11th Slovak-Czech-Polish Seminarium
„Flows, Spaces and Societies in Central Europe“
June 14th-16th, 2017

How a man changes the river (the Váh River in the 20th Century case study)

the Váh River story (some of the stories)

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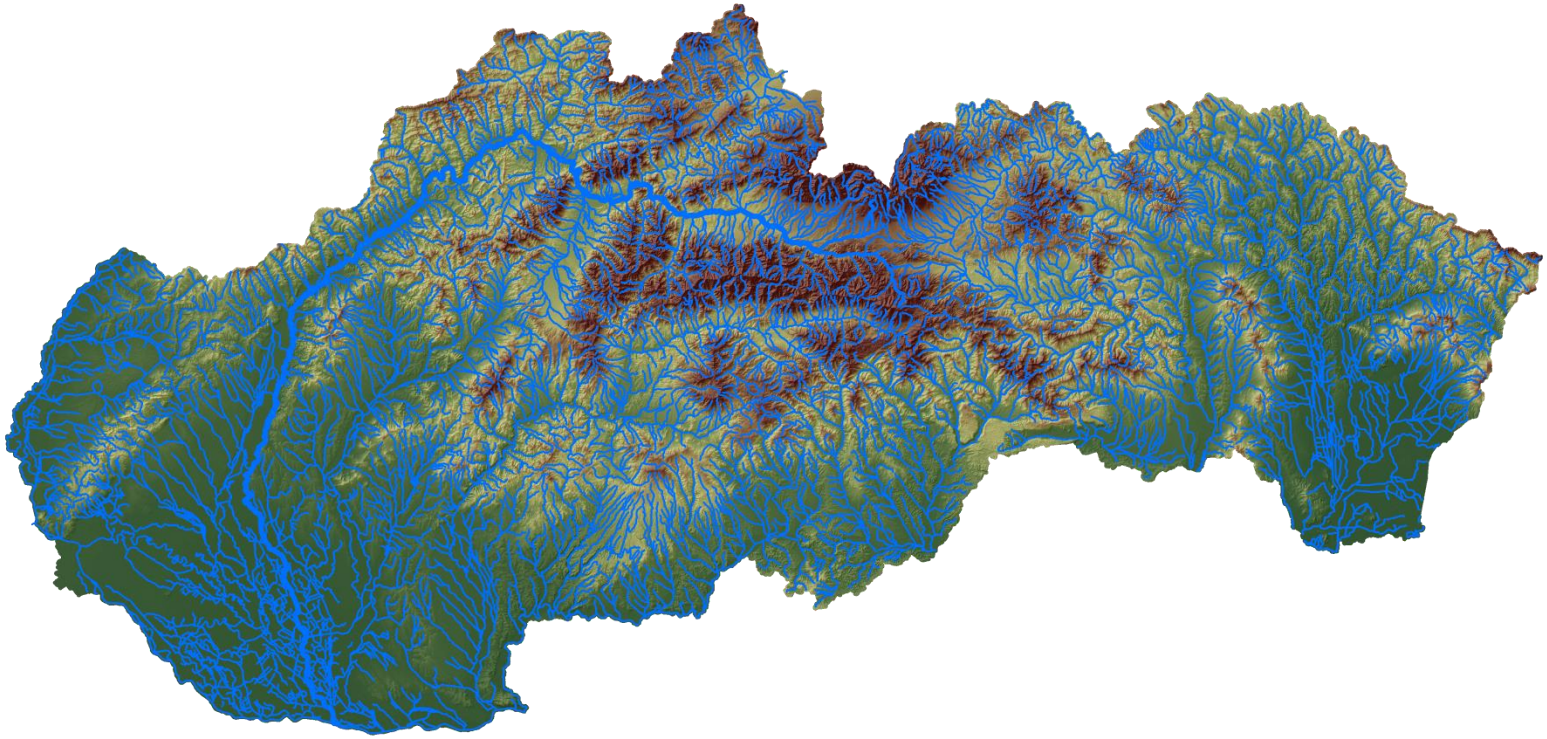
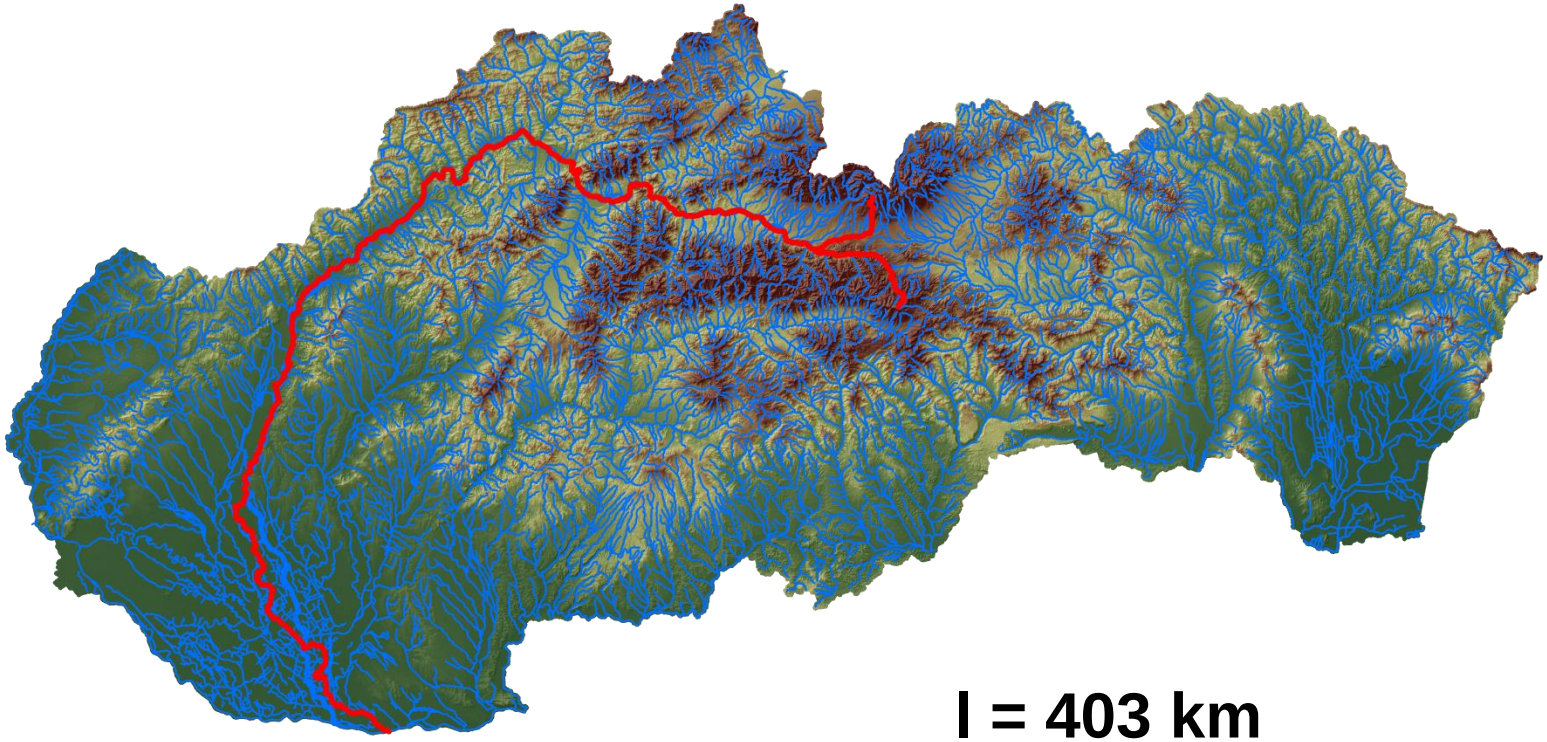
men and rivers

- migration corridors
- transportation
- seatlements
- agriculture
- industry – water, energy
- natural hazard – floods, bank erosion
- human modification of riverine landscape
- river channel straightening
- damming
- by-passing
- embankments constructing

the Váh River



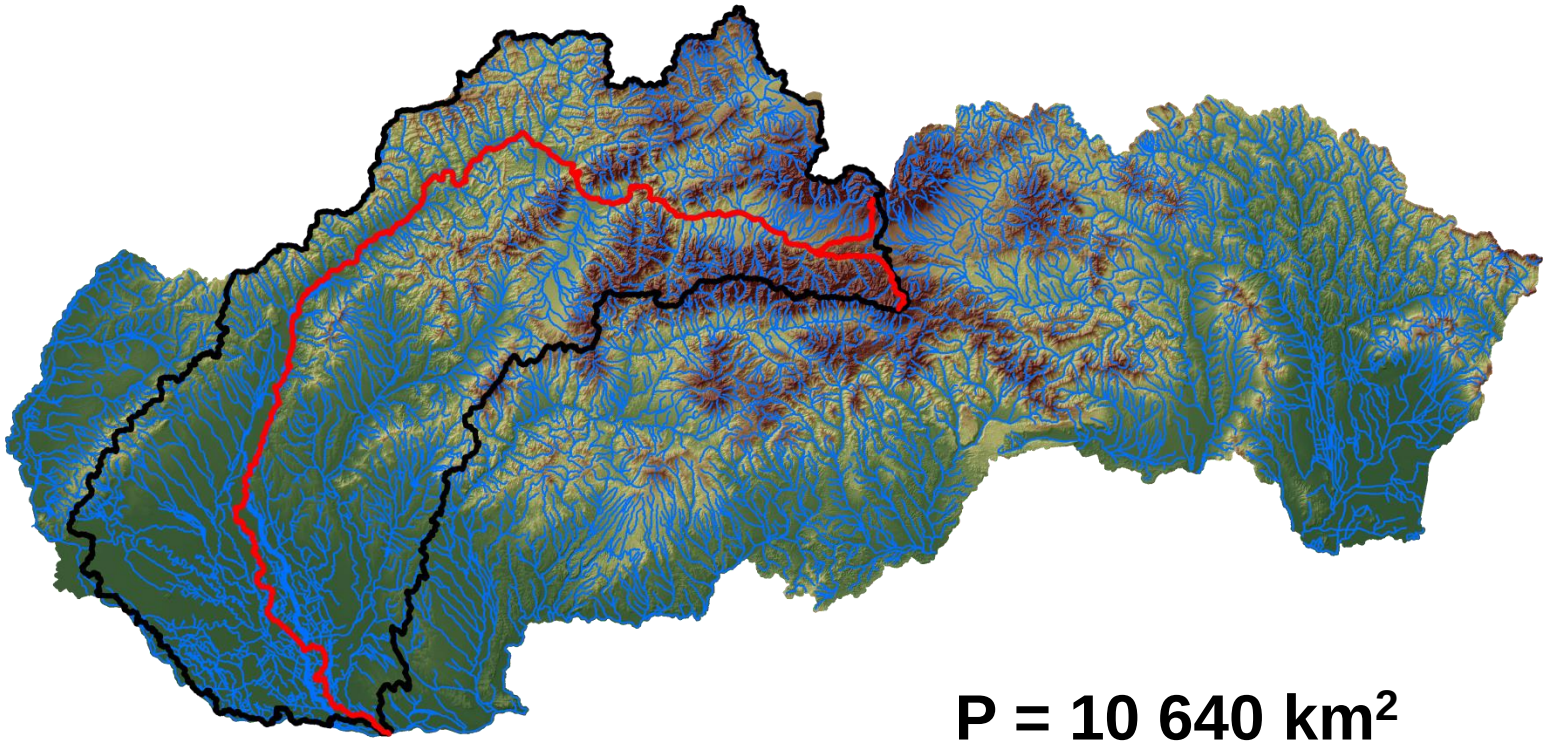
the Váh River



l = 403 km

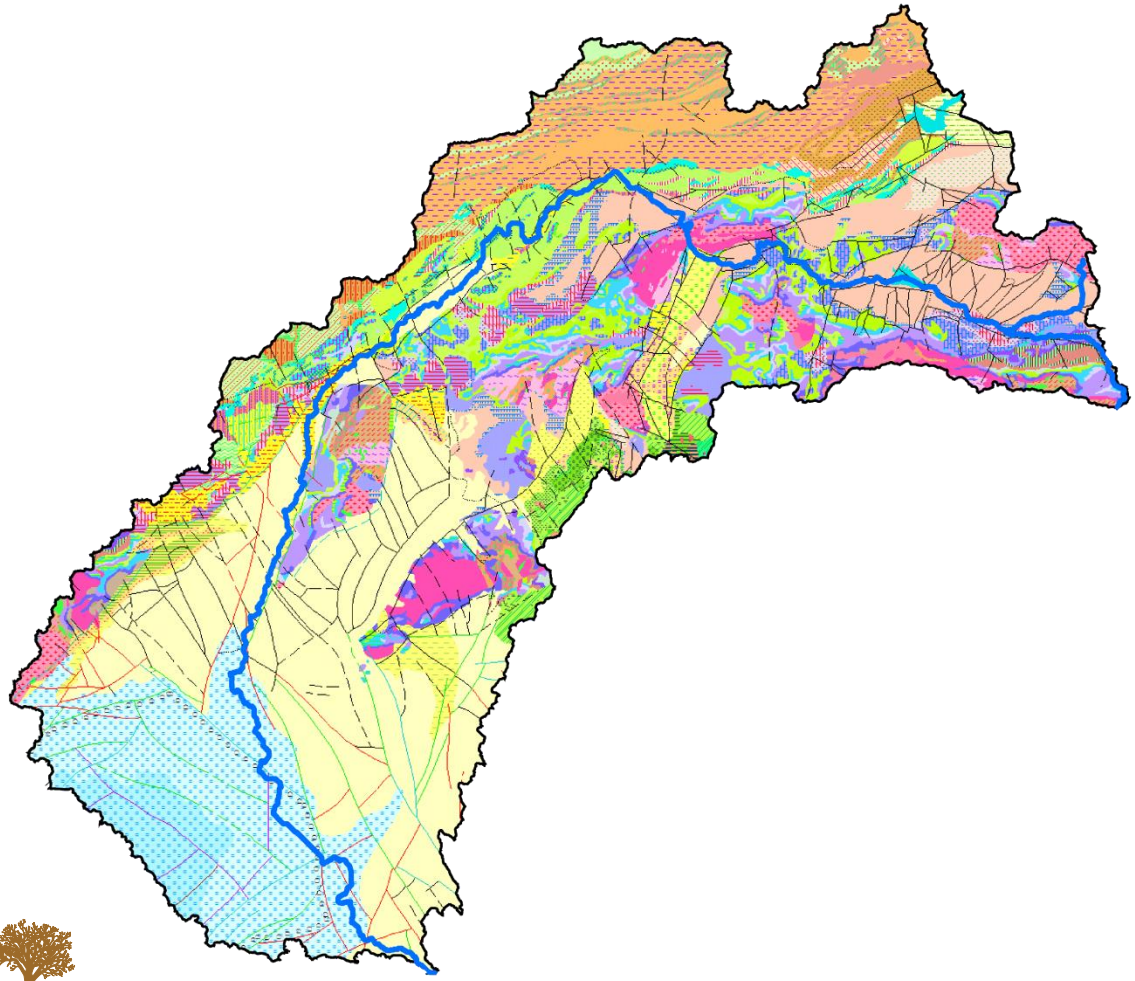
Q = 196 m^3s^{-1}

the Váh River



P = 10 640 km^2

the Váh River



the Váh River

the Váh River

- first regulations at the beginning of the 19th Century
- construction of the “Váh Cascade” system in the 20th Century
- 22 dams and hydropower plants
- diverged (by-passed) channel reaches, total length of 140 km (more than 1/3 of whole river length)

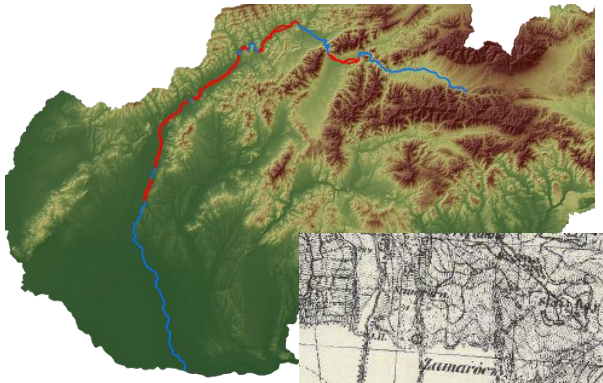
segment	dam	by-pass	construction
1	Liptovská Mara + Bešeňová		1975 - 1976
2	Krpelianska priahrada		1957
3		Krpeliansky kanál	1957 - 1961
4			
5	VD Žilina		1994 - 1998
	Hričovská priehrada		1962 - 1964
6	Hričovská priehrada	Hričovský kanál	1962 - 1965
7	Nosická priehrada	Nosický kanál	1956 - 1958
8		Kočkovský kanál	1936 - 1949
9		Biskupický kanál	1953 - 1956
10		Biskupický kanál	1953 - 1956
	Sĺňava	Drahovský kanál	1960 - 1961
11	Kráľová		1985

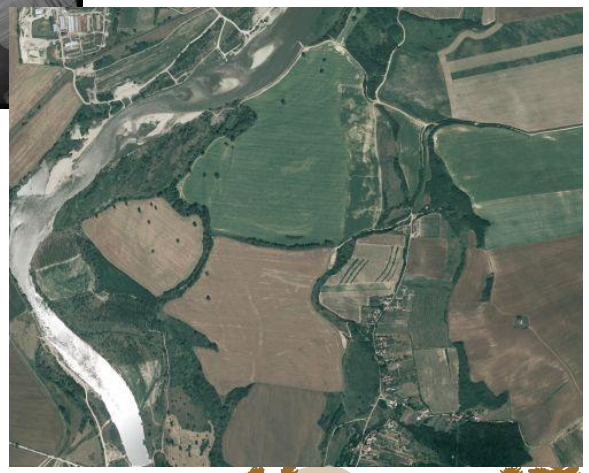
aims of study

- classification - segments
- transformation of the Váh River fluvial system in the 20th Century
- connectivity
- riverine landscape evolution

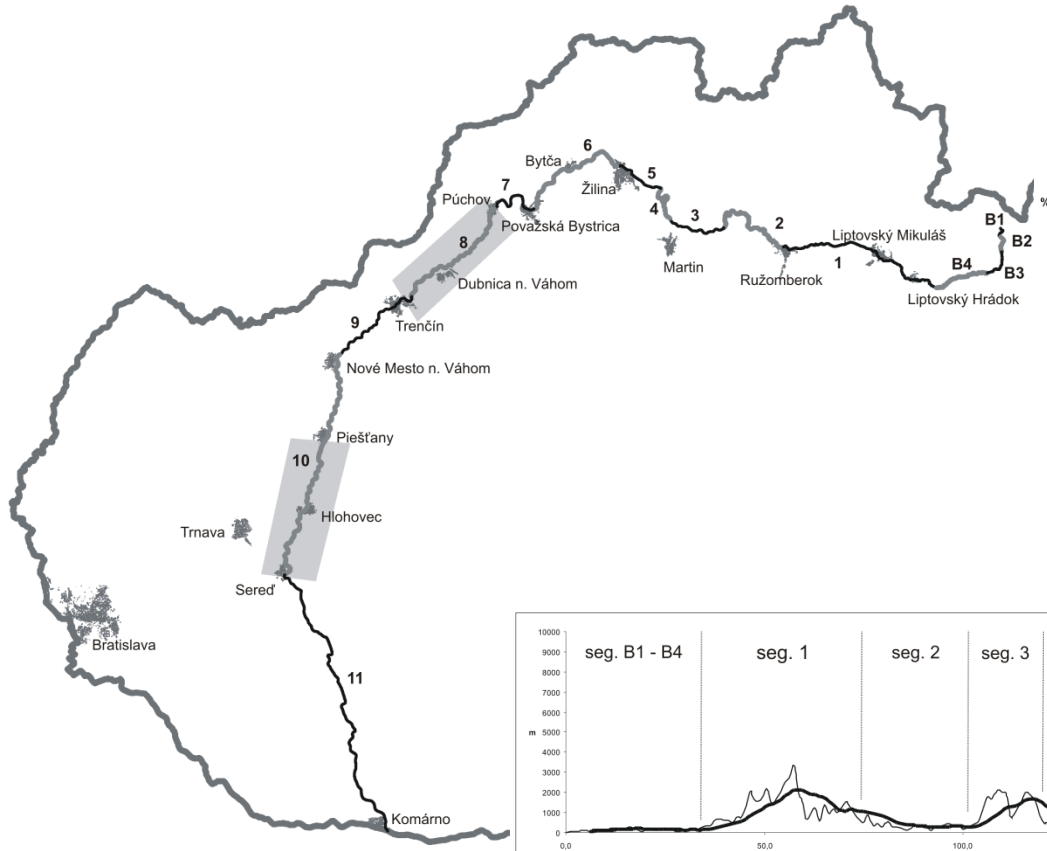
data

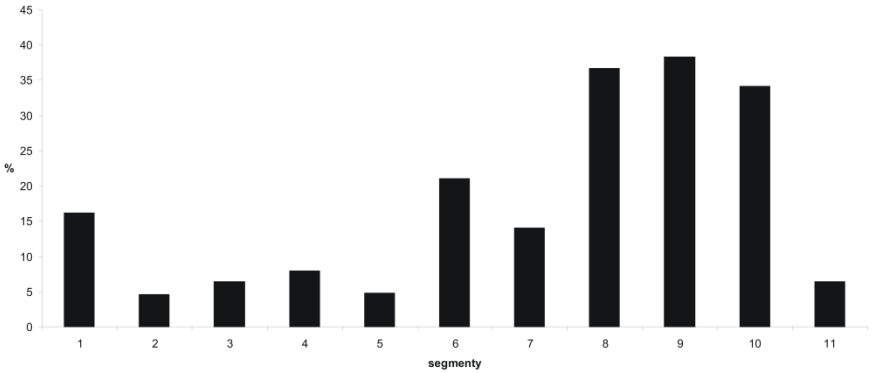
- DMR
- geologic maps
- topographic data (The Third Military Survey 1869-1887; ZB GIS 2005-2008)
- orthophotomaps (ca. 1950, ca. 2000)



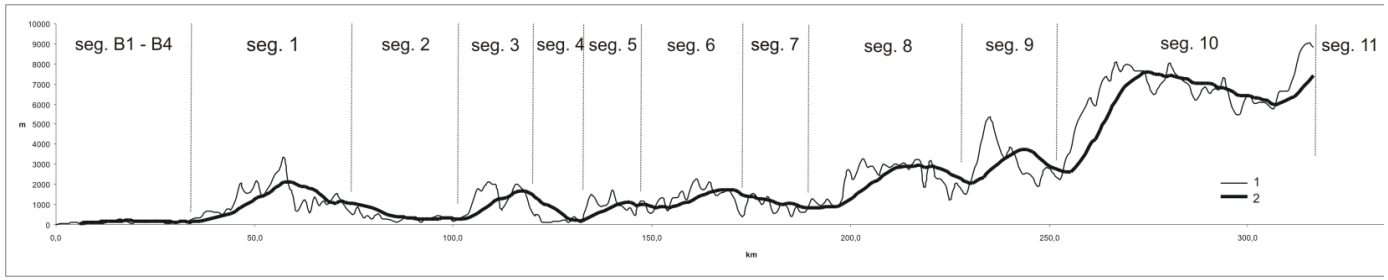


classification





anabranching rate (1900)



valley width

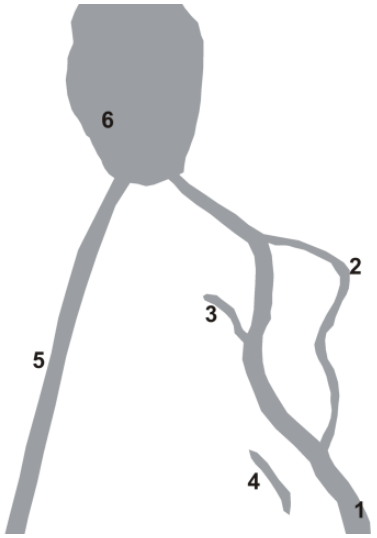
transformation - methodology

- identification of basic elements of fluvial system
- identification of active flood-plain
- calculating reduction rates

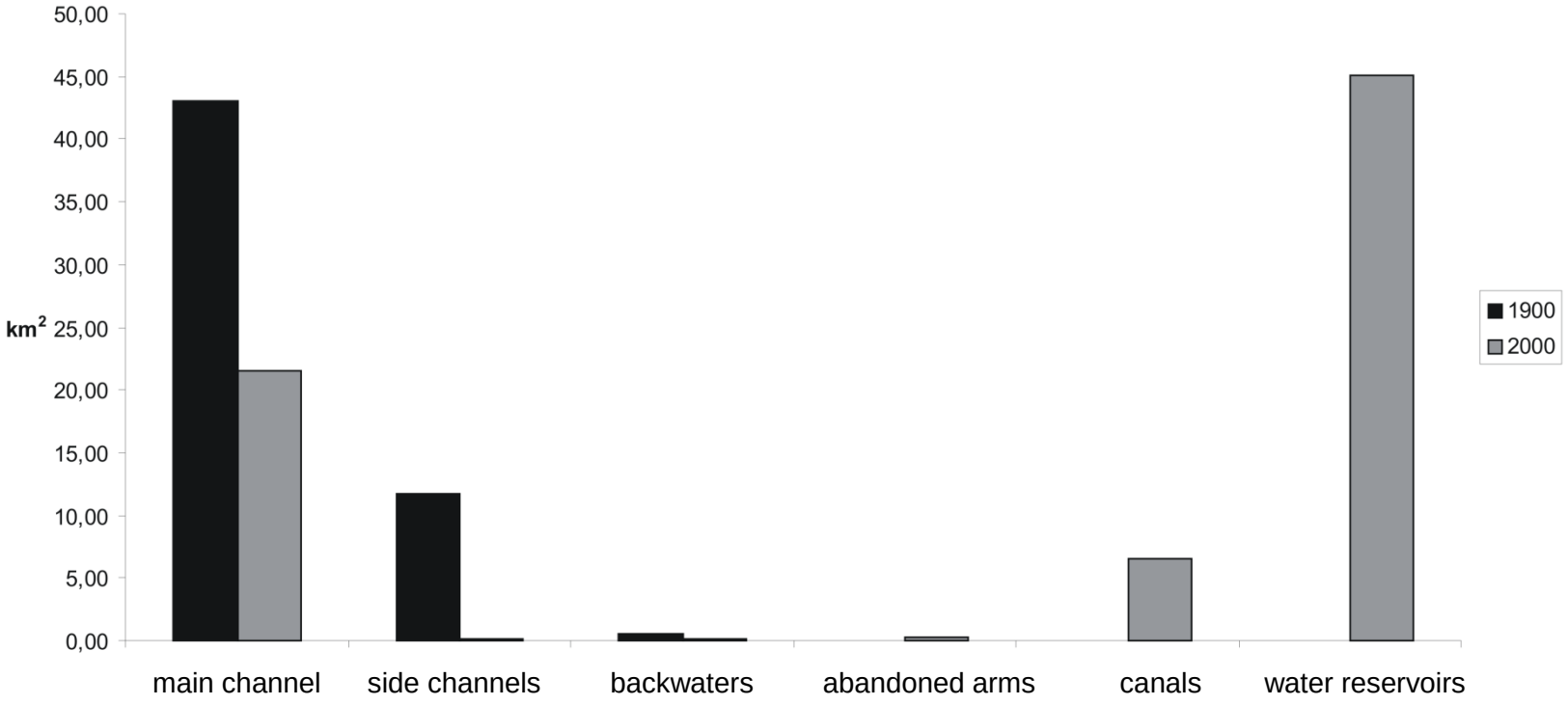
$$Rp=(P1900 – P2000)/P1900.100$$

$$Rk=(K1900 – Kvn – K2000)/(K1900 – Kvn).100$$

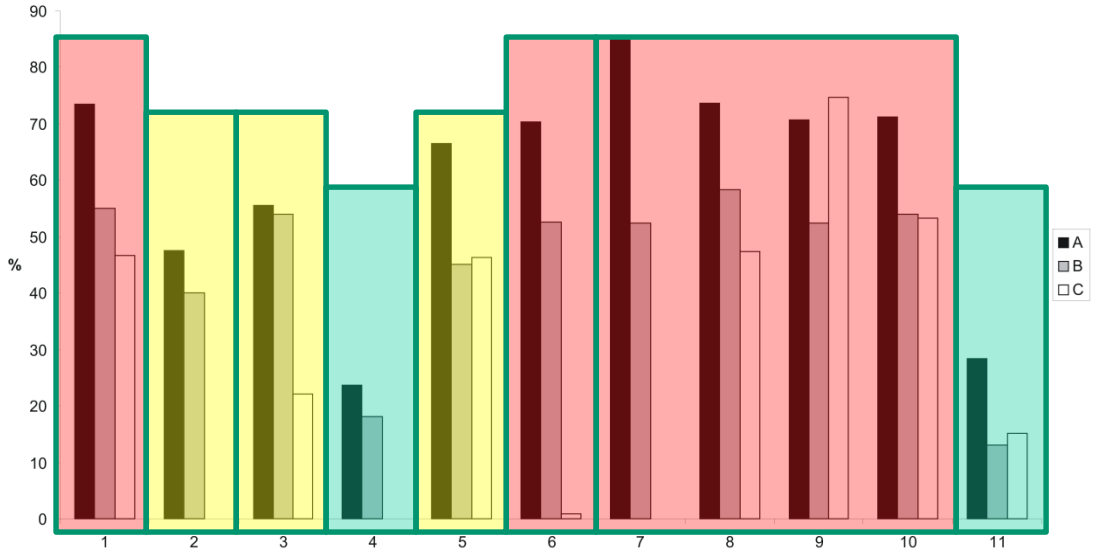
$$Rn=(N1900 – N2000)/N1900 .100$$



transformation



reduction rates



A – fluvial system area
B – main channel
C – potentially active floodplain

1. high reduction (Rp 70-85%; Rk 50-60%; Rn 45-75%)
2. medium reduction
3. lower reduction (Rp 20-30%; Rk 10-20%; Rn 0-20%)

river connectivity

- fluvial geomorphic processes - combination of erosion, transport and deposition of sediments by flowing water
- sediment fluxes within the river systems - understanding their evolution and functioning
- connectivity - linkage of sediment through the system - sediment sources and storage zones (Hooke 2003)
- various landforms (buffers, barriers, blankets), can disrupt longitudinal, lateral or vertical linkages (Fryirs et al. 2007)
- human modification – considerable barriers to sediment movement

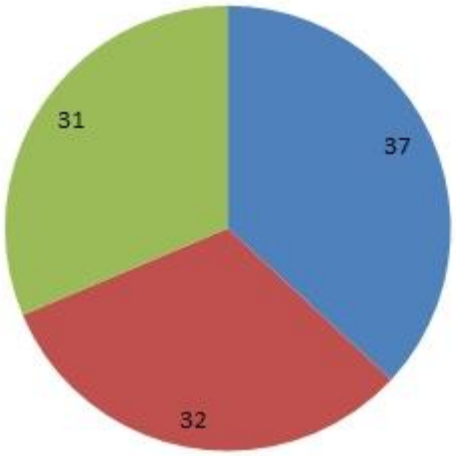
connectivity – research questions

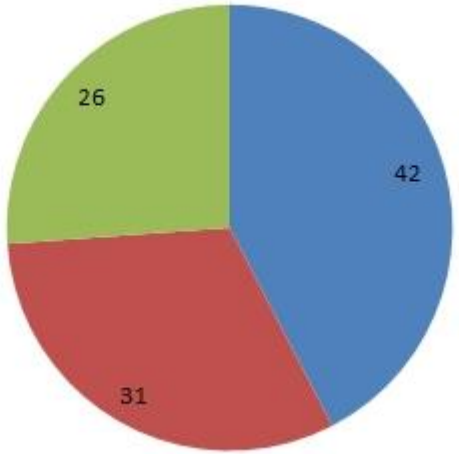
- How to identify and evaluate connectivity rate within whole river basin considering natural conditions and anthropogenic impact?
- What data are we able to gain?
- Does it change in time?
- Does the disconnectivity rate increase?
- Are the any spatial differences in river segments behaviour?

longitudinal connectivity within channel – channel bars evolution

channel bars locatisation

1950

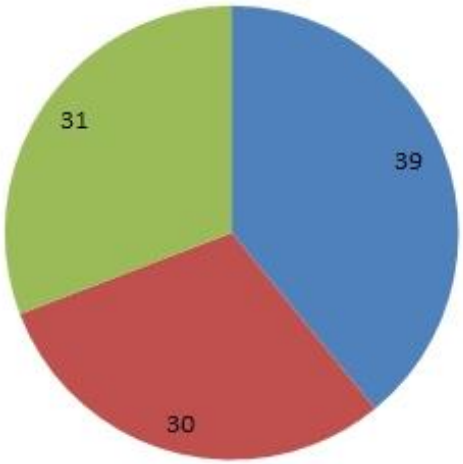


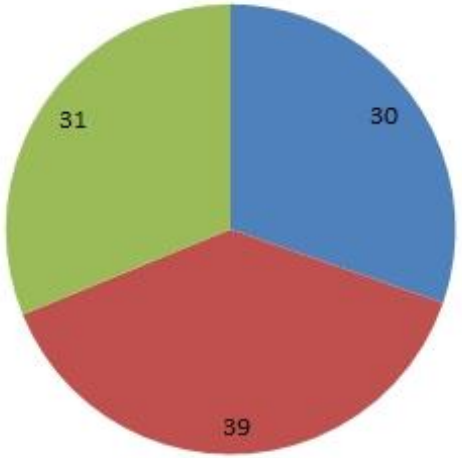


number

area (ha)

2000





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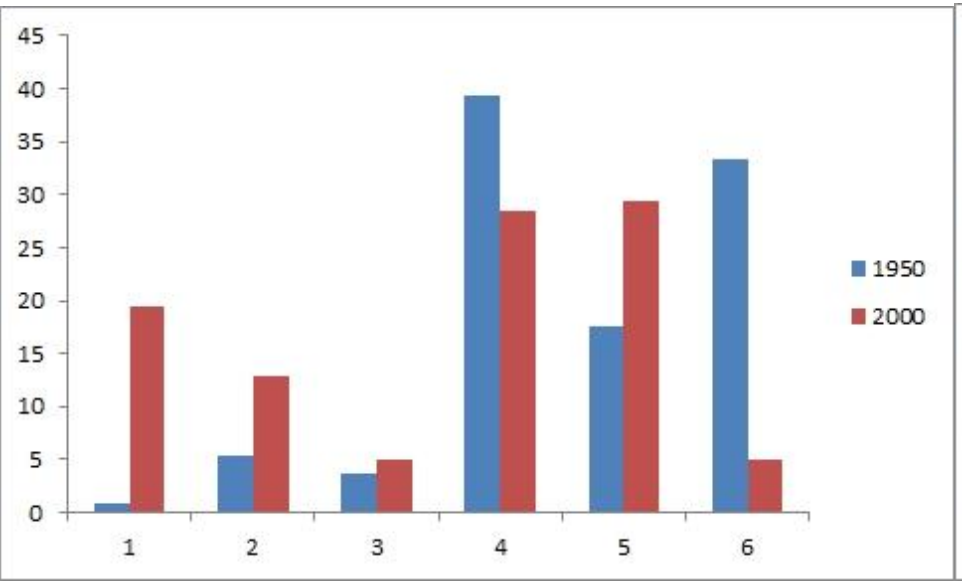
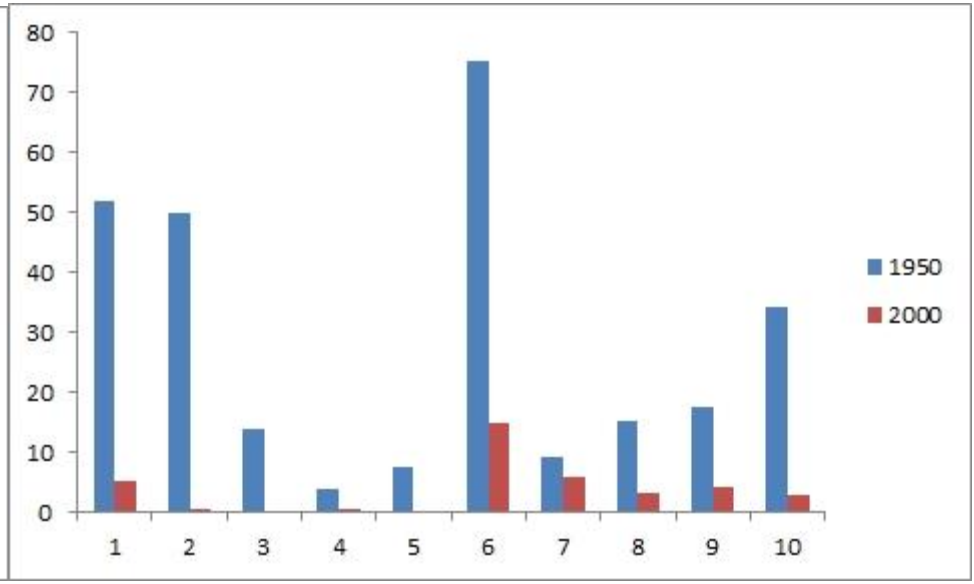
P





Vegetation cover of bars in %

1 – wood
2 – wood/grass
3 – grass
4 – grass/bare
5 – bare
6 – mix

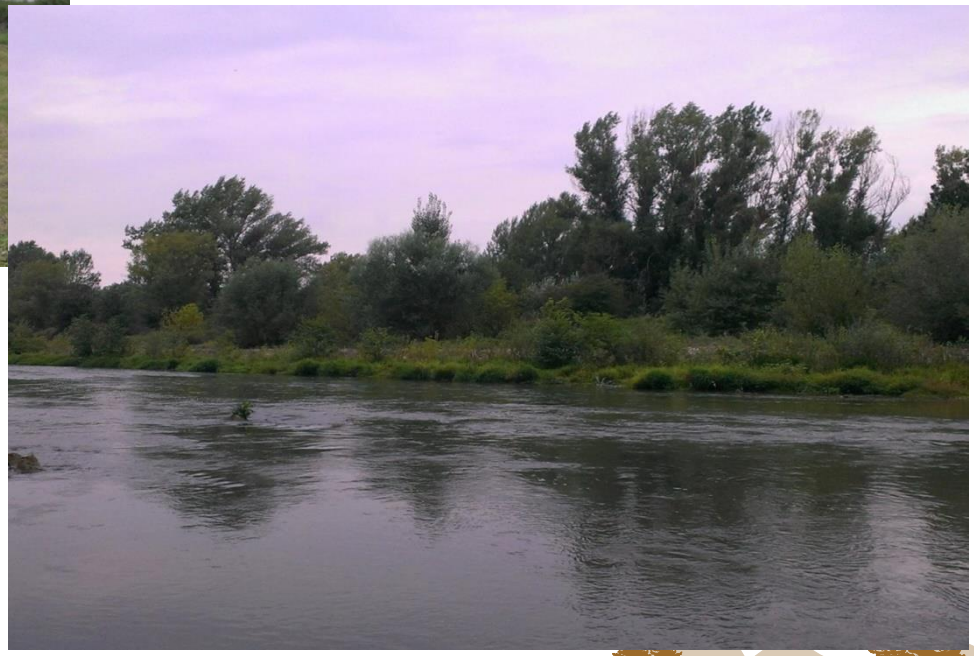
Channel bars area evolution within segments in ha

1 – Kráľova Lehota – Liptovský Mikuláš
2 – Liptovský Mikuláš – Bešeňová
3 – Bešeňová - Ružomberok
4 – Ružomberok - Kraľovany
5 – Kraľovany - Krpeľany
6 – Krpeľany – Vrútky
7 – Vrútky – Strečno
8 – Strečno – Žilina
9 – Žilina – Hričov
10 – Hričov - Bytča

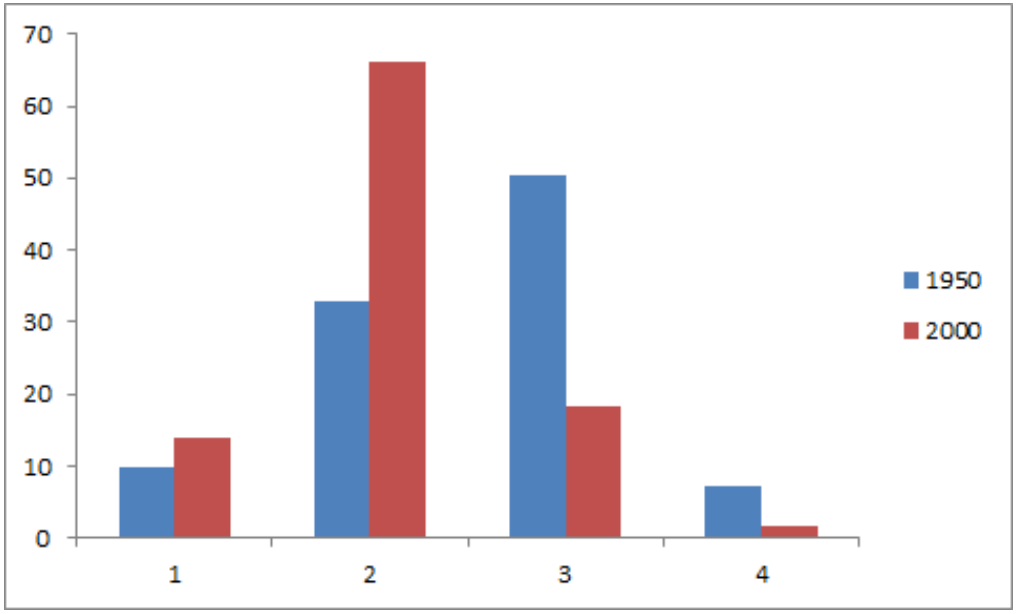
channel bars stabilisation

- according number - ca. 40 % bars - overlapping in both time horizons
- according area - ca. 60 % - overlapping in both time horizons
- diminishing of smaller and stabilisation of larger bars

lateral connectivity – river banks analysis



Kráľova Lehota – Martin



Riverbank vegetation cover in %

1 – woody (areal)
2 – woody (linear)
3 – grass/arable
4 – bare

Anthropogenic barriers

1950 – 28 %
2000 – 54 %

Piešťany – Sereď case study

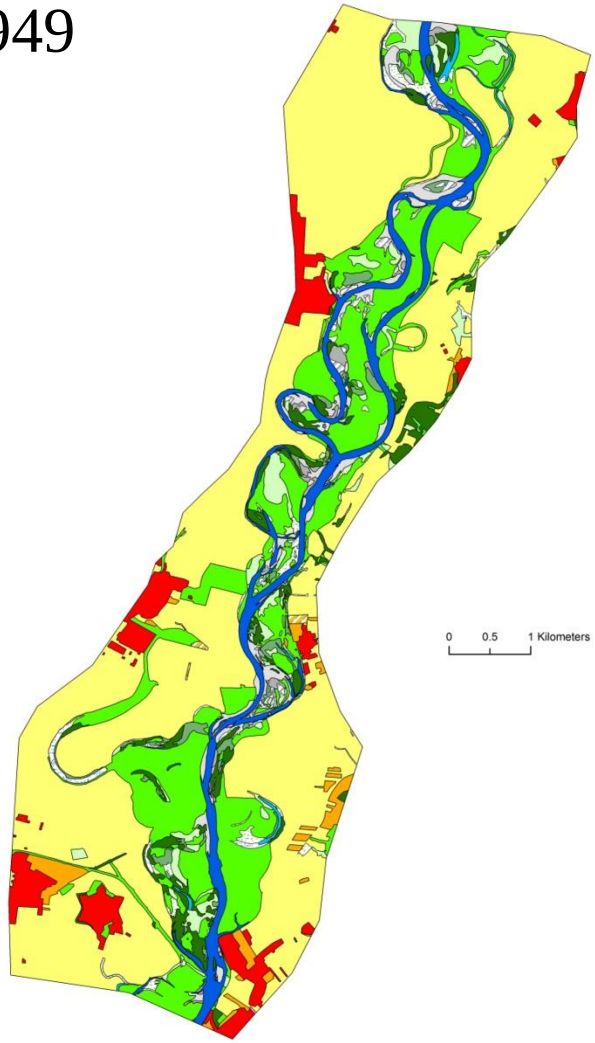
- 35 km long reach
- between the Sĺňava and Kráľová Reservoirs
- partly by-passed
- anastomosing system before construction
- changes of the land cover structures (1949 – 2003)

Piešťany – Sereď case study

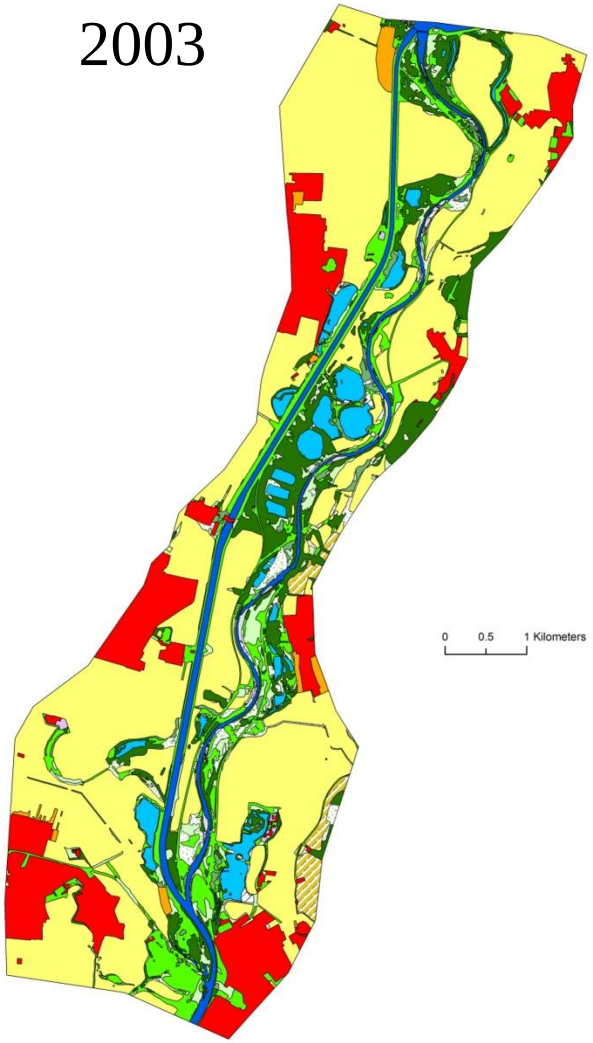
1 – flowing water
2 – water area
3 – sand, gravel (without vegetation)
4 – pioneer vegetation on the banks and bars
5 – bars and banks with dispersed woody vegetation
6 – marshes
7 – grass
8 – grass with sparse woody vegetation
9 – scrubs
10 – forest - continuous
11 – forest - discontinuous
12 – arable land
13 – gardens
14 – orchards, vineyards
15 – built-up areas
16 – artificial areas
17 – gravel mining

ha	SPOLU									
	1	2	3	4	5	6	7	8	9	10
1	199,64	31,60	16,00	5,21	0,88	4,18	94,90	40,93	16,81	125,80
2	0,93	3,46					2,40	0,45	0,16	3,62
3	11,45	13,57	1,80	1,05	0,06	0,19	29,03	9,69	8,71	30,85
4	2,13	4,50	0,18	0,08		0,67	9,73	2,42	2,80	11,66
5	3,78	3,30	0,02			0,31	8,05	4,34	3,30	9,84
6		1,70					6,54	2,13	0,71	3,29
7	32,81	96,36	2,78	1,07	0,10	2,00	340,68	93,29	48,43	220,39
8	11,27	10,10	0,50	0,21	0,01	0,38	52,63	34,68	13,41	85,85
9	3,58	6,52	0,01			0,27	16,34	7,83	9,01	55,76
10	9,85	15,49	1,69	0,52		0,68	52,89	27,68	15,97	243,19
11	7,50	4,70	0,20	0,46		0,24	17,16	11,24	6,37	39,10
12	27,73	13,11	0,06	0,08		0,06	129,66	17,29	18,62	68,51
13		0,08	0,19				26,93	9,50	9,47	30,91
14							3,53	0,45	0,51	2,38
15										
16	0,41						0,76		0,05	
	311,09	204,49	23,43	8,68	1,05	8,99	791,21	261,90	154,34	931,15

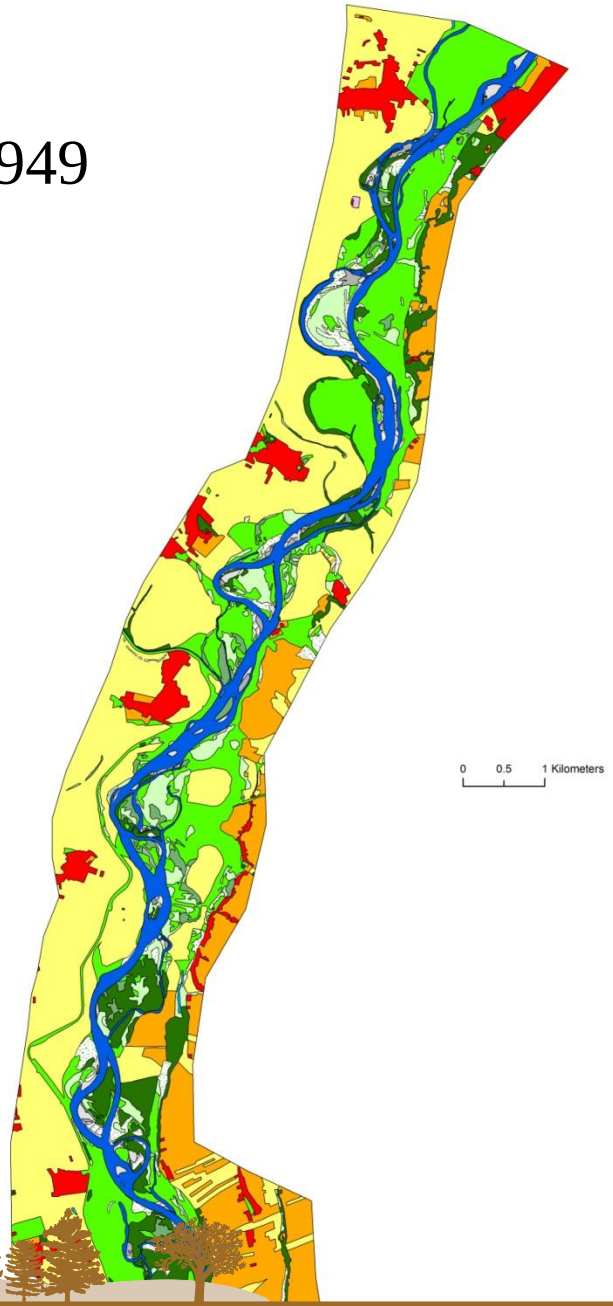
1949



2003



1949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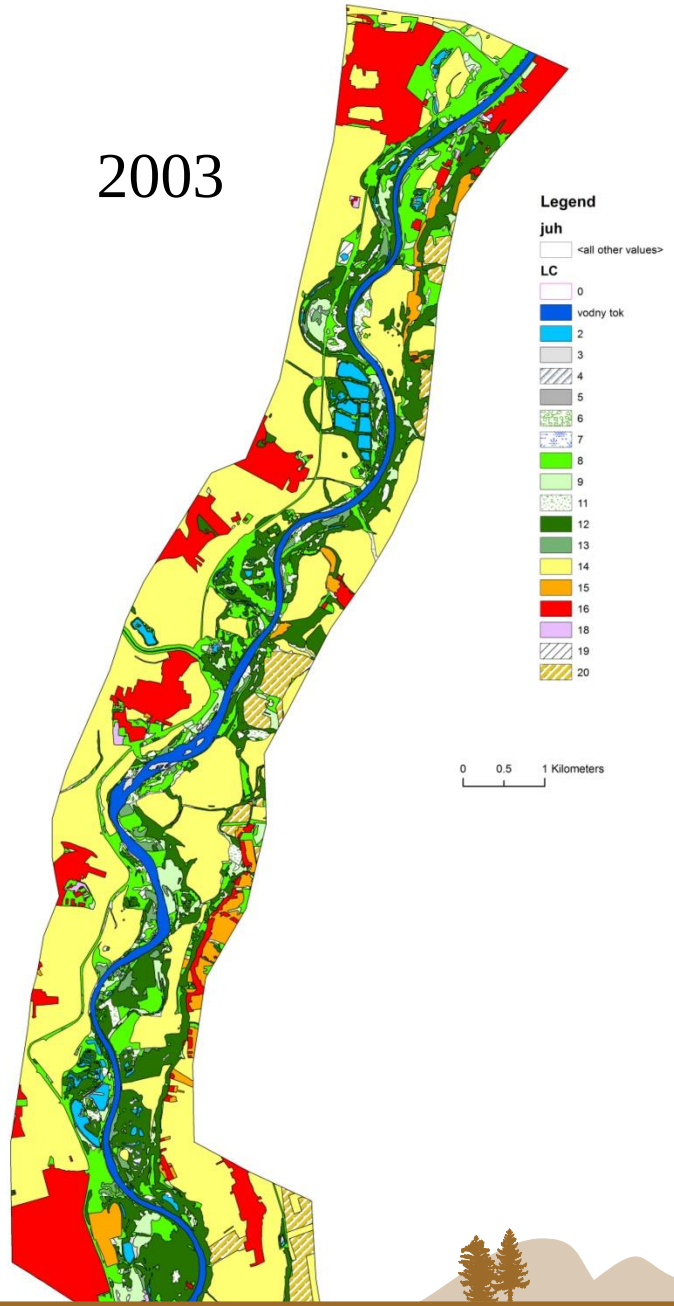
2003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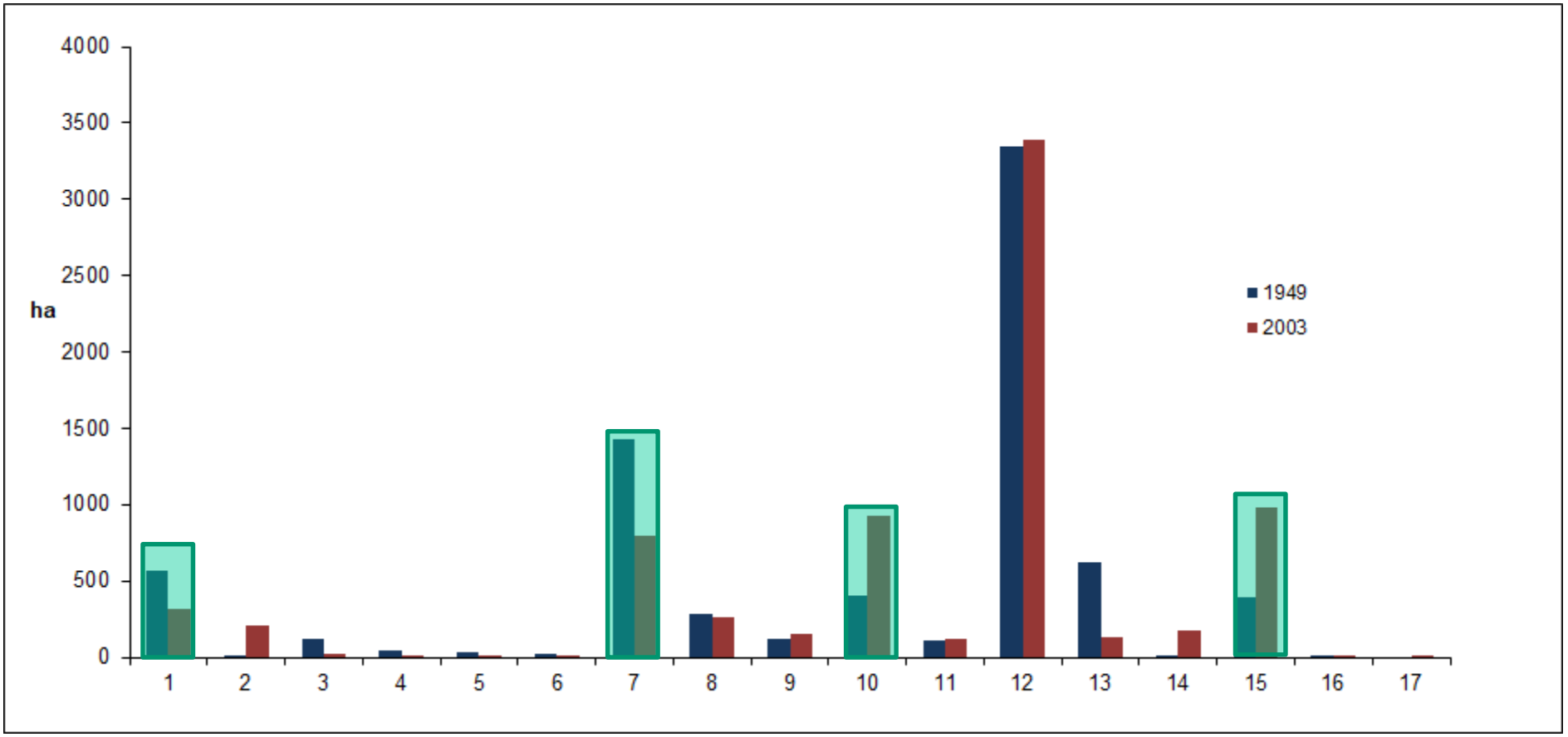
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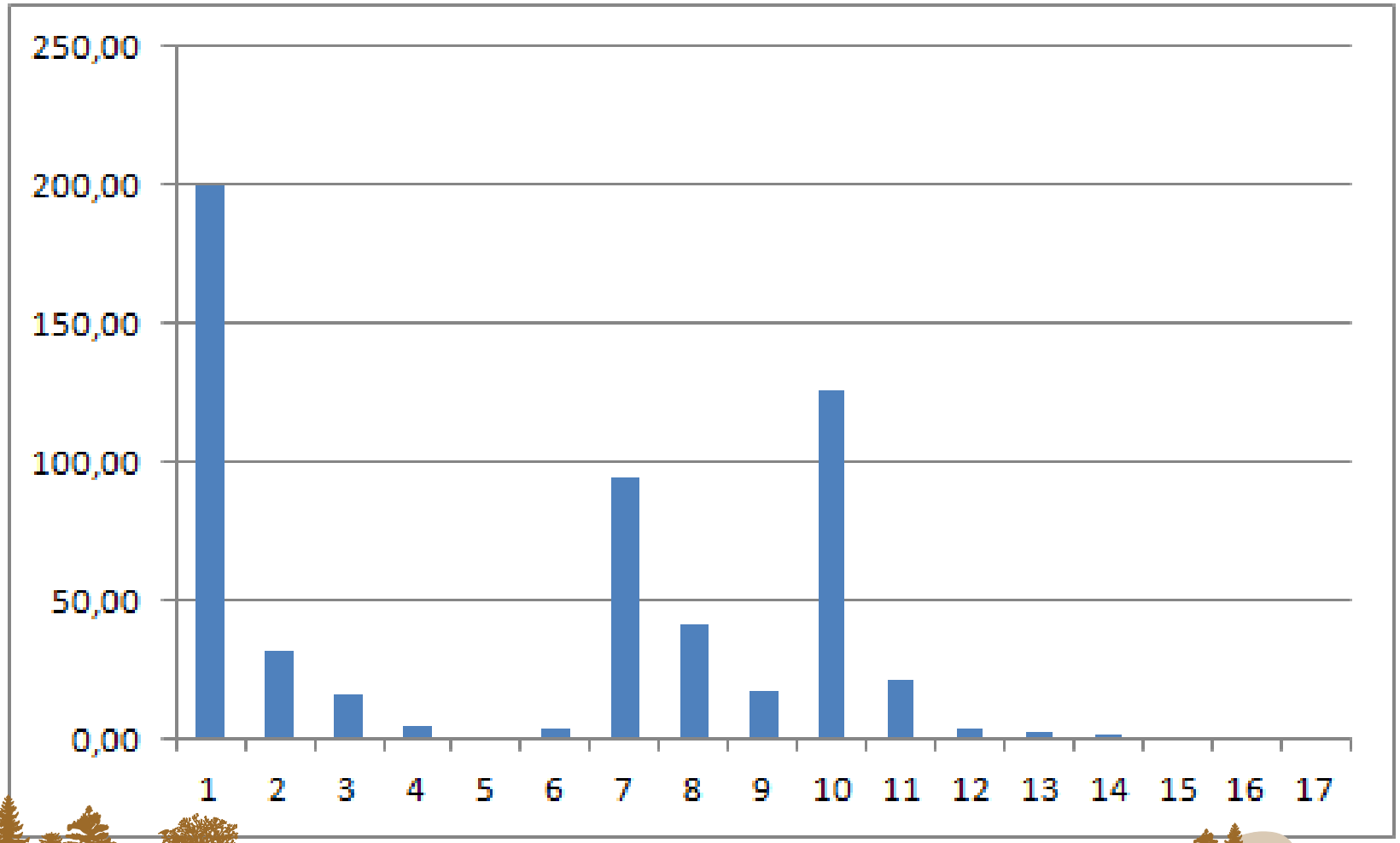
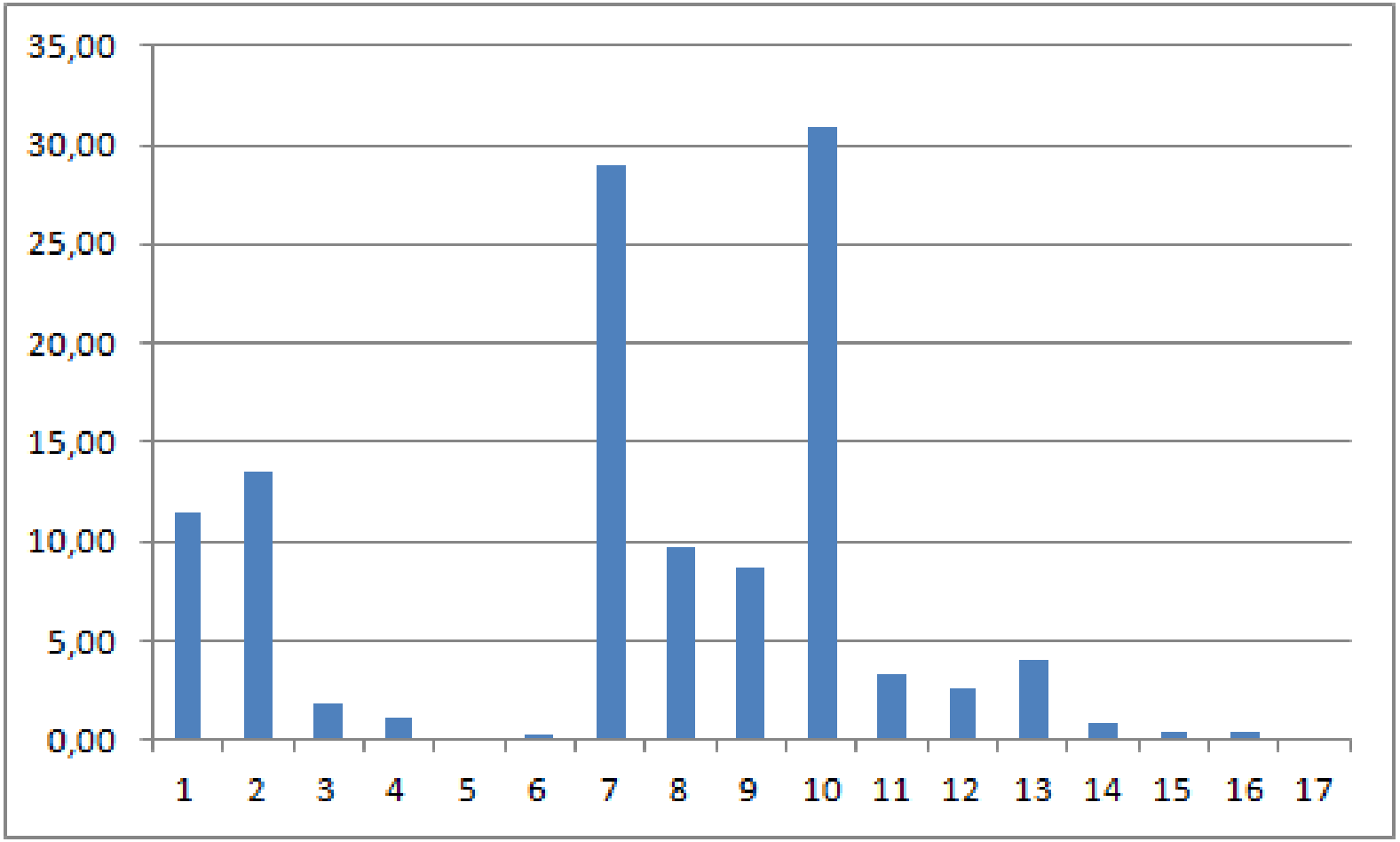
1949
2003

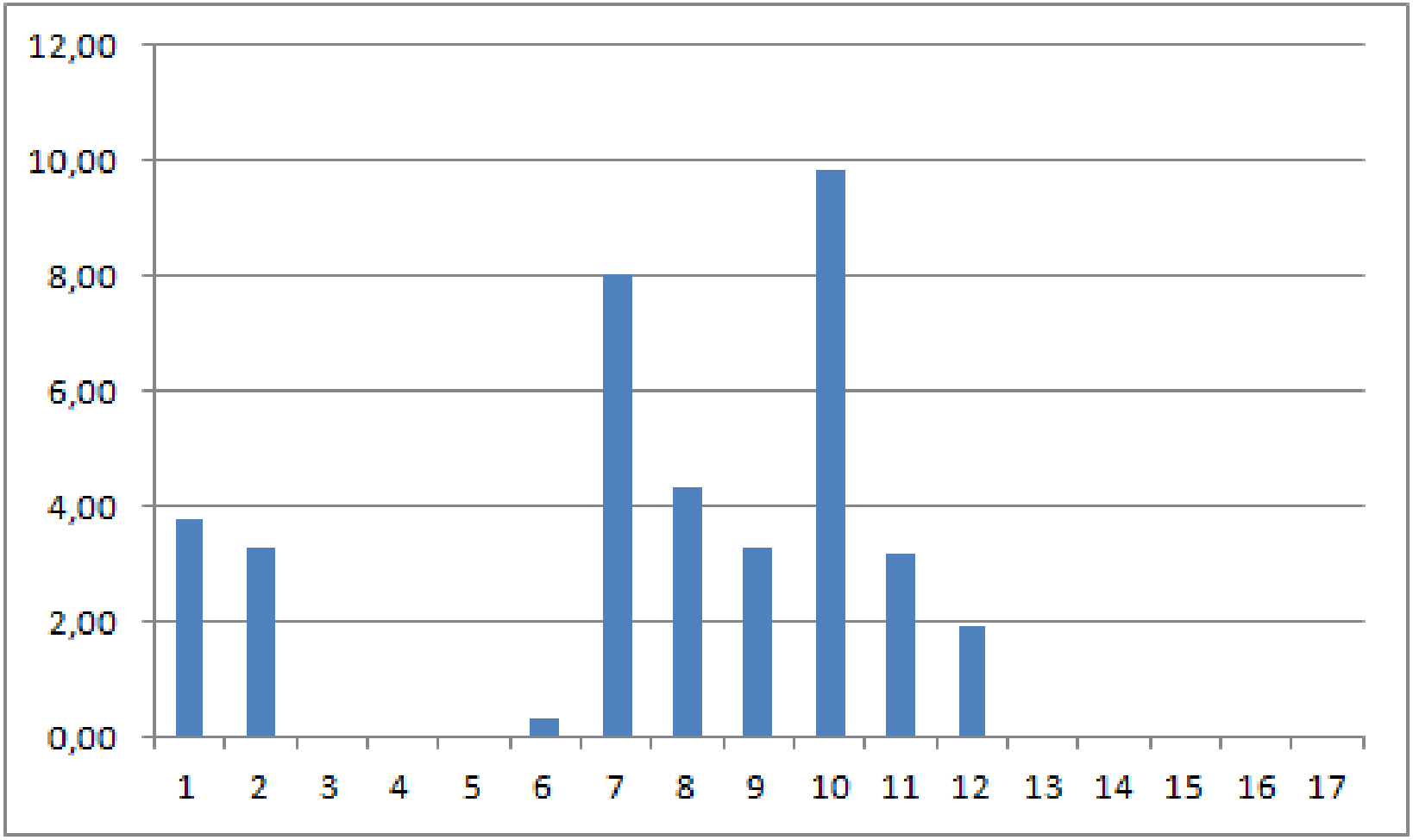
LC 1 (flowing water) changes (ha)



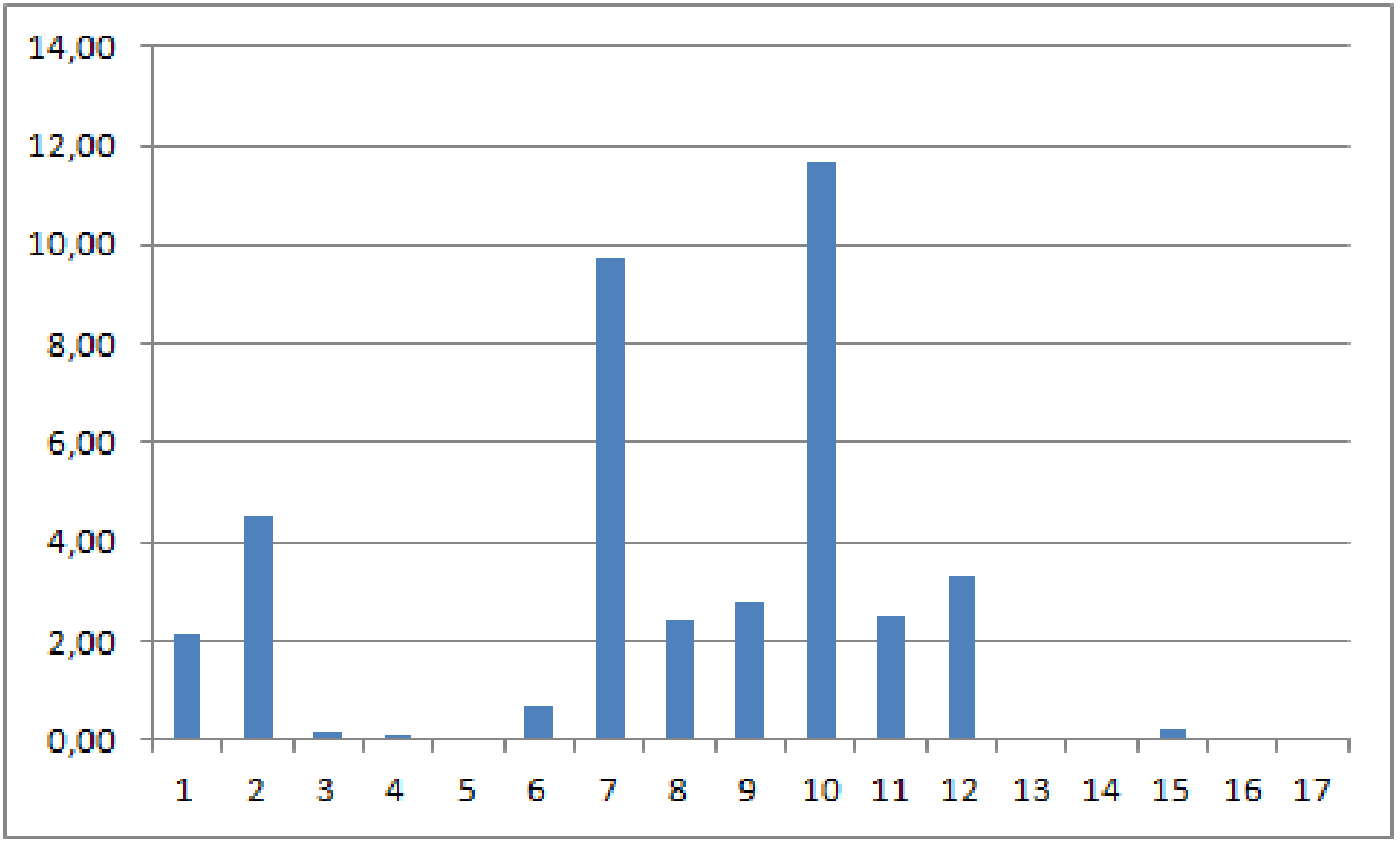
LC 3 (sandy and gravel bars without vegetation) changes (ha)



LC 5 (bars and river banks with dispersed woody vegetation) changes (ha)



LC 4 (bars and river banks with pioneer vegetation) changes (ha)



„highlights“

- dams – barriers for transport of (mainly coarse) sediments
- channel bars and bank lines evolution - connectivity decreasing - longitudinal as well as lateral
- channel degradation – narrowing and incision (effect of bars stabilisation and decreased sediment load)
- significant degradation of former annabranching system
- vegetation succession
- channel pattern simplification and strong reduction of valuable aquatic and semi-aquatic habitats
- sediments trapped in reservoirs


Thank you for your attention!