water and chemicals; modeling use, soil erosion, and variability estimate	% sand, silt, & clay; less eroded sites or landscape positions
Depth of soil, topsoil, and rooting	Estimate of productivity potential and erosion; normalizes landscape and geographic variability	cm or m; non cultivated sites or varying landscape positions
Infiltration and soil bulk density (SBD)	Potential for leaching, productivity, and erosivity; SBD needed to adjust analyses to volumetric basis	Minutes/2.5 cm of water and g/cm ³ row and/or landscape positions
Water holding capacity (water retention characteristic)	Related to water retention, transport, and erosivity; available H ₂ O: Calculate from SBD, texture, and OM	% (cm ³ /cm ³), cm of available H ₂ O/30 cm; precipitation intensity
	Chemical	
Soil organic matter (OM) (total organic C and N)	Defines soil fertility, stability, and erosion extent; use in process models and for site normalization	kg C or N/ha-30 cm; noncultivated or native control
pH	Defines biological and chemical activity thresholds; essential to process modeling	Compared with upper and lower limits for plant and microbial activity
Electrical conductivity	Defines plant and microbial activity thresholds; presently lacking in most process models	dS/m ¹ ; compared with upper and lower limits for plant and microbial activity
Extractable N, P, and K	Plant available nutrients and potential for N loss; productivity and environmental quality indicators	kg/ha-30 cm; seasonal sufficiency levels for crop growth
	Biological	
Microbial biomass C and N	Microbial catalytic potential and repository for C and N; modeling: Early warning of management effects on OM	kg N or C/ha-30 cm; relative to total C and N or CO ₂ produced
Potentially mineralizable N (anaerobic incubation)	Soil productivity and N supplying potential; Process modeling; (surrogate indicator of biomass)	kg N/ha-30 cm/d; relative to total C or total N contents
Soil respiration, water content, and temperature	kg C/ha/d; relative microbial biomass activity, C loss vs. inputs and total C pool	Microbial activity measure (in some cases plants) process modeling; estimate of biomass activity

Indikátory kvality půdy zahrnují charakteristiky:

- **fyzikální** – textura, hloubka půdy, infiltrace, vodní kapacita, pórovitost, struktura
- **chemické a fyzikálně chemické** - obsah humusu a jeho kvalita, N tot., KVK, pH, vodivost, obsah živin, kontaminanty v půdě ...
- **biologické** – C, N mikrobní biomasy, mineralizovatelný N, respirace, aktivita enzymů, biomasa a abundance jednotlivých skupin živočichů ...



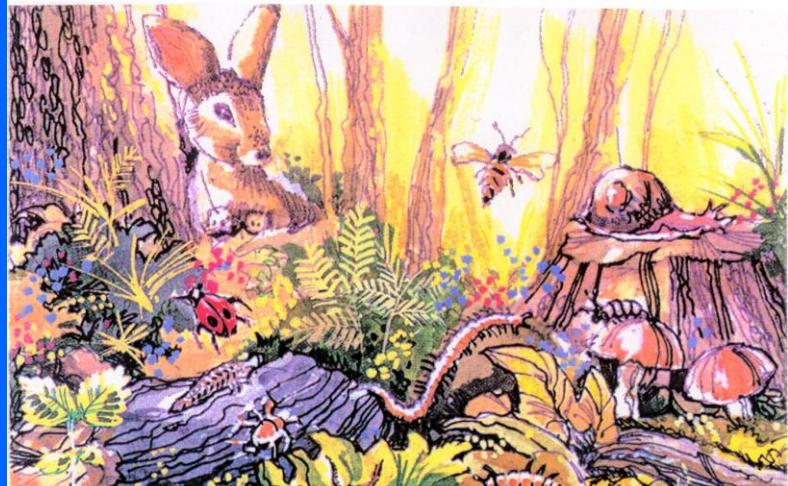
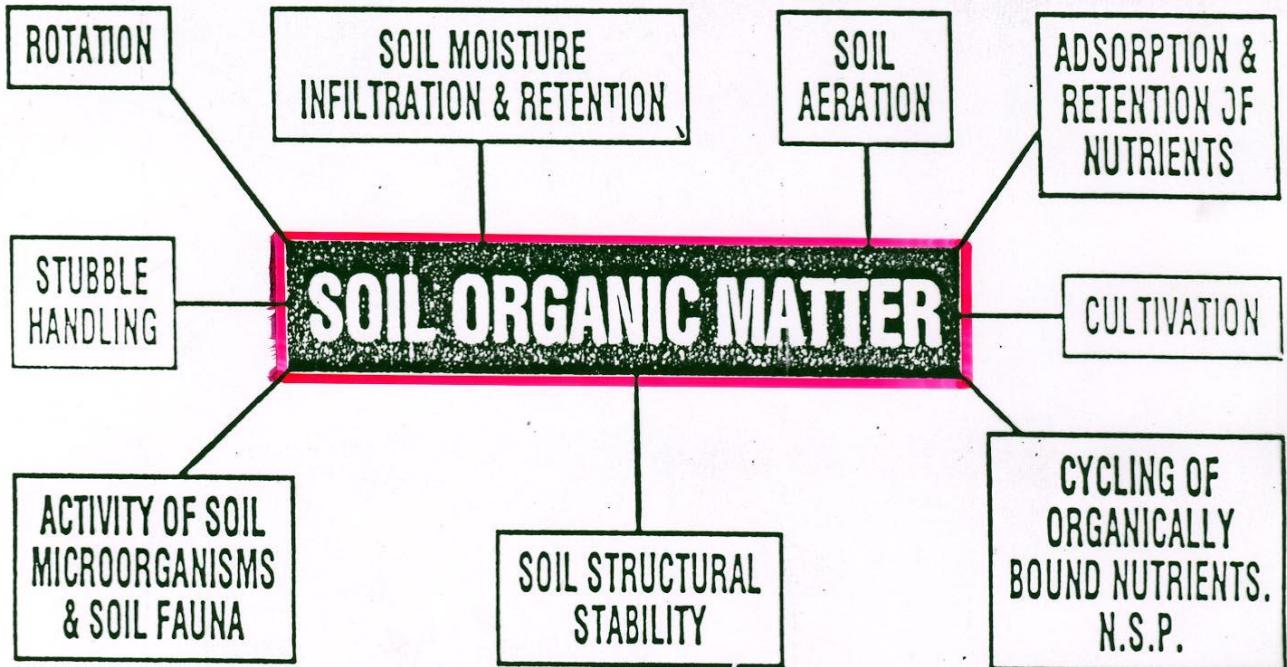


Figure 2 **Central role of organic matter**



Po prvním monitoringu během konverze by pravidelné sledování mělo probíhat:

- na orné půdě – pšenice ozimá (nebo jiná oz. Obilovina), polovina dubna, minimálně 1x za 5 let na každém pozemku
 - na trvalých travních porostech
 - louky – polovina dubna, pastviny – před pastvou
- Termín: obnovené travní porosty – 1x za 5 let, starší porosty (min. 15 let staré) – 1x za 7 let





SOIL - Questions refer primarily to the plow layer

Descriptive Properties

SCORE

1. EARTHWORMS³

- 0 Little sign of worm activity
- 2 Few worm holes or castings
- 4 Worm holes and castings numerous

2. EROSION⁴

- 0 Severe erosion, considerable topsoil moved, gullies formed
- 2 Moderate erosion, signs of sheet and rill erosion, some topsoil blows
- 4 Little erosion evident, topsoil resists erosion by water or wind

3. TILLAGE EASE⁵

- 0 Plow scours hard, soil never works down
- 2 Soil grabs plow, difficult to work, needs extra passes
- 4 Plow field in higher gear, soil flows & falls apart, mellow

4. SOIL STRUCTURE⁶

- 0 Soil is cloddy with big chunks, or dusty and powdery
- 2 Soil is lumpy or does not hold together
- 4 Soil is crumbly, granular

5. COLOR (MOIST)¹³

- 0 Soil color is tan, light yellow, orange, or light gray
- 2 Soil color is brown, gray, or reddish
- 4 Soil color is black, dark brown, or dark gray

6. COMPACTION¹¹

- 0 Soil is tight & compacted, cannot get into it, thick hardpan
- 2 Soil packs down, thin hardpan or plow layer
- 4 Soil stays loose, does not pack, no hardpan

7. INFILTRATION¹²

- 0 Water does not soak in, sits on top or runs off
- 2 Water soaks in slowly, some runoff or puddling after a heavy rain
- 4 Water soaks right in, soil is spongy, no ponding

INTERPRETING THE SOIL HEALTH SCORECARD'S RESULTS

Review the scorecard and tally the number of indicator properties that reside within the three categories of health listed below. Divide the number in each health category by the total number of questions answered (a maximum of 43) and multiply by 100% for the percentage within each category.

HEALTH CATEGORY	NUMBER	%
HEALTHY (SCORE OF 3 - 4)	<input type="text"/>	<input type="text"/>
IMPAIRED (SCORE OF 1.5 - 2.5)	<input type="text"/>	<input type="text"/>
UNHEALTHY (SCORE OF 0 - 1)	<input type="text"/>	<input type="text"/>
TOTAL	<input type="text"/>	100%

Scorecard users should examine the distribution of indicator properties within the three categories of health. Ideally, one would prefer to see all of the properties score in the *healthy* category. Even if 90% or more of the indicators you scored are *healthy*, your soil may still have serious problems with the remaining properties. For indicators either in the *impaired* and *unhealthy* categories, careful consideration is necessary to identify what caused the property to be in a less-than-optimum condition. *Impaired* indicator properties should be closely monitored over time to determine whether they are deteriorating or improving. *Unhealthy* properties need immediate attention and corrective action. You may also wish to give higher priority to those properties farmers considered more important as indicated by their relative rank in superscript.



Děkuji za pozornost