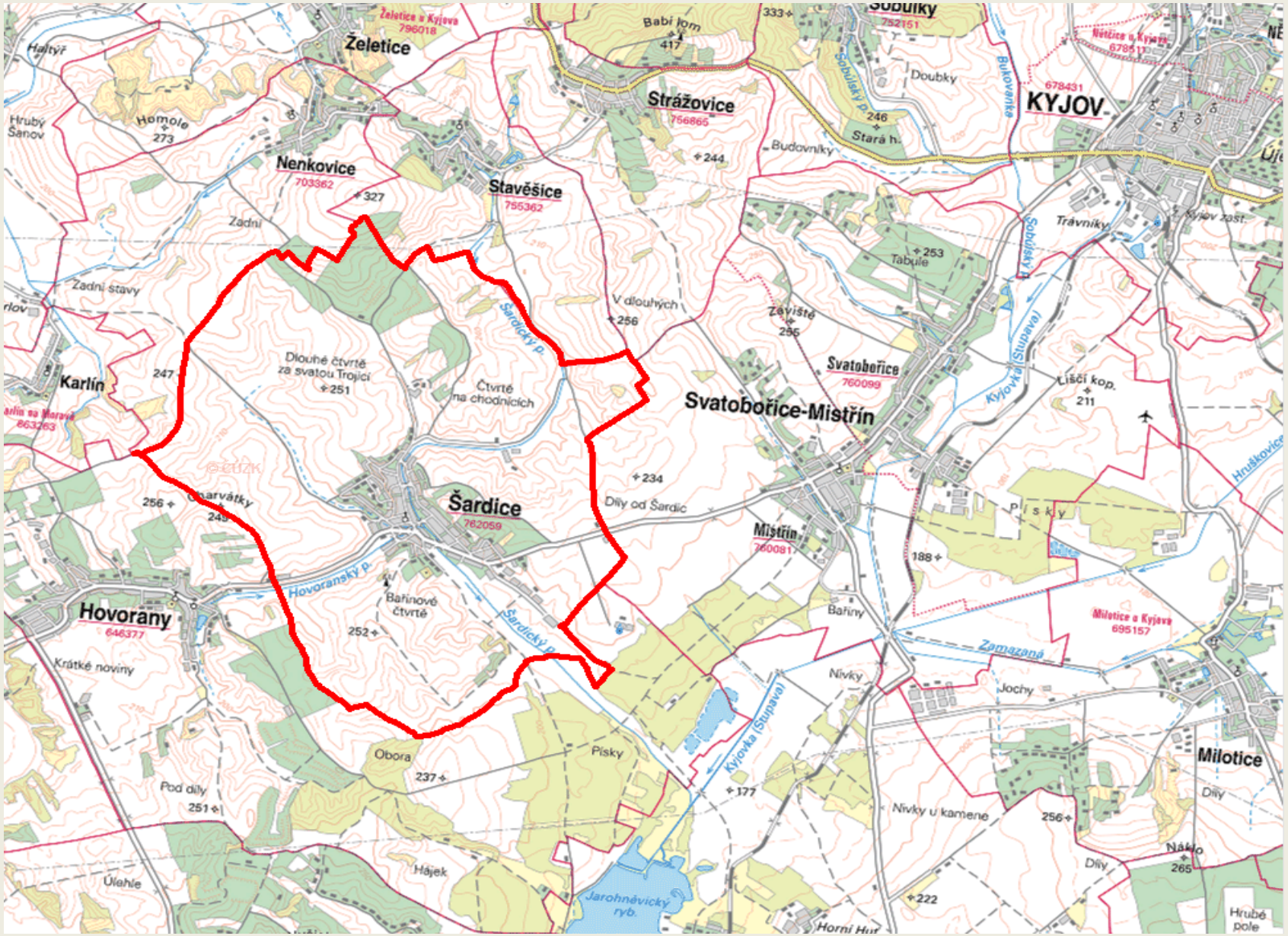
Land use changes and their impact on soil erosion in South Moravia region

Case study area
Šardice, district of Hodonín

prof. Ing. Miroslav Dumbrovský,CSc.,
Ing. Veronika Sobotková, PhD.,

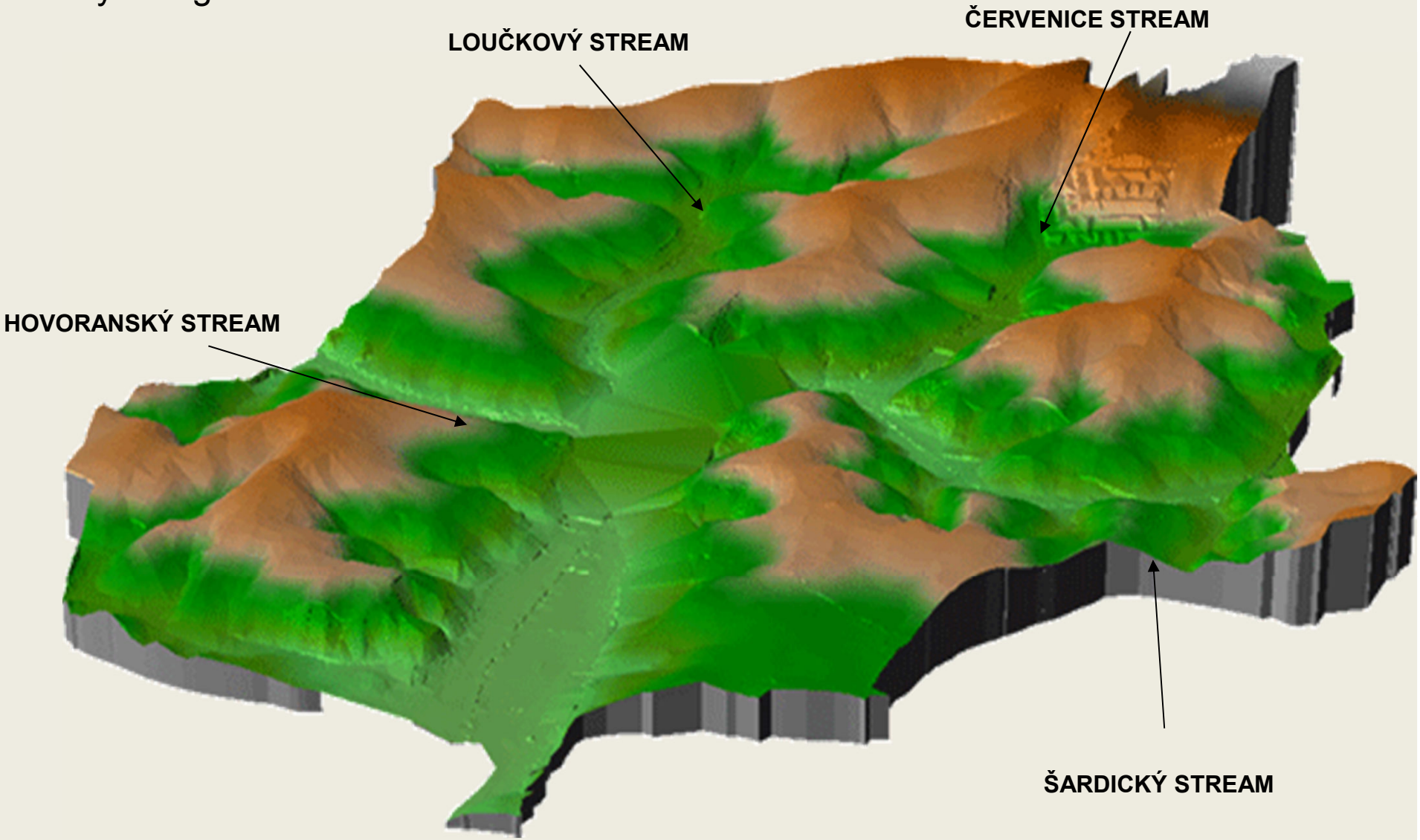
Brno University of Technology
Department of Landscape Water Management



Sardice - village in the district Hodonin in the South region, 8 km southwest of Kyjov city. In 2012 there were 2.232 inhabitants.

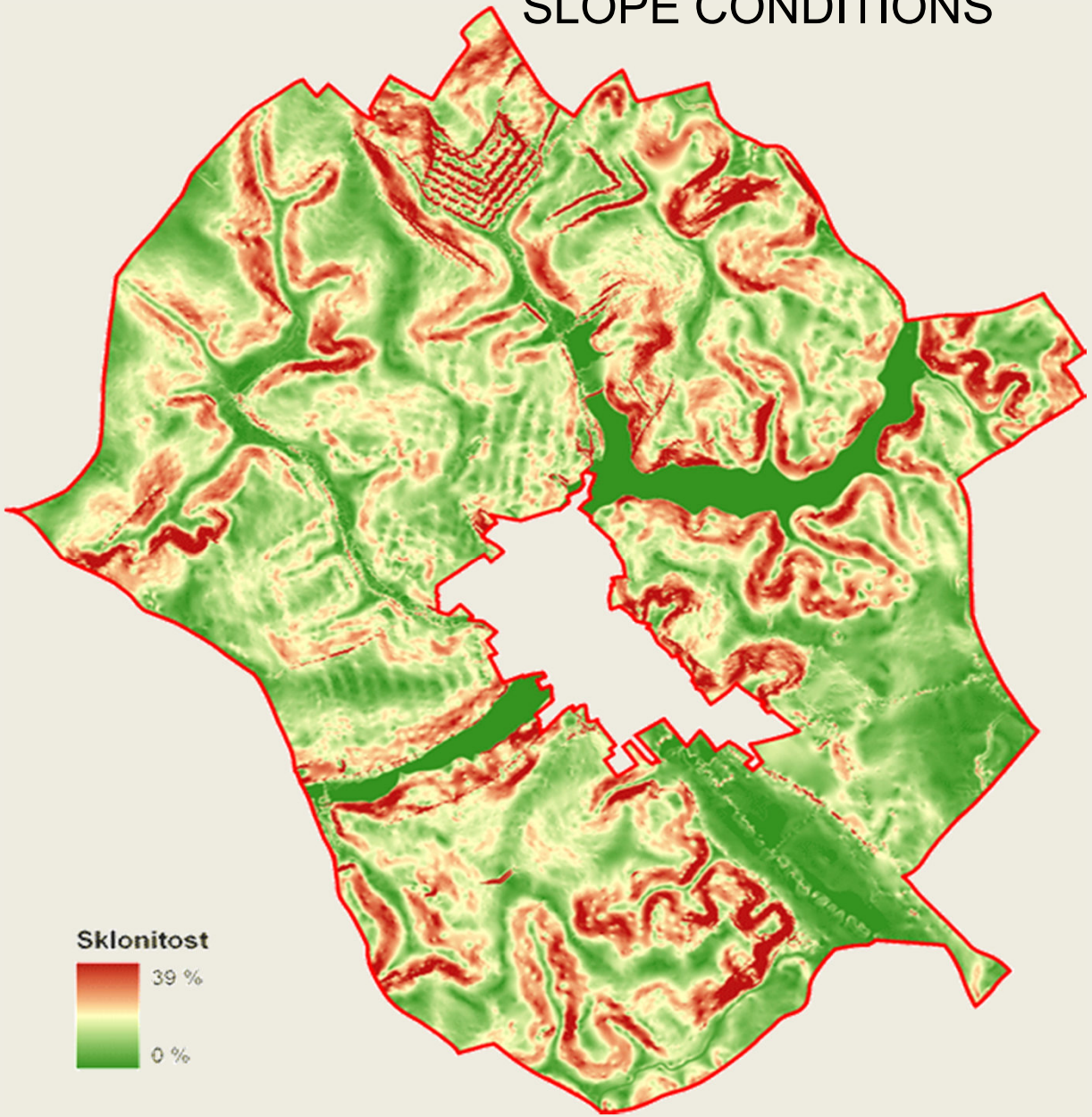
Sardice are important wine-growing settlements in the wine region

Hydrological conditions:

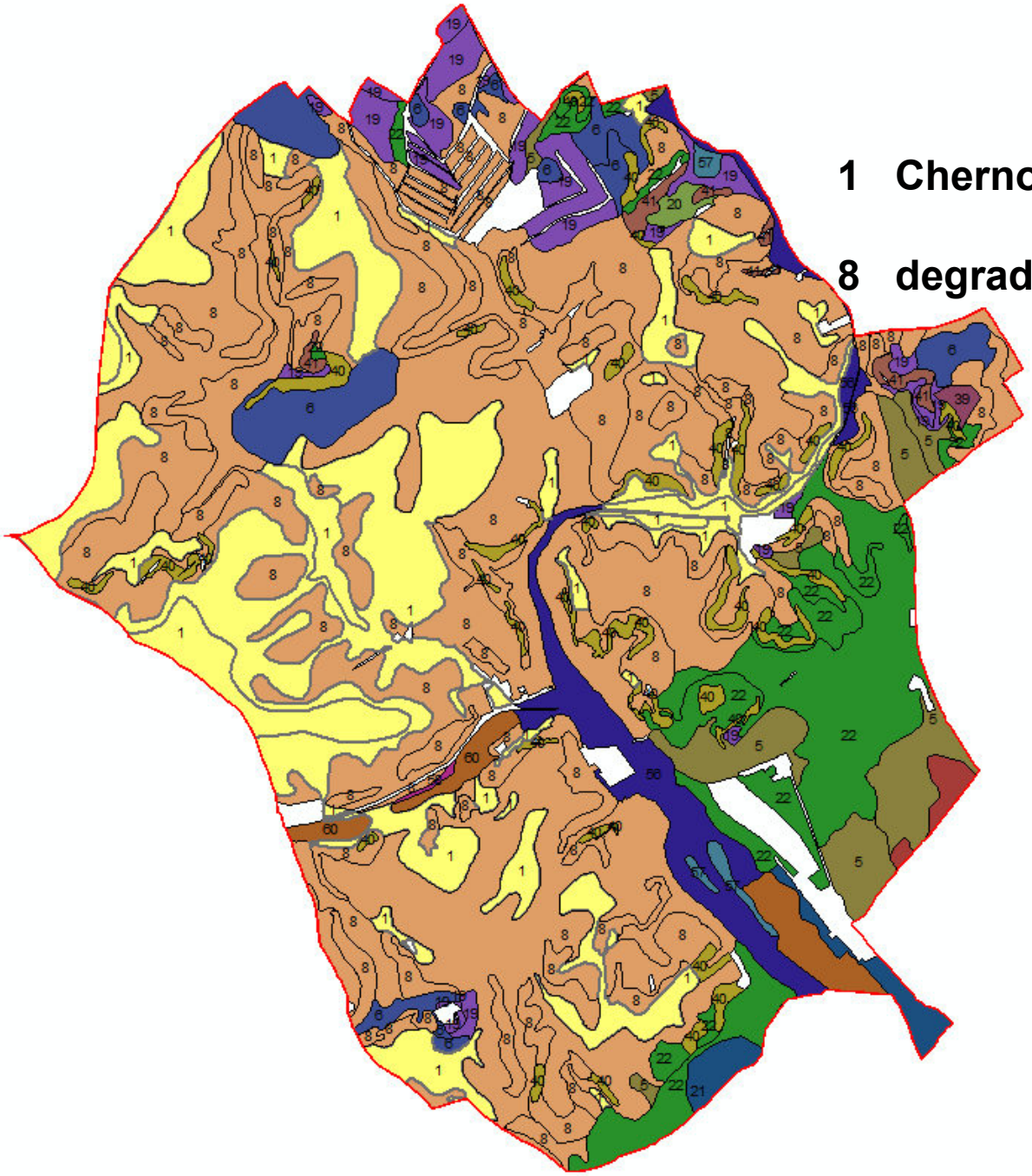


Sardice territory is located in the Morava River basin, subcatchment Kyjovka River. The main recipients are Šardicky, Loučkovy and Hovoransky stream.

SLOPE CONDITIONS



High uneven gradient of slope, relief, topography

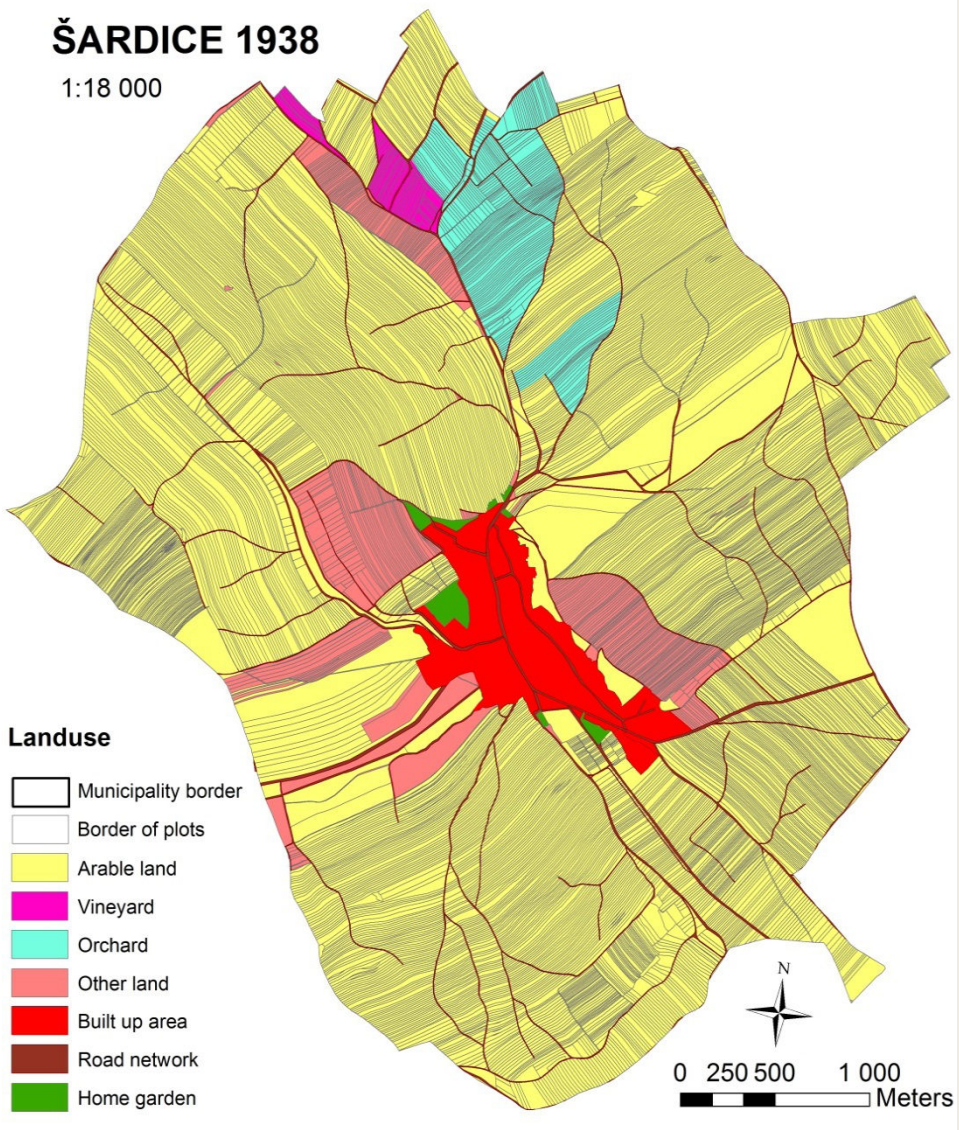


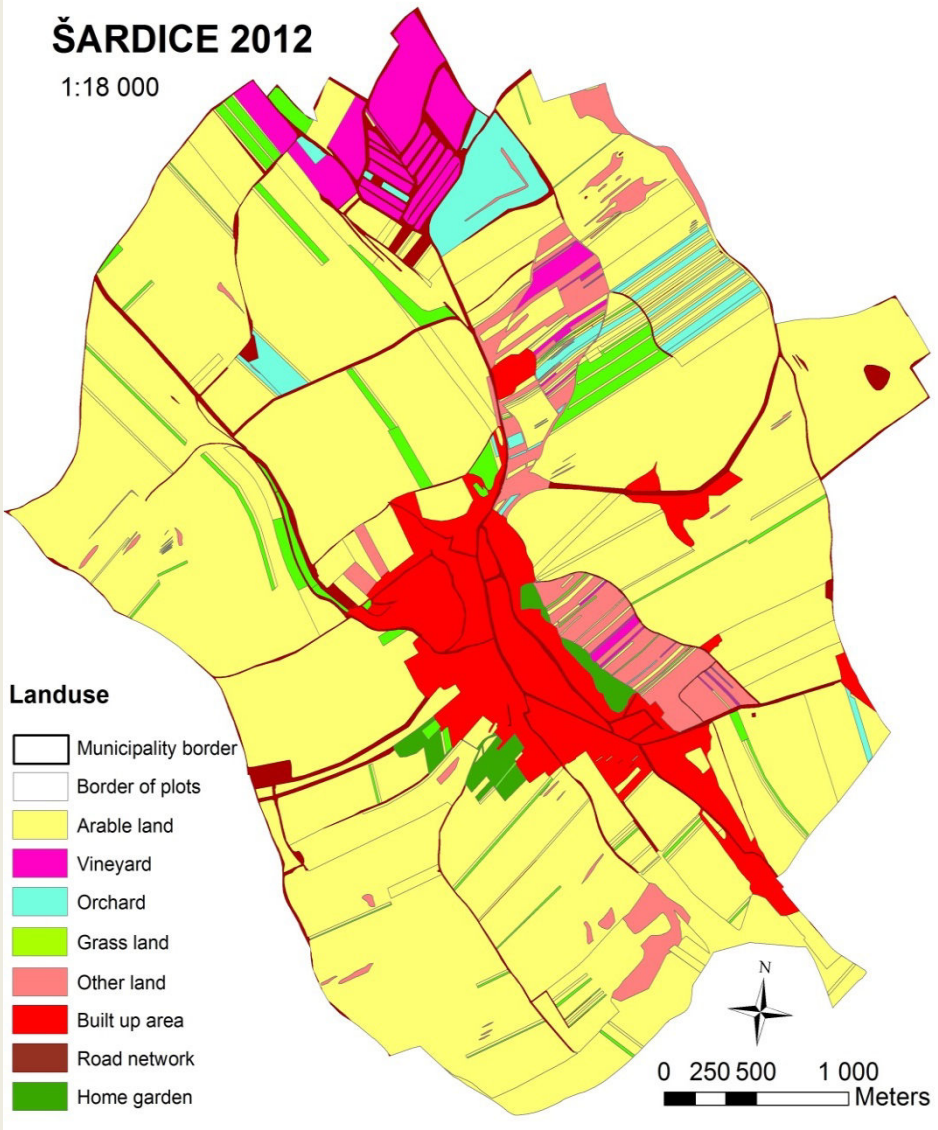
DISTRIBUTION OF
MAIN SOIL UNITS

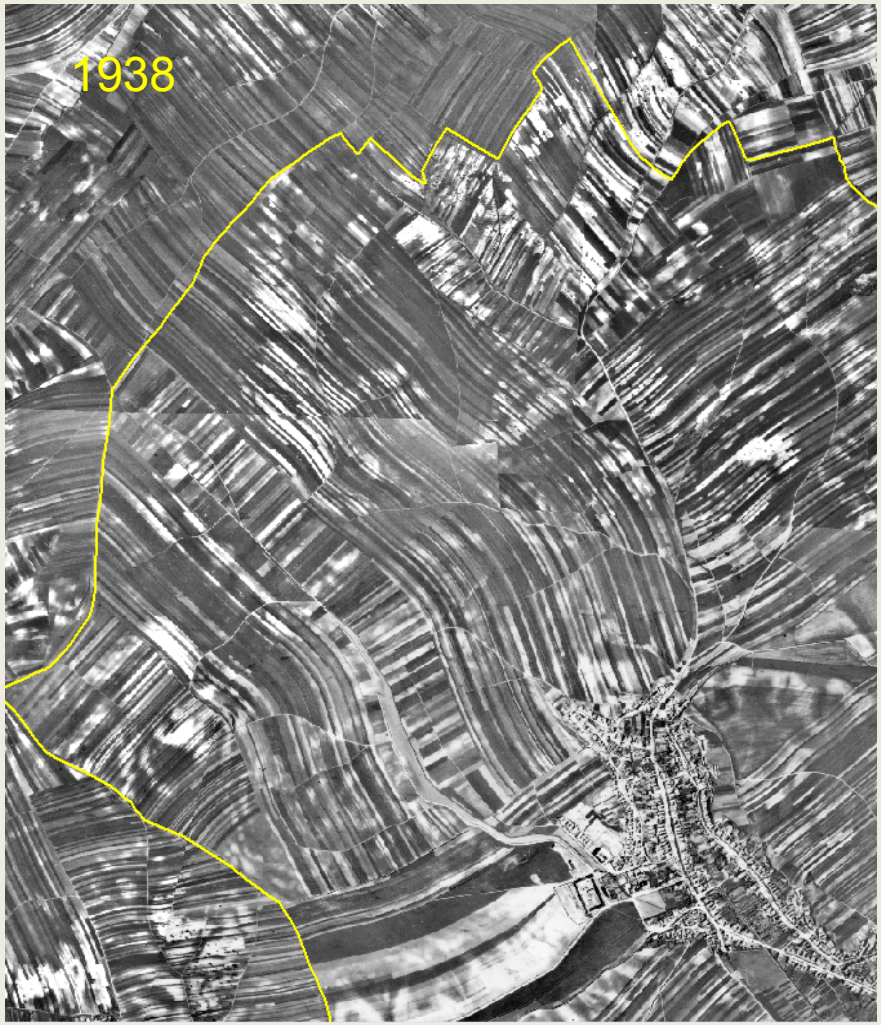
1 Chernozem - loess

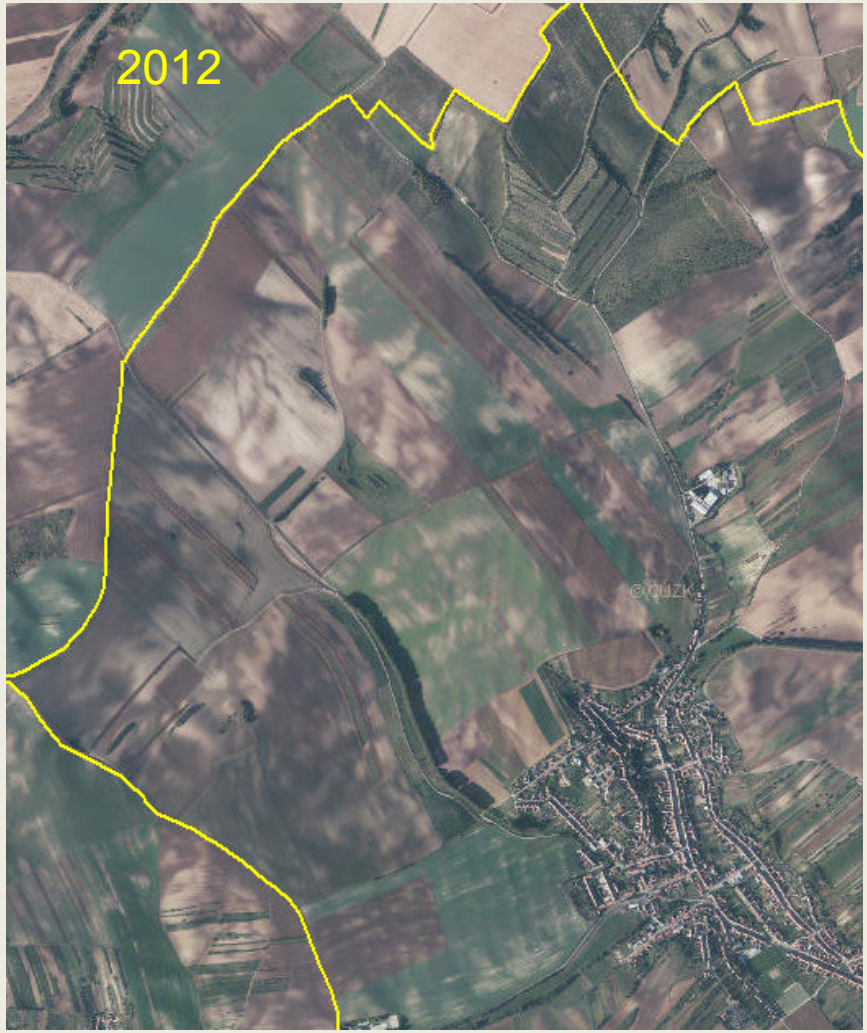
8 degraded „washed“ chernozem

DEVELOPMENT OF LANDSCAPE COVER

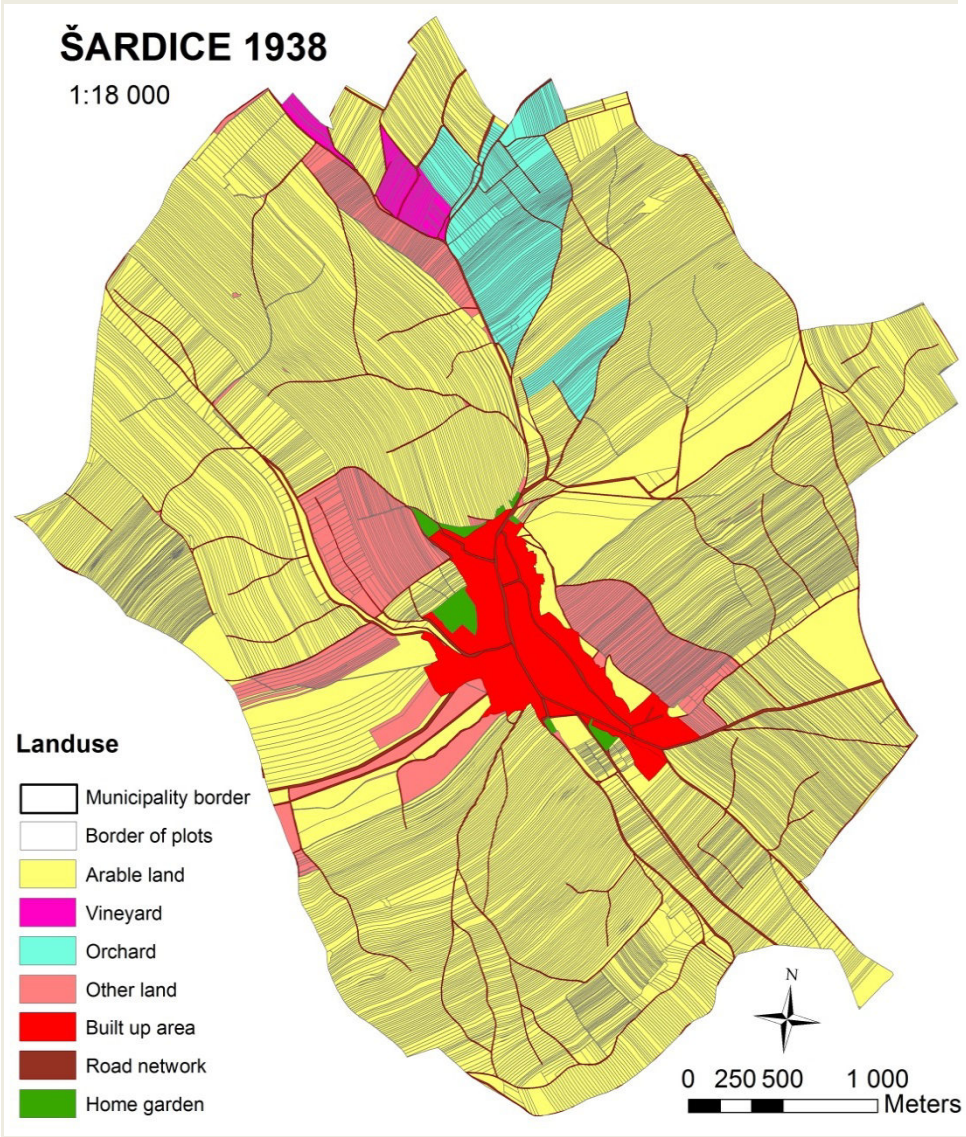


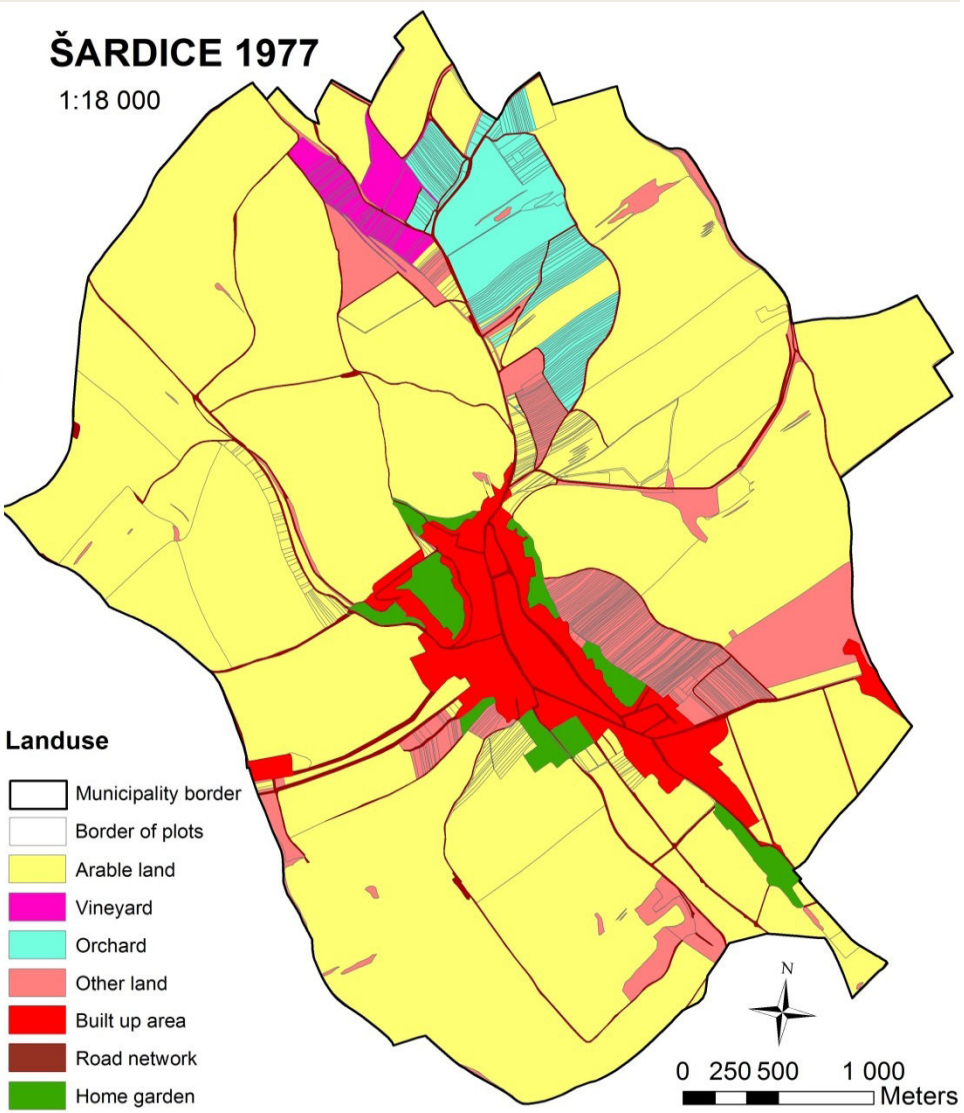



1938

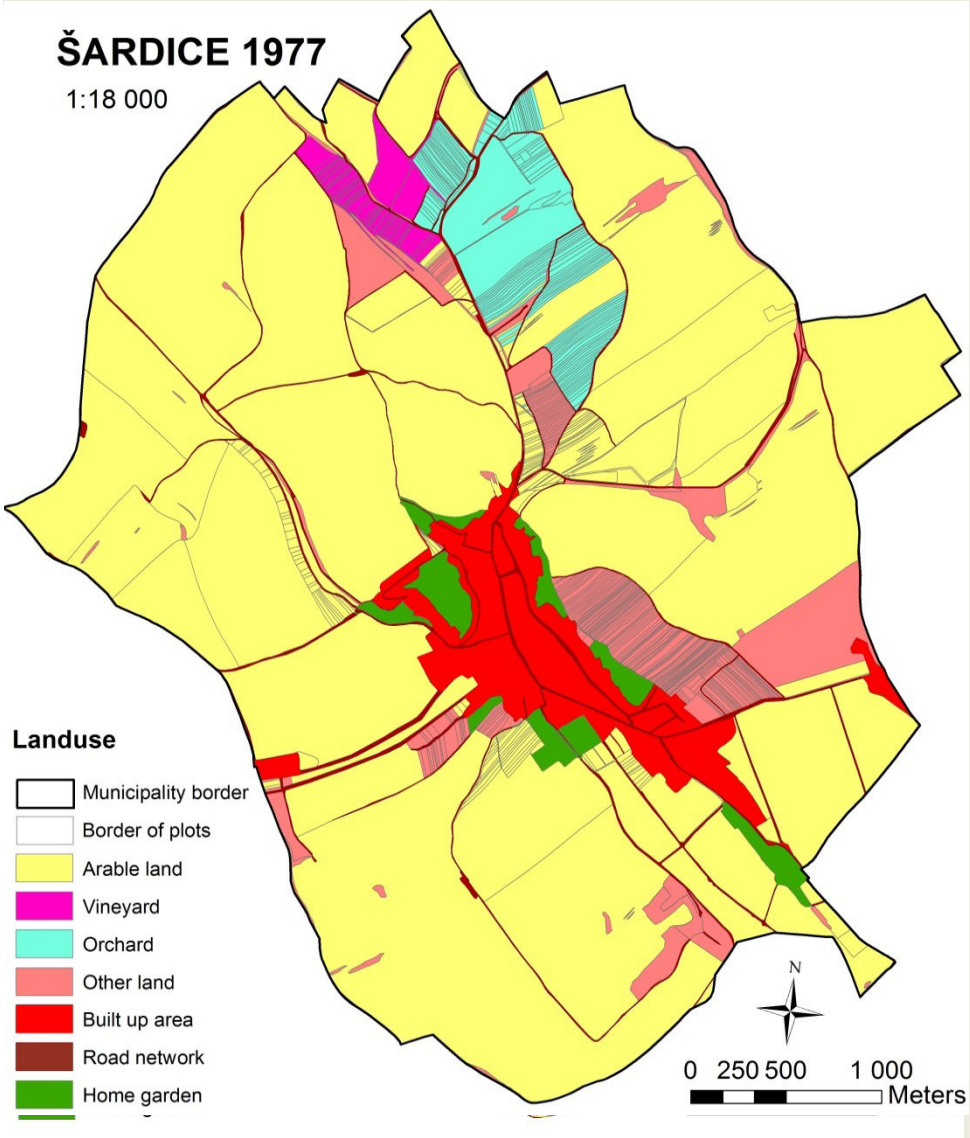

2012

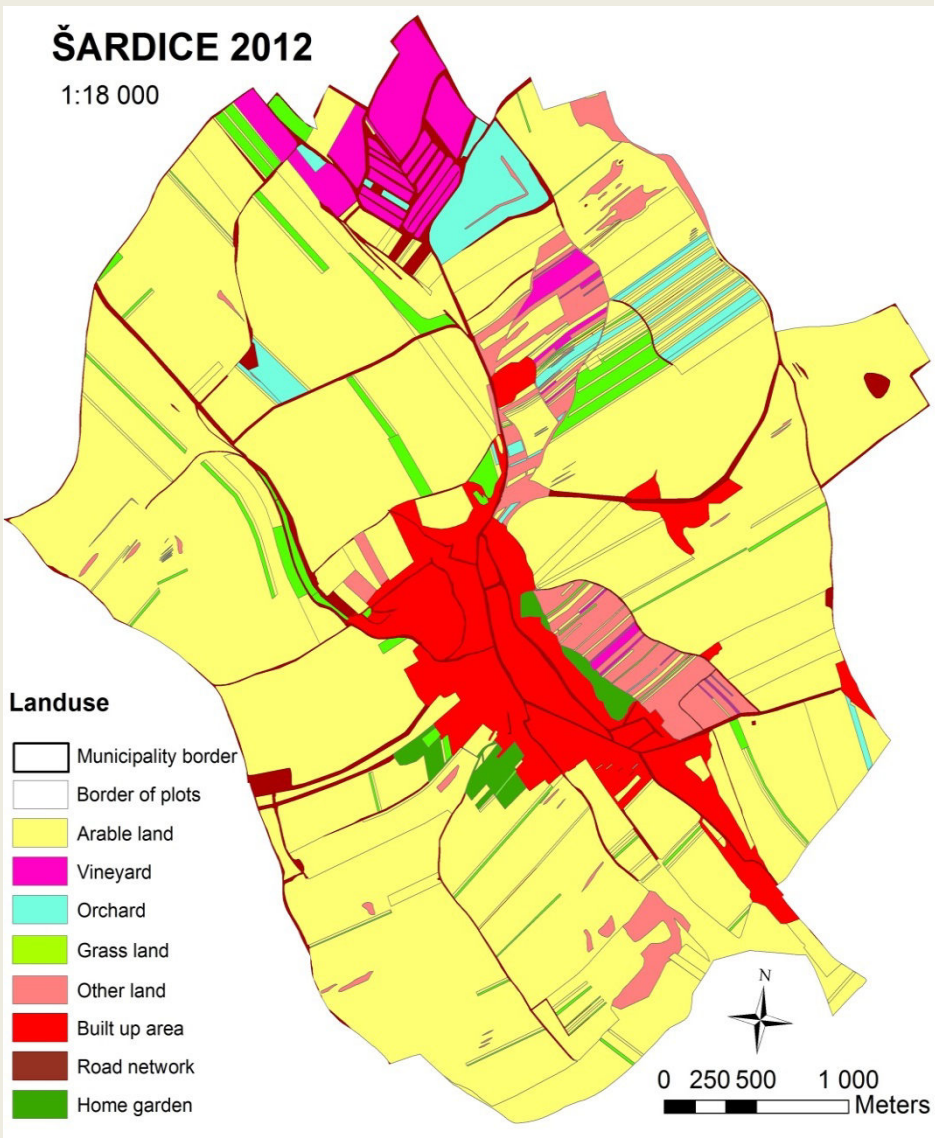
DEVELOPMENT OF LANDSCAPE COVER

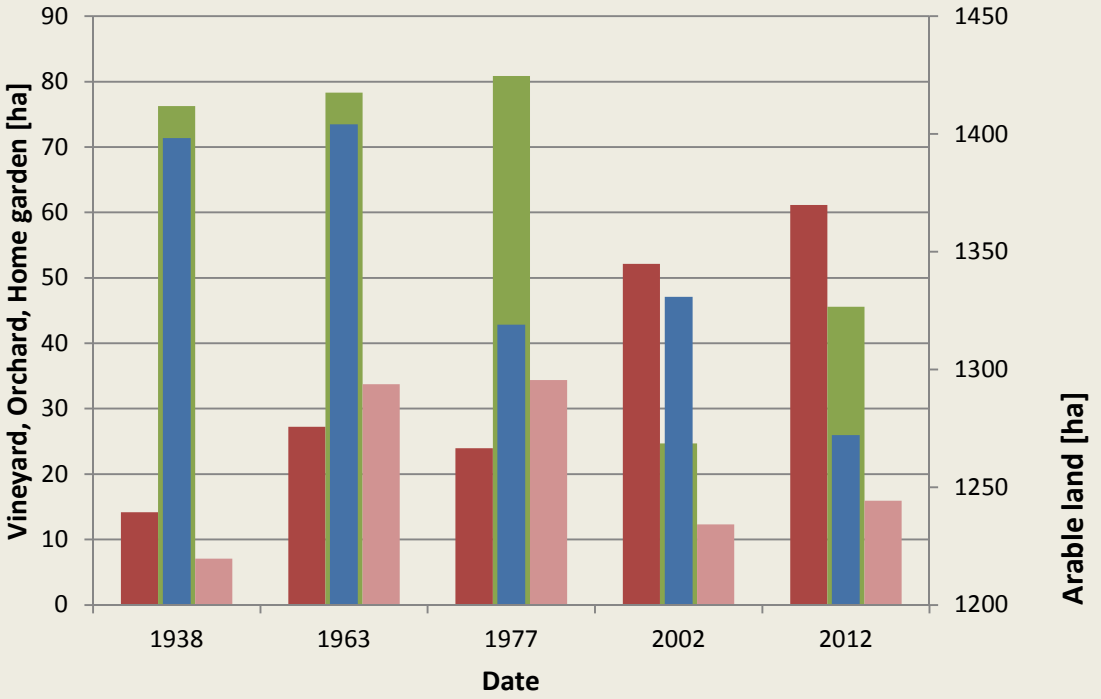


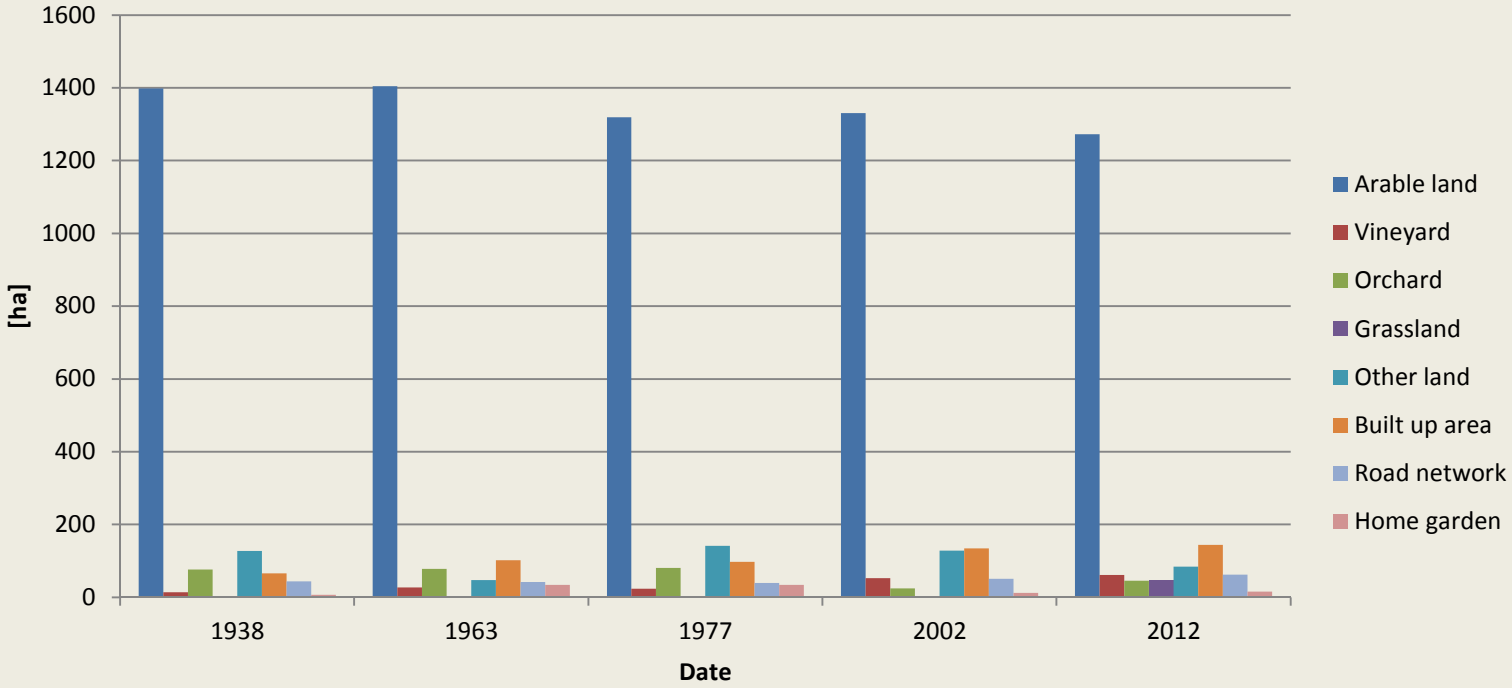


DEVELOPMENT OF LANDSCAPE COVER

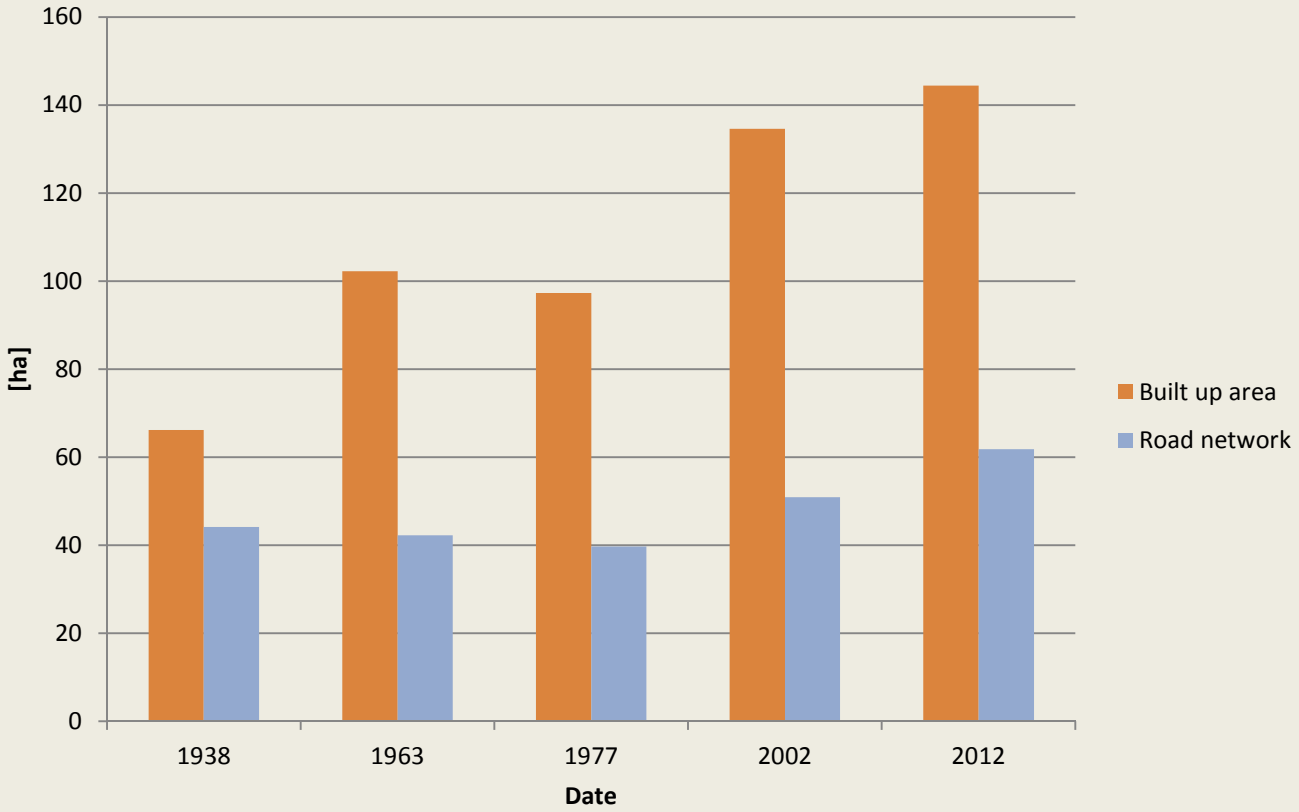




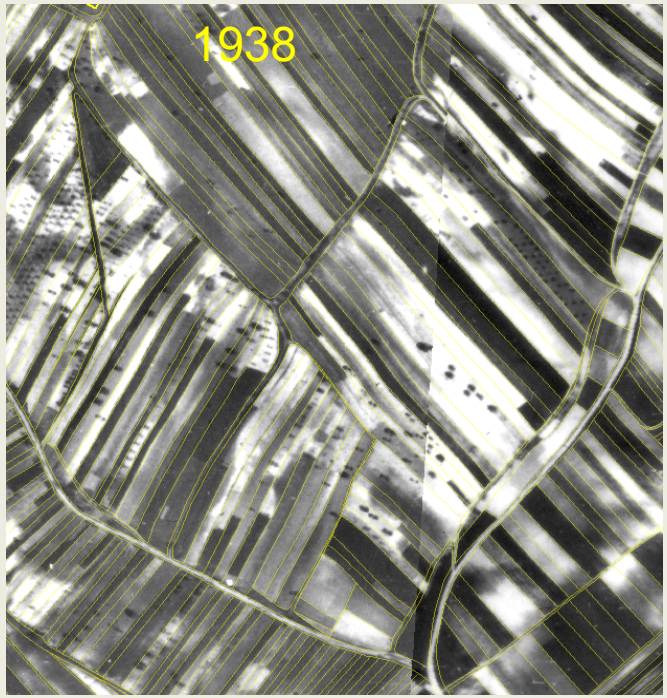

Vineyard, Orchard, Home garden [ha]
Arable land [ha]
Date
1938
1963
1977
2002
2012
Vineyard
Orchard
Home garden
Arable land

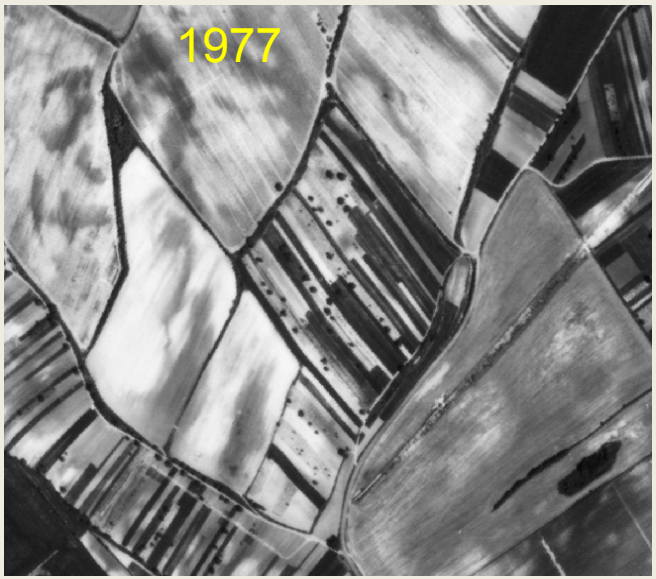

[ha]
Date
1938
1963
1977
2002
2012
Arable land
Vineyard
Orchard
Grassland
Other land
Built up area
Road network
Home garden

DEVELOPMENT OF BUILT UP AREA 1938-2012


160
140
120
100
80
60
40
20
0
[ha]
1938
1963
1977
2002
2012
Date
Built up area
Road network

BENCH TERRACES





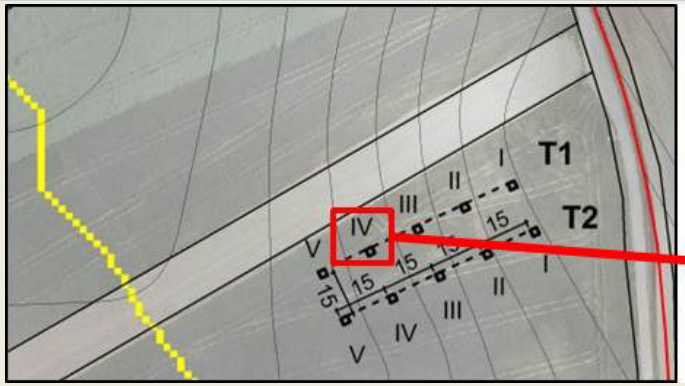
LAND CONSOLIDATION – FLOOD PROTECTION – RETENTION DAM

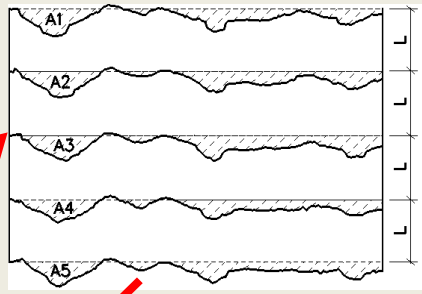
GEOMORPHOLOGY OF CADASTRAL AREA ŠARDICE

SOIL EROSION RATE ASSESSMENT

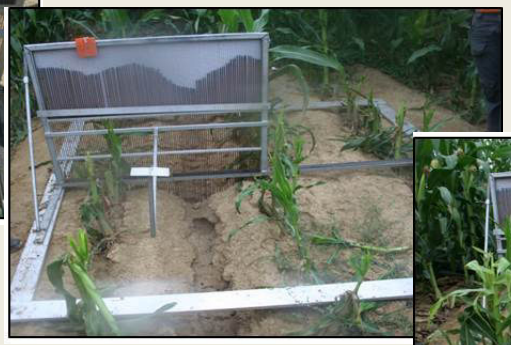
SOIL EROSION PROCESSES IN CADASTRAL AREA ŠARDICE

VOLUMETRIC MEASUREMENT OF RILL EROSION

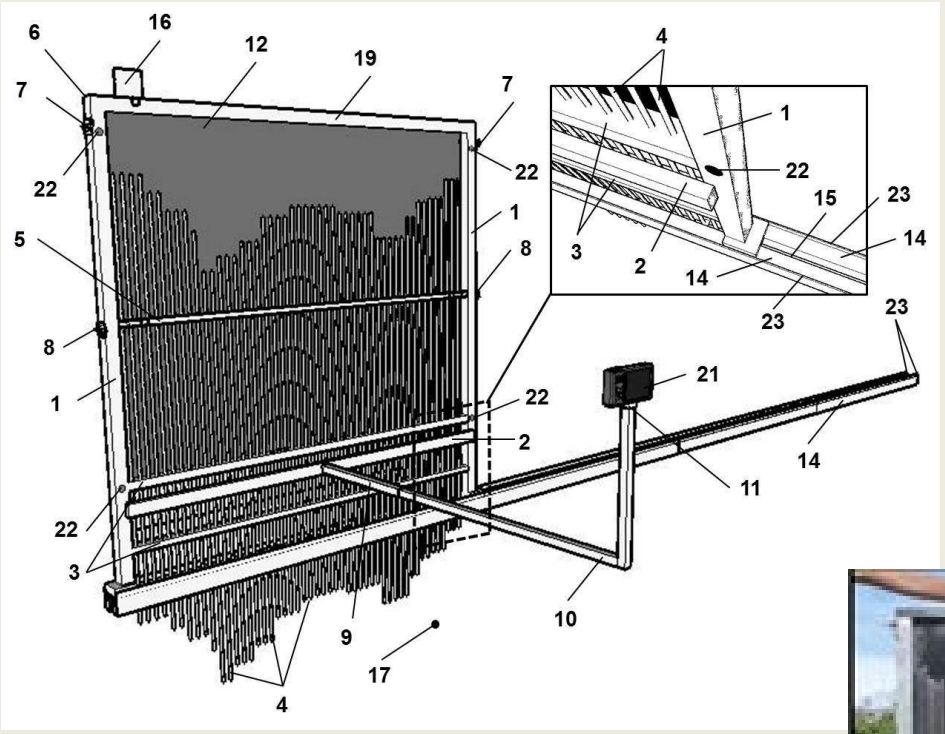




$$V = \sum \left(\frac{A_1 + A_2}{2} \cdot L \right) + \left(\frac{A_2 + A_3}{2} \cdot L \right) + \ldots\ldots$$



VOLUMETRIC MEASUREMENT OF EPHEMERAL GULLY EROSION EROSION



$G = R \cdot K \cdot L \cdot S \cdot C \cdot P$ USLE

Where:

G is the annual average soil erosion rate ($t.ha^{-1}.y^{-1}$)

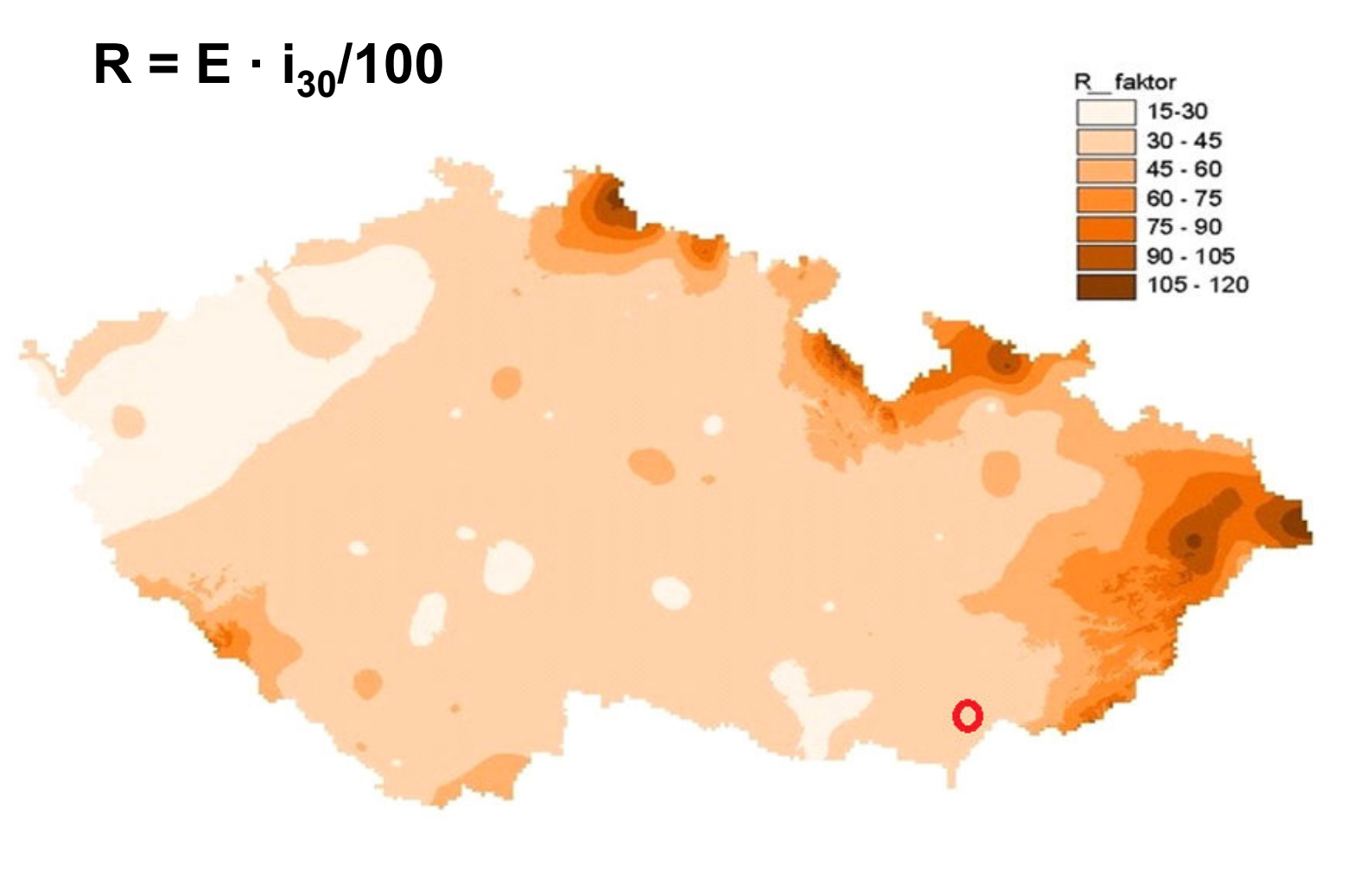
R….rainfall erosivity factor ($MJ.mm.\ ha^{-1}.h^{-1}.a^{-1}$)
K….soil erodibility factor ($t.ha^{-1}.h^{-1}.ha^{-1}.MJ.mm^{-1}$)
L….slope length factor (-)
S….slope gradient factor (-)
C….crop management factor (-) and
P…. practice management factor (-)

GIS METHODES……DME…….USLE2D

R is a factor of erosive effect of rain / MJ • ha^{-1} • cm^{-1} • h /,

Product of the total **kinetic energy** of torrential rain (**E** / J • m^{-2} /,) and its **maximum 30-minute intensity**.(i_{30} / cm • h^{-1} /.)

$$R = E \cdot i_{30}/100$$

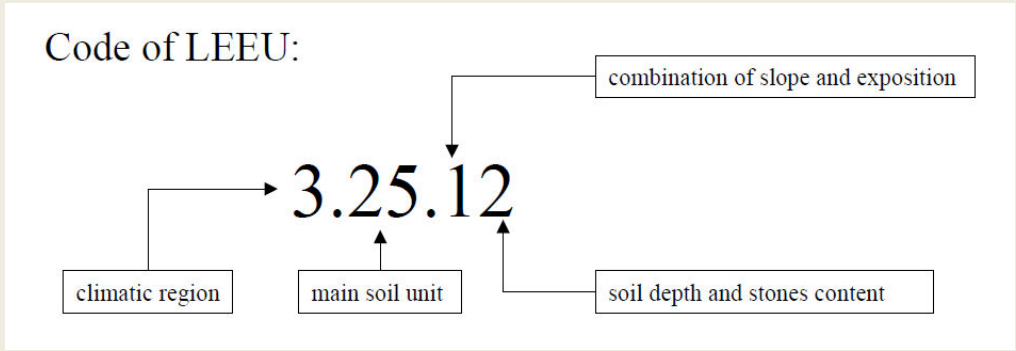


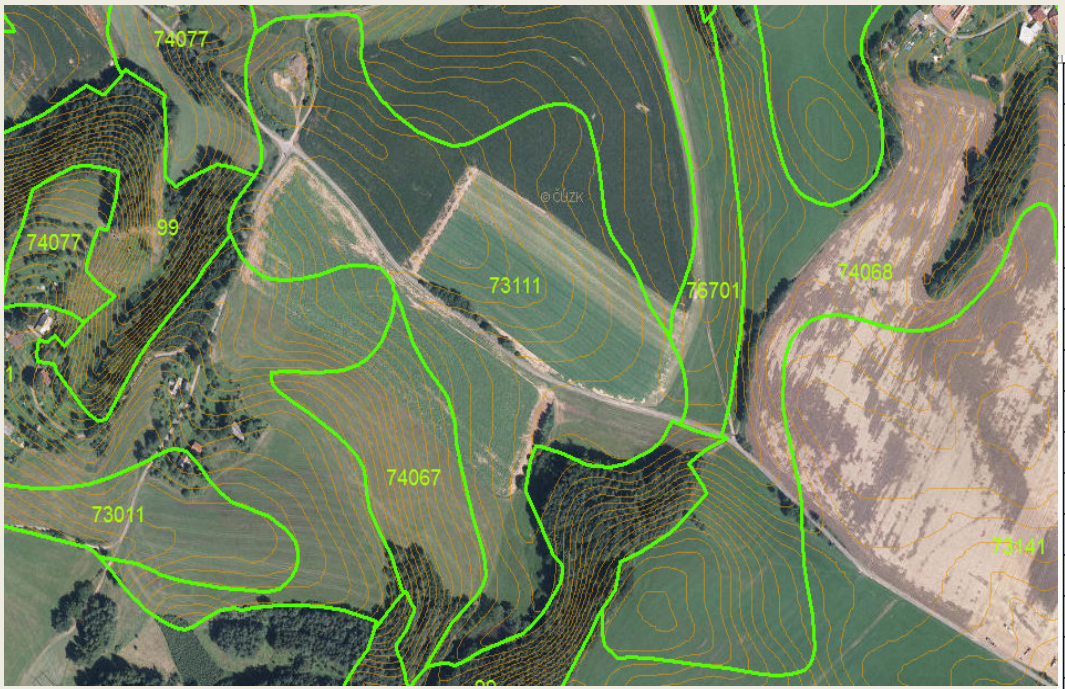
The annual average efficiency of rain erosion factor **R = 40 MJ • ha^{-1} • cm • h^{-1}** determined by the long series of observations of precipitation

Soil erodibility factor (K) two methods of determining

1. based on analysis of soil samples 2. by the system of main soils units

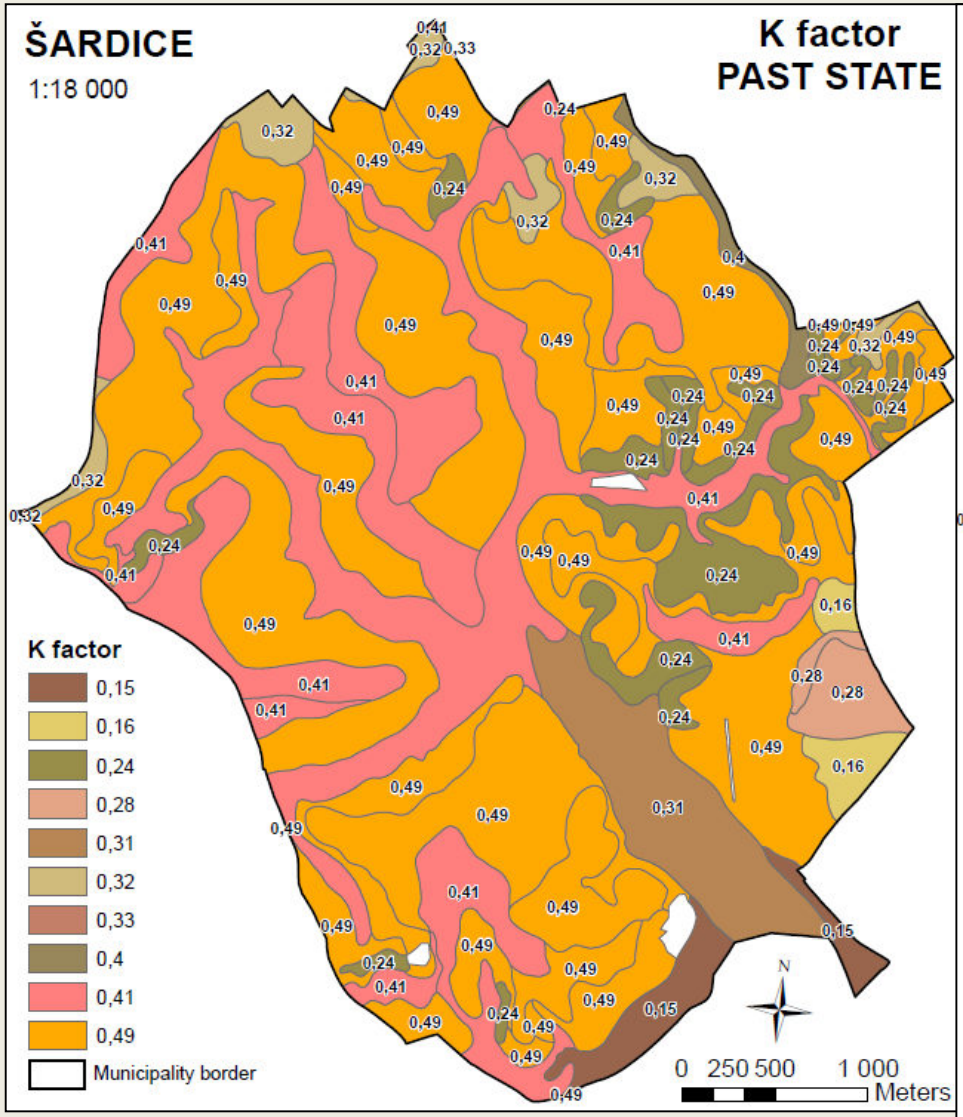
- ❑ categories of grain size
- ❑ % of humus content
- ❑ class soil structure of topsoil
- ❑ permeability class of the soil profile

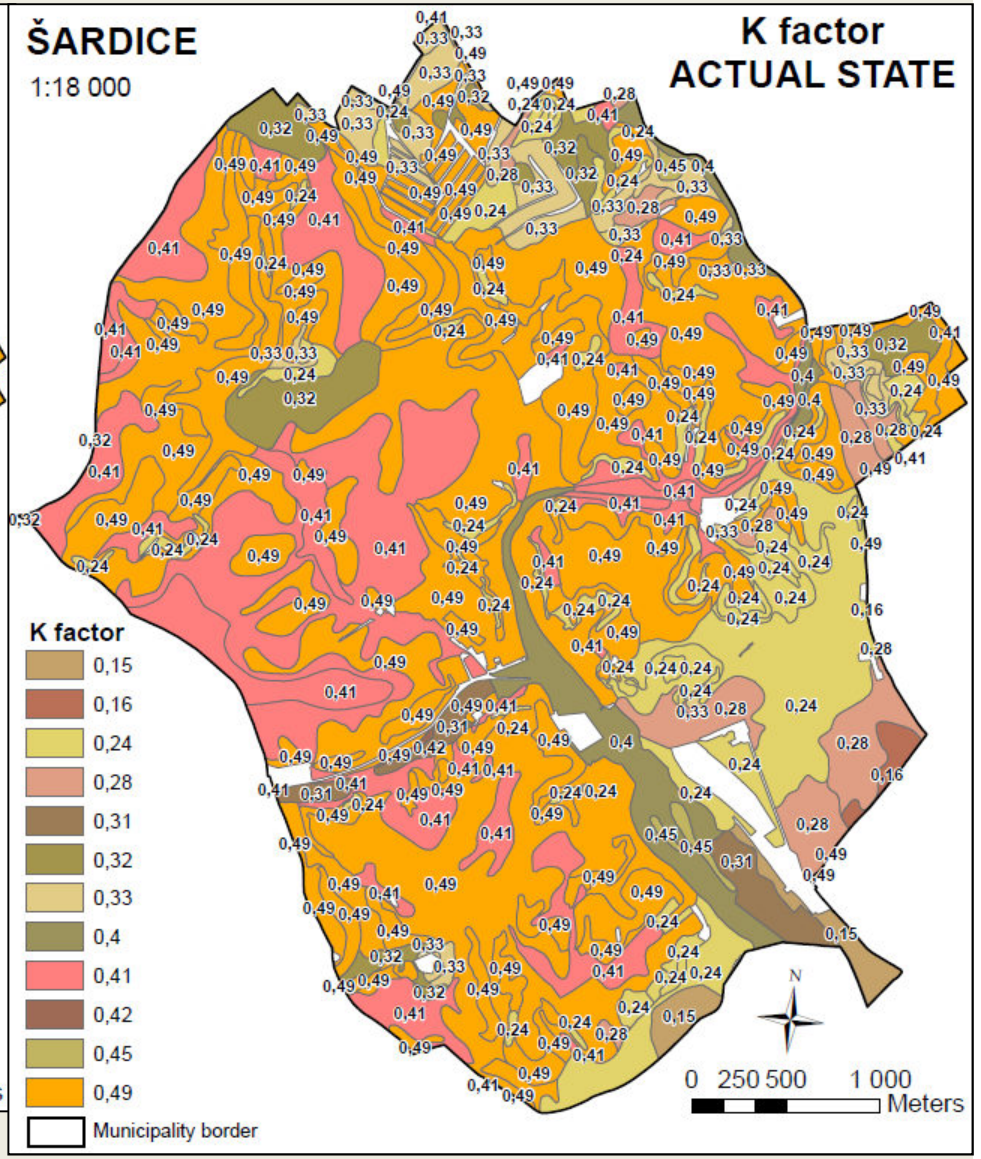




MSU	K - factor	MSU	K – factor
01	0,41	40	0,24
02	0,46	41	0,33
03	0,35	42	0,56
04	0,16	43	0,58
05	0,28	44	0,56
06	0,32	45	0,54
07	0,26	46	0,47
08	0,49	47	0,43
09	0,60	48	0,41
10	0,53	49	0,35
11	0,52	50	0,33
12	0,50	51	0,26
13	0,54	52	0,37
14	0,59	53	0,38
15	0,51	54	0,40
16	0,51	55	0,25

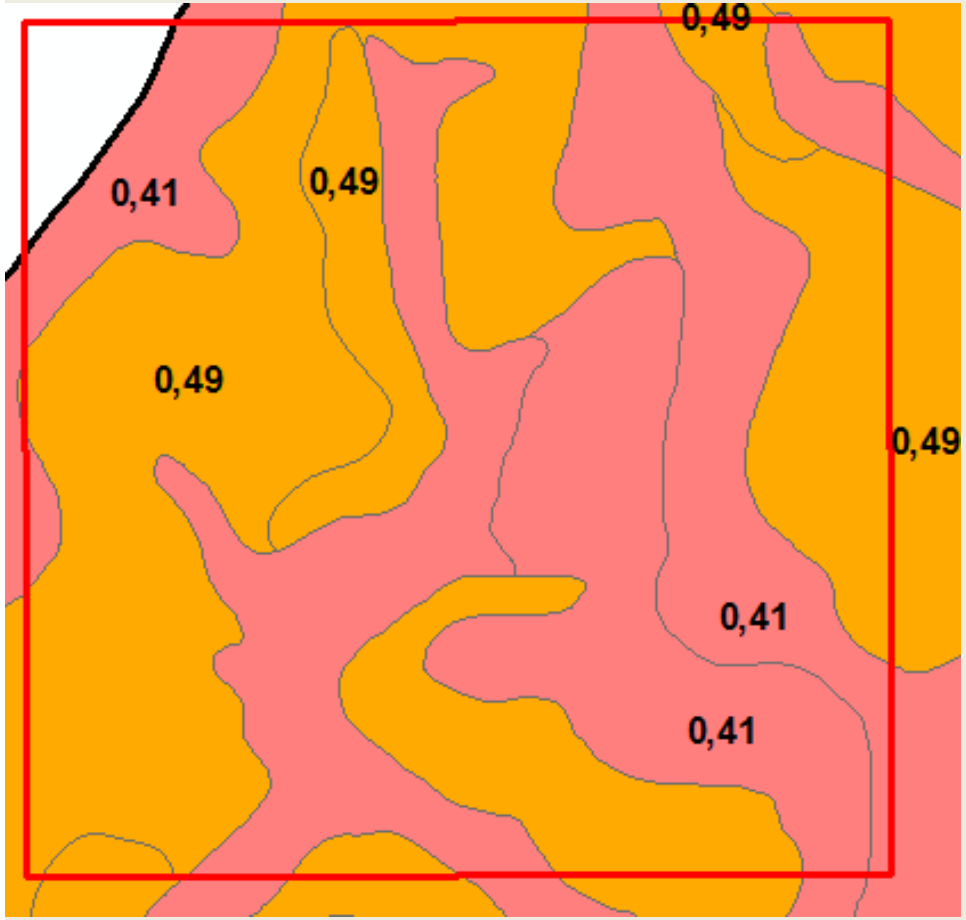
DISTRIBUTION OF K FACTORS



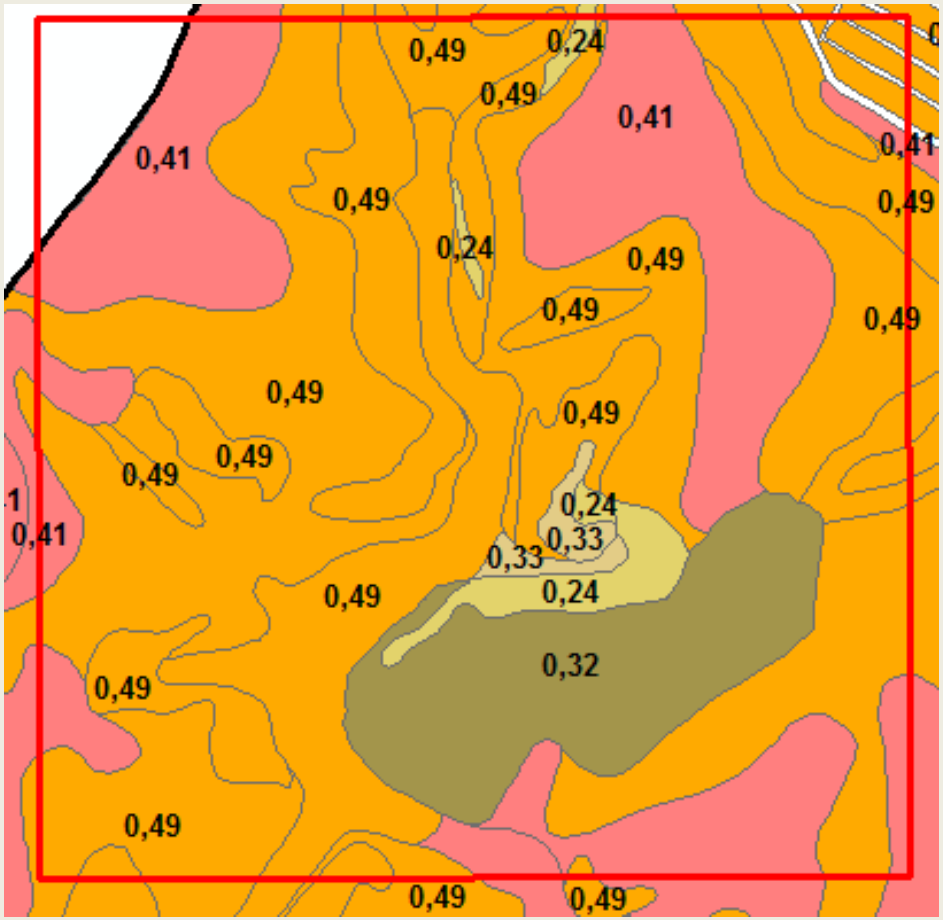


DISTRIBUTION OF K FACTORS
detail 2

PAST STATE



ACTUAL STATE



AVERAGE STRUCTURE OF CROPS

1938

Chronicle of the village Sardice , local old-timers

4% legumes (lentils, peas, beans)
1% Papaver
50% Cereals (Winter wheat (60%) Spring barley (40%))
10 % beet for feeding
10% Potatoes
20 % Perennial forage (clover, alfalfa)
5% Grassland (pastures,meadows)

1977

10%Corn
55% Cereals (30% Winter wheat ,25% Spring barley)
25% alfalfa
10% sugar beet

2012

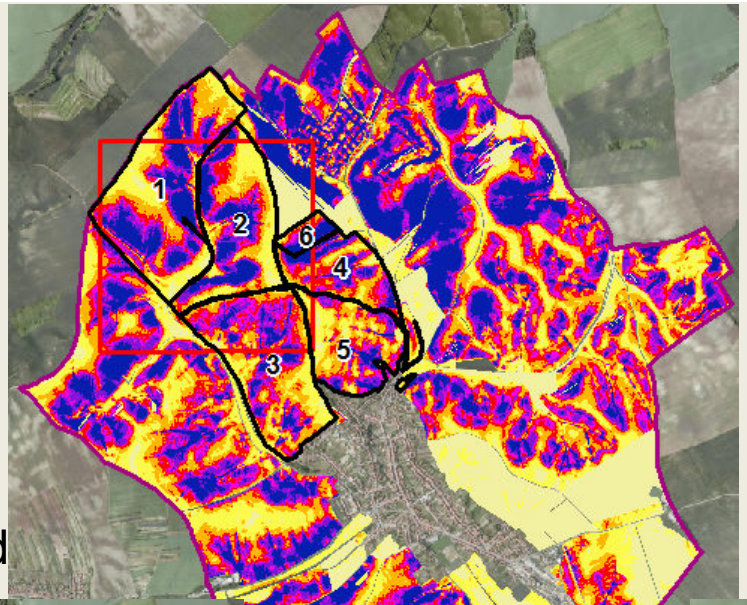
50% Cereals (35% Winter wheat ,15% Spring barley)
30 % corn
20 % winter rape

THE AVERAGE VALUE OF CROP MANAGEMENT FACTOR *C*

CROPS	C FAKTOR	CROPS	C FAKTOR
Winter wheat	0,12	Hop garden	0,8
Winter rye	0,17	Winter rape	0,22
Spring barley	0,15	Sun flower	0,6
Winter barley	0,17	Papaver, poppy	0,5
Oat	0,1	Other oilseeds	0,22
Corn for grain	0,61	Corn for silage	0,72
legumes	0,05	Other annual forage	0,02
Early potatoes	0,6	Other perennial forage	0,01
Potatoes	0,44	Vegetable	0,45
Meadows	0,005	Orchards, wineyards	0,45

Soil erosion rate in this year – 1938, 1977, 2012 R40

1938
R = 40
K = PS
P = 0,6
C = 0,179 - arable land



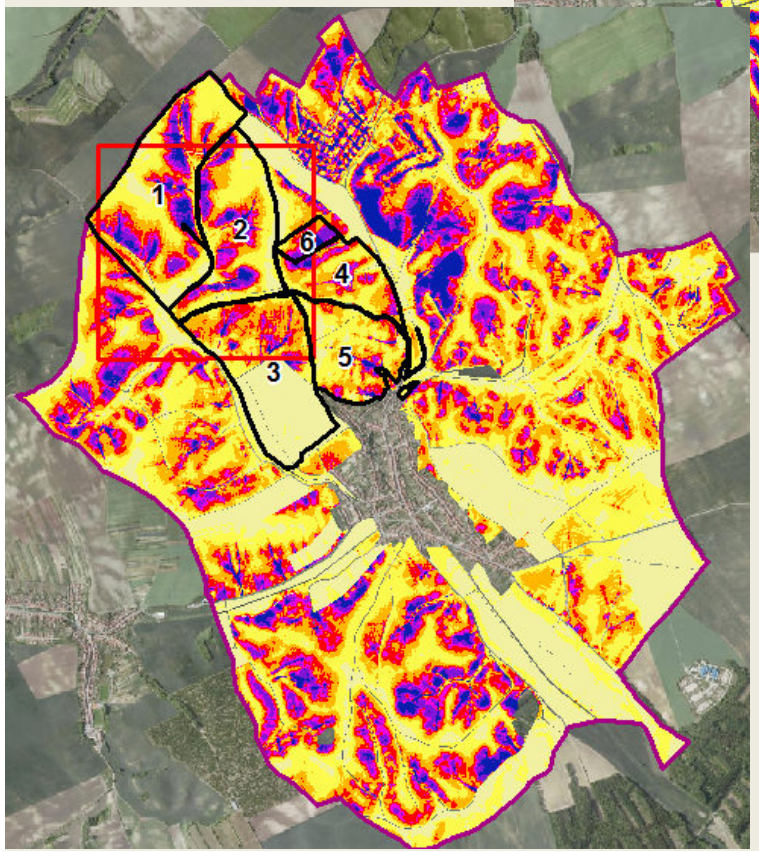
Legend

- Reseach plots
- Detail
- Municipality border

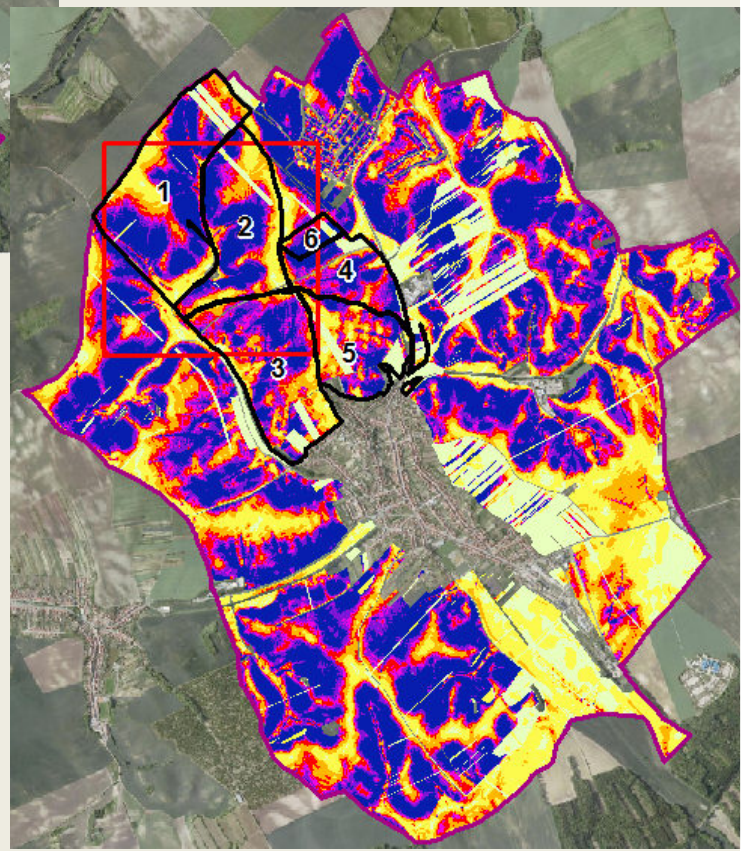
Soil Erosion Rate $t.ha^{-1}.rok^{-1}$

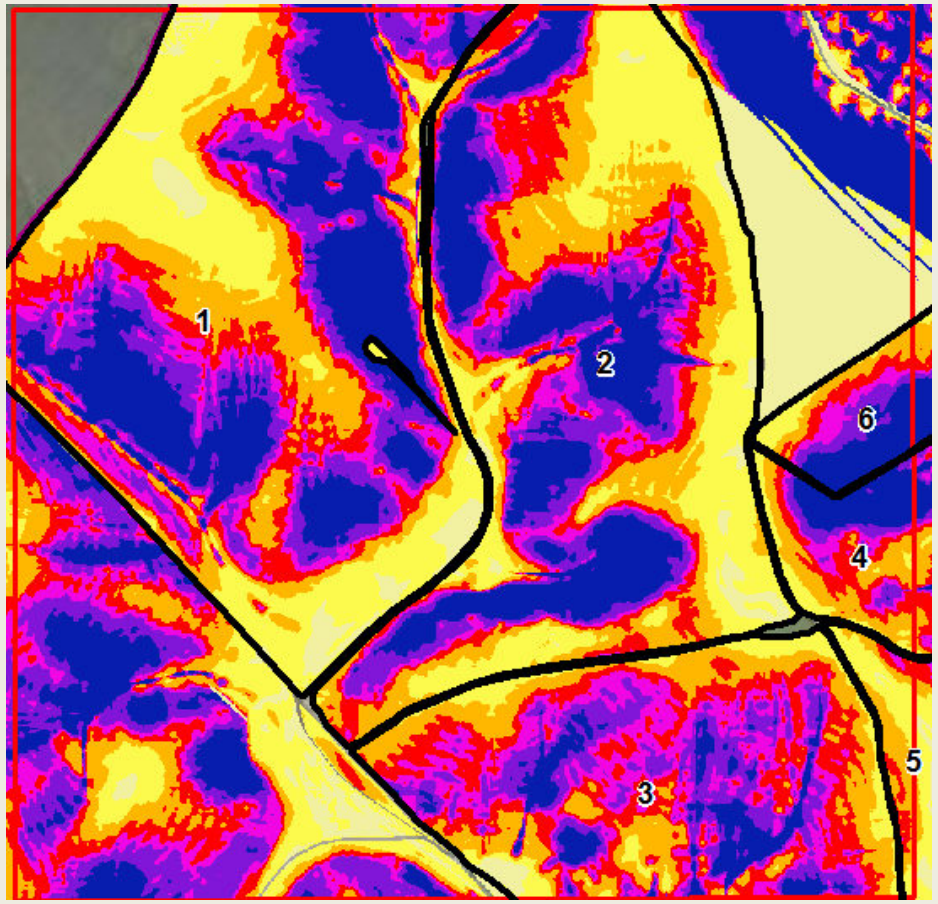
- 0.00 - 1.00
- 1.01 - 5.00
- 5.01 - 10.00
- 10.01 - 15.00
- 15.01 - 20.00
- 20.01 - 30.00
- 30.01 - more

2012
R = 40
K = AS
P = 1,0
C = 0,325 - arable land



1977
R = 40
K = PS
P = 1,0
C = 0,211 – arable land



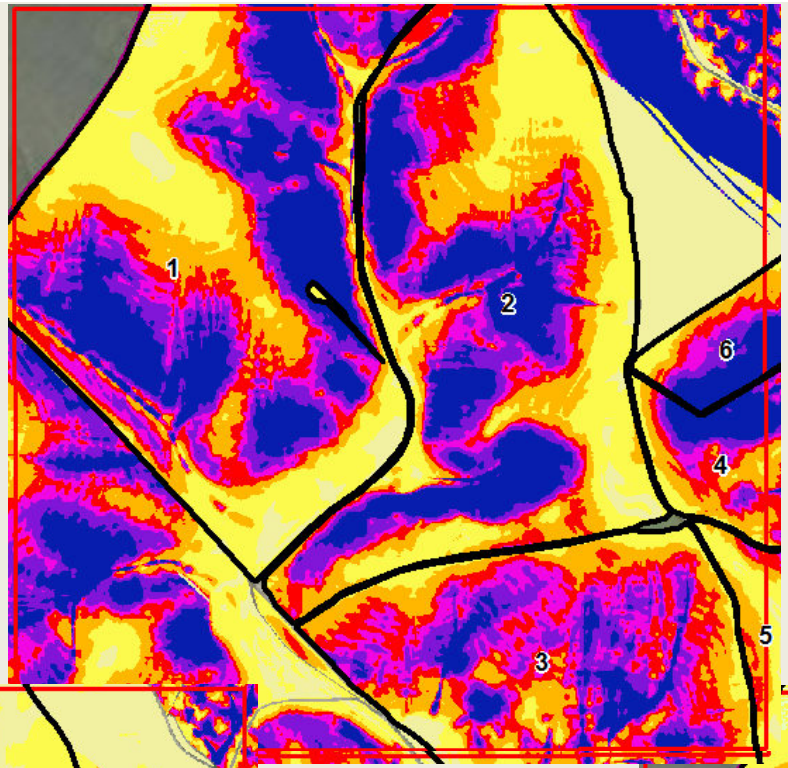


Soil Erosion Rate
t.ha^{-1}.rok^{-1}

- 0.00 - 1.00
- 1.01 - 5.00
- 5.01 - 10.00
- 10.01 - 15.00
- 15.01 - 20.00
- 20.01 - 30.00
- 30.01 - more

Soil erosion rate
1938, 1977, 2012
Detail
R40

1938
R = 40
K = PS
P = 0,6
C = 0,179 - arable land

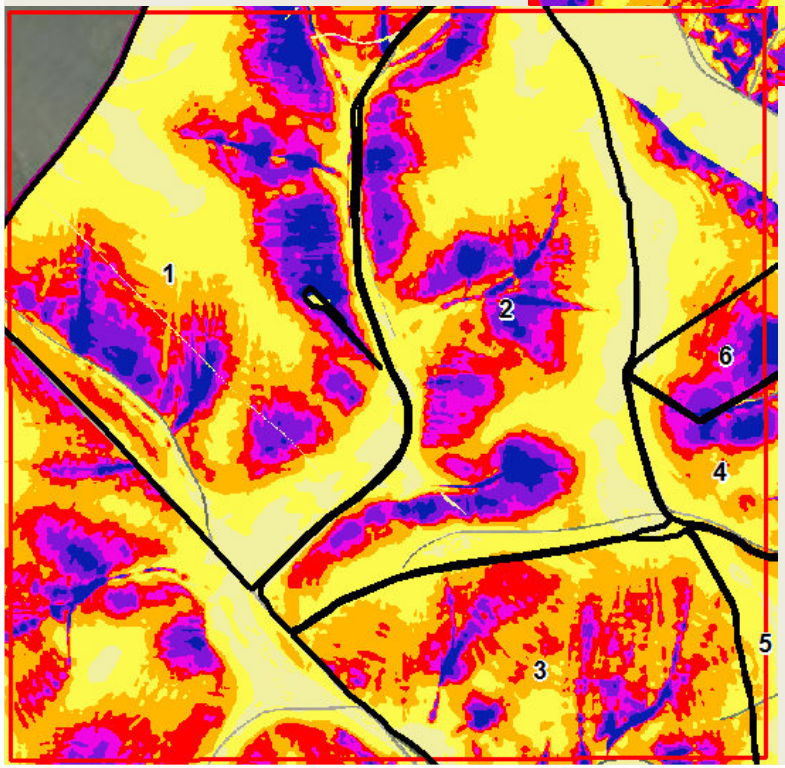


Reseach plots
Detail
Municipality border

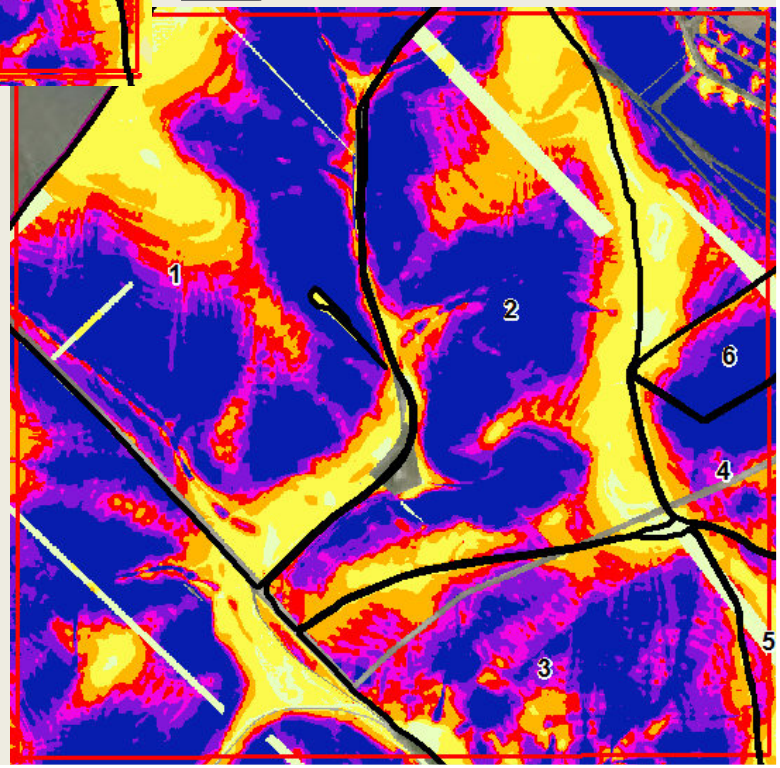
Soil Erosion Rate
t.ha^{-1}.rok^{-1}

0.00 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 15.00
15.01 - 20.00
20.01 - 30.00
30.01 - more

2012
R = 40
K = AS
P = 1,0
C = 0,325 - arable land



1977
R = 40
K = PS
P = 1,0
C = 0,211 - arable land



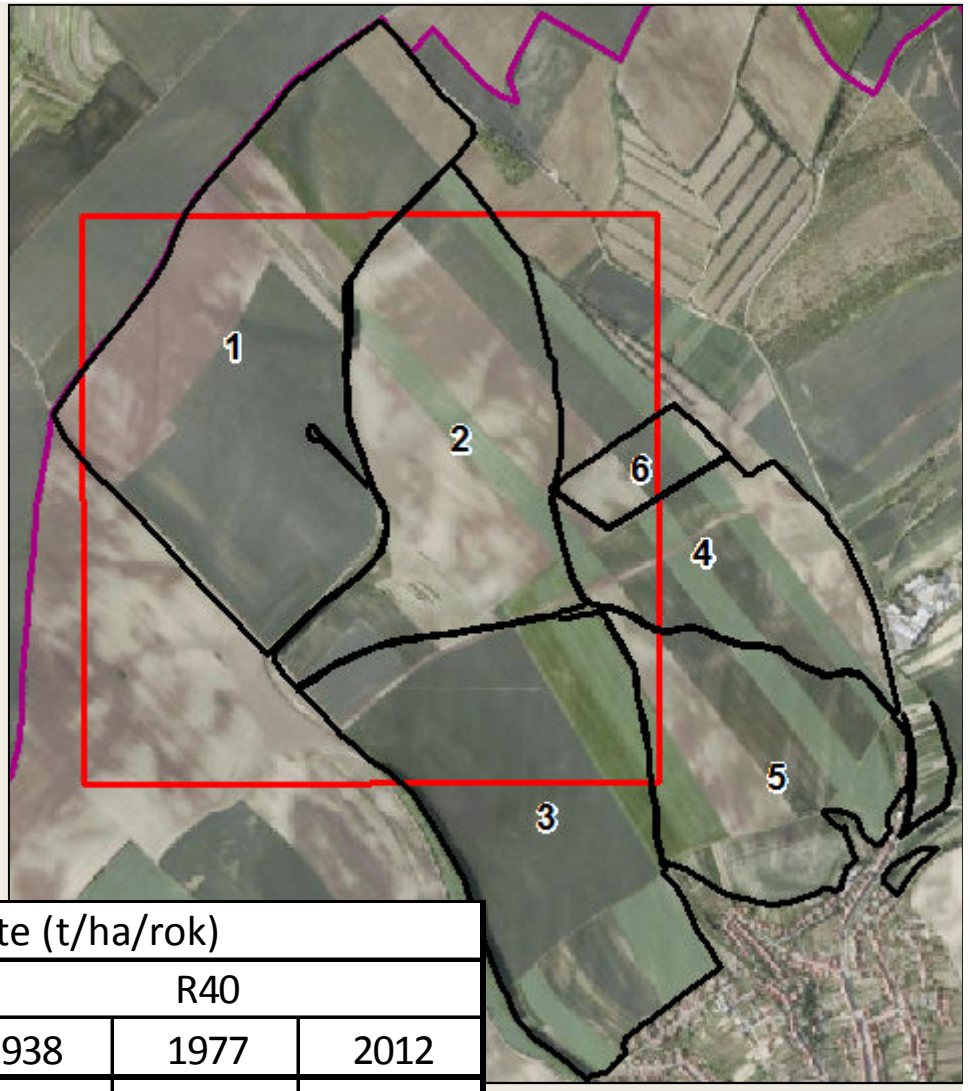
Calculating erosion by inserting barriers among the boundary of plots

Whole plot without barriers P = 1,0

Whole plot without barriers P = 0,6

Divided plot with barriers P = 1,0

Soil erosion rate in this year – 1938, 1977, 2012 R20 and R40



Plot´s number	AREA (m^2)	Mean soil erosion rate (t/ha/rok)					
		R20			R40		
		1938	1977	2012	1938	1977	2012
1	848604	4.985	9.874	14.941	9.969	19.748	29.883
2	577772	4.661	9.315	13.503	9.323	18.631	27.005
3	674616	2.564	7.564	10.418	5.128	15.129	20.835
4	291516	4.794	9.718	14.135	9.588	19.436	28.270
5	383220	3.350	6.758	8.853	6.700	13.517	17.705
6	67448	8.772	12.956	17.109	17.544	25.912	34.219

CONCLUSION

Recently land consolidation offers potential possibilities for the flexible, environmental - friendly sustainable agriculture.

It requires the following elements:

1) Rational land use - taking into consideration both the production and the environmental aspects.

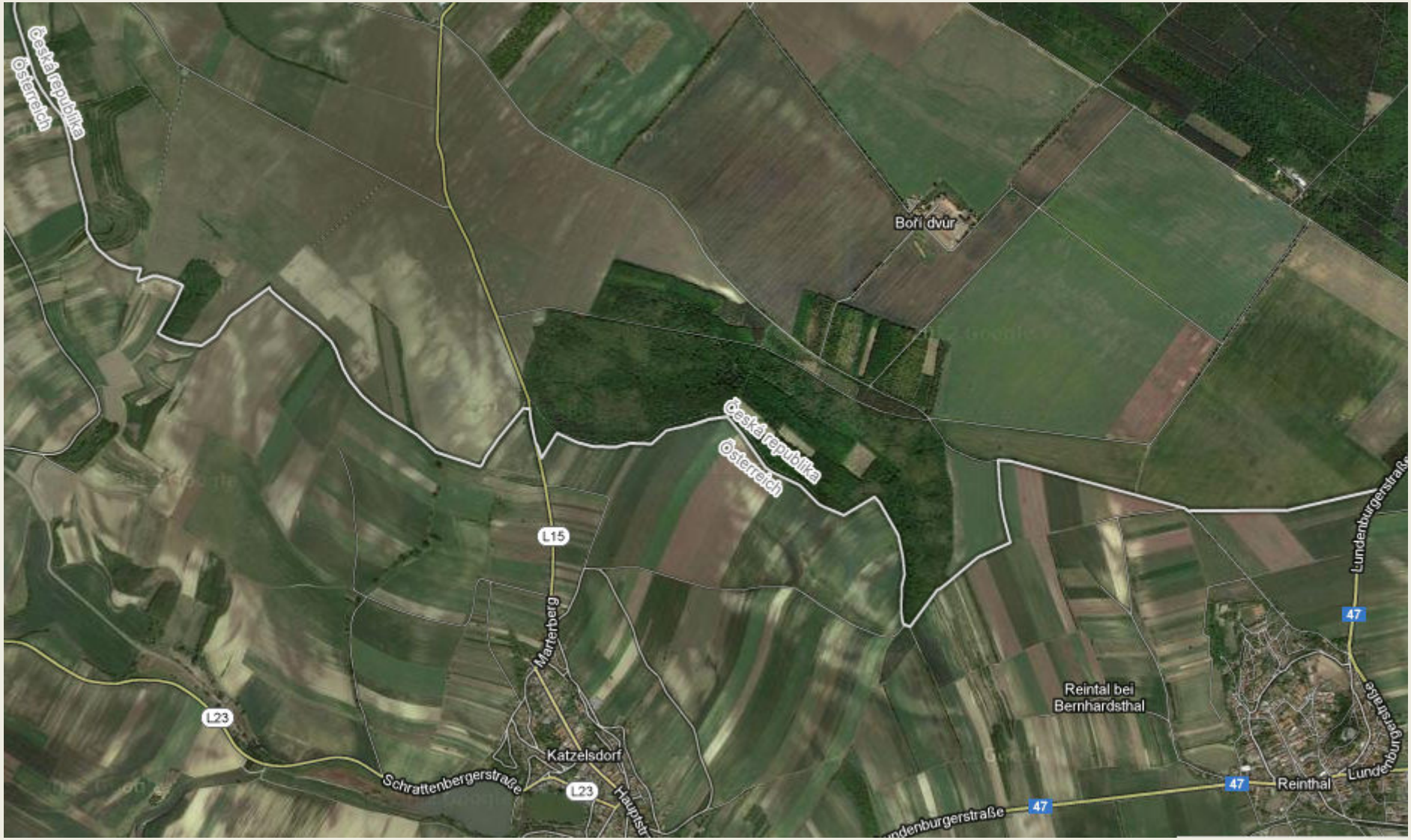
2) Rationalization of the structure of agricultural lands by an optimation of plot sizes (according to the given physiography, particularly slope and soil characteristics.

3) Adoption and implementation of scientific-based crop production and soil management technologies.

4) Introduction of areas with up-to-date soil conservation practices for water and wind erosion control in erosion sensitive areas

THANK YOU FOR YOUR ATTENTION


Česká republika
Österreich


Česká republika
Österreich
Bofi dvur
Česká republika
Österreich
L15
Marterberg
L23
Schrattenbergerstraße
Katzelsdorf
L23
Reintal bei
Bernhardsthal
47
Lundenburgerstraße
47
Reinthal
Lundenburgerstraße
47

THE INTENSITY OF WATER EROSION INDICATES FREQUENT PLOWING NEOGENE SEDIMENTS (FORMER SEABED)

INTENSIVELY DAMAGES CAUSED BY SOIL EROSION IN WIDE-ROW CROPS (MAINLY CORN) GROWN ON SLOPES WITHOUT USING EROSION CONTROL

The annual value of the R factor is determined from long-term records of precipitation and the sum of the erosive effect of torrential rains that occurred in a given year,

- the rains are not involved with a total of less than **12.5 mm**,
- and if in the course of **15** minutes fallen at least **6.25 mm** and must be separated from other rainy period longer than six hours.

The Czech Republic was originally annual average efficiency of rain erosion factor R = 40 MJ • ha^{-1} • cm • h^{-1} determined by the long series of observations of precipitation

Here is a comparison of the state

cultivation methods were quite different

since 1950, intensive agriculture

spatial distribution of plots (parcel of owners)

The largest area of arable land was in 1938

overview of land use assessment

As a case study area was selected cadastral area ŠARDICE

there are significant changes

square frame, 100 pins

5 measurements within the frame

calculation of volumes

Natural conditions on the territory of the Czech Republic are suitable for the accelerated soil erosion which can be a danger.

In the past, Czech landscape was resistent enough against this danger, because of high diversity of the crops planted and small acreage of the fields. However, the socialist land reforms resulted in an extreme acceleration of the erosion phenomena, beginning from the 1950s'. During the last 40 years drastic changes brought by collective farming system and soil management have greatly affected soil losses.

Most of the previously existing hedges, balks, hollow ways and field paths disappeared, giving way to large fields. The criteria of soil homogeneity, water runoff concentration, wildlife protection and landscape aesthetics were not respected.