CONVERGES
European Riparian Ecosystems

STRUCTURE EVOLUTION OF THE RIPARIAN VEGETATION AND ITS ROLE IN BAR STABILISATION ON THE BRAIDED-WANDERING RIVER SYSTEM

Slovak Rivers LAB

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GEOGRAFICKÝ ÚSTAV SAV
INSTITUTE OF GEOGRAPHY SAS

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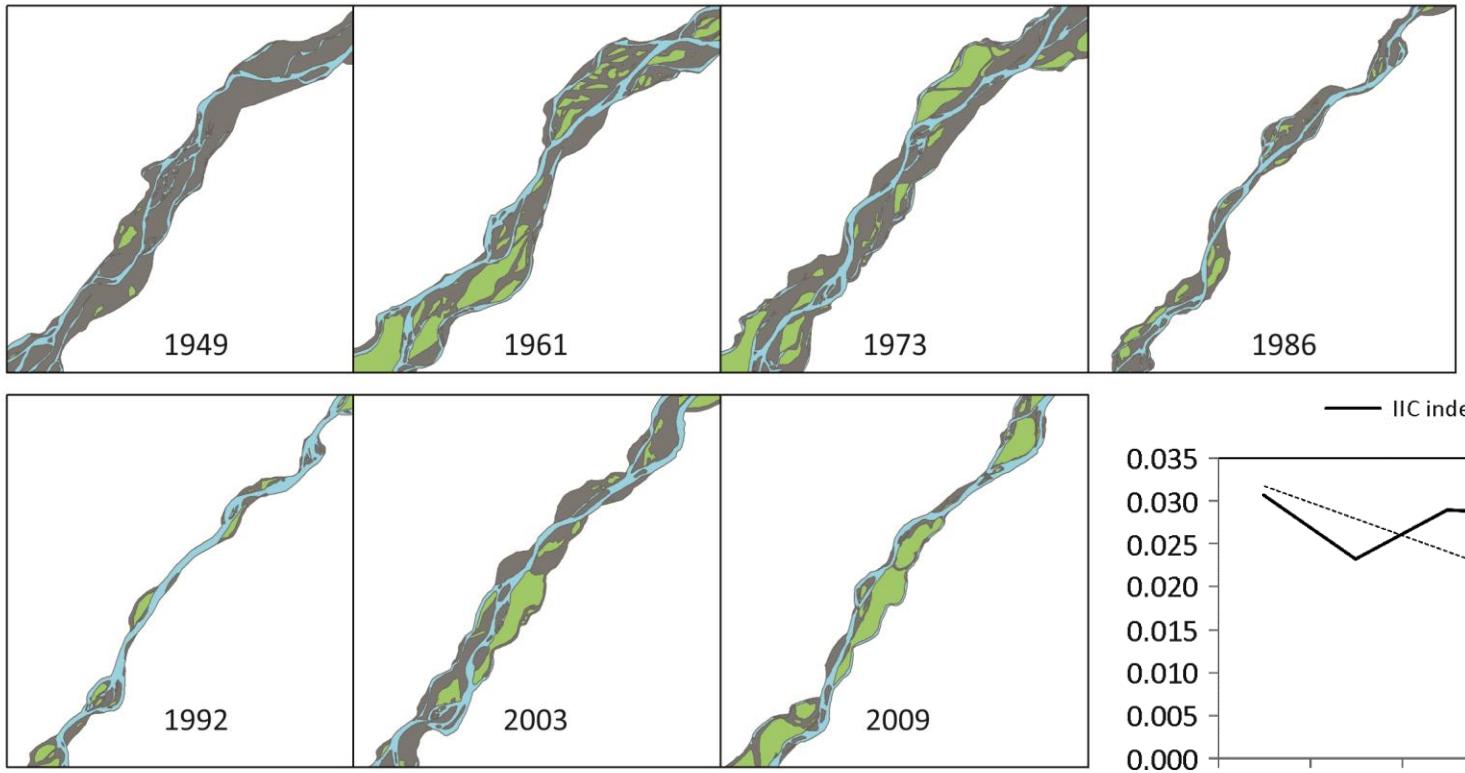
PŘÍRODOVĚDECKÁ FAKULTA MU

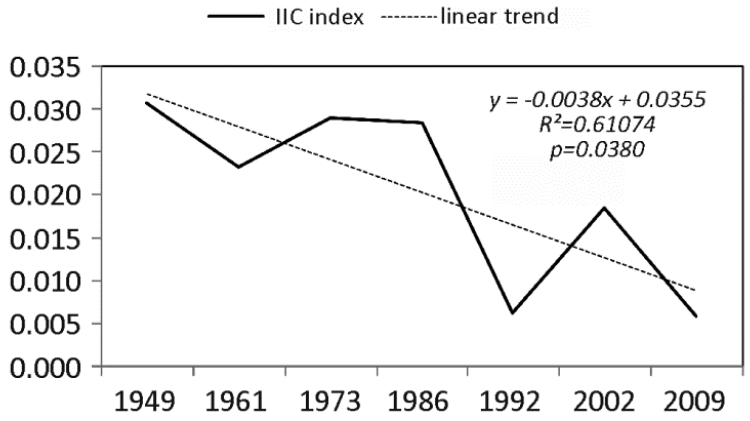
úke SAV
Ústav krajinnej ekológie Slovenská akadémia vied

UNIVERSITAS MASARYKIANA BRUNENSIS

SLOVACA SLOVAK ACADEMY OF SCIENCES ACADEMIA SCIENTIARUM

Previous research problem #DEGRADATION of the RIVER SYSTEM

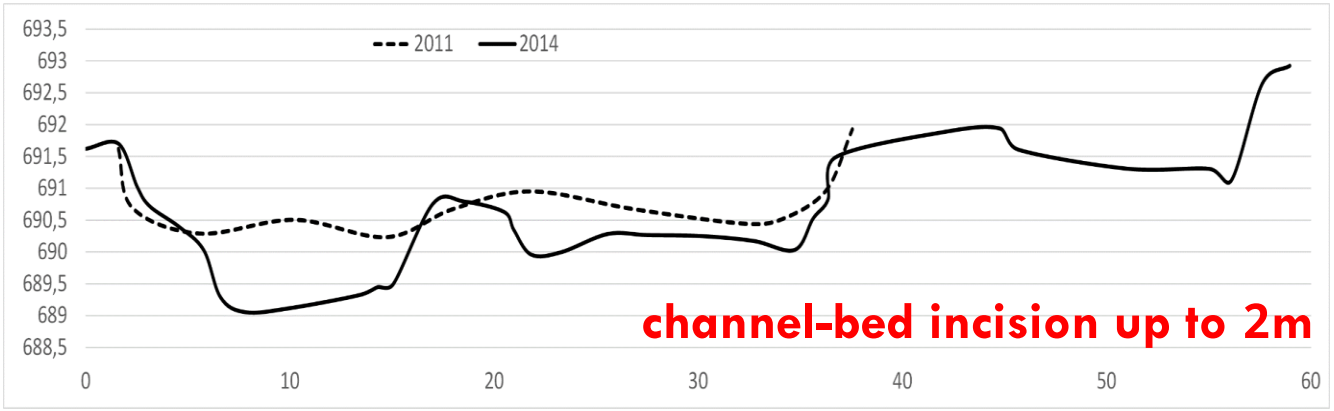


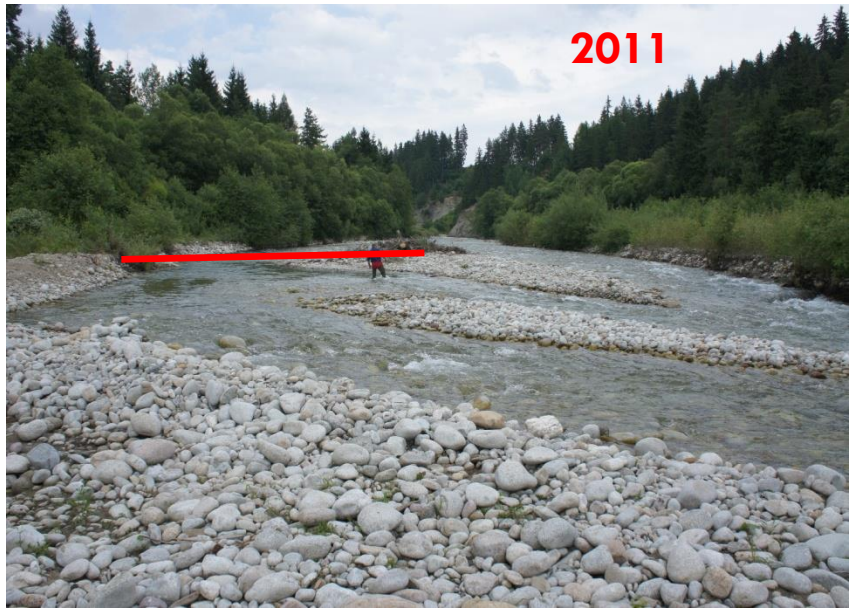


Kidová , Lehotský, Rusnák (2016)
Geomorphology

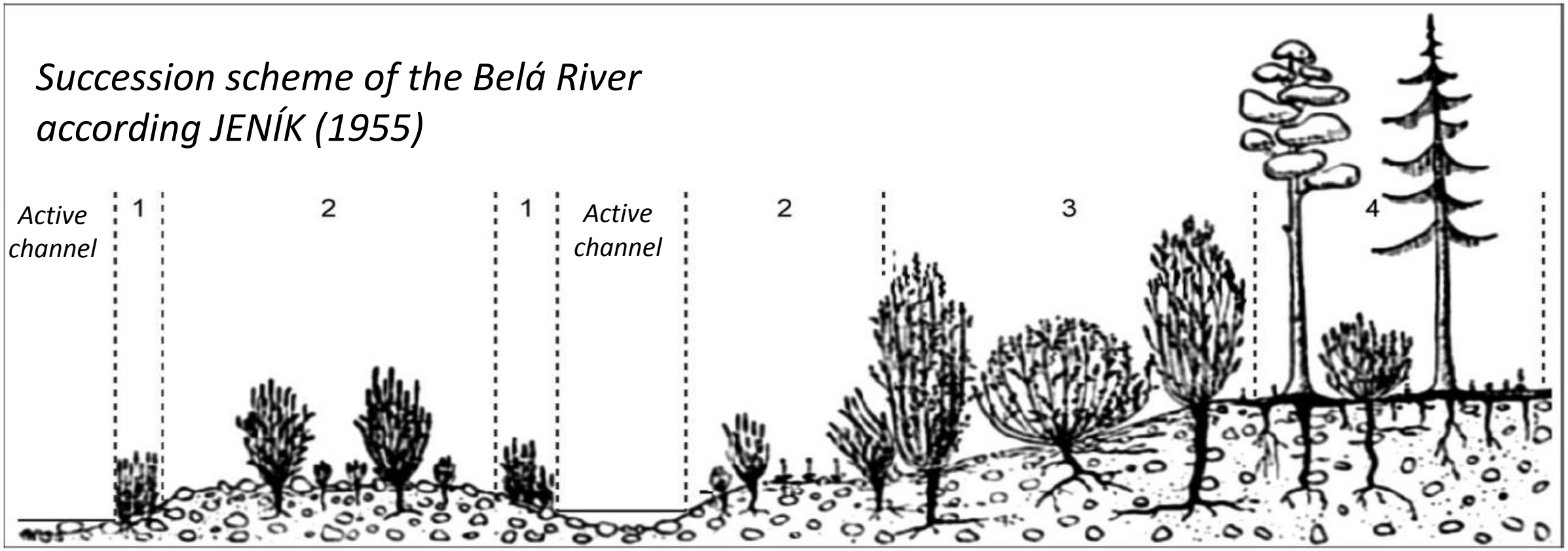
Lehotský, Rusnák, Kidová, Dudžák (2018)
Land Degrad. & Dev. special issue

Previous research problem #DEGRADATION of the RIVER SYSTEM **#CHANNEL INCISION**





~~Previous~~ research problem #DEGRADATION of the RIVER SYSTEM #CHANNEL INCISION **#ROLE of the RIPARIAN ZONE**



1. *Calamagrostidetum pseudophragmitis;* 2. *Myricarietum germanicae ;* 3. *Salicetum incano-purpureae ;* 4. *Pinetum salicetosum a Piceetum*

~~Previous~~ research problem #DEGRADATION of the RIVER SYSTEM #CHANNEL INCISION **#ROLE of the RIPARIAN ZONE**

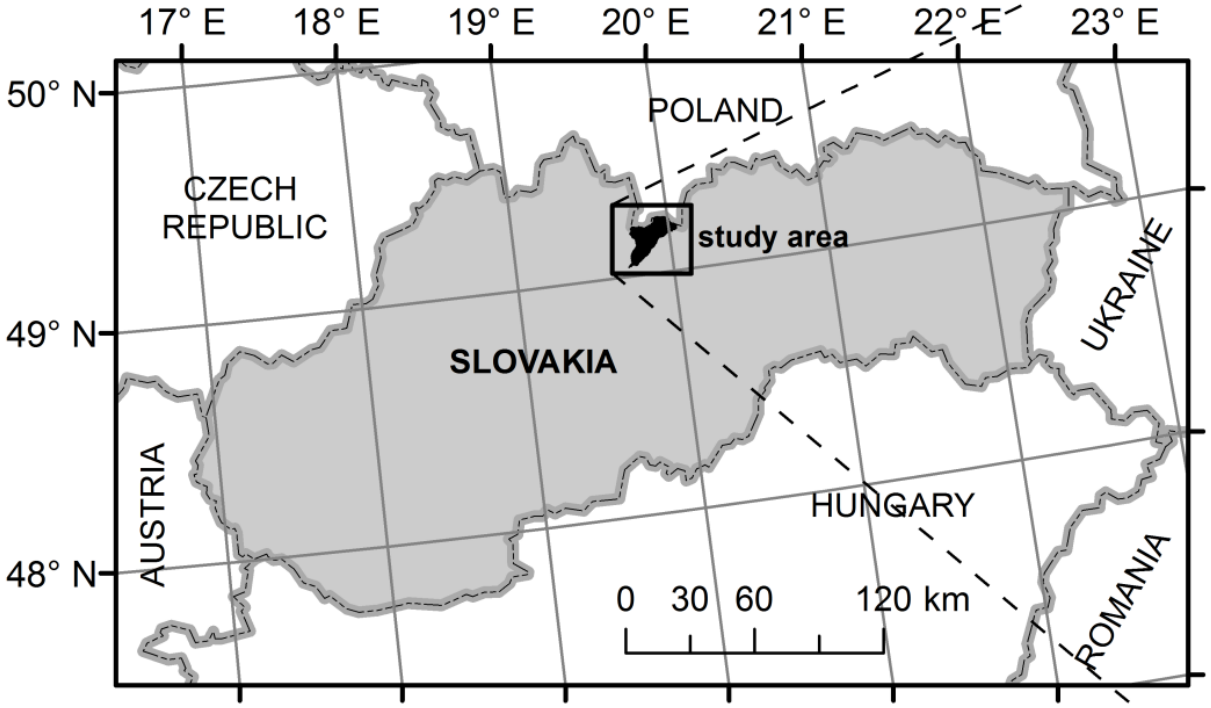
Succession scheme of the Belá River according JENÍK (1955)

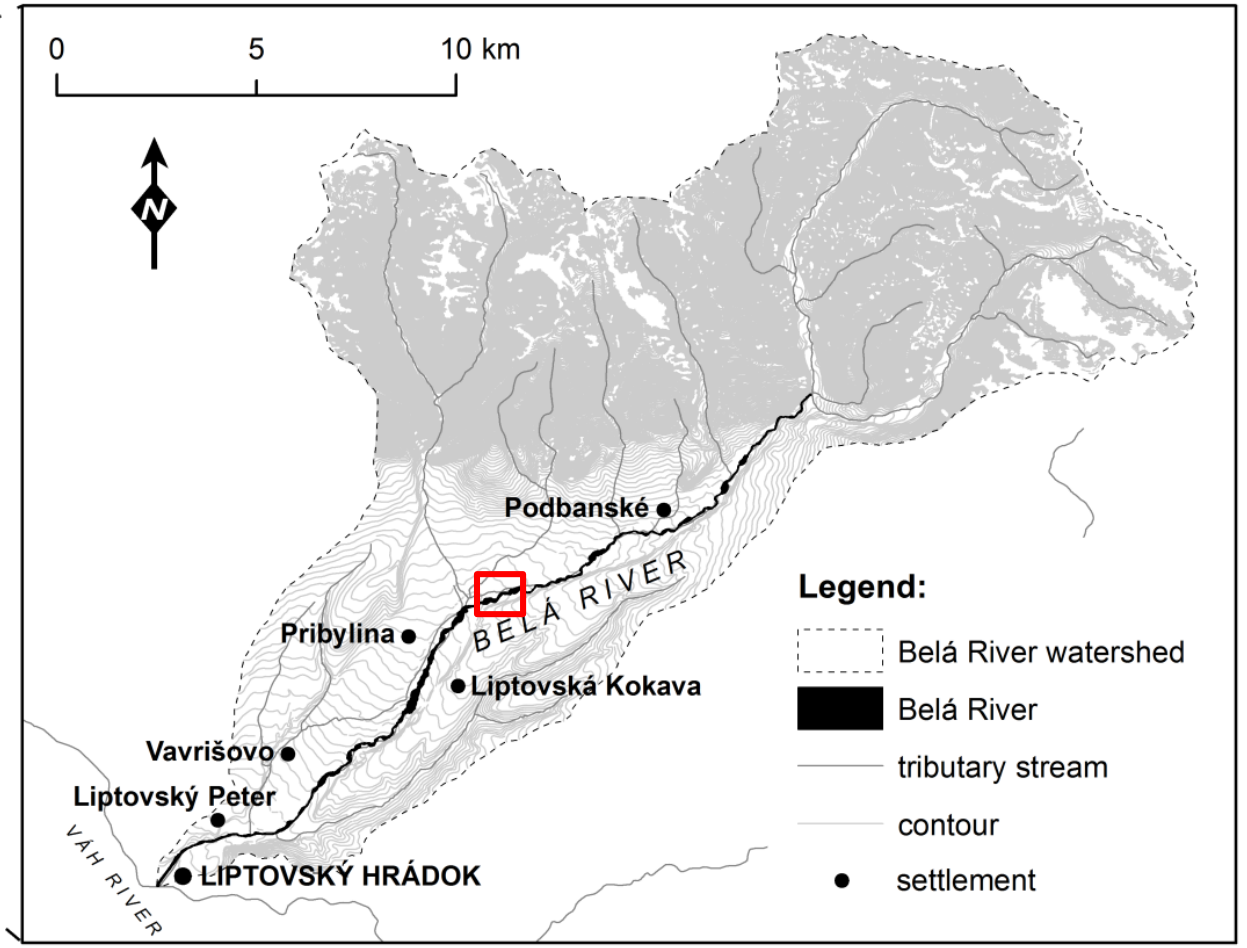
The **aim of the presented study** is to i) update/ improve the knowledge about vegetation dynamics on the study multi-thread river; ii) identify the vegetation species which are responsible for stabilisation of the in-channel landforms.

1. *Calamagrostidetum pseudophragmitis;* 2. *Myricarietum germanicae ;* 3. *Salicetum incano-purpureae ;* 4. *Pinetum salicetosum a Piceetum*

STUDY AREA the multi-thread Belá River; braided-wandering; 244 km^2 watershed; glacifluvial sediment; 23,6 km length in total; tested unmanaged river reach (1km)

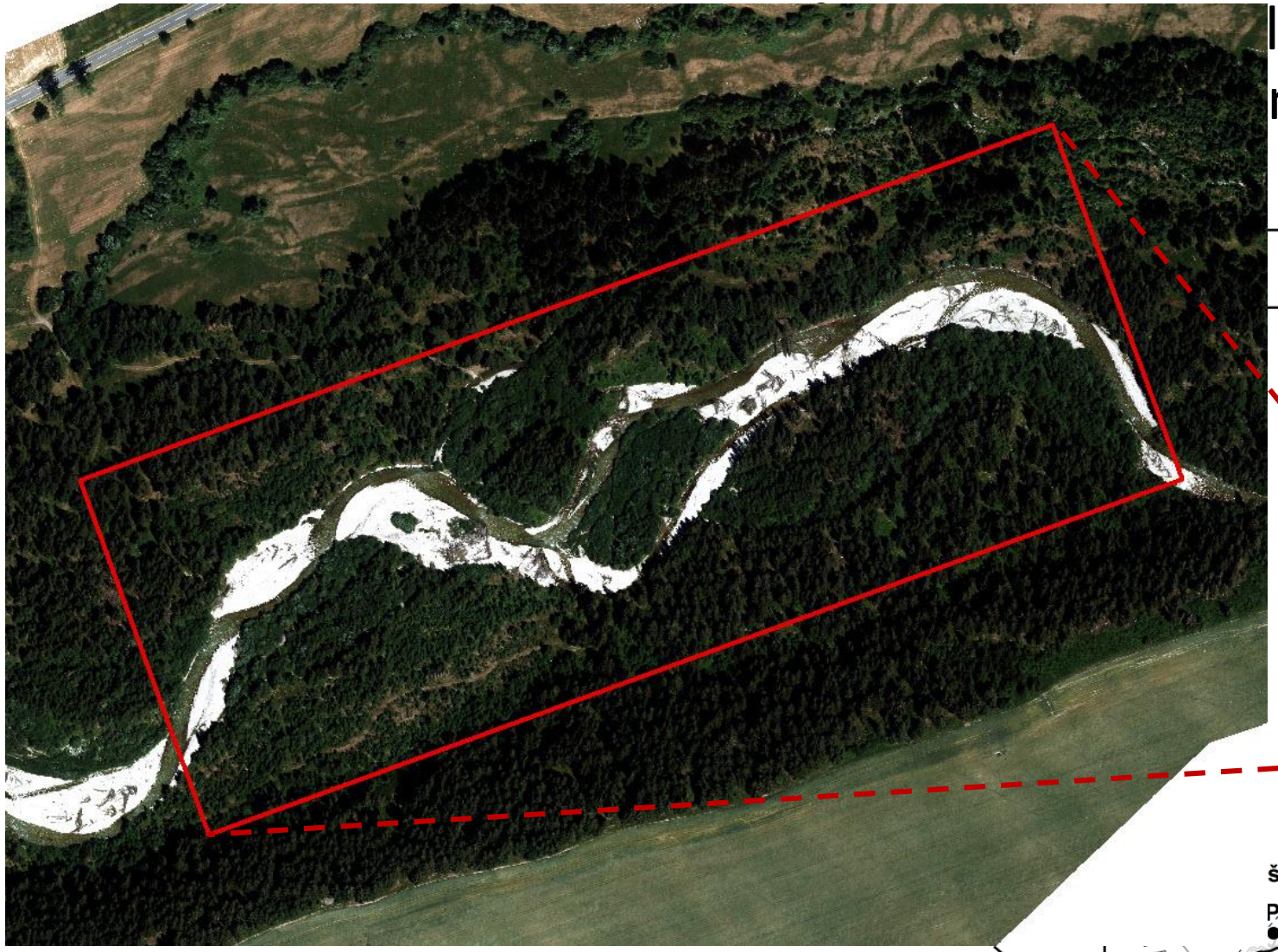
Photo: Kidová (2018

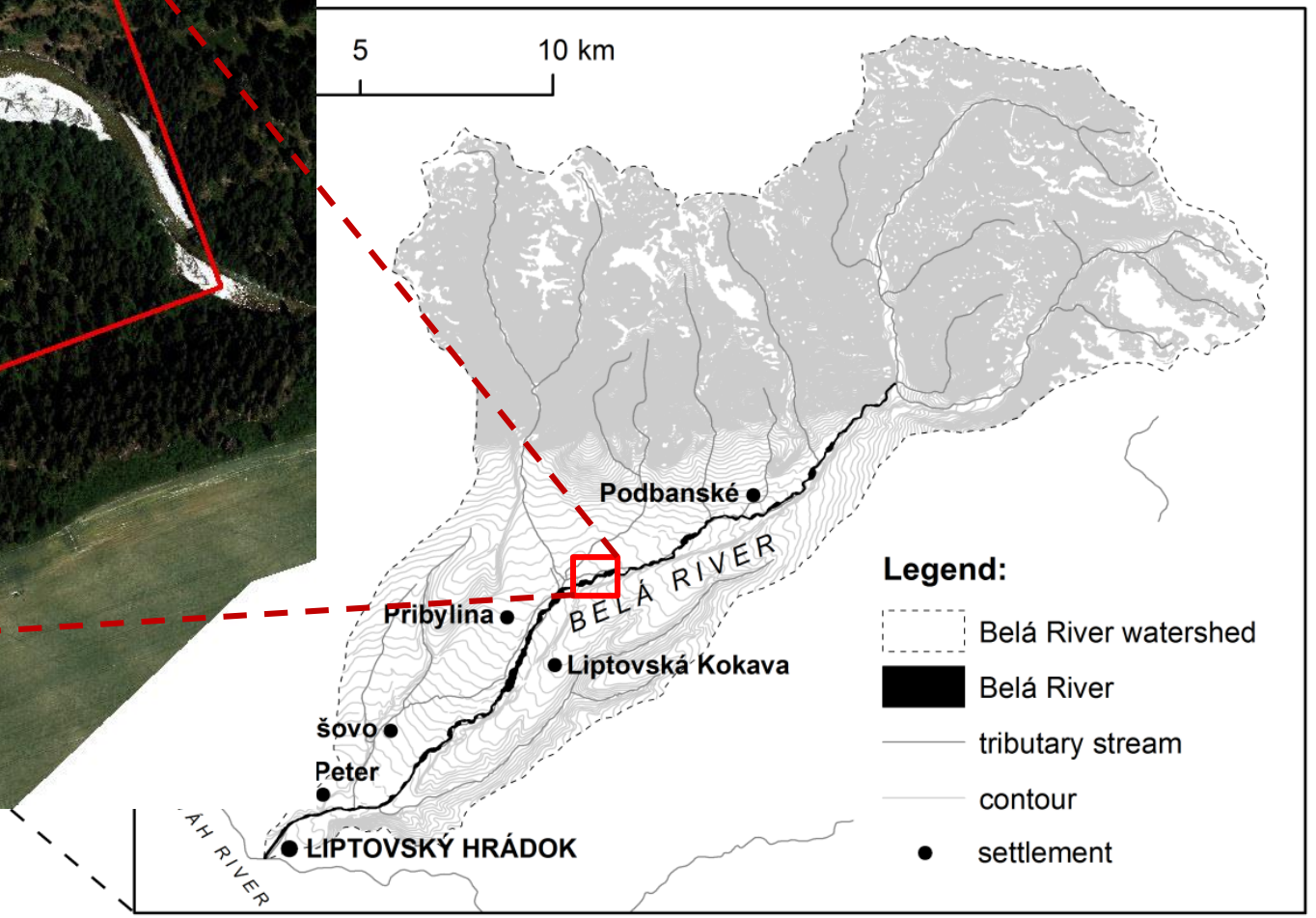




STUDY AREA the multi-thread Belá River; lacifluvial managed

Photo: Kidová (2018



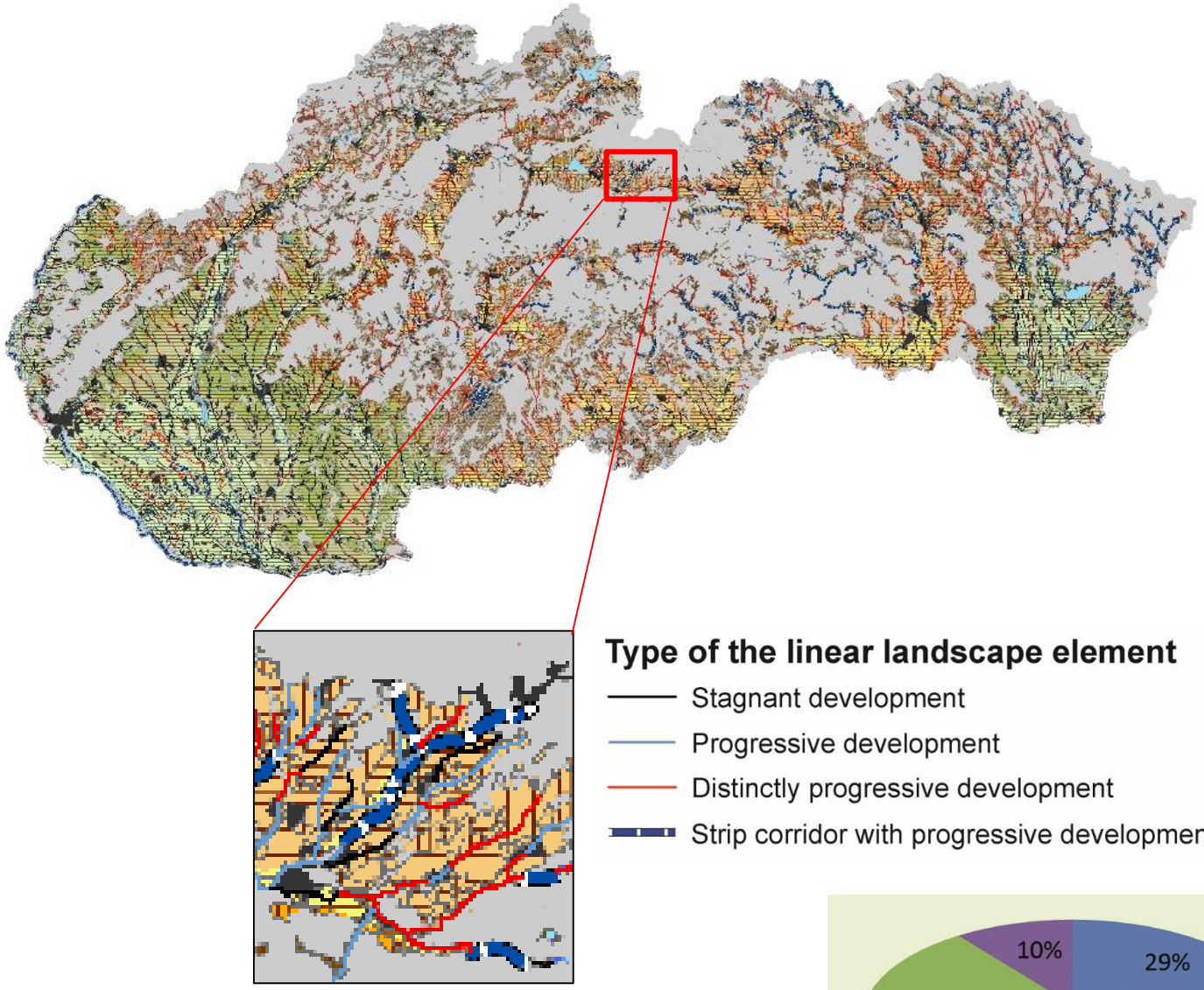


NATURA 2000 - STANDARD DATA FORM

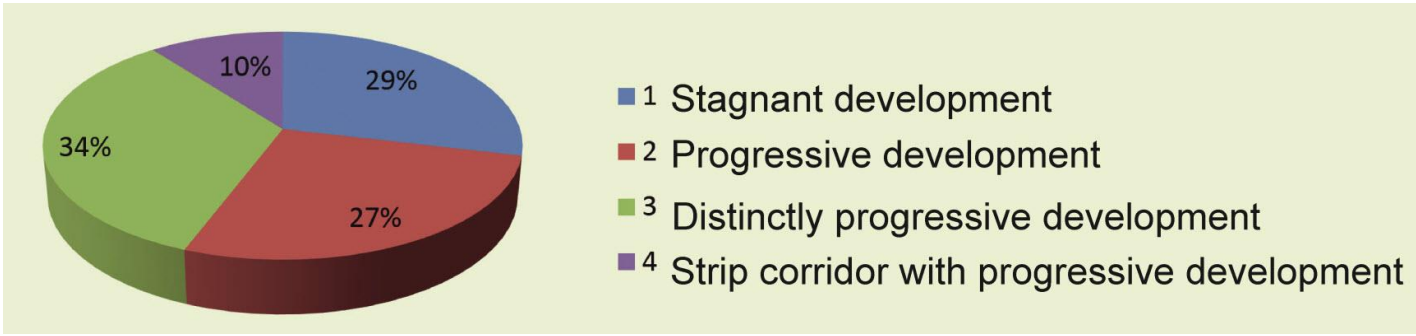
**For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)**

SITE	**SKUEV0141**
SITENAME	**Belá**

The Belá River floodplain is unique for the entire territory of Western Carpathians. Its **permanently changing channel is during high water levels continually filled in by new sediments** of pebbles and gravel originating in the border valleys of the Západné and Vysoké Mts. As a result, the channel permanently changes its typical features and shape. The site is formed by Belá River and adjacent riparian forest stands.
The **river represents the largest montane braiding river in Slovakia** and it is also noted for the presence of **best preserved riparian forest stands with German tamarisk *Myricaria germanica* in Slovakia**.



According results of the **national research for linear (riparian) landscape elements** in time horizons **between 1986 and 2004** the **STUDY AREA** #unmanaged upper part of the river was characterised as a **strip corridor with progressive development**.



METHODS for **tested river reach**

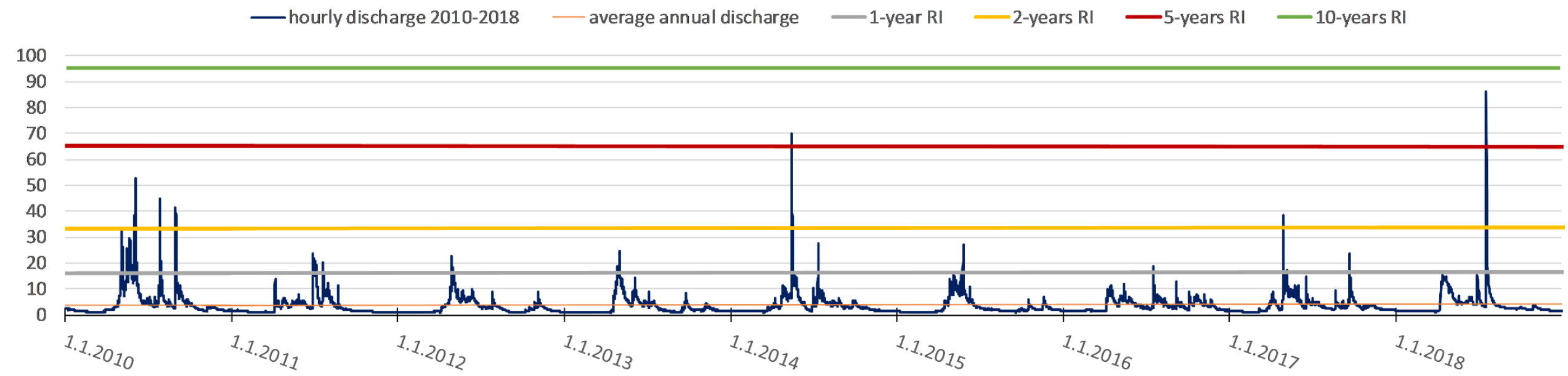
#in office

GIS analyses (LC vegetation structure within active channel and floodplain)

#field work

phytocoenological registrations according to Zürrych-Montpellier school (Braun-Blanquet, 1964) and cross-section measurements

HYDROLOGICAL DATA



$Q_{Lipt. Hrádok} = 6{,}8\ m^3.s^{-1}$

$Q_{Podbanské} = 3{,}5\ m^3.s^{-1}$

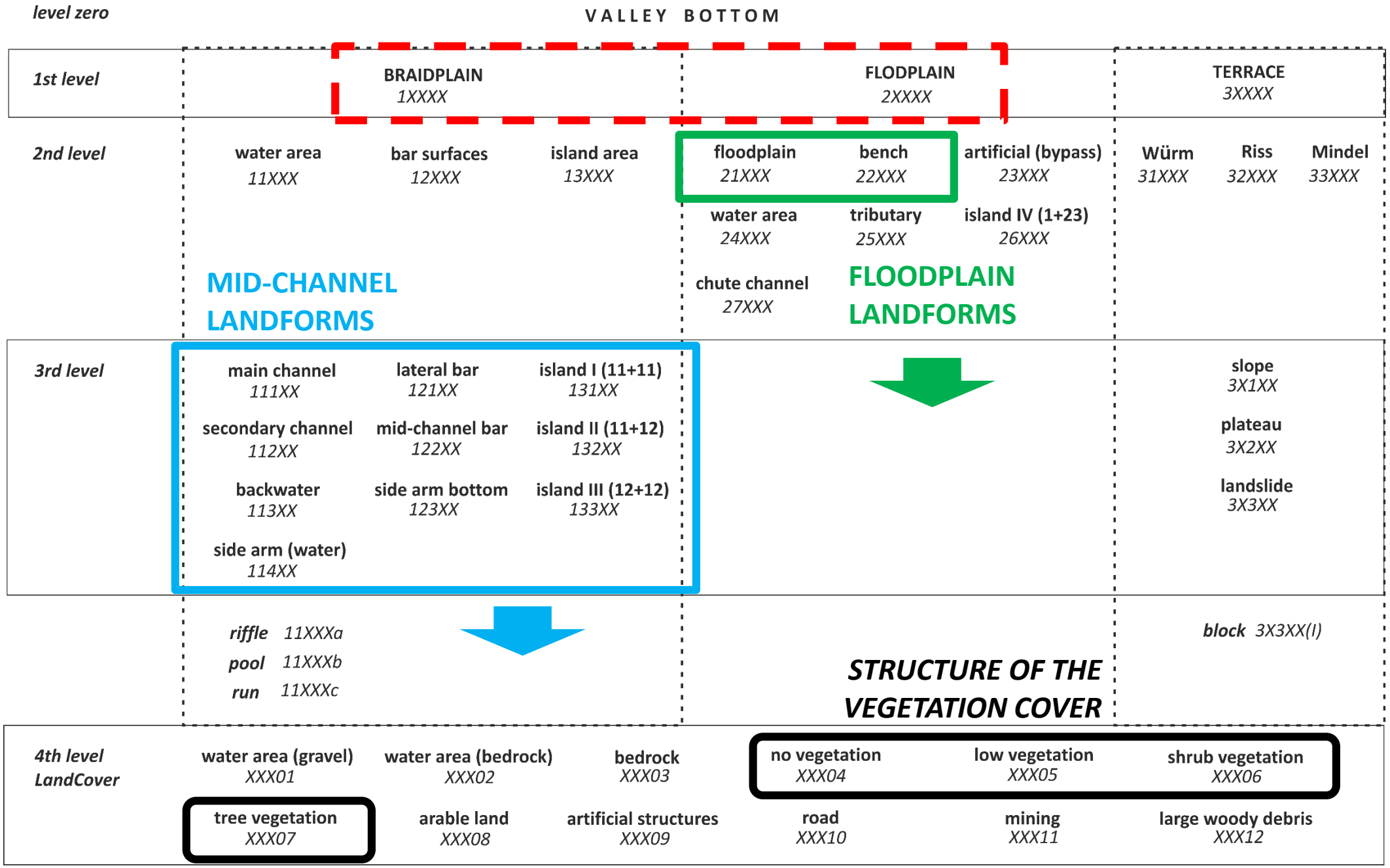
$Q_{Podbanské\ max\ 1958} = 180\ m^3.s^{-1}$

GIS geodatabase design

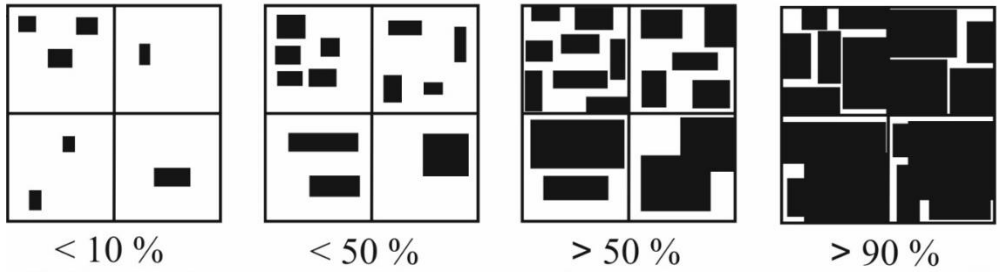
level zero — VALLEY BOTTOM

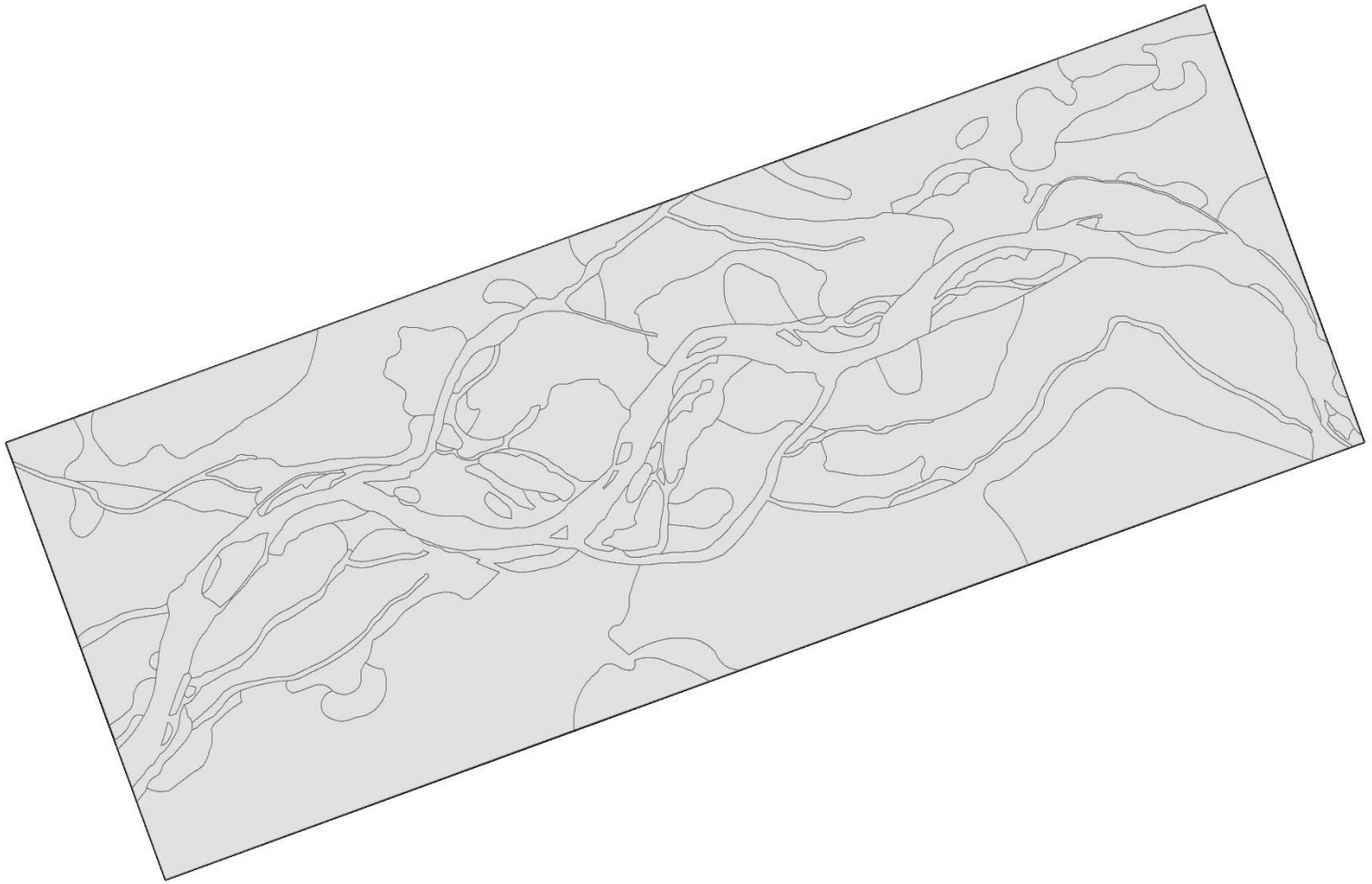
1st level	**BRAIDPLAIN** *1XXXX*			**FLODPLAIN** *2XXXX*			**TERRACE** *3XXXX*		
2nd level	**water area** *11XXX*	**bar surfaces** *12XXX*	**island area** *13XXX*	**floodplain** *21XXX*	**bench** *22XXX*	**artificial (bypass)** *23XXX*	**Würm** *31XXX*	**Riss** *32XXX*	**Mindel** *33XXX*
				water area *24XXX*	**tributary** *25XXX*	**island IV (1+23)** *26XXX*			
				chute channel *27XXX*					
3rd level	**main channel** *111XX*	**lateral bar** *121XX*	**island I (11+11)** *131XX*				**slope** *3X1XX*		
	secondary channel *112XX*	**mid-channel bar** *122XX*	**island II (11+12)** *132XX*				**plateau** *3X2XX*		
	backwater *113XX*	**side arm bottom** *123XX*	**island III (12+12)** *133XX*				**landslide** *3X3XX*		
	side arm (water) *114XX*								
	riffle *11XXXa*						***block*** *3X3XX(l)*		
	pool *11XXXb*								
	run *11XXXc*								
4th level LandCover	**water area (gravel)** *XXX01*	**water area (bedrock)** *XXX02*	**bedrock** *XXX03*	**no vegetation** *XXX04*	**low vegetation** *XXX05*	**shrub vegetation** *XXX06*			
	tree vegetation *XXX07*	**arable land** *XXX08*	**artificial structures** *XXX09*	**road** *XXX10*	**mining** *XXX11*	**large woody debris** *XXX12*			

GIS geodatabase design



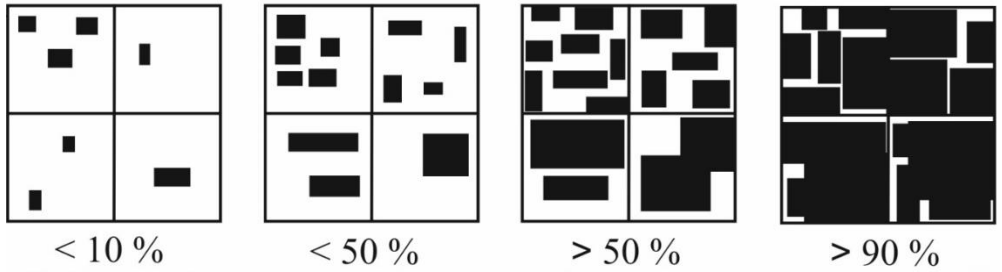
METHODS #LC; vegetation structure

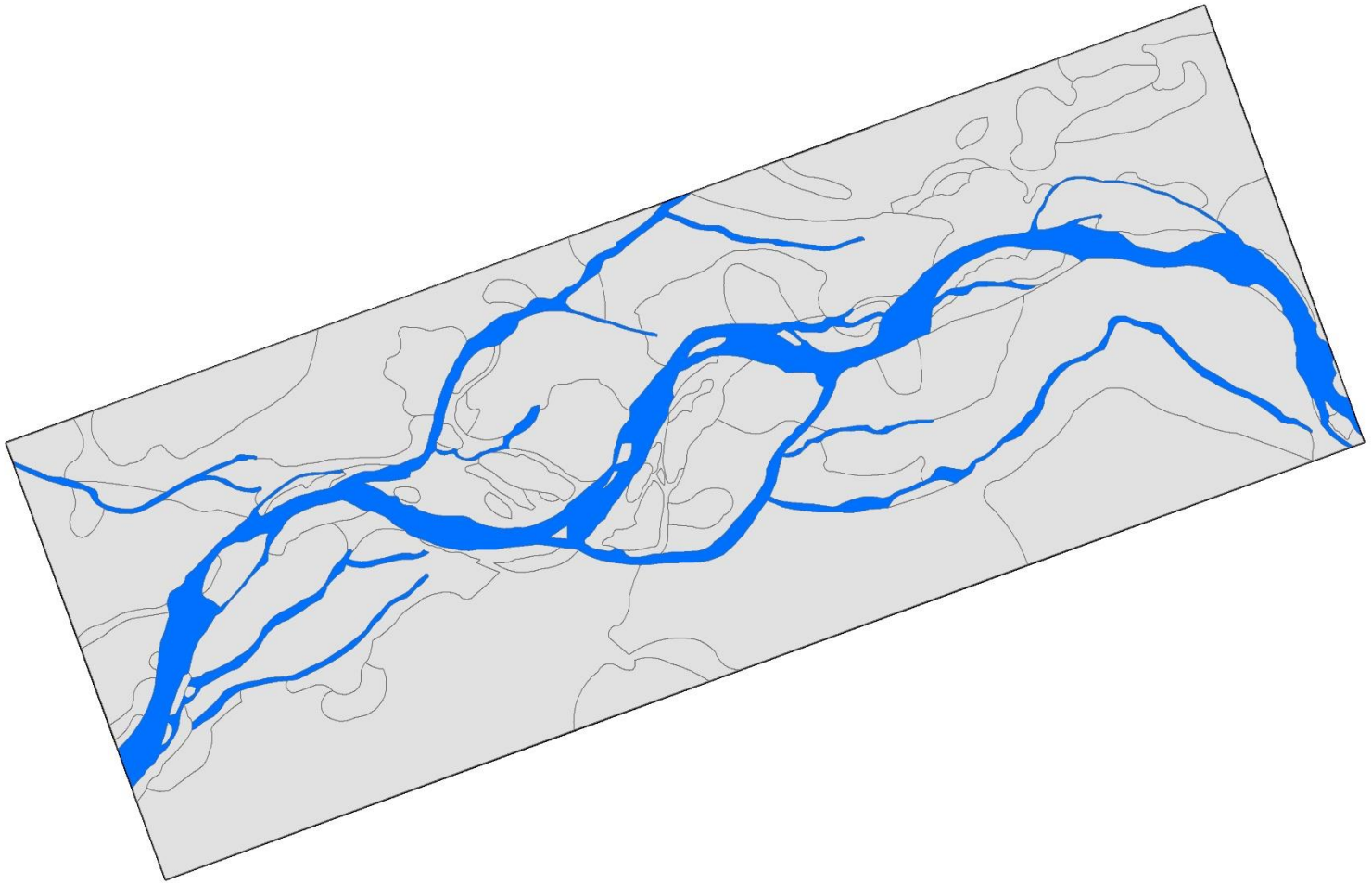




Eight types of LC

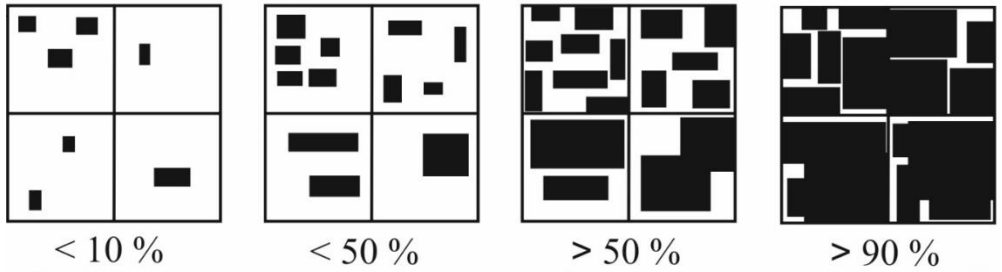
METHODS #LC; vegetation structure

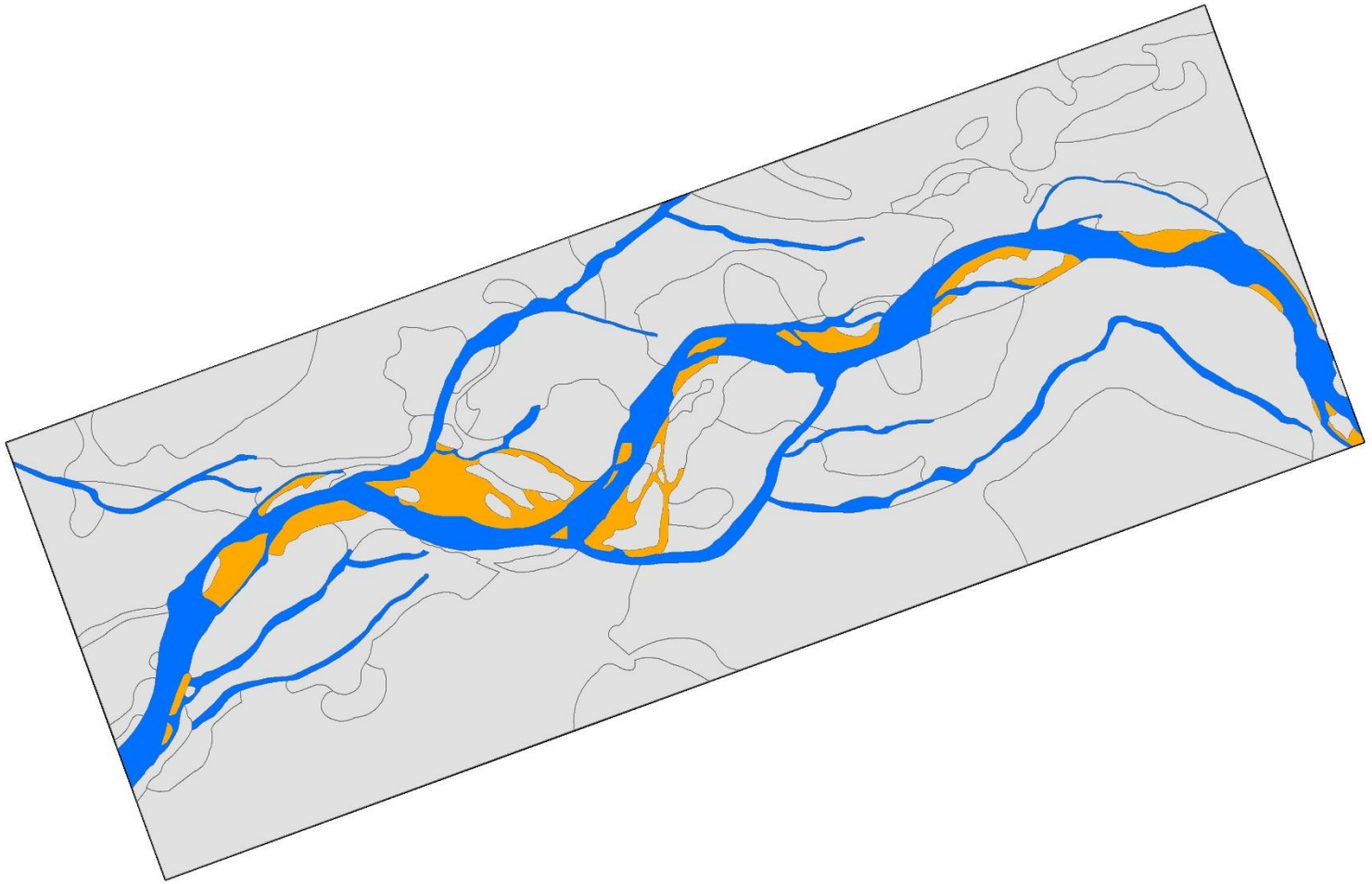




1. Water area

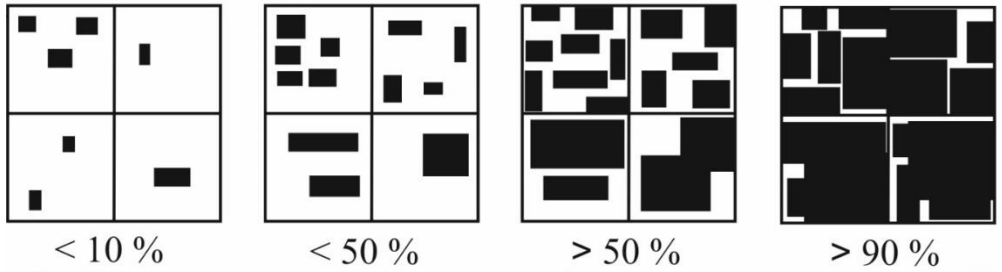
METHODS #LC; vegetation structure

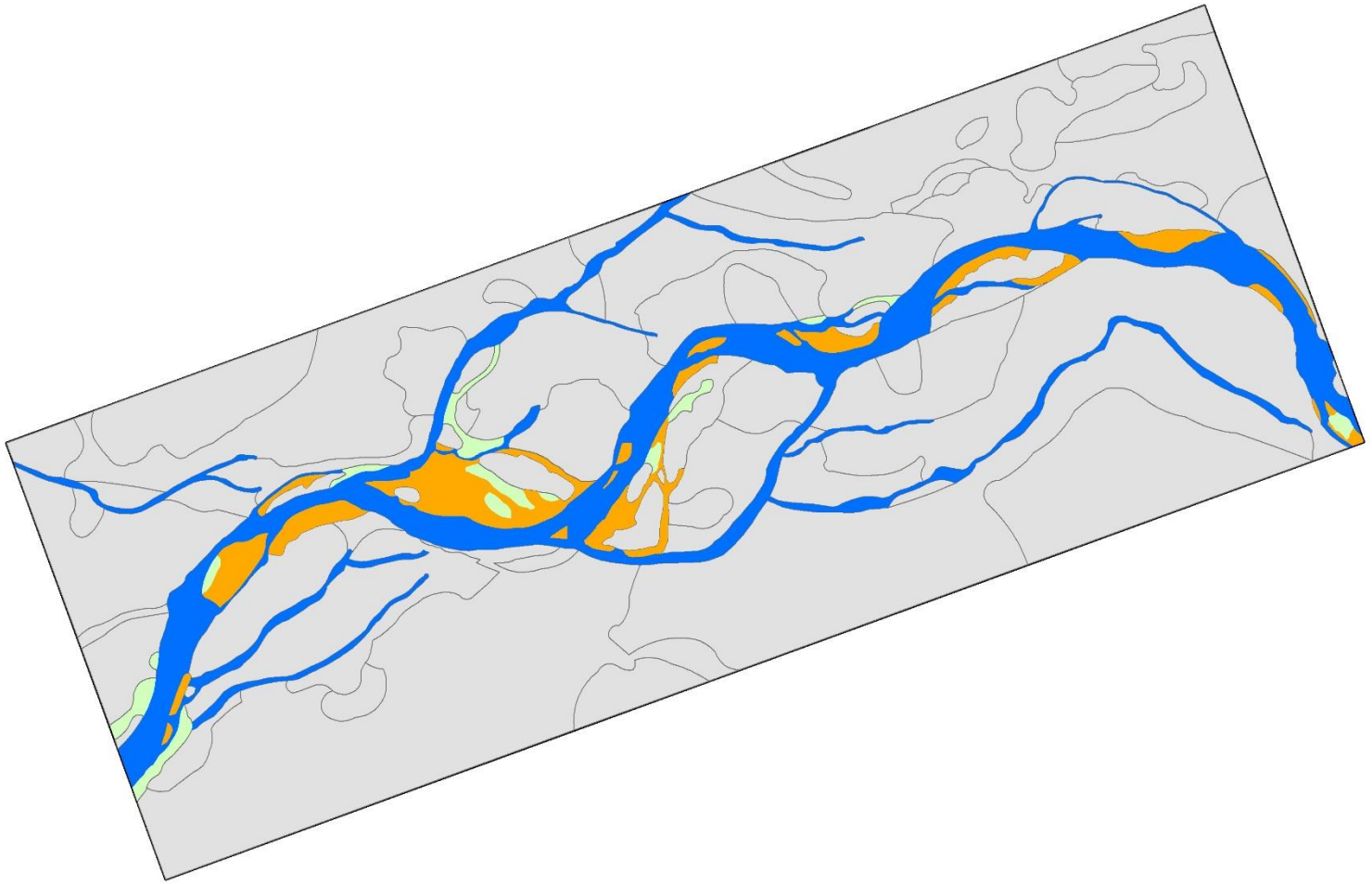




2. Bare gravel-bar area

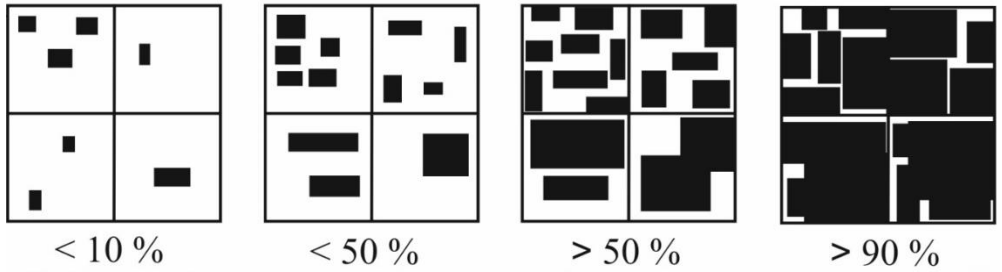
METHODS #LC; vegetation structure

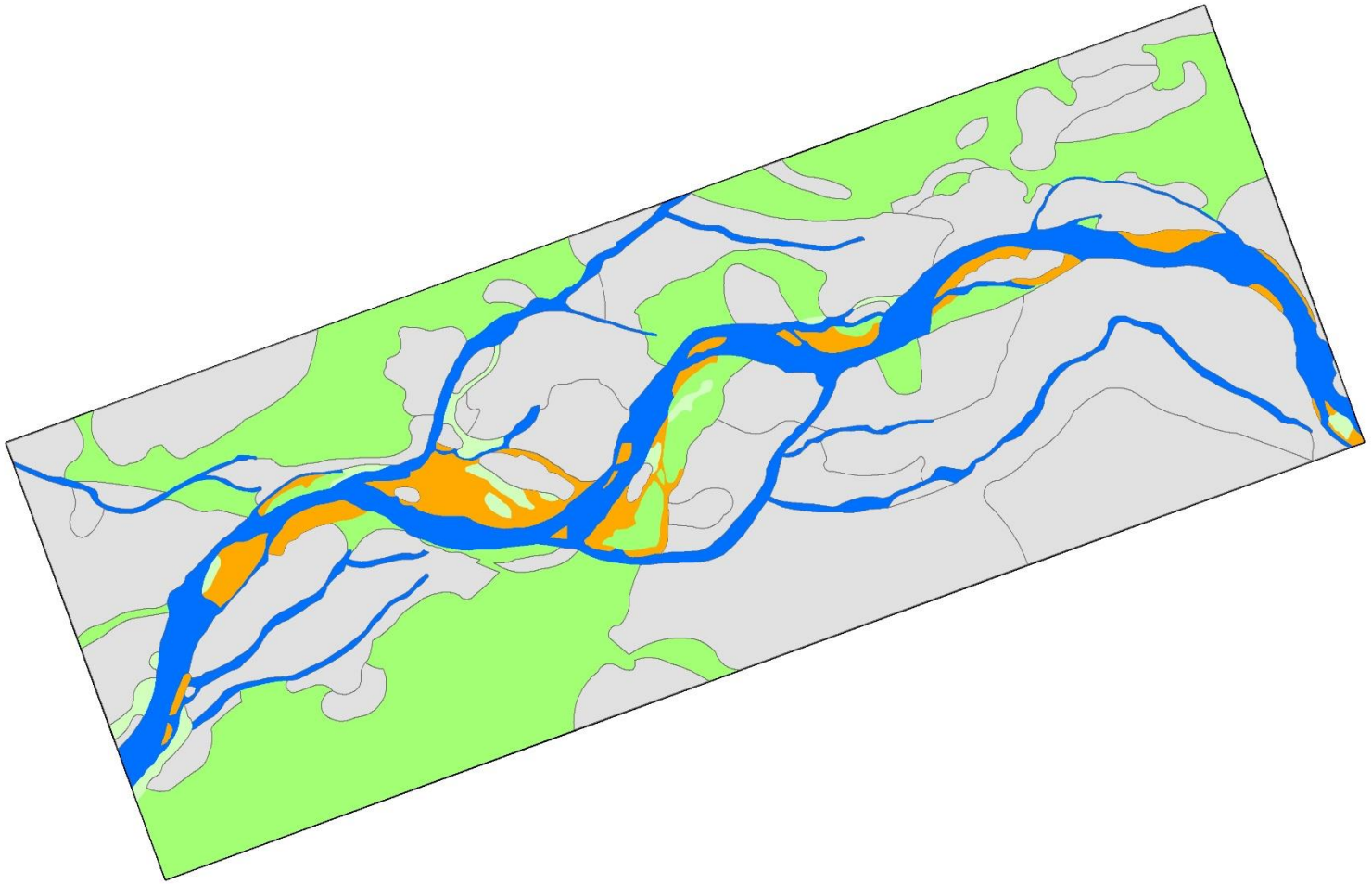




3. Sparse herb vegetation

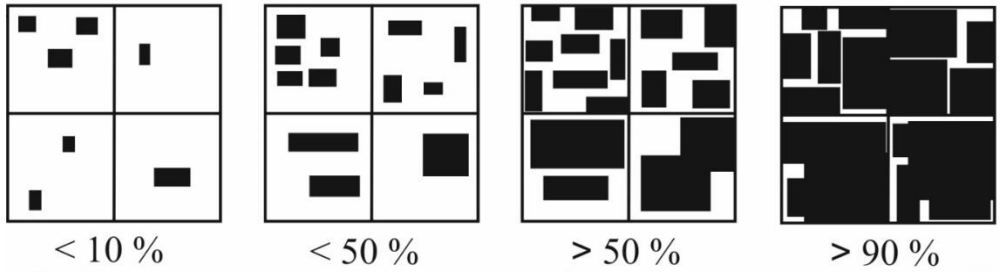
METHODS #LC; vegetation structure

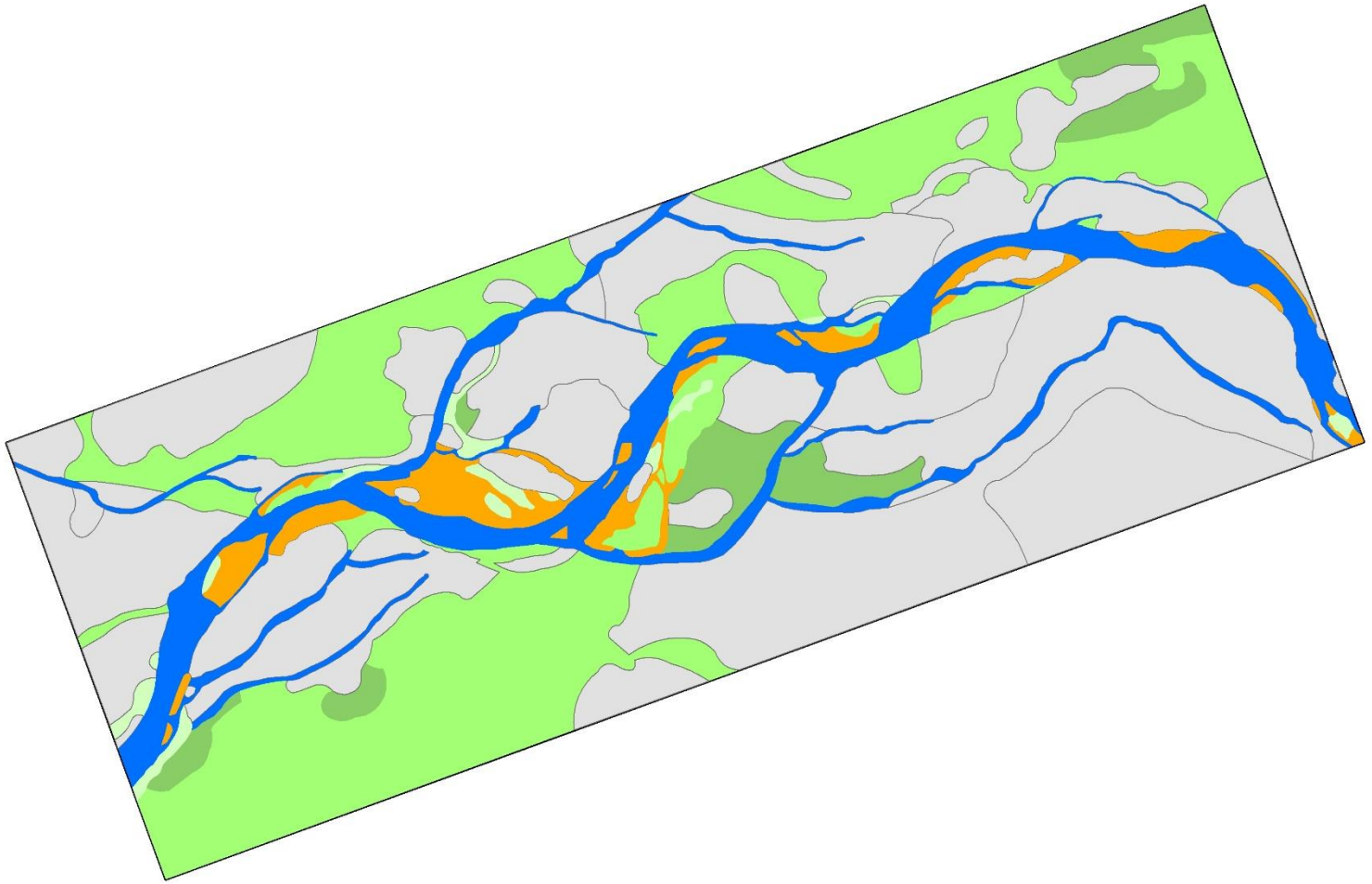




4. Dense herb vegetation

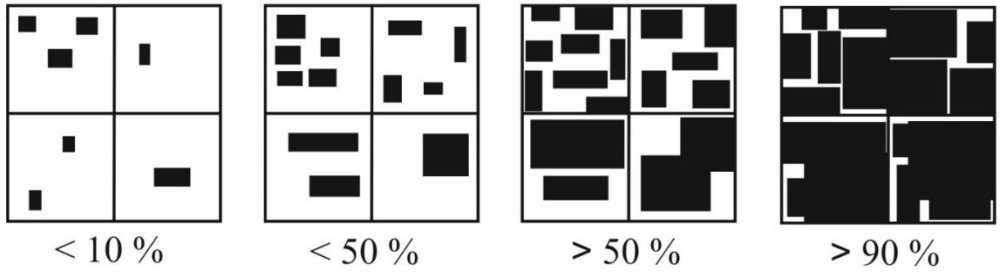
METHODS #LC; vegetation structure

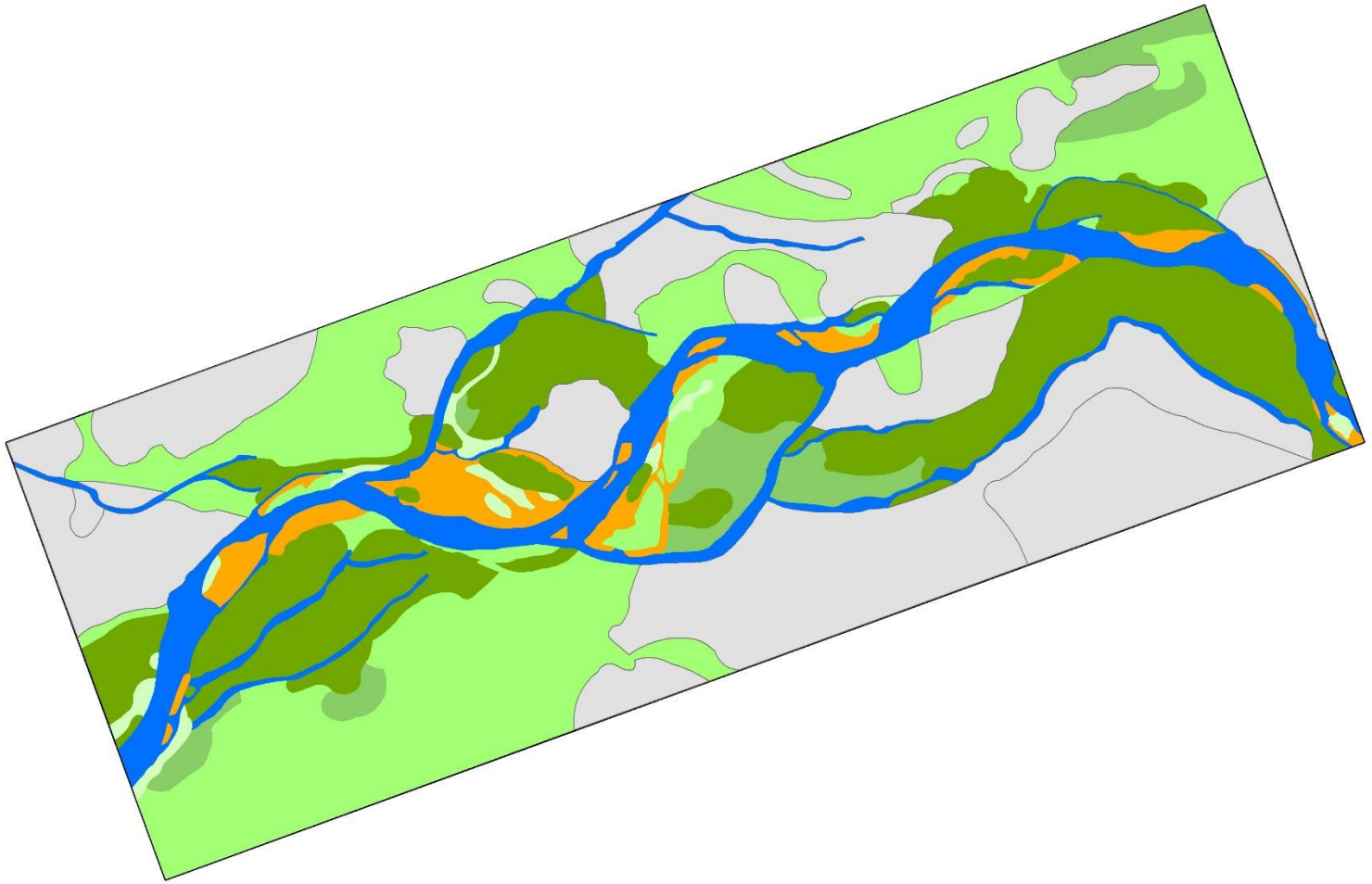




4. Sparse shrubs area

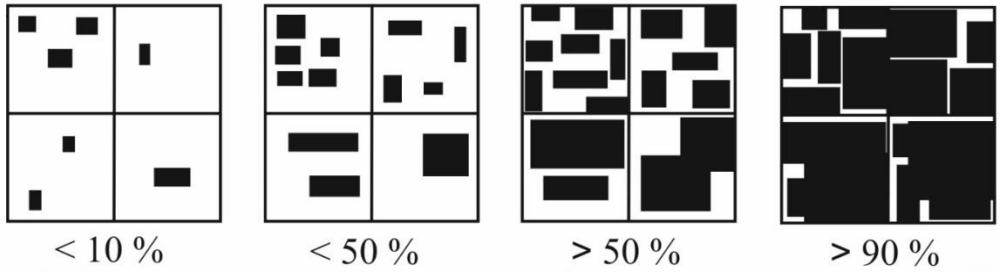
METHODS #LC; vegetation structure

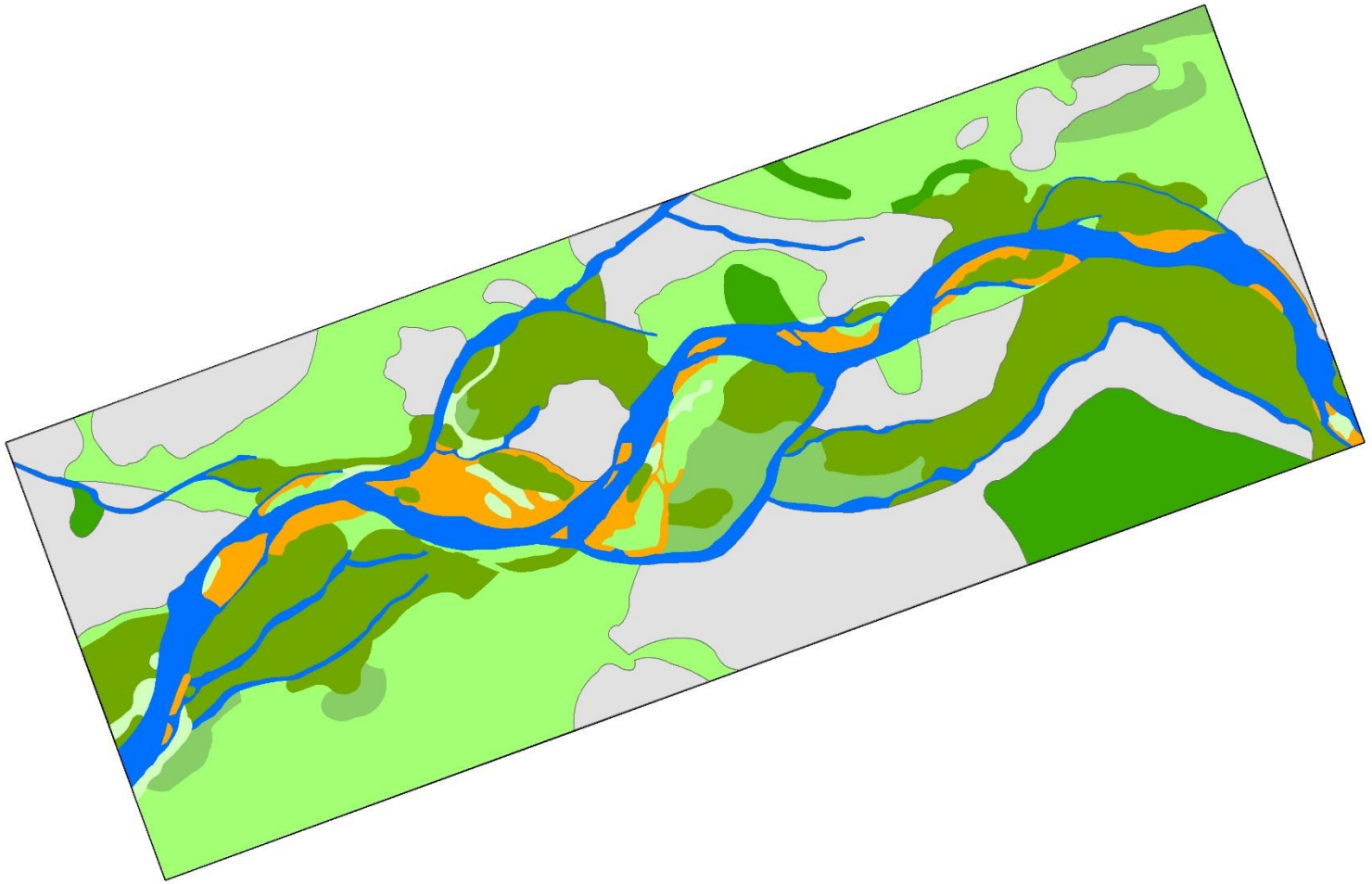




5. Dense shrubs area

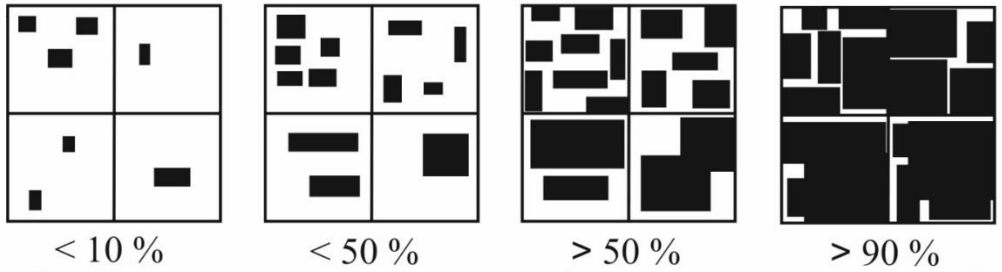
METHODS #LC; vegetation structure

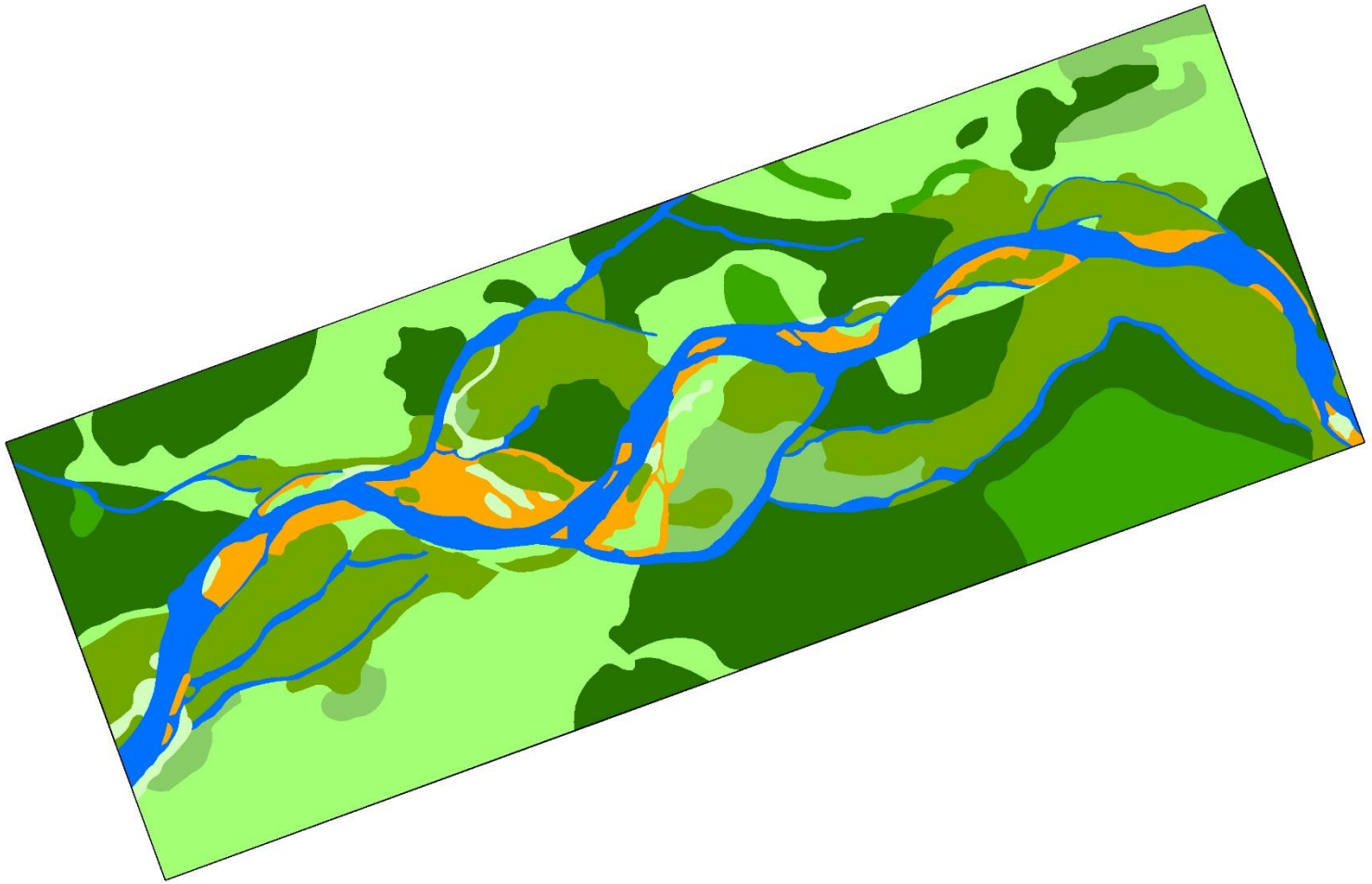




7. Sparse trees area

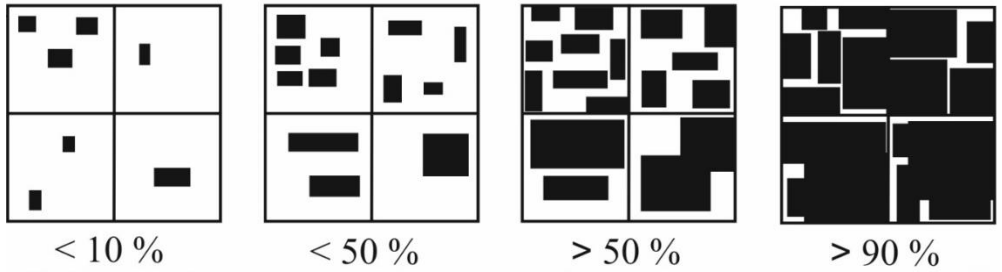
METHODS #LC; vegetation structure

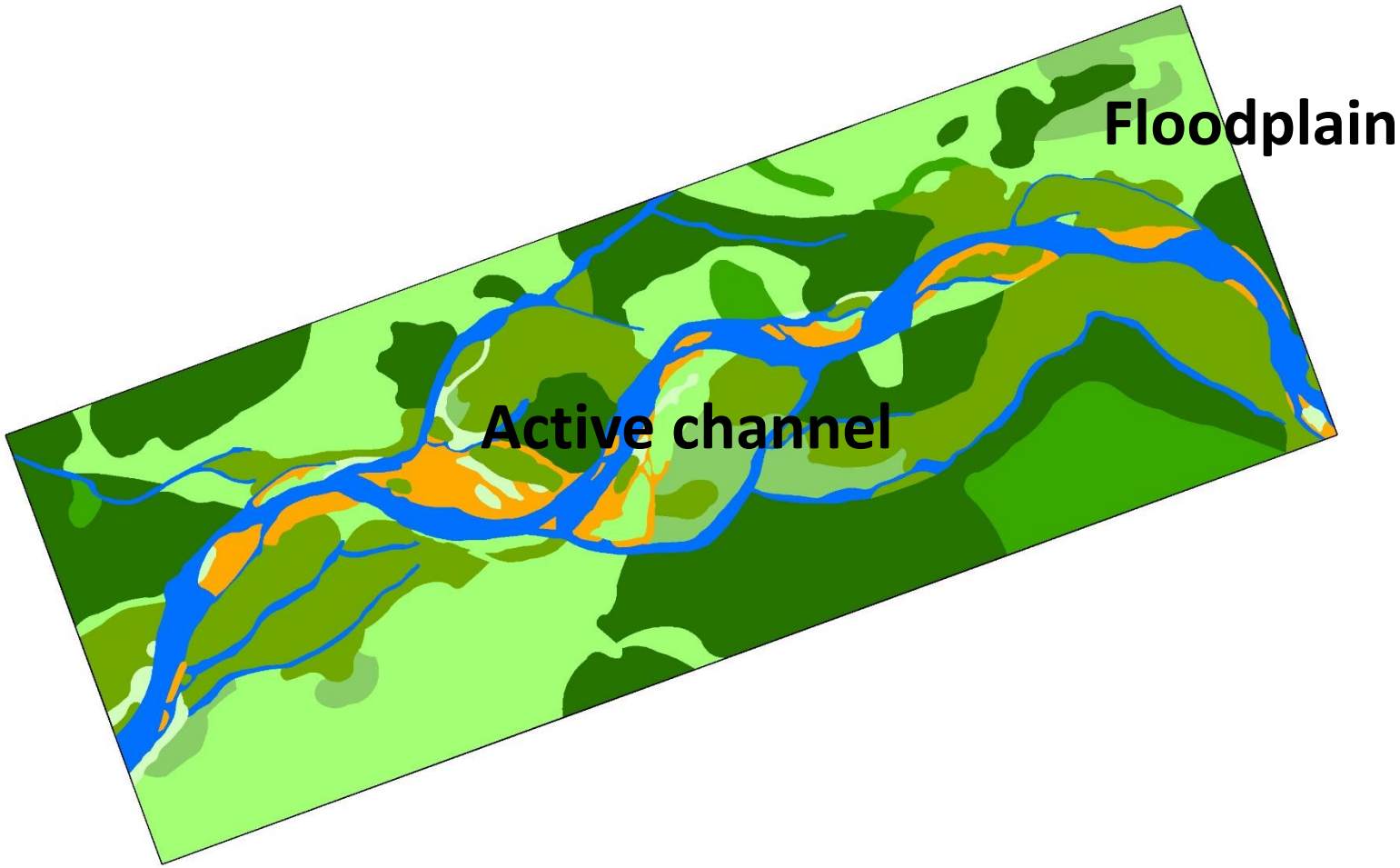




8. Dense trees area

METHODS #LC; vegetation structure





9 time horizons:

1949
1961
1973
1986
1992
2003
2012
2015
2018

in

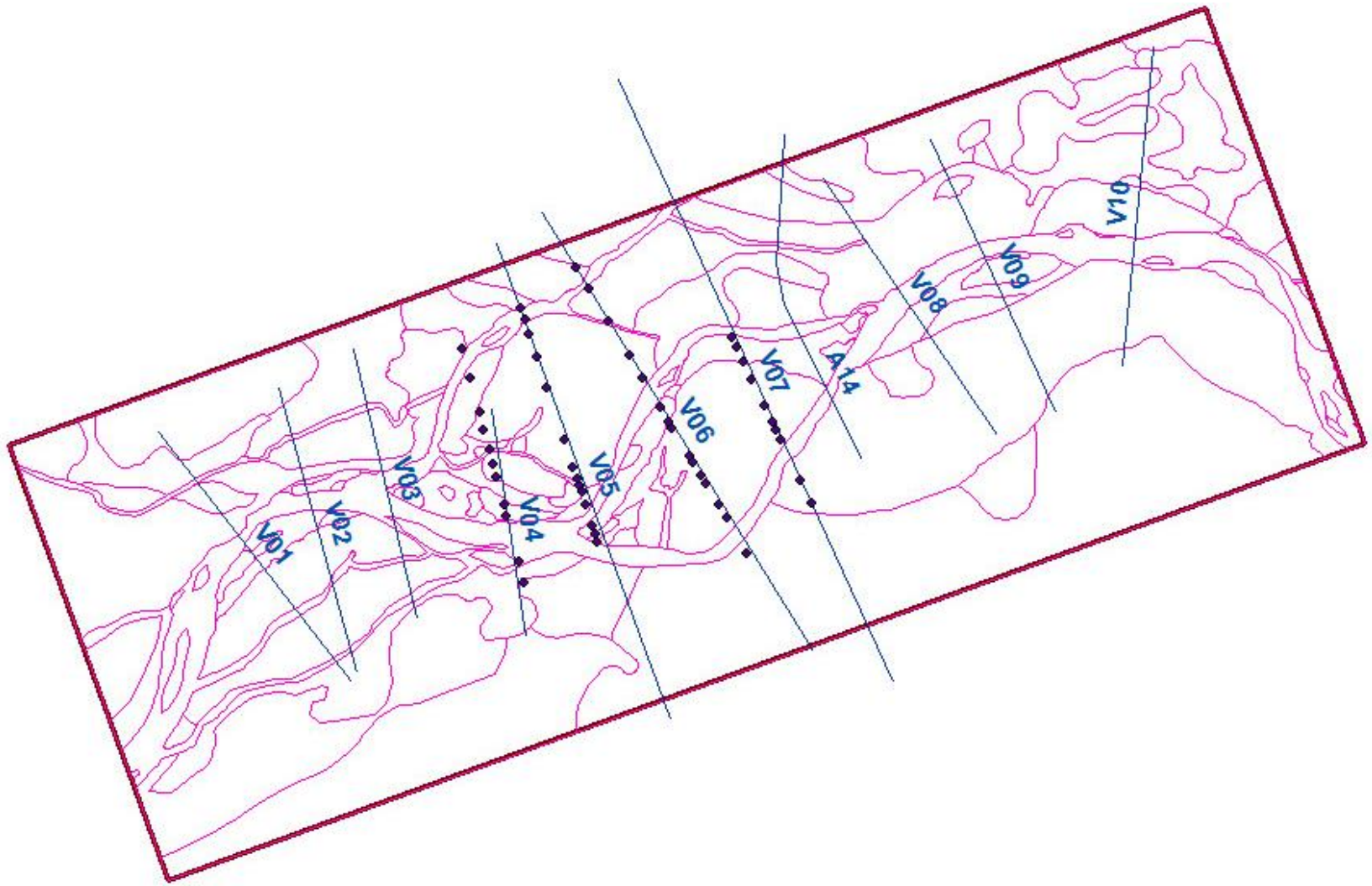
8. Dense trees area

METHODS #phytocoenological registration (2013/2018)

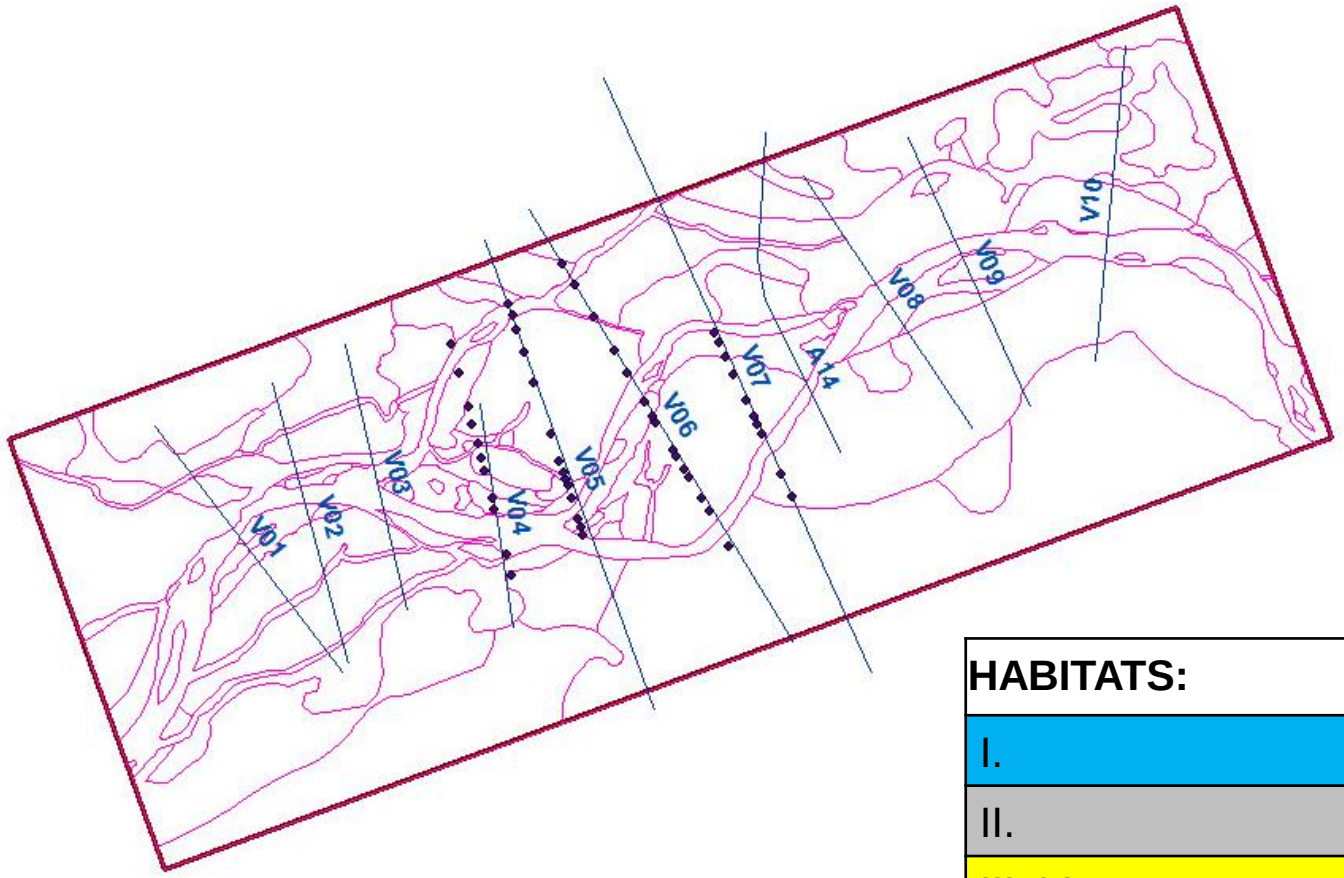
Two phytocoenological registrations (2013 and 2018, summer aspect) according to Zürrych-Montpellier school (Braun-Blanquet, 1964) were realized on the study river reach. The grain size and vegetation homogeneous 4x4m square area was selected on every in-channel form (bar, island) and floodplain on cross-section width. Plant representation was evaluated by a nine-step Braun-Blanquet scale of abundance and dominance (Westhoff a van der Maarel, 1978).

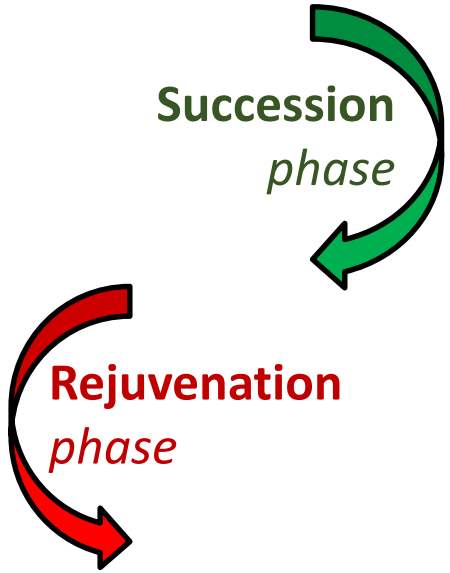
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	**Druh**	**Vedecký názov**	**Synonymum**	**Etáž**	**Nové číslo**	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**		**9**		**10**		**11**		**12**		**13**		**14**		**15**		**16**		**17**		**18**		**19**	
2	(kód)				Staré číslo	50		49		48		47		46		45		44		43		42		41		35		32		31		30		34		33		29		28		27	
3					**Rok**	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	201
4	Ace.pse7	Acer pseudoplatanus		E1																														r									
5	Rum.ace6	Acetosa pratensis	Rumex acetosa	E1														r																									
6	Rum.scu6	Acetosa scutata	Rumex scutatus	E1																1		+																					
7	Acet.vul6	Acetosella vulgaris		E1																																							
8	Aco.var6	Aconitum variegatum		E1																							r															
9	Ado.mos6	Adoxa moschatellina		E1												r																											
10	Aeg.pod6	Aegopodium podagraria		E1			+	+	1	+		+		1	1	1	1	+	+	+		r			+		+	1		2a	2a	+	1	1	1	1	1	+	1	+	1		
11	Agros.sto6	Agrostis stolonifera		E1			+		+						+		+	r		+		+			+											1						+
12	Ach.mil6	Achillea millefolium		E1																					+																	
13	Aju.rep6	Ajuga reptans		E1				+	+			+		r	+	r	+		+							r	+												+			
14	Alc.sp.6	Alchemilla sp.		E1			r																										r							+		
15	Aln.inc1	Alnus incana		E3		2b	1										1													3	2a		+		+		2m		3		+		
16	Aln.inc4	Alnus incana		E2		1	+	3	1							2b		1		2a										+	+	1	2m		+	+	1	3	1		1		
17	Aln.inc7	Alnus incana		E1		r										+						1		r						r							r					
18	Ang.syl6	Angelica sylvestris		E1				r		r		+				+	r	+	r			r				+						+						r	r	r		
19	Anth.odo6	Anthoxanthum odoratum		E1																																						
20	Ant.syl6	Anthriscus sylvestris		E1			+		+								+																				+		+			
21	Anthy.vul6	Anthyllis vulneraria		E1																																						
22	Aqu.vul6	Aquilegia vulgaris		E1												r																										
23	Ara.alp6	Arabis alpina		E1																+																						
24	Are.ser6	Arenaria serpyllifolia		E1																				+																		
25	Arr.ela6	Arrhenatherum elatius		E1																				r																		
26	Art.vul6	Artemisia vulgaris		E1																		r																				
27	Asa.eur6	Asarum europaeum		E1																																						
28	Ath.fil6	Athyrium filix-femina		E1				r											+	+								+											+			
29	Ave.bre6	Avena sativa	Avena brevis	E1																																						
30	Aven.fle6	Avenella flexuosa		E1																																						
31	Bet.pen4	Betula pendula		E2																					r																	
32	Bet.pen7	Betula pendula		E1																																						
33	Cala.aru6	Calamagrostis arundinacea		E1		1																				1	1													+		
34	Cala.pse6	Calamagrostis pseudophragmites		E1																				1	2a												+			r		1	2a
35	Cala.vil6	Calamagrostis villosa		E1																							+				+										
36	Calt.pal6	Caltha palustris		E1		1						+													+							+	r				+				

METHODS #cross-section measurements (2013/2018)



METHODS #cross-section measurements (2013/2018) plus #phytocoenological registration





HABITATS:	
I.	Active channel
II.	Gravel bars
III.-V.	Grass-herbaceous vegetation
VI.-VII.	Shrubs, shrub willows, shrub shores
VIII.	Forest, trees with forest character (variously involved)

8 TYPES of HABITATS for the GRAVEL-BED BELÁ RIVER

HABITATS:	
I.	Active channel
II.	Gravel bars
III.-V.	Grass-herbaceous vegetation
VI.-VII.	Shrubs, shrub willows
VIII.	Forest, trees with forest character

I. Active channel

II. Young gravel bars_habitat **Br1 Gravel bars without vegetation**

III. Older gravel bars_habitat **Br2, Br3, Br4, Br6 Gravel bars with inicial pioneer vegetation**

IV. Banks and alluvial deposits with herbaceous vegetation_habitat of European importance **Br2 Mountain streams and herbal vegetation along their banks**

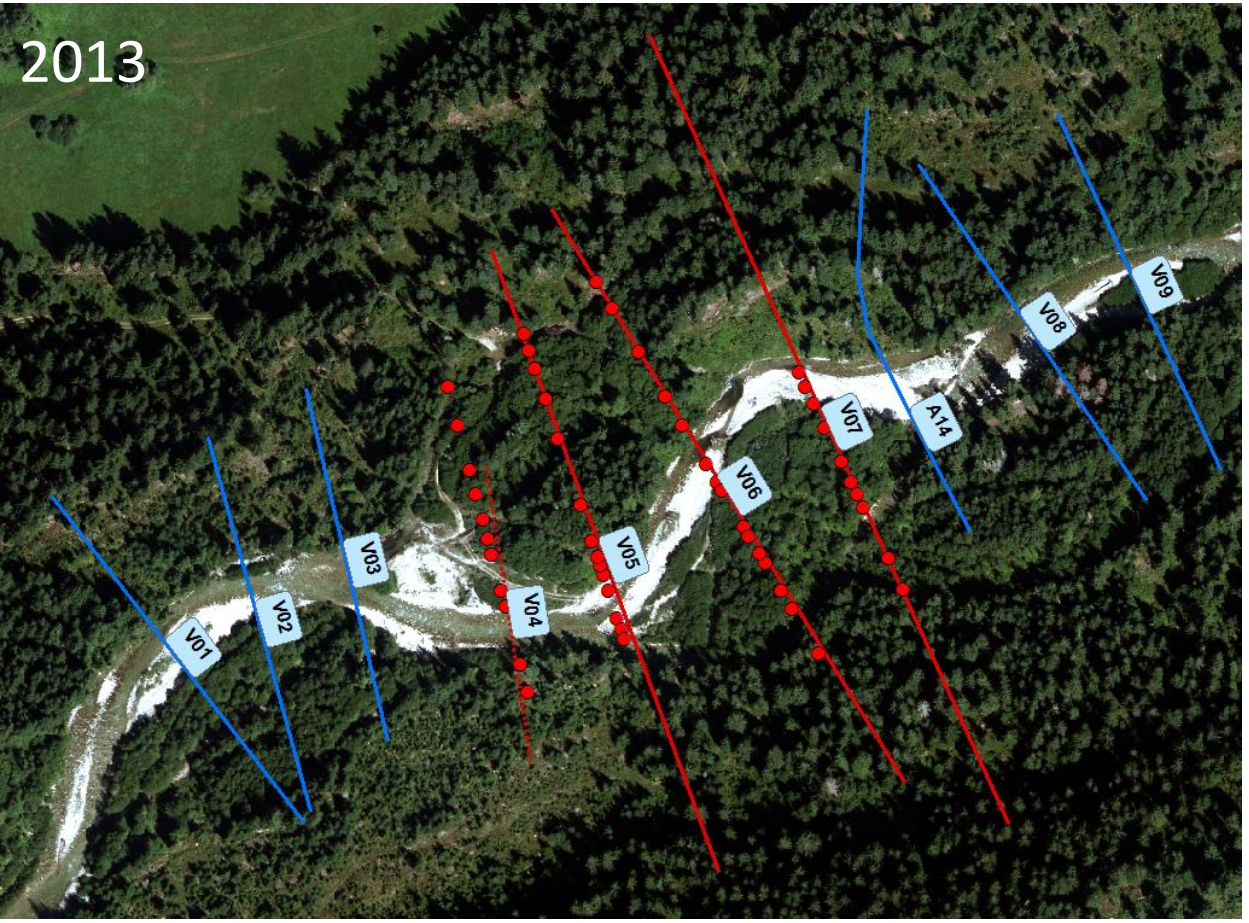
V. Banks and slightly wet slopes with herbaceous vegetation_habitat of European importance **Br6 Riparian vegetation with Petasites**

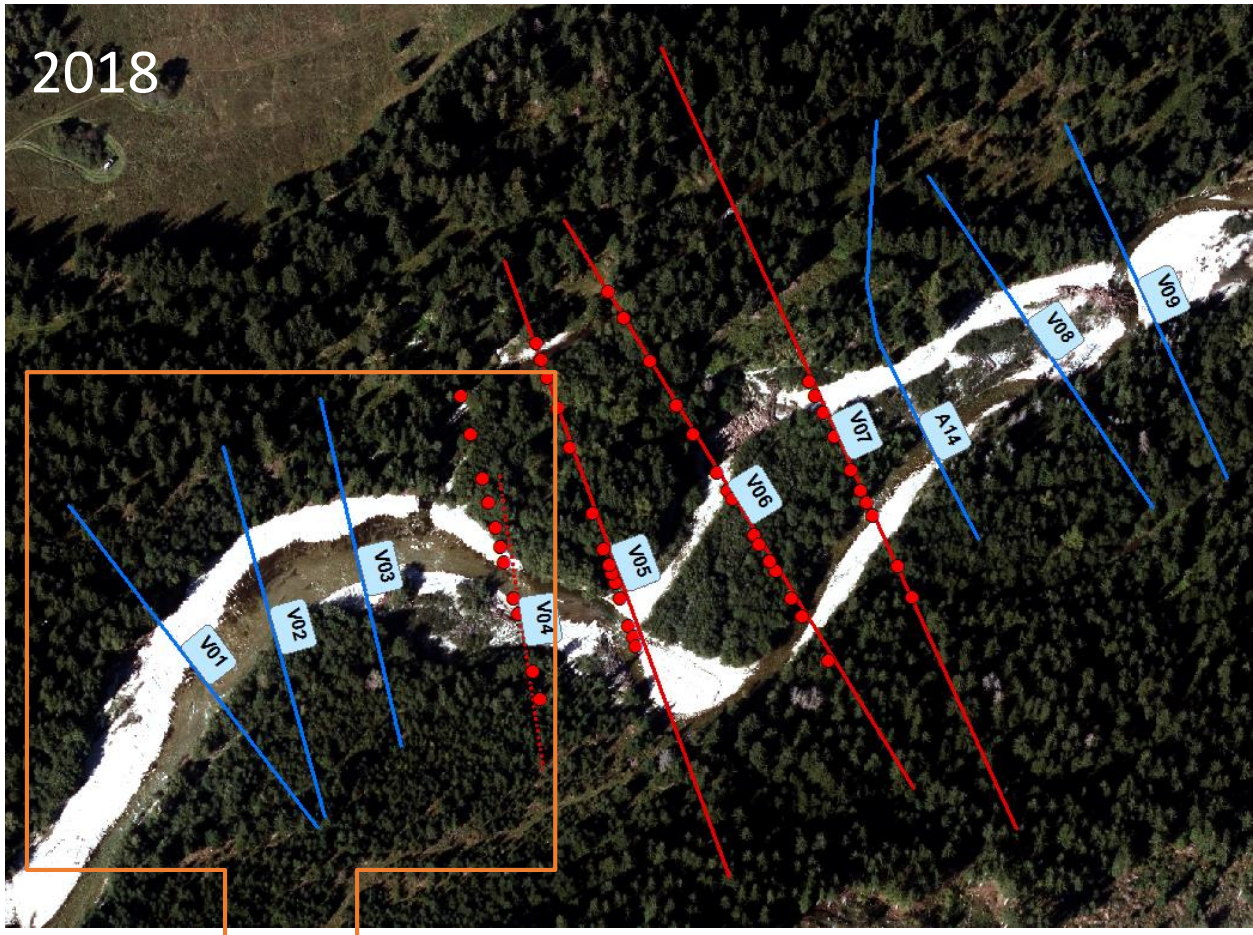
VI. Alluvial deposits with shrub vegetation of *Myricaria germanica*_habitat of European importance **Br3 Mountain streams and shrub vegetation with *Myricaria germanica***

VII. Alluvial deposits with shrub vegetation of *Salix sp.*_habitat of European importance **Br4 Mountain streams and shrub vegetation with *Salix elaeagnos***

VIII. Higher banks, terraces and slopes with forest vegetation_priority habitat of European importance **Ls1.4 Mountain alder floodplain forests**

METHODS #cross-section measurements_V5, V6, V7



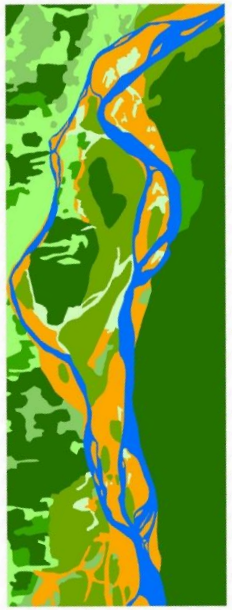


artificial channel created by stabilizing works after flood event in 2018, July (10-years RI)

1949

1961

1973



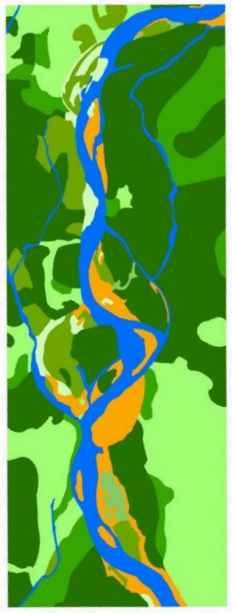
1986

1992

RESULTS

#vegetation structure

2003



2012

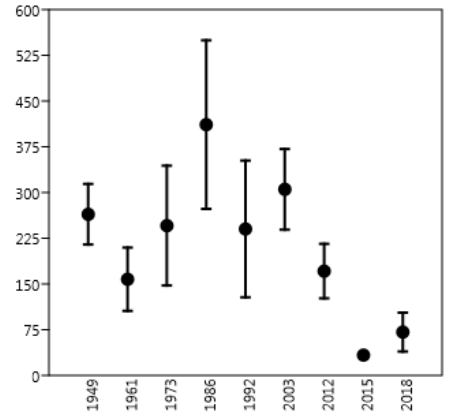
2015

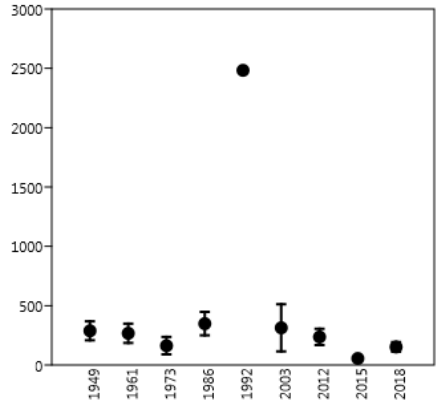
2018

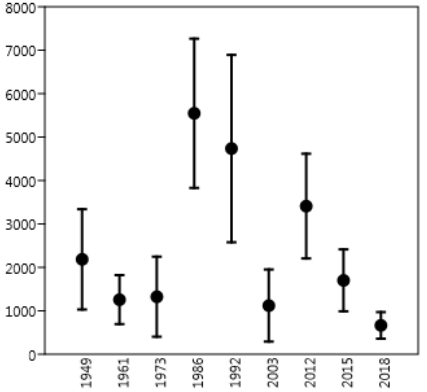
BB_scale

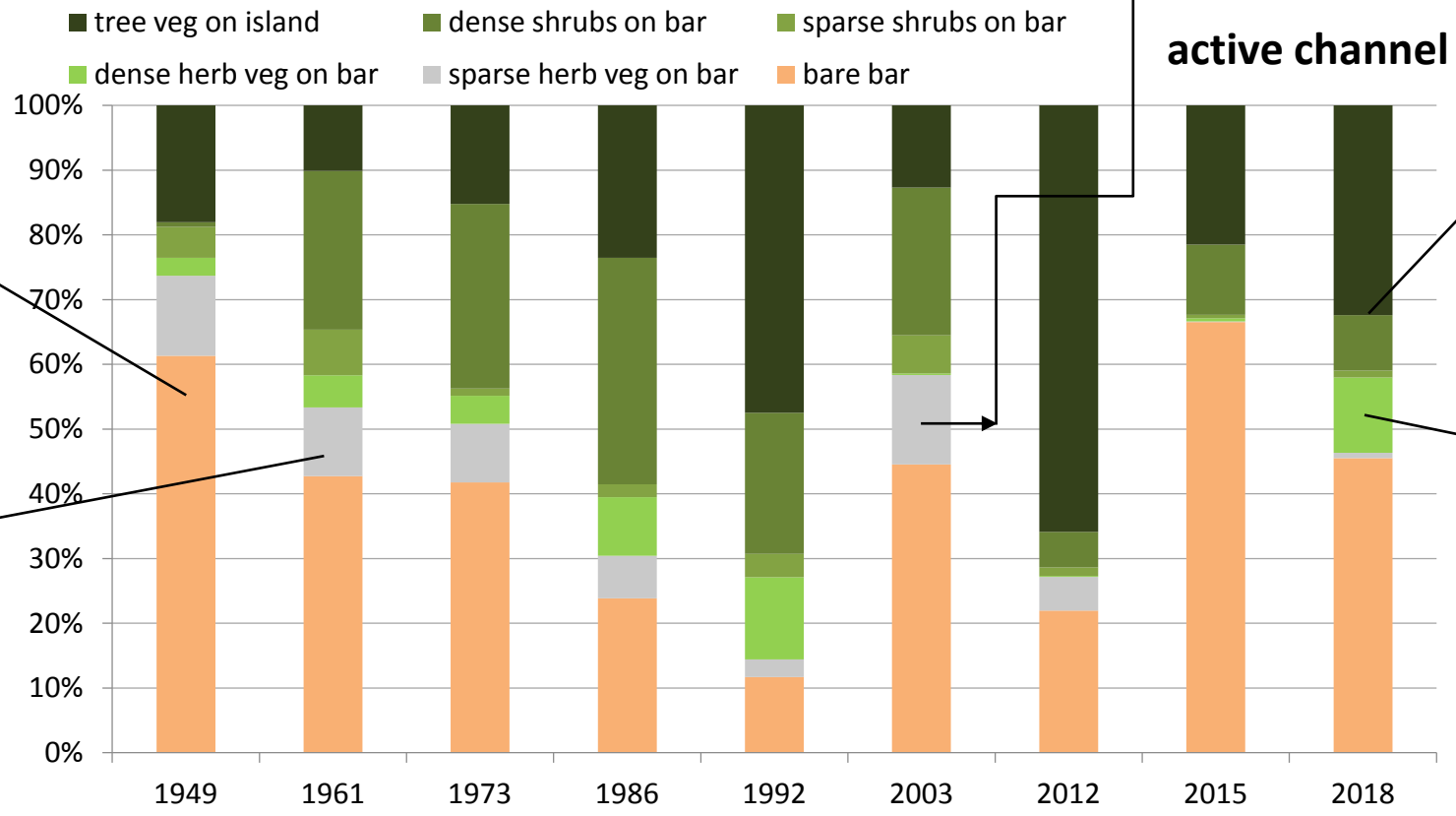
- water area
- bare bar area
- sparse herb vegetation
- dense herb vegetation
- sparse shrubs
- dense shrubs
- sparse trees
- dense trees

RESULTS #vegetation structure

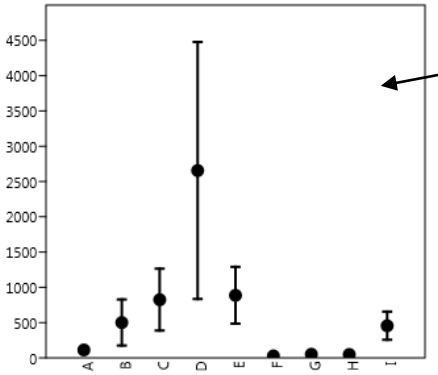


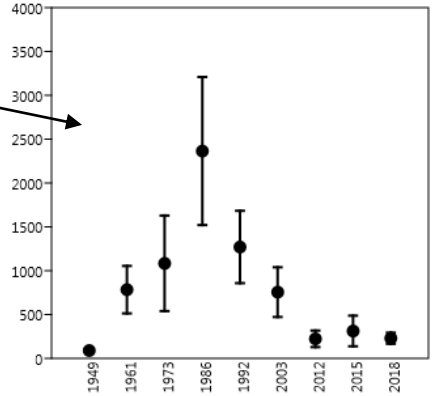




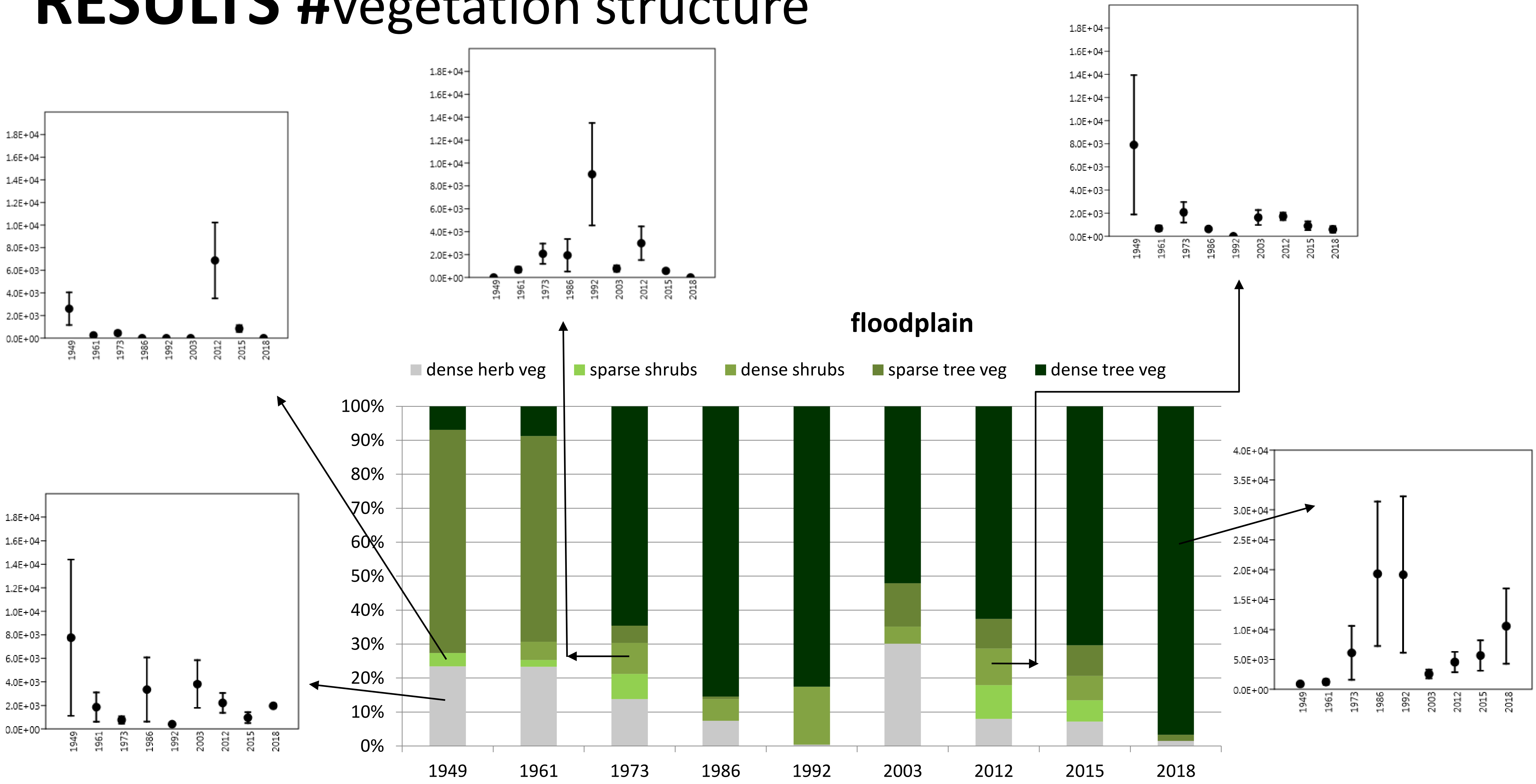


active channel

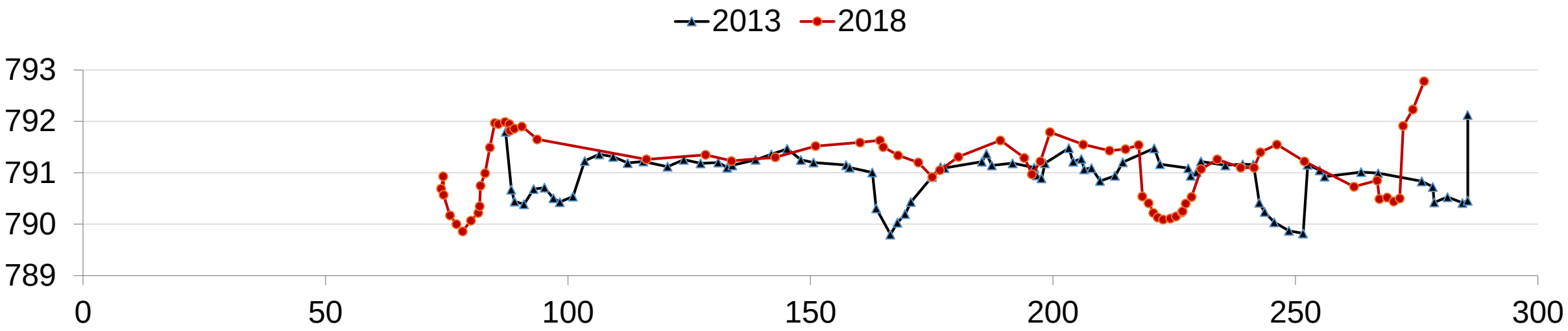




RESULTS #vegetation structure

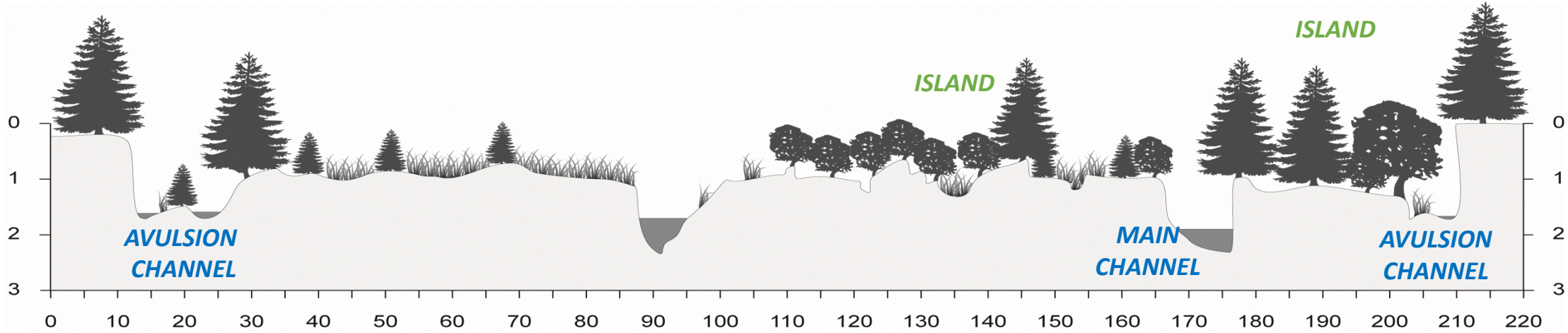


RESULTS #cross-section measurements_V7

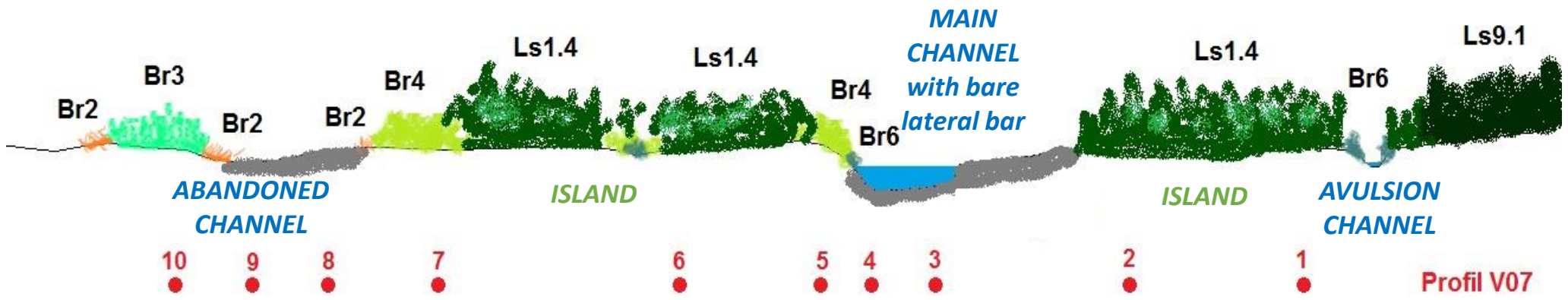


RESULTS #cross-section_V7 #phytocoenological registration

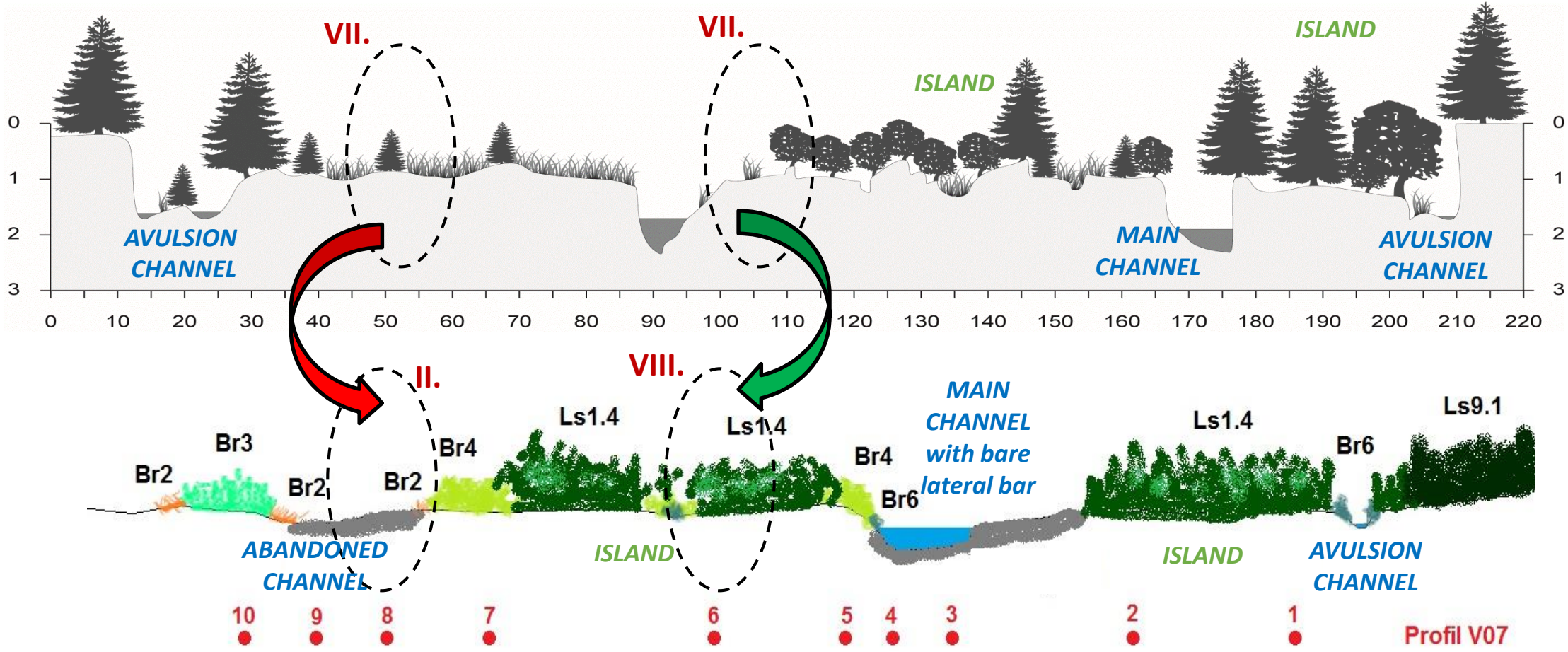
2013



2018



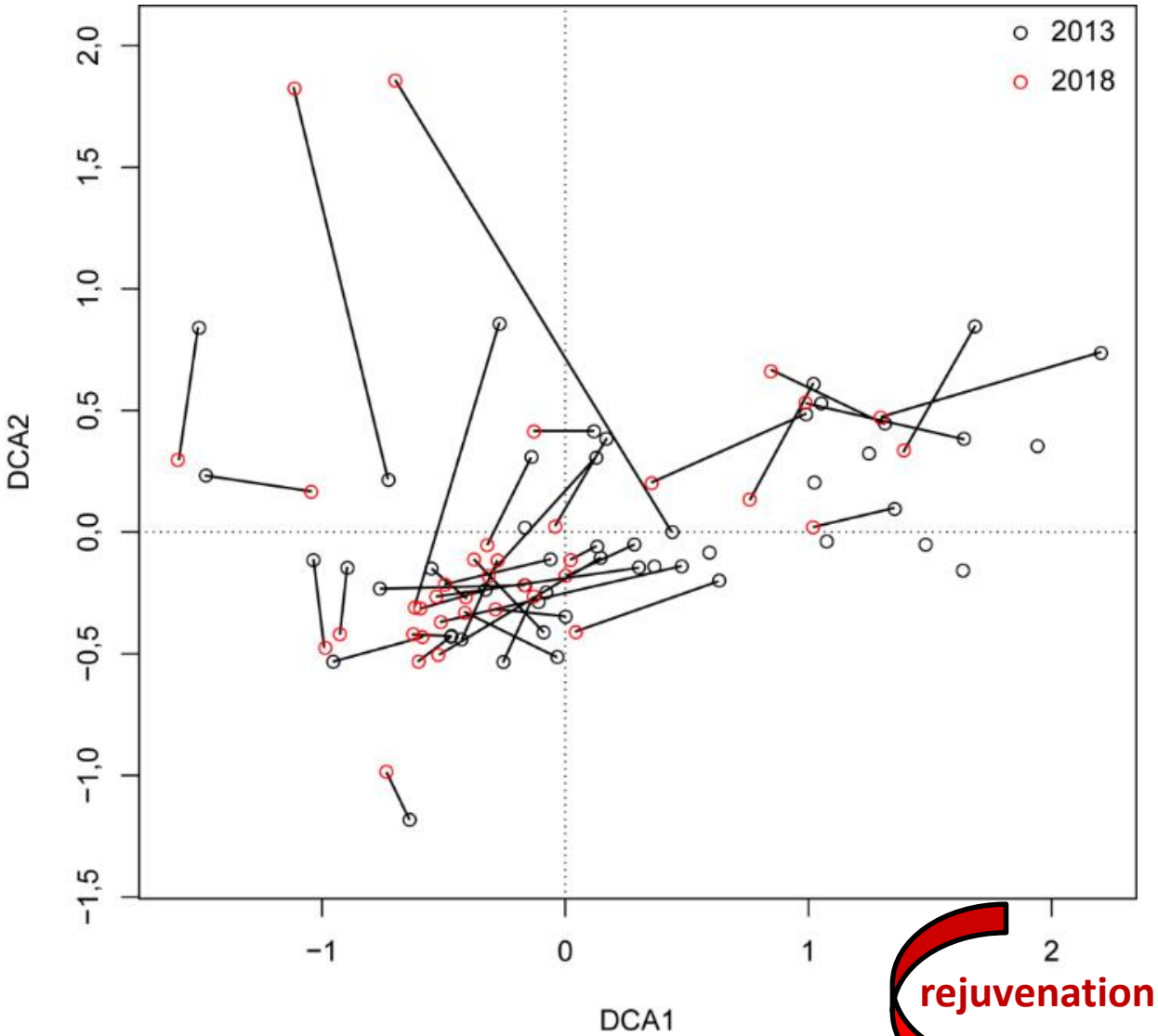
RESULTS #cross-section_V7 #phytocoenological registration

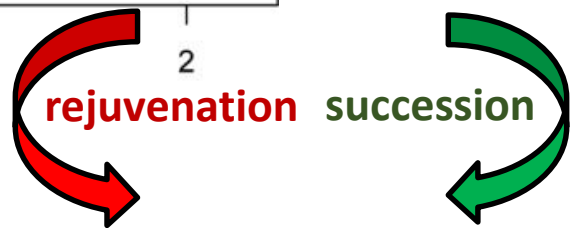


10		9		8		7		6		5		4		3		2		1	
2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018	2013	2018

RESULTS #phytocoenological registration

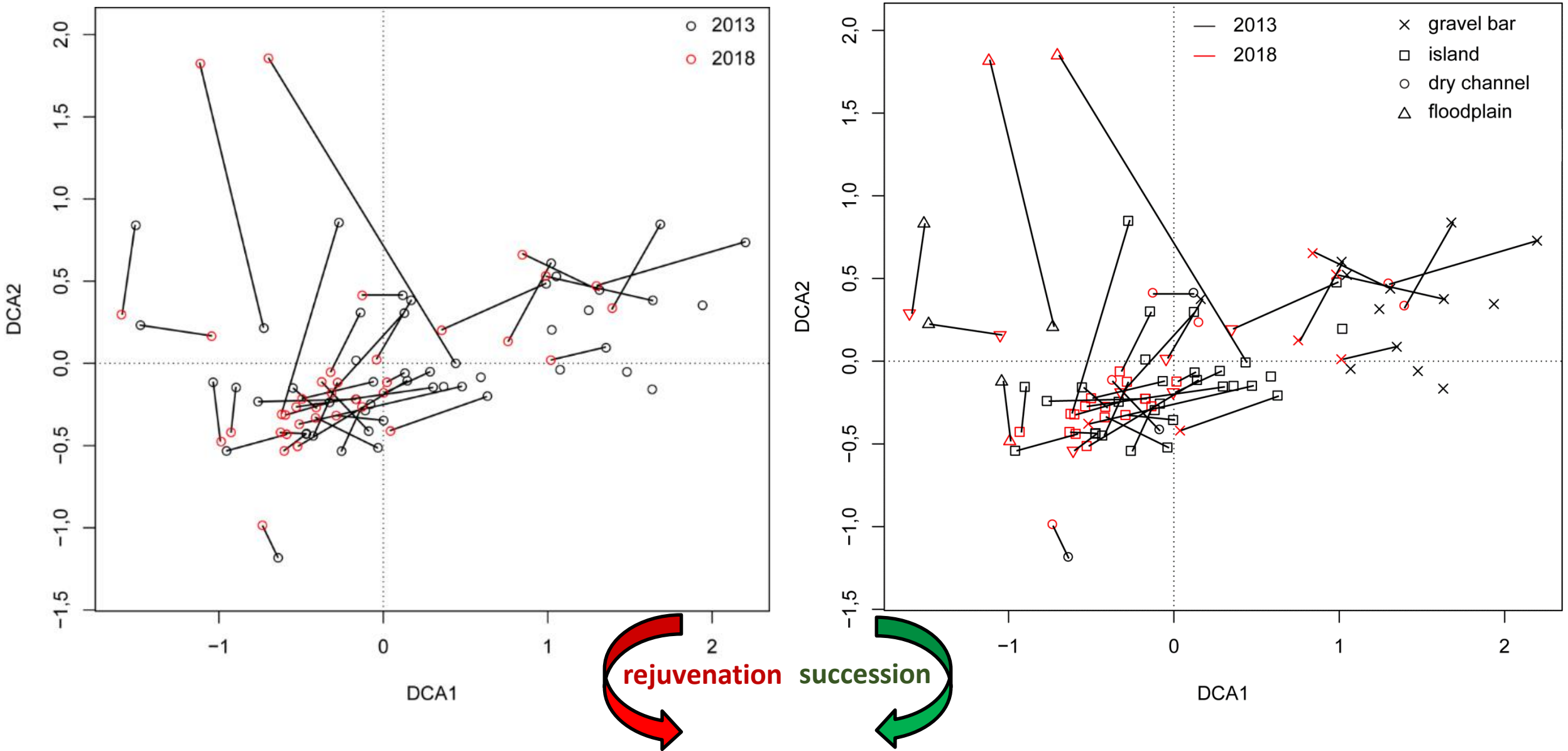
DETRENDED CORRESPONDENCE ANALYSIS (DCA)



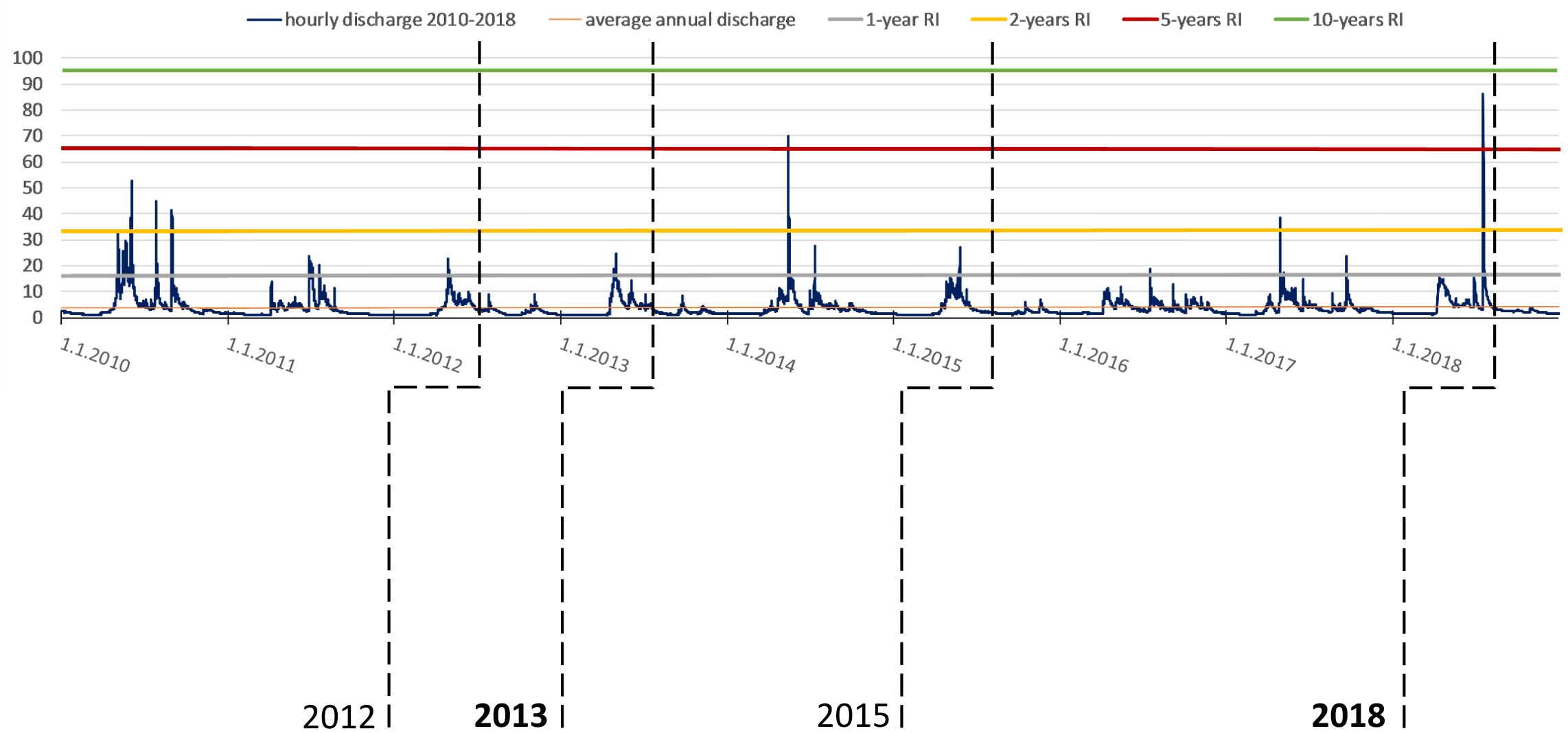


RESULTS #phytocoenological registration

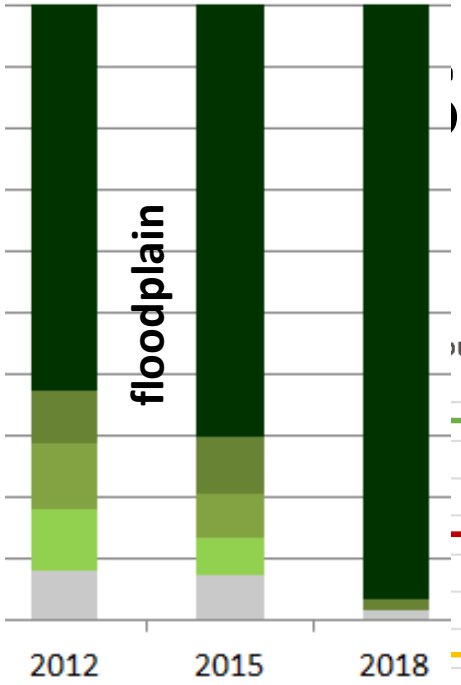
DETRENDED CORRESPONDENCE ANALYSIS (DCA)

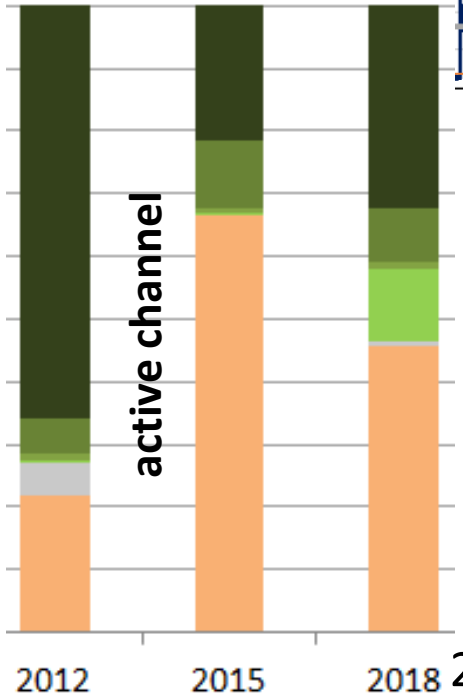


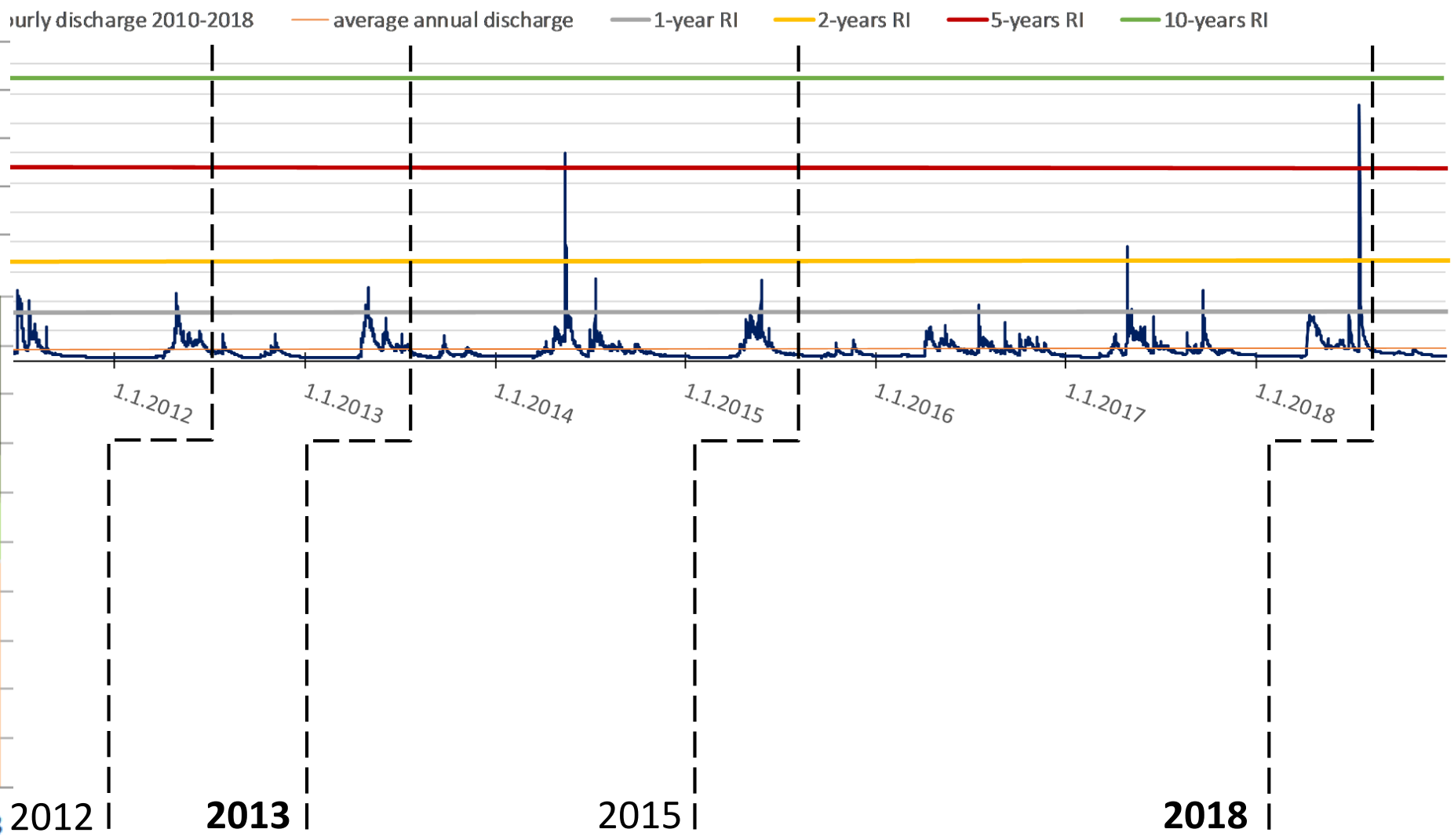
CONCLUSSION #vegetation dynamics and flood events



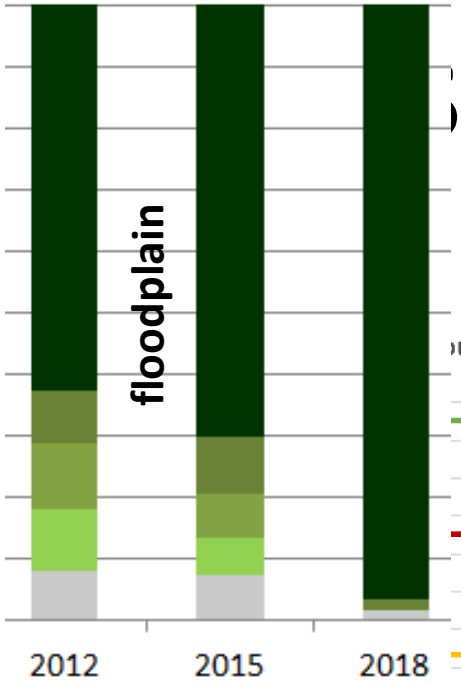
SION #vegetation dynamics and flood events

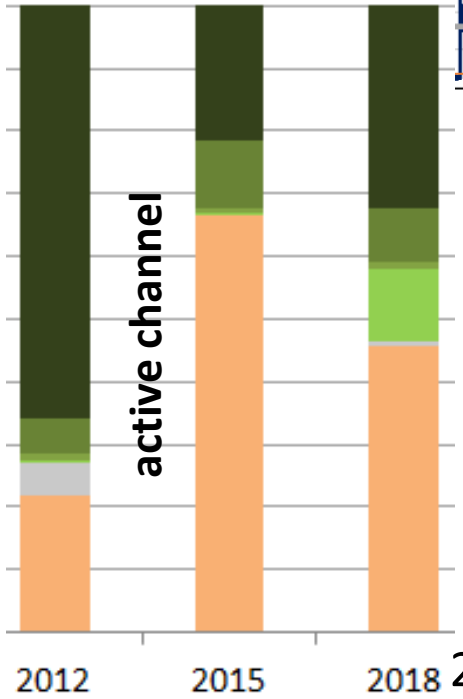


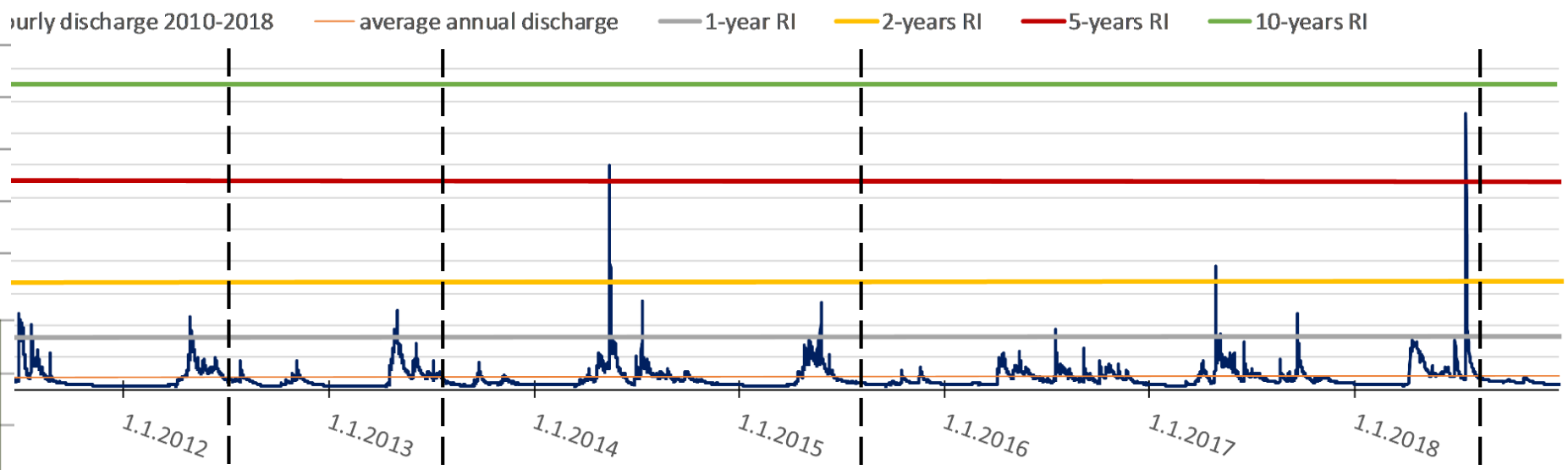


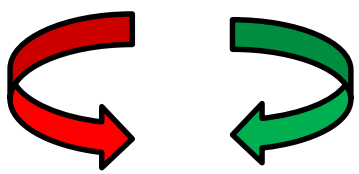


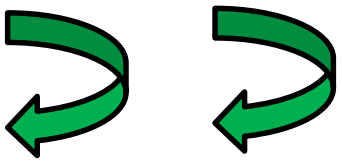
SION #vegetation dynamics and flood events











ACH F ACH F

2012 **2013** 2015 **2018**

?

CONCLUSSION #vegetation species responsible for bar stabilisation

Br2 Mountain streams and herbal vegetation along their banks

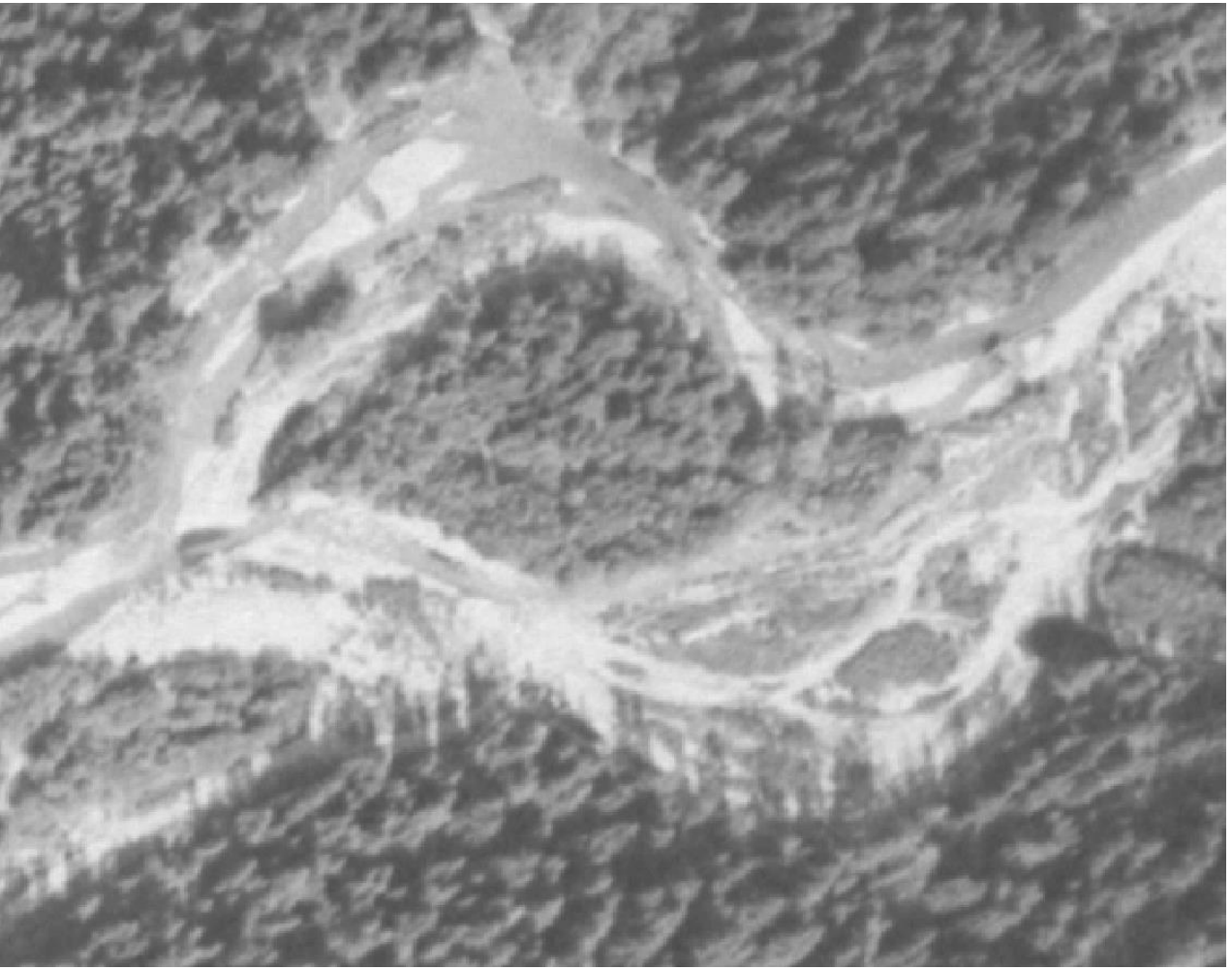
Calamagrostis pseudophragmites (dominant), *Agrostis stolonifera*, *Dactylis glomerata*, *Galium schultesii*, *Myosotis scorpioides*, *Petasites hybridus*, *Petasites kablikianus*, *Ranunculus repens*, *Rumex alpinus*, *Stellaria nemorum*, *Tanacetum vulgare*, *Taraxacum sp.*, mladé jedince drevín *Myricaria germanica*, *Salix elaeagnos*, *Salix purpurea*.

Br6 Riparian vegetation with Petasites

Petasites kablikianus (dominant), *Petasites hybridus*, *Aegopodium podagraria*, *Angelica sylvestris*, *Carduus personata*, *Crepis paludosa*, *Geum rivale*, *Chaerophyllum hirsutum*, *Myosotis scorpioides*, *Orobanche flava*, *Roegneria canina*, *Rumex alpinus*, *Stellaria nemorum*.

The "higher„ placement of the community in the successive row on a gravel bar (such as **Br2-Br3-Br4-Ls1.4** or **Br6-Br4-Ls1.4**), the more stable the bar is.

#RS DATA QUALITY for interpretation of vegetation structure_readibility of aerial photos; result accuracy?

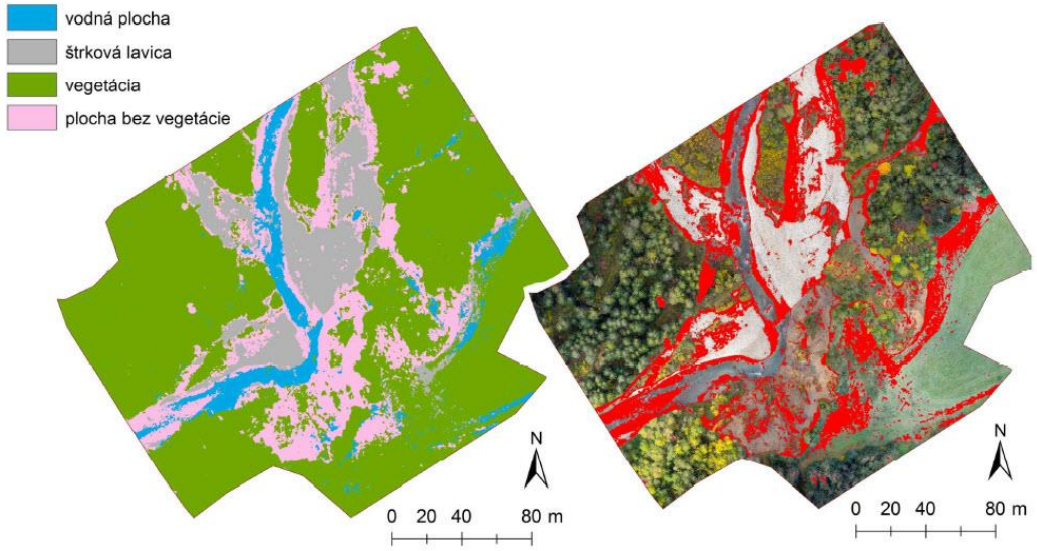


Aerial photo_1961

Ortho-photo mosaic_2015_rgbi cannals

#final remark and future chalenges

- Conceptual model of vegetation dynamics
- UAV mapping for detailed vegetation structure and automatic object-based classification



R u s n á k, M., S l á d e k, J., K i d o v á, A, 2018:
USING UAV TECHNOLOGY FOR LANDSCAPE CLASSIFICATION AND MAPPING IN FLUVIAL GEOMORPHOLOGY.
Geographical Journal, 70 (2), 141-160

THANK YOU FOR YOUR ATTENTION

https://slovakriverslab.org/

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