FLOOD PULSING SYSTEM - ASSESSMENT AND CONSERVATION (Case study from Poland and proposal for comparative study)

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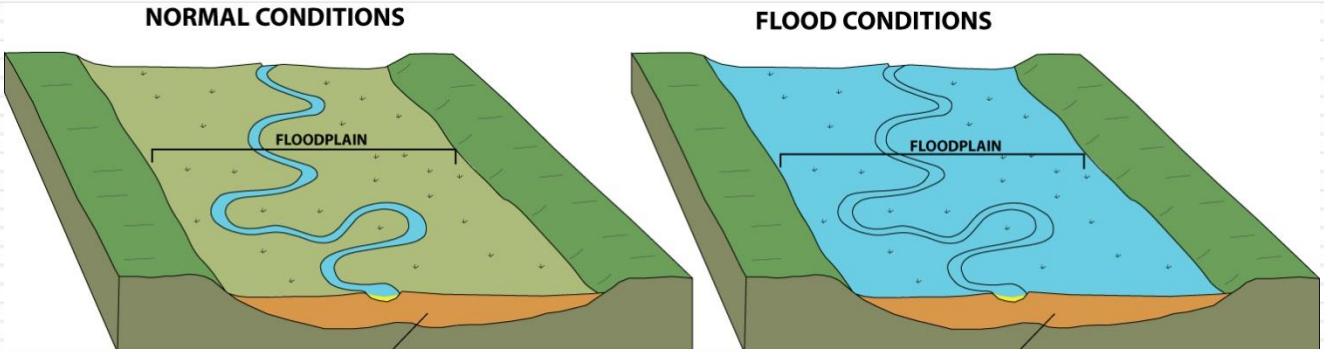
Contents

- Context
- Study area
- Method
  - Source of inundation
  - Hydrodynamic model and vegetation maps
  - Floodplain vegetation impact
- Results and Conclusions
- Further study (Discussion)
  - Idea and goal
  - Method
  - Way to go…

Floodplains

- **Floodplains:** “areas periodically inundated by overflow from rivers and by snow melt, precipitation or groundwater (Junk et al., 1989)



(Romans, 2011)

  - ➢ Exchange nutrients and sediments
  - ➢ Enhance biological productivity

- Increasingly threatened -> Knowledge required for maintenance of ecosystem services

Two perspectives

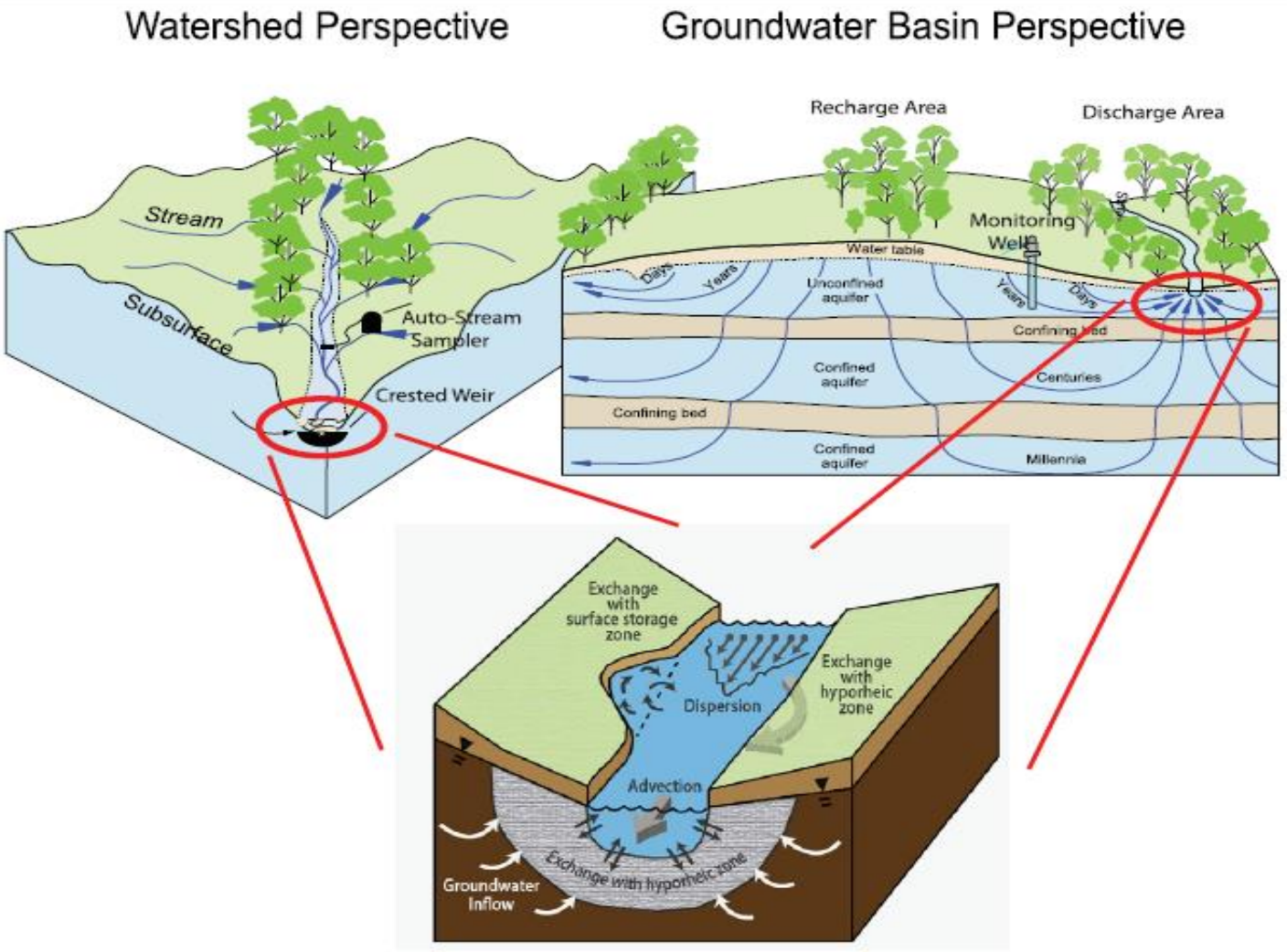


Figure 4. The river corridor in relation to watershed and groundwater basin perspectives of hydrologic transport.

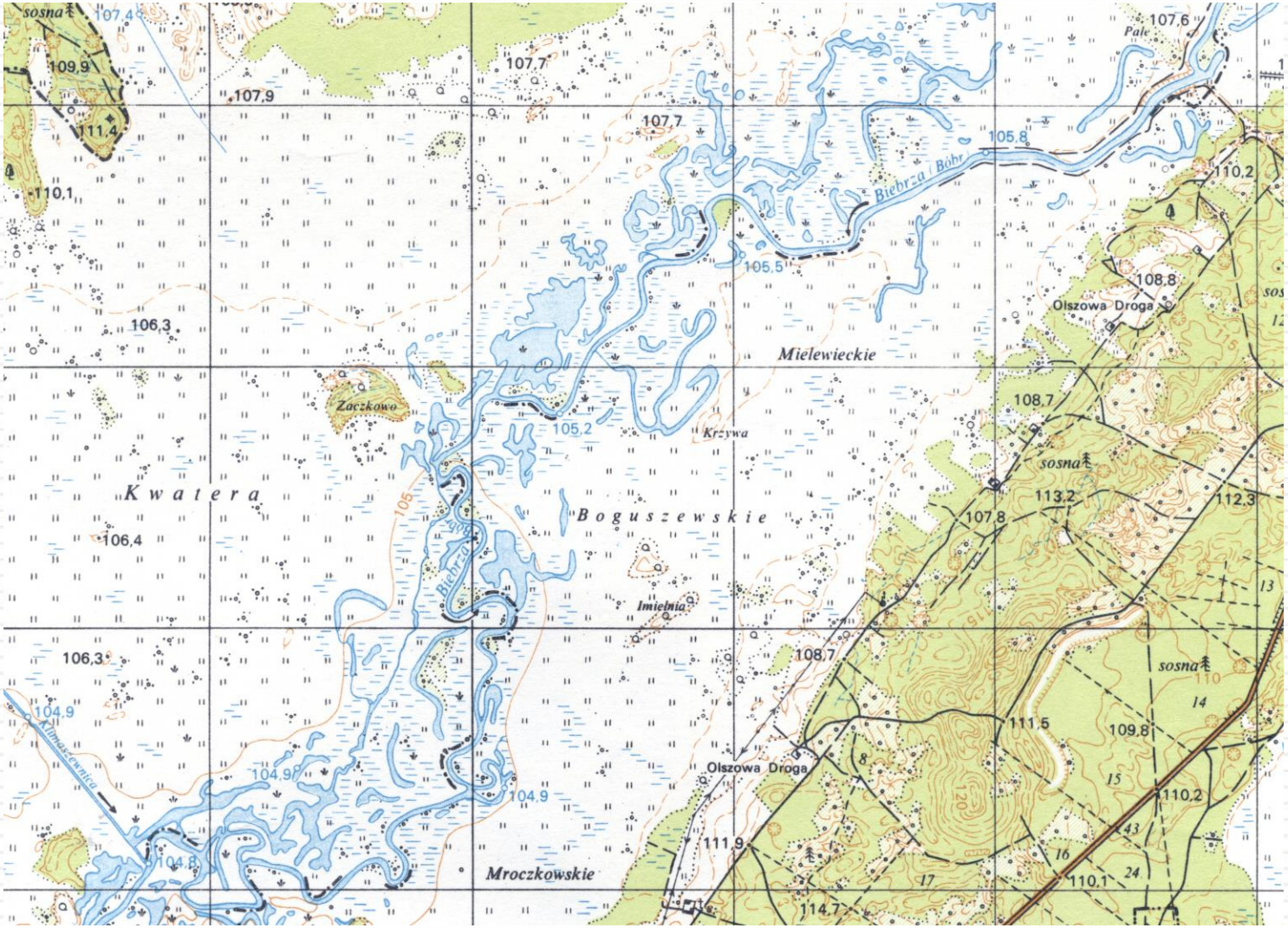
River corridor science: Hydrologic exchange and ecological consequences from bedforms to basins

Jud Harvey[1] and Michael Gooseff[2]

A virgin river surrounded by undrained mires (Western Siberia)

Courtesy Martin Wassen, Utrecht University

A river with little human interference (Eastern Poland)



1km

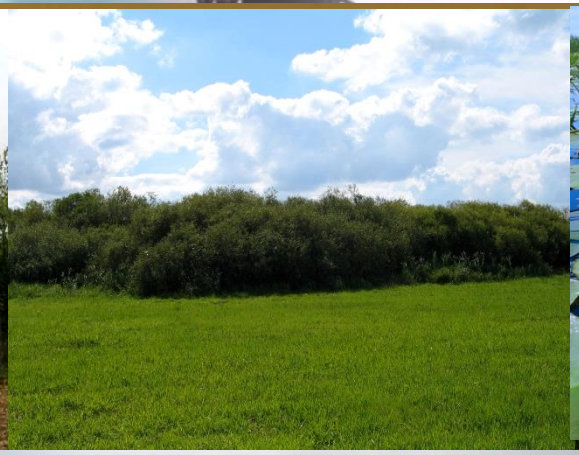
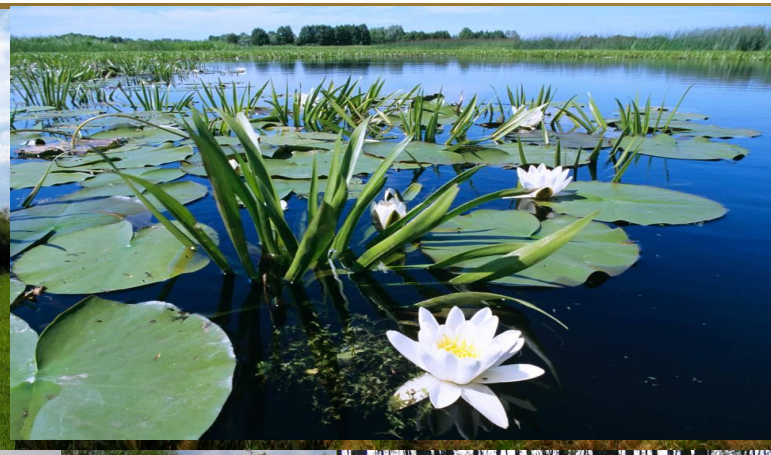
Courtesy Martin Wassen, Utrecht University

A river dominated by man (the Netherlands)

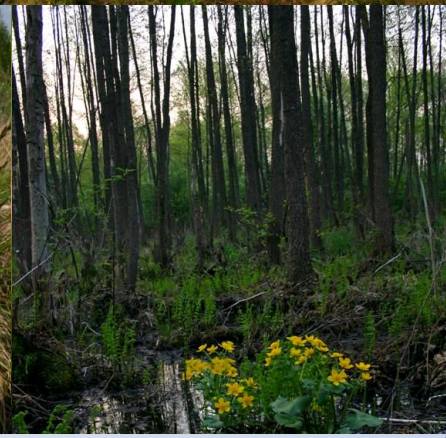
1km

Courtesy Martin Wassen, Utrecht University

Vegetation of the riparian wetlands

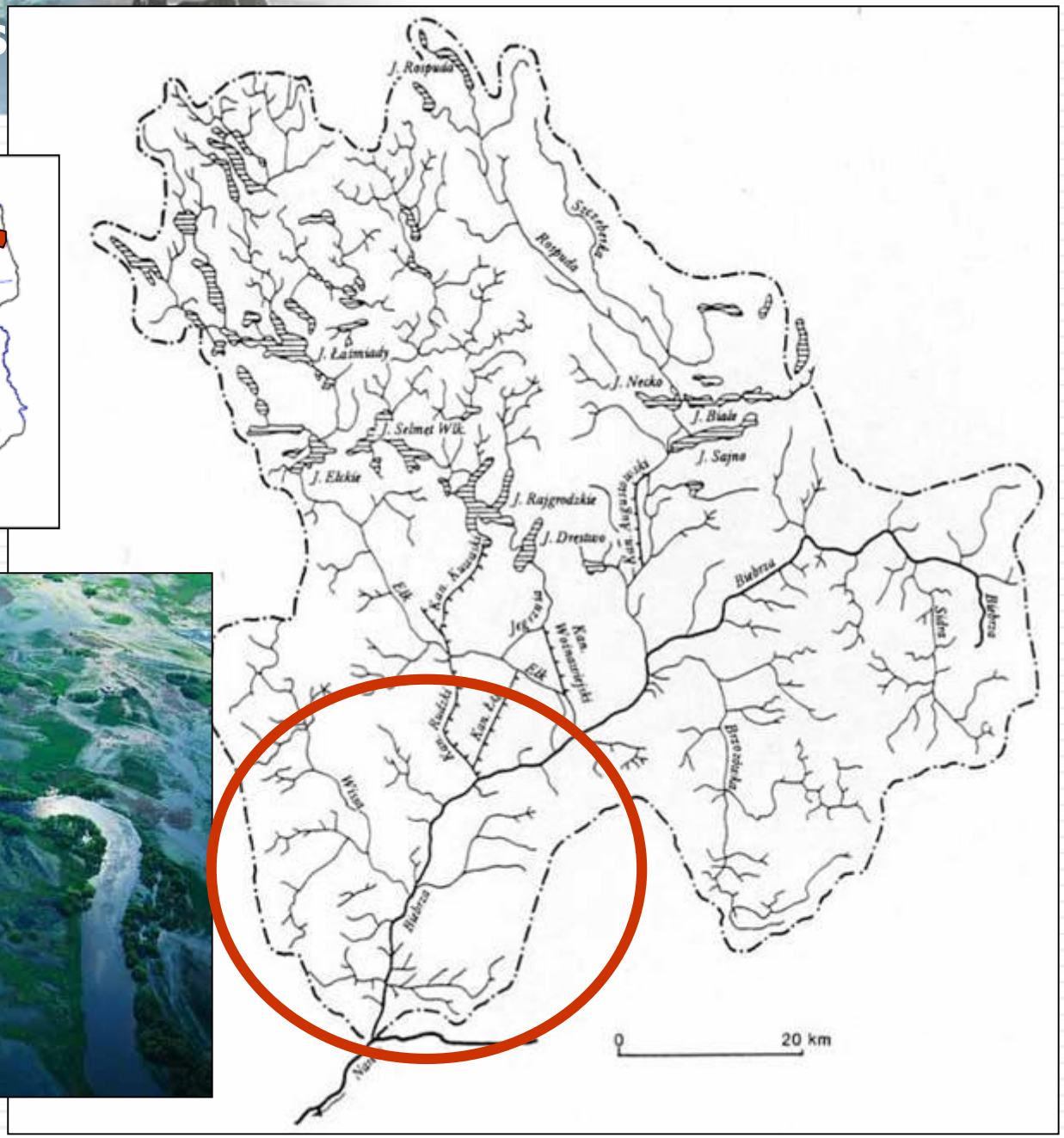




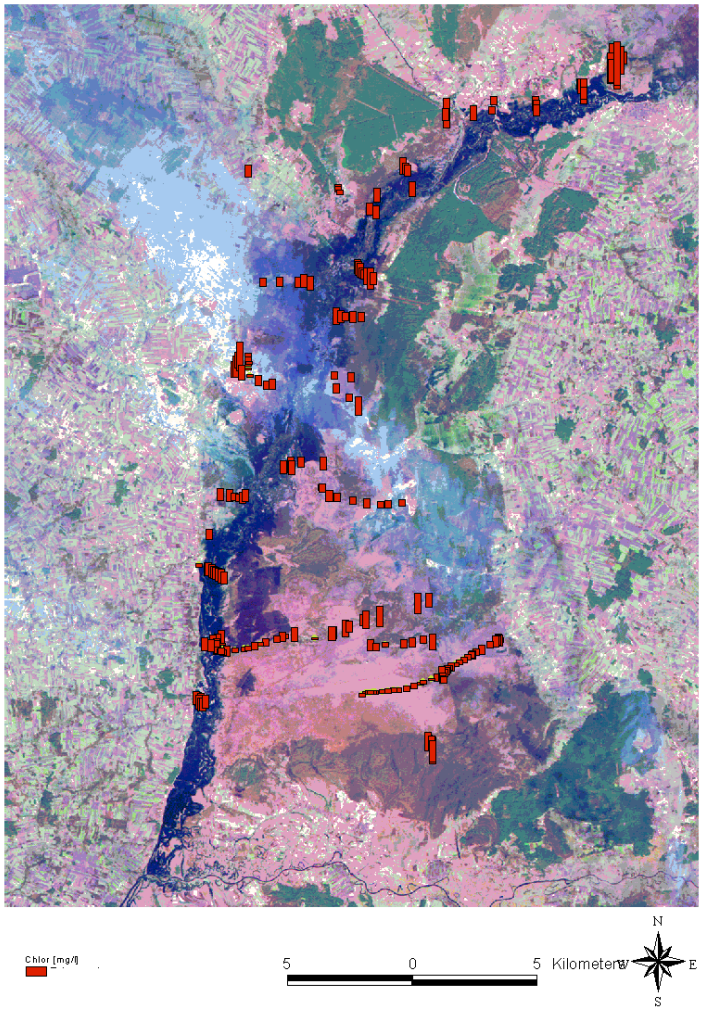



17 4 '96

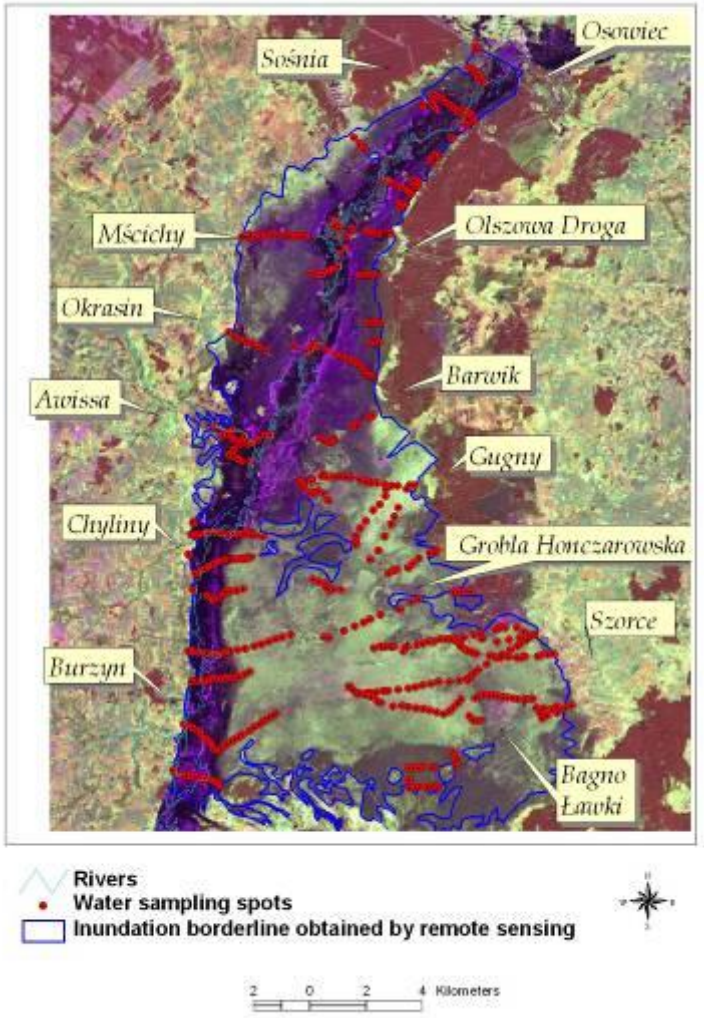
Biebrza Wetlands



RS and chemical transects

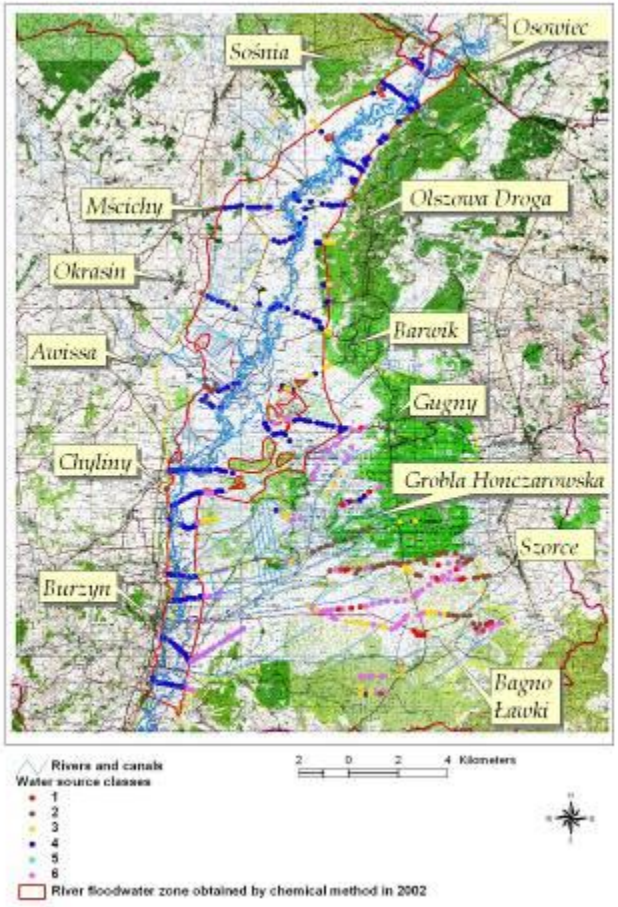


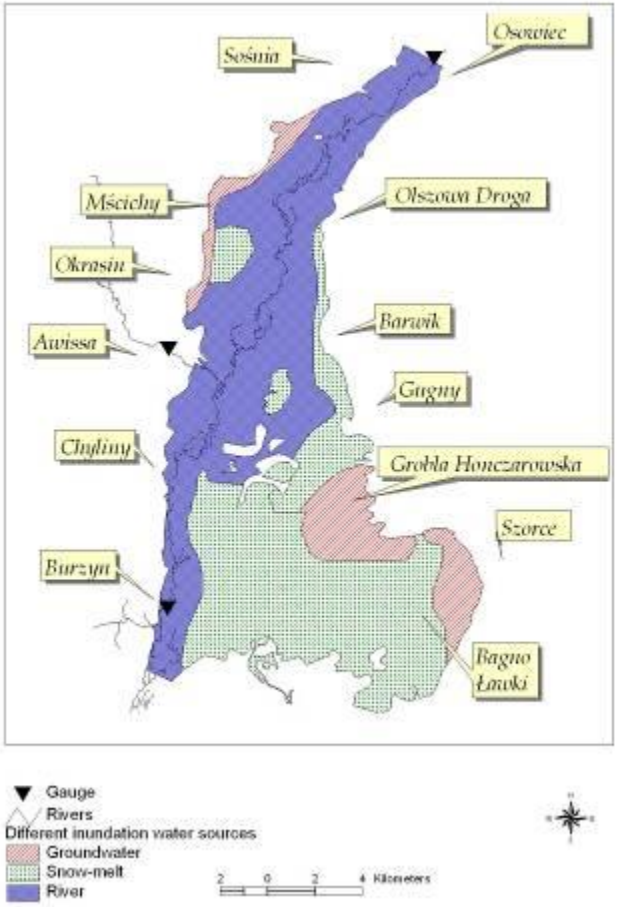
Landsat satellite images



796 water samples

Results of chemical analysis



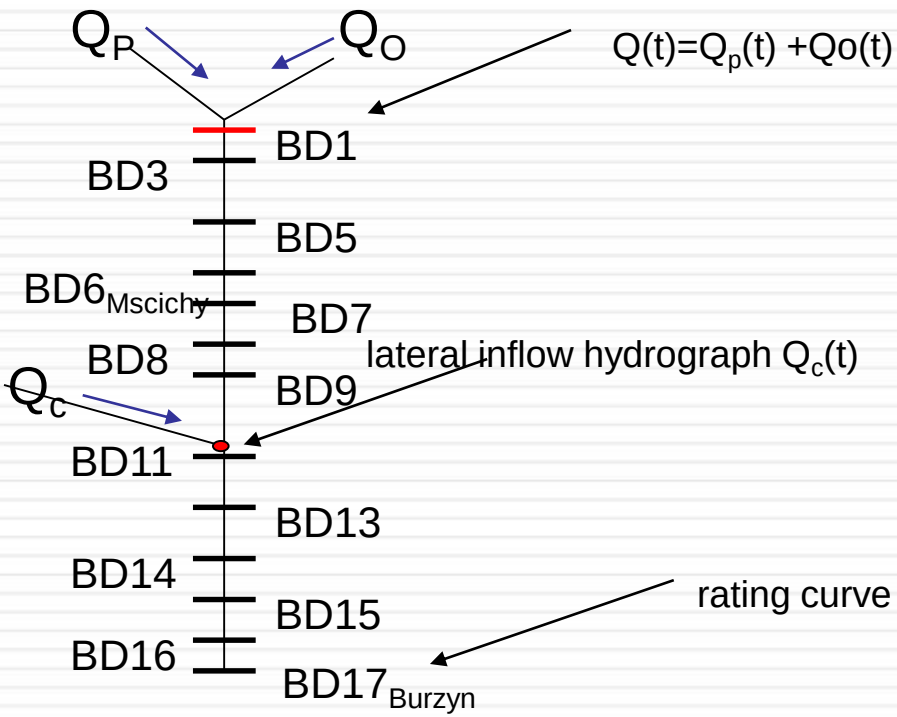


Chromanski et al, Ecological Engineering, 2011

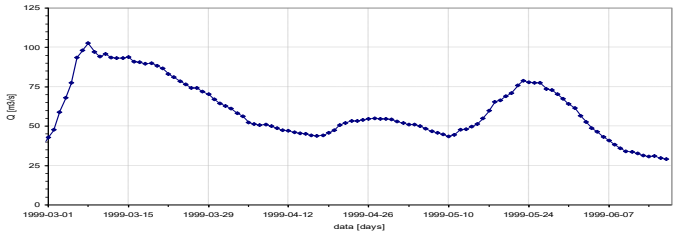
Hydraulic model topological scheme

Unsteady 1-D hydraulic model – Full St. Venant equations

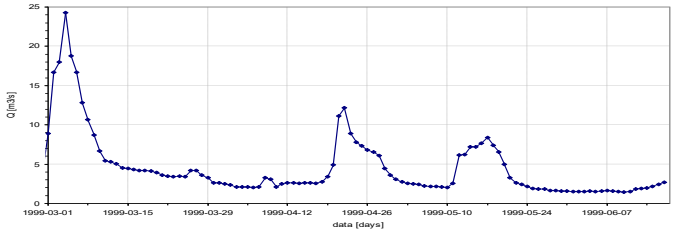
Boundary conditions



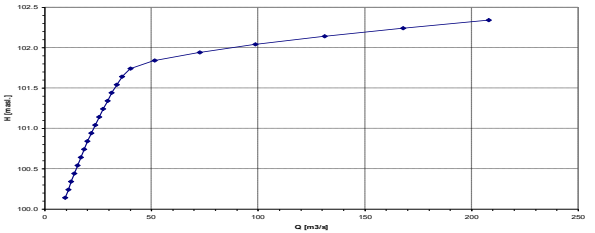
$Q(t)=Q_p(t)+Qo(t)$



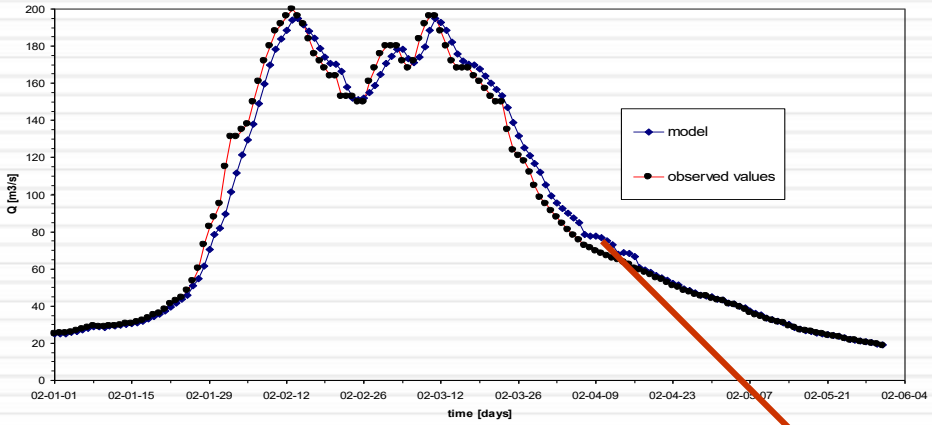
lateral inflow hydrograph $Q_c(t)$



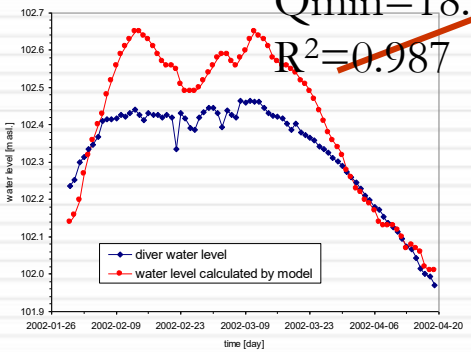
rating curve



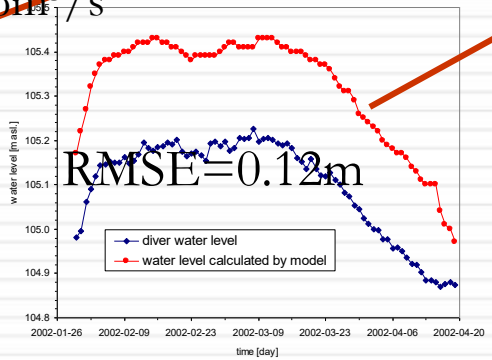
Results of hydraulic model



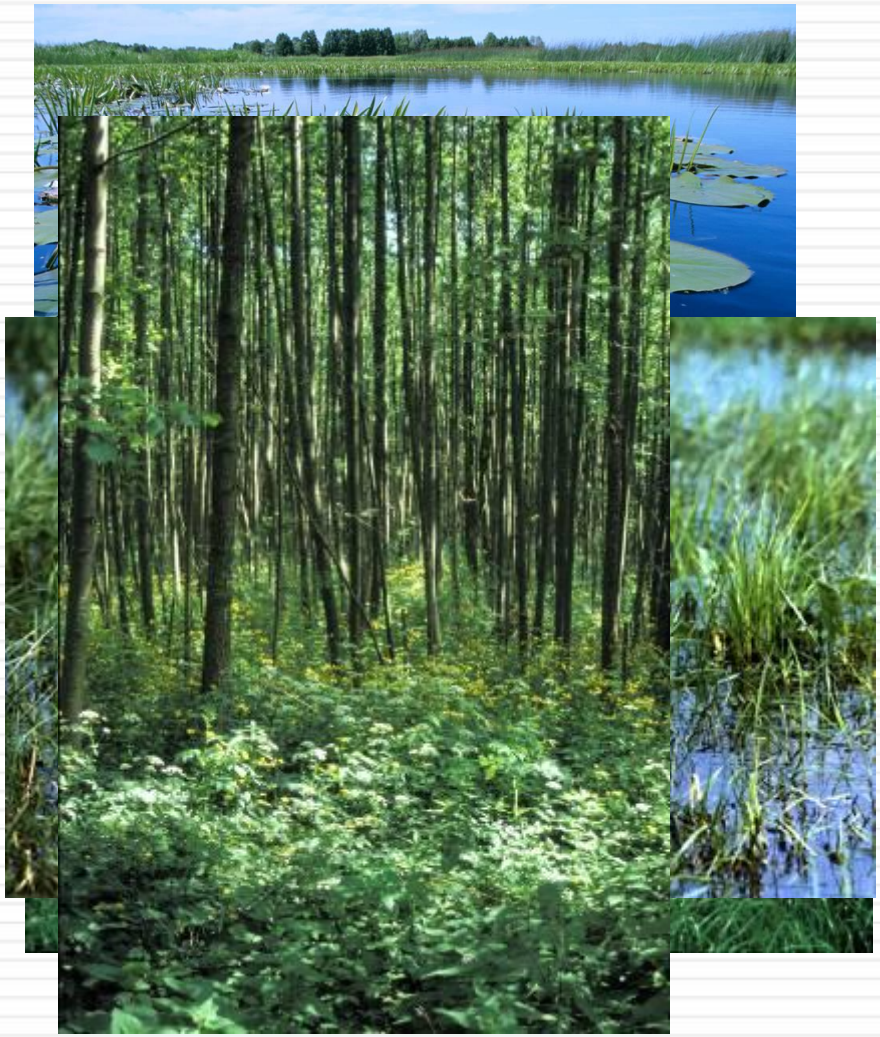
RMSE=6.89m^3/s
Qmax=200m^3/s
Qmin=18.6m^3/s
R^2=0.987

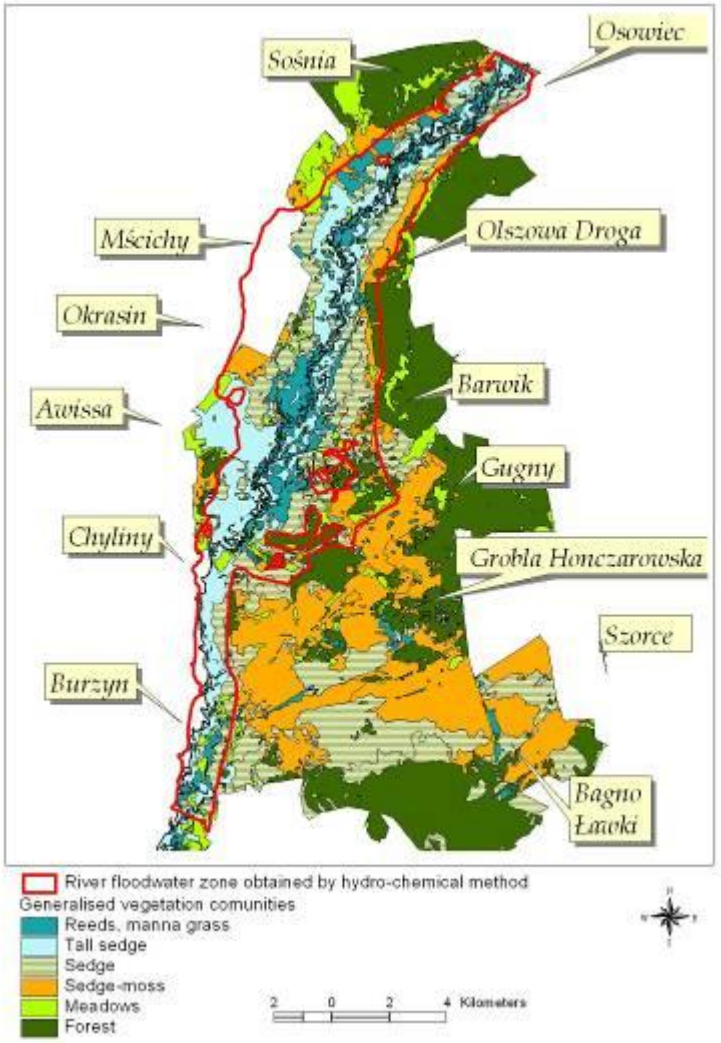


RMSE=0.12m

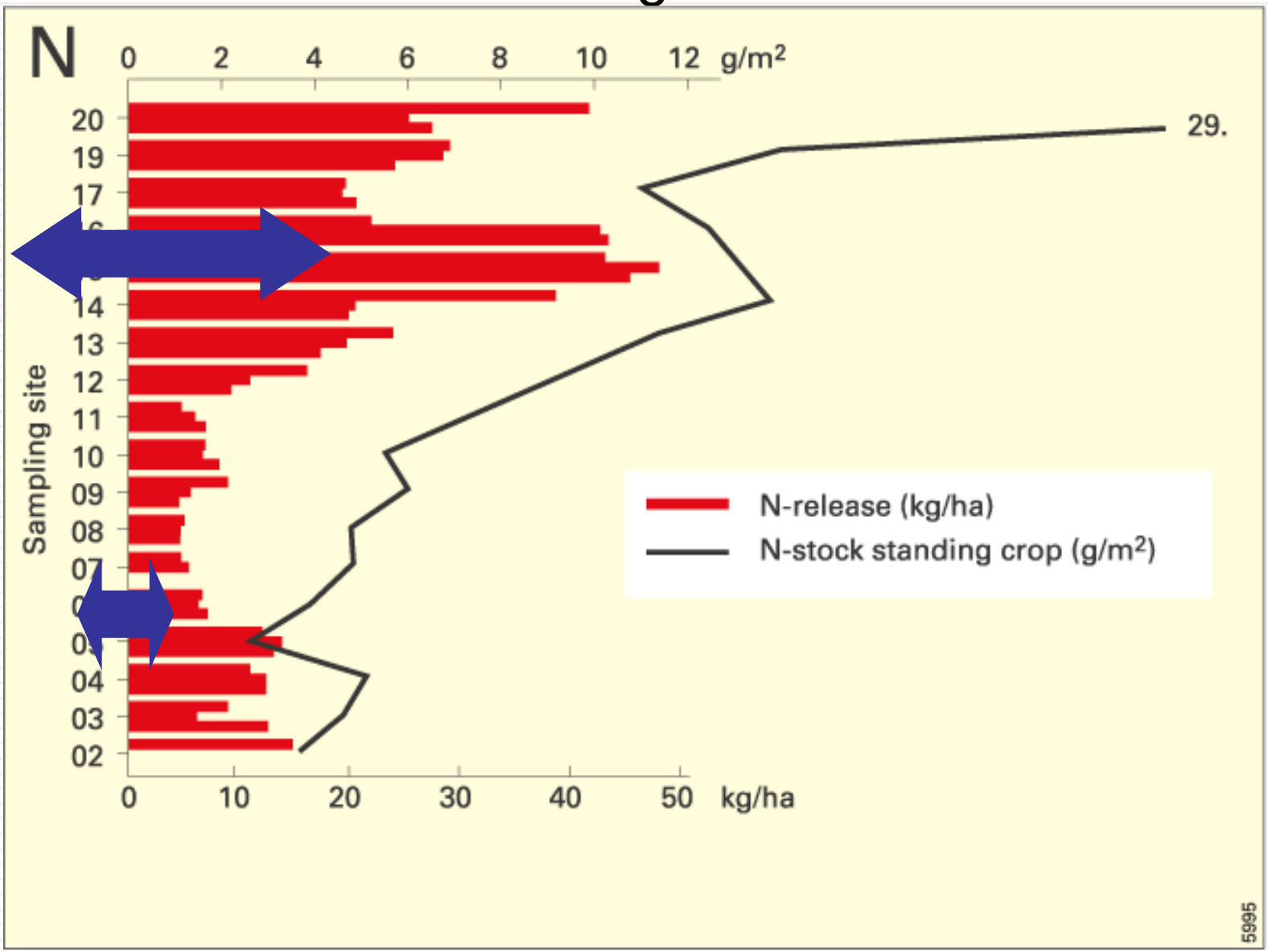


RMSE=0.22m



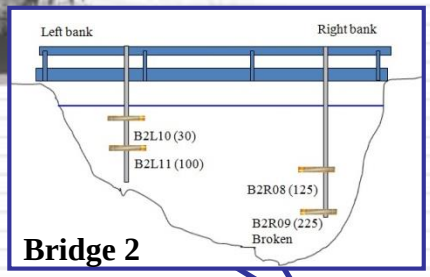

Osowiec
Sośnia
Olszowa Droga
Mścichy
Okrasin
Barwik
Awissa
Gugny
Chyliny
Grobla Honczarowska
Szorce
Burzyn
Bagno Ławki
River floodwater zone obtained by hydro-chemical method
Generalised vegetation comunities
Reeds, manna grass
Tall sedge
Sedge
Sedge-moss
Meadows
Forest
2 0 2 4 Kilometers

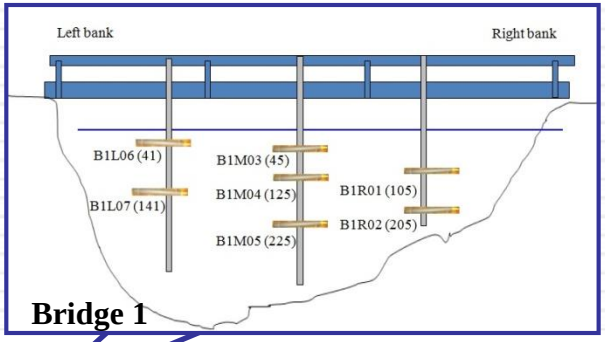
Water level dynamics, N-release and N-uptake in vegetation

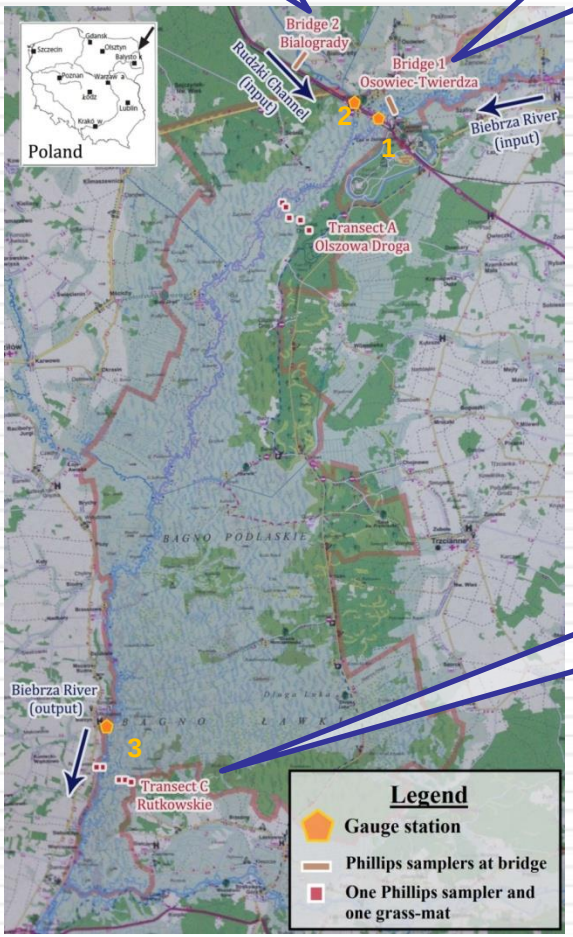


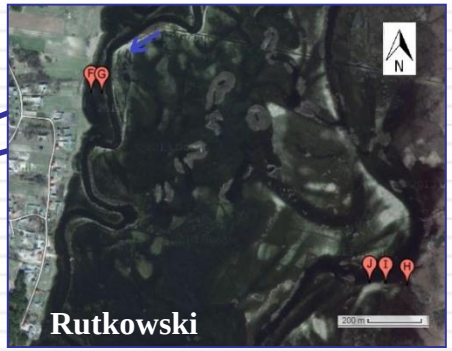
Wassen et al, Plant Ecology, 2003

	Sink/source	Spatial variation
Dissolved	Existing data Gauge stations 1993- 2009	5 Inundation water samples Olszowa Droga
Particulate	Inflow: Phillips samplers at bridges Outflow: next to river Rutkowski	5 Phillips samplers and grass-mats Olszowa Droga









Keizer et al, Ecological Engineering, 2014

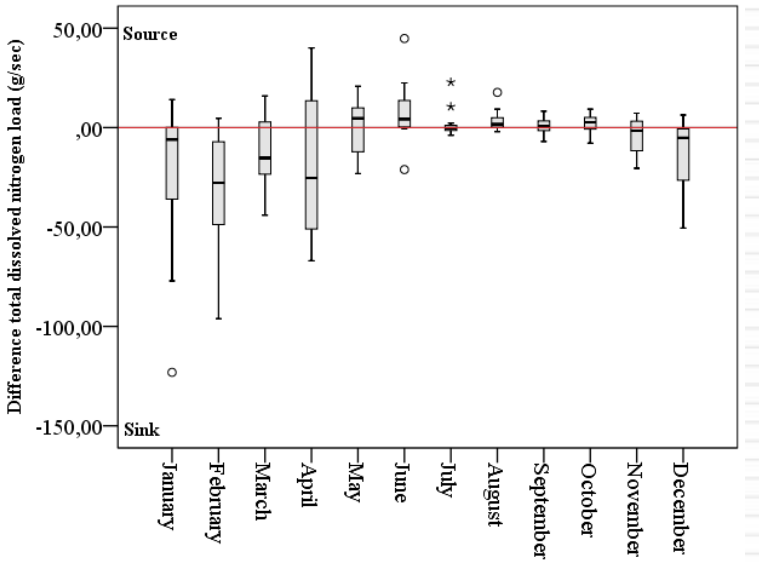
1. Biebrza-Osowiec; 2. Rudzki-Osowiec; 3. Biebrza-Burzyn

Installation Phillips samplers and grass-mats

Collection at bridge

Collection Phillips samplers and grass-mats

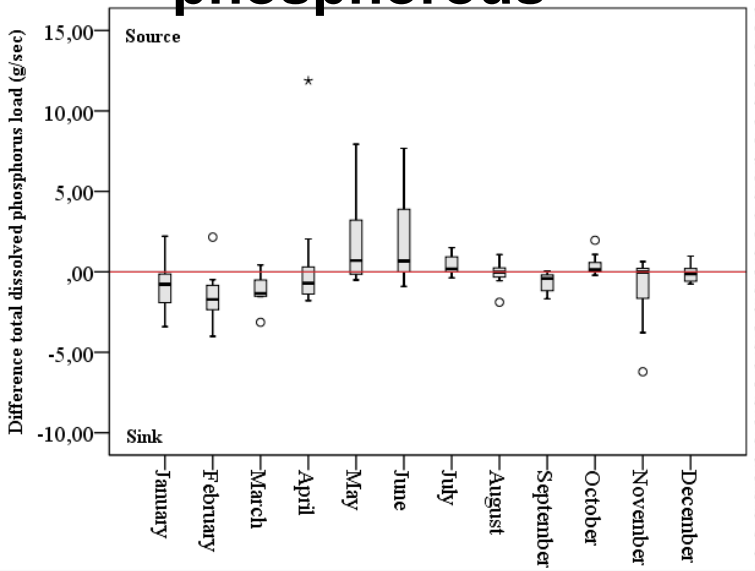
Dissolved nitrogen



Significant sink

- -7,52g.sec^{-1}
- P= 0.037

Dissolved phosphorous

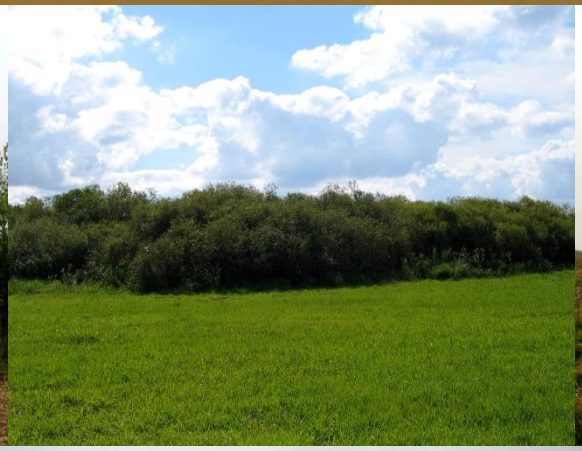
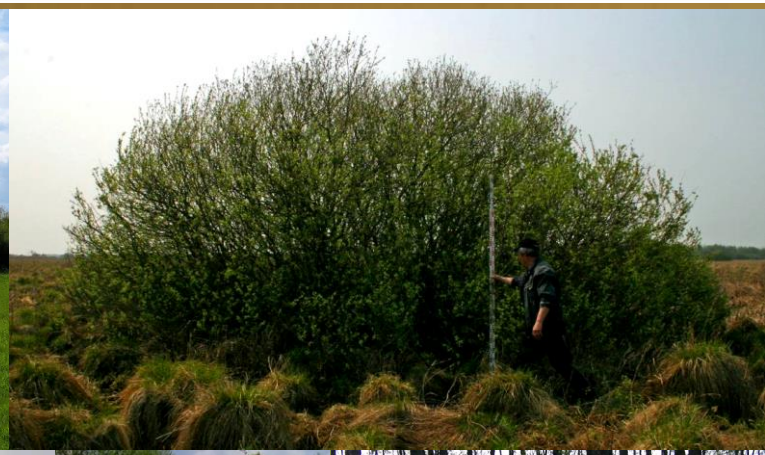


Neither sink nor source

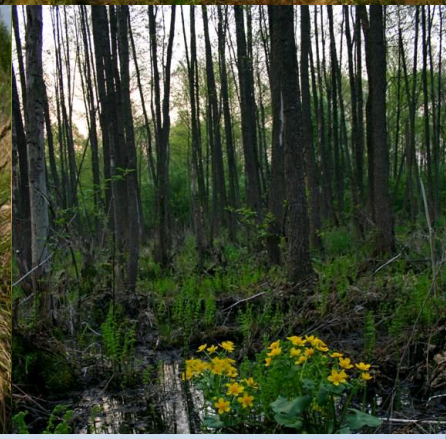
- 0.01g.sec^{-1}
- P= 0.124

Universiteit Utrecht

Vegetation of the riparian wetlands – other perspective

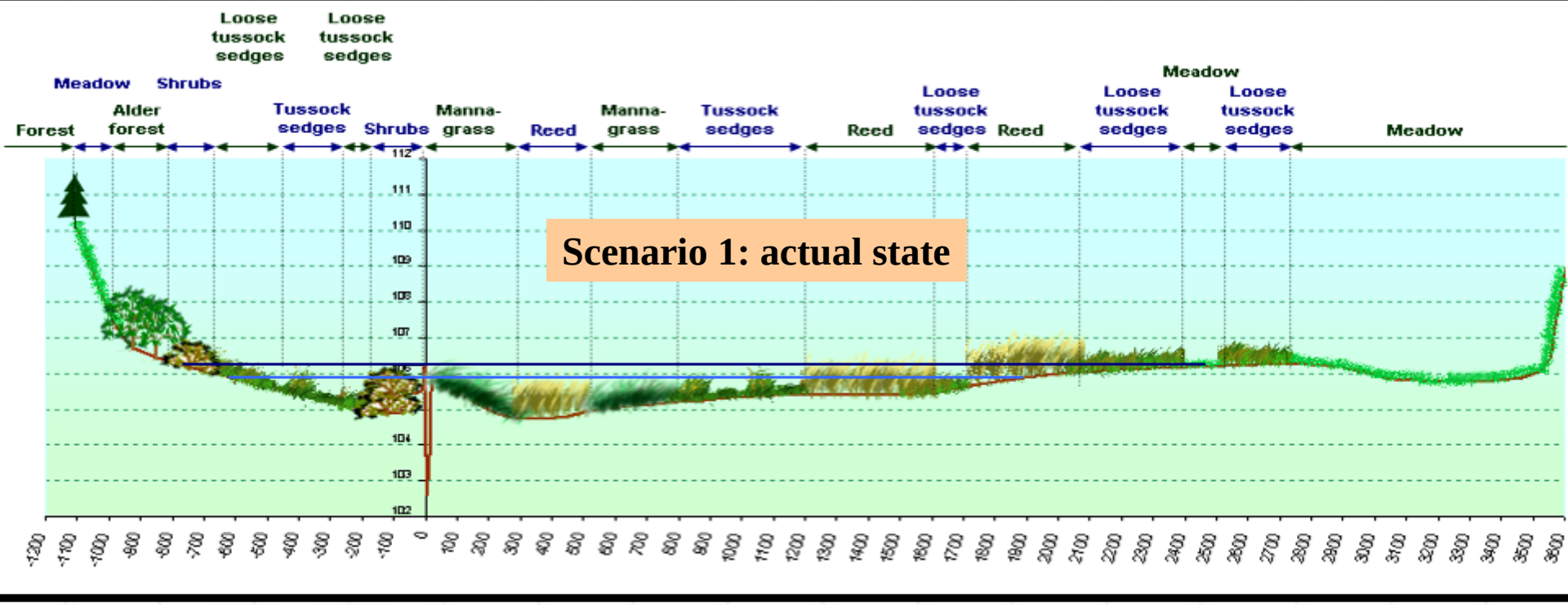


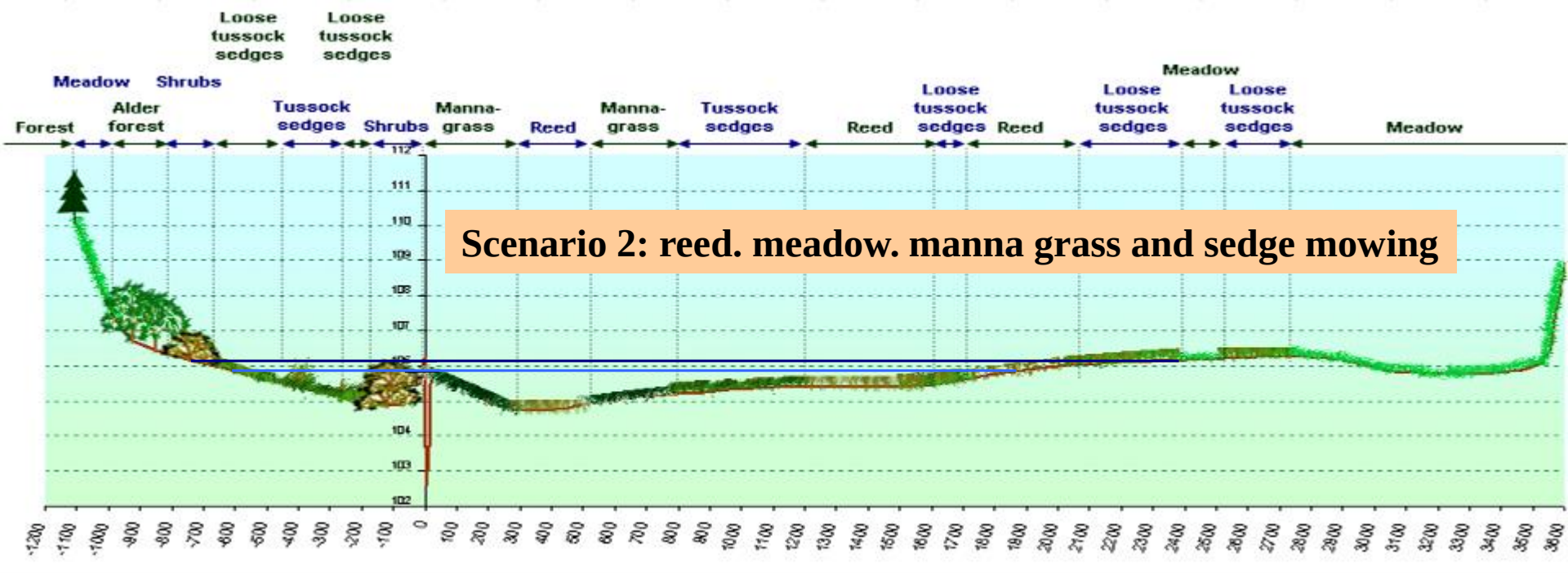


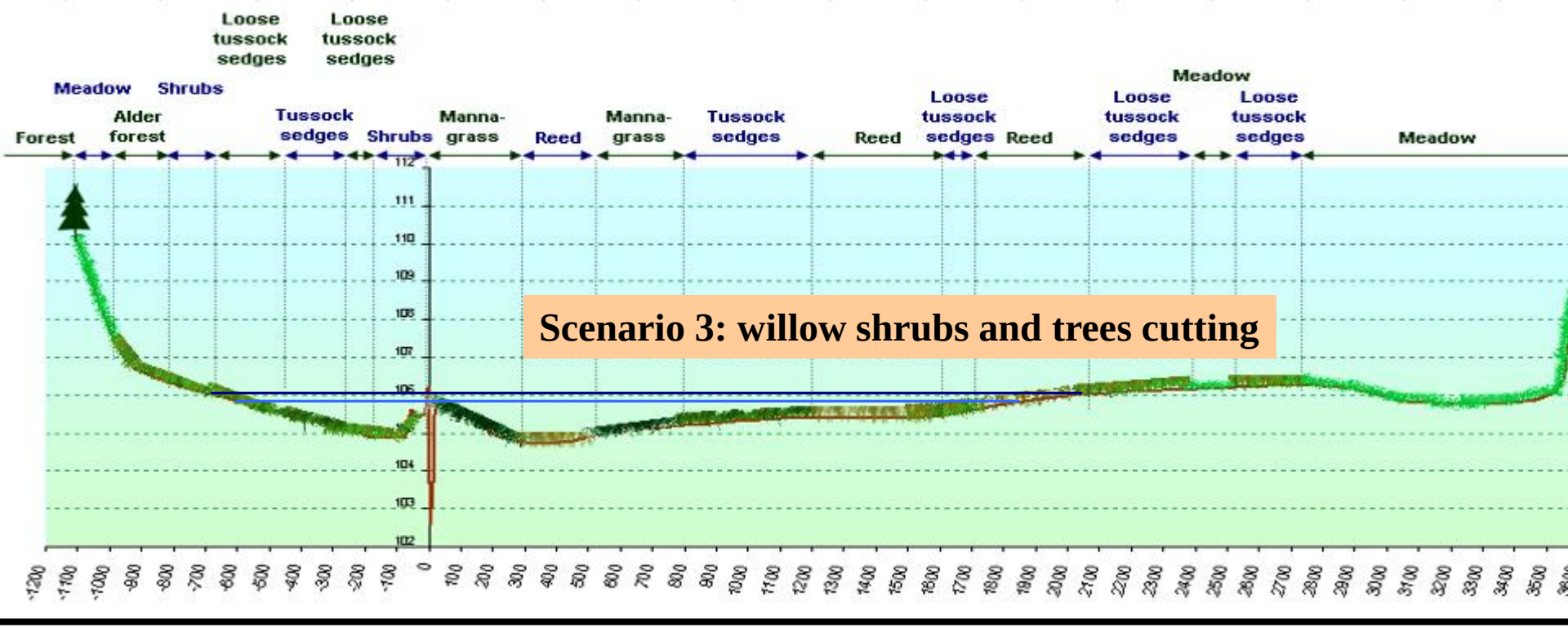


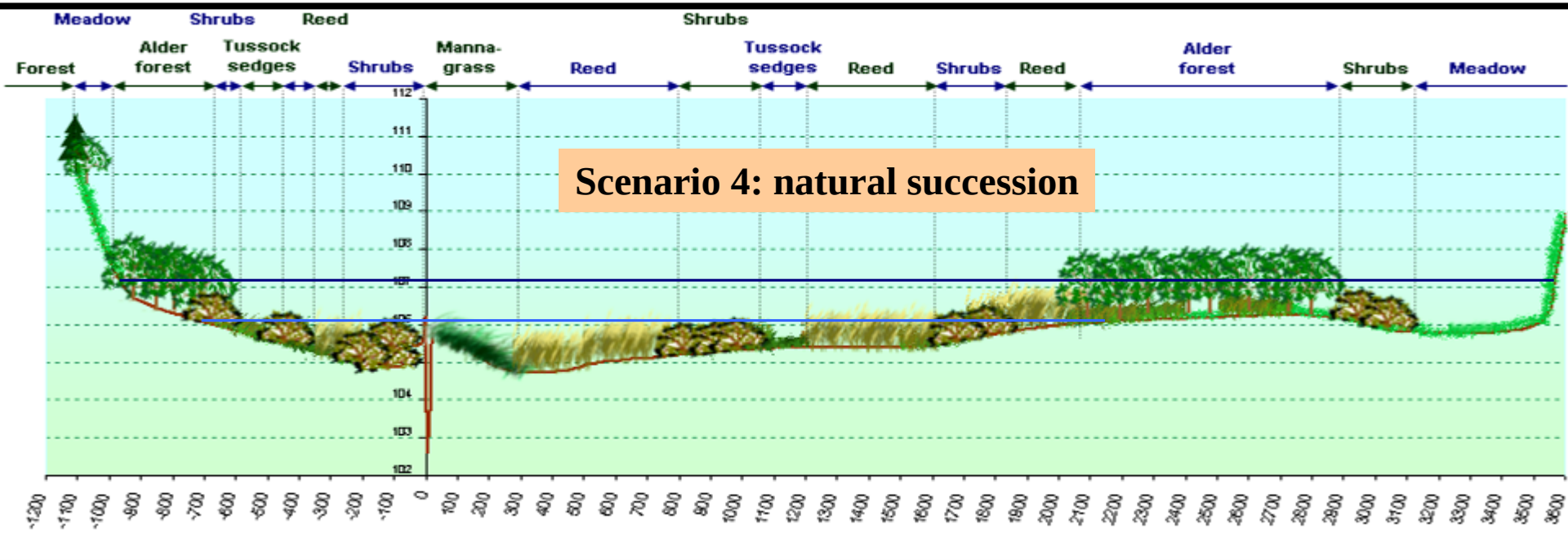
Changes of hydraulic properties in time and space

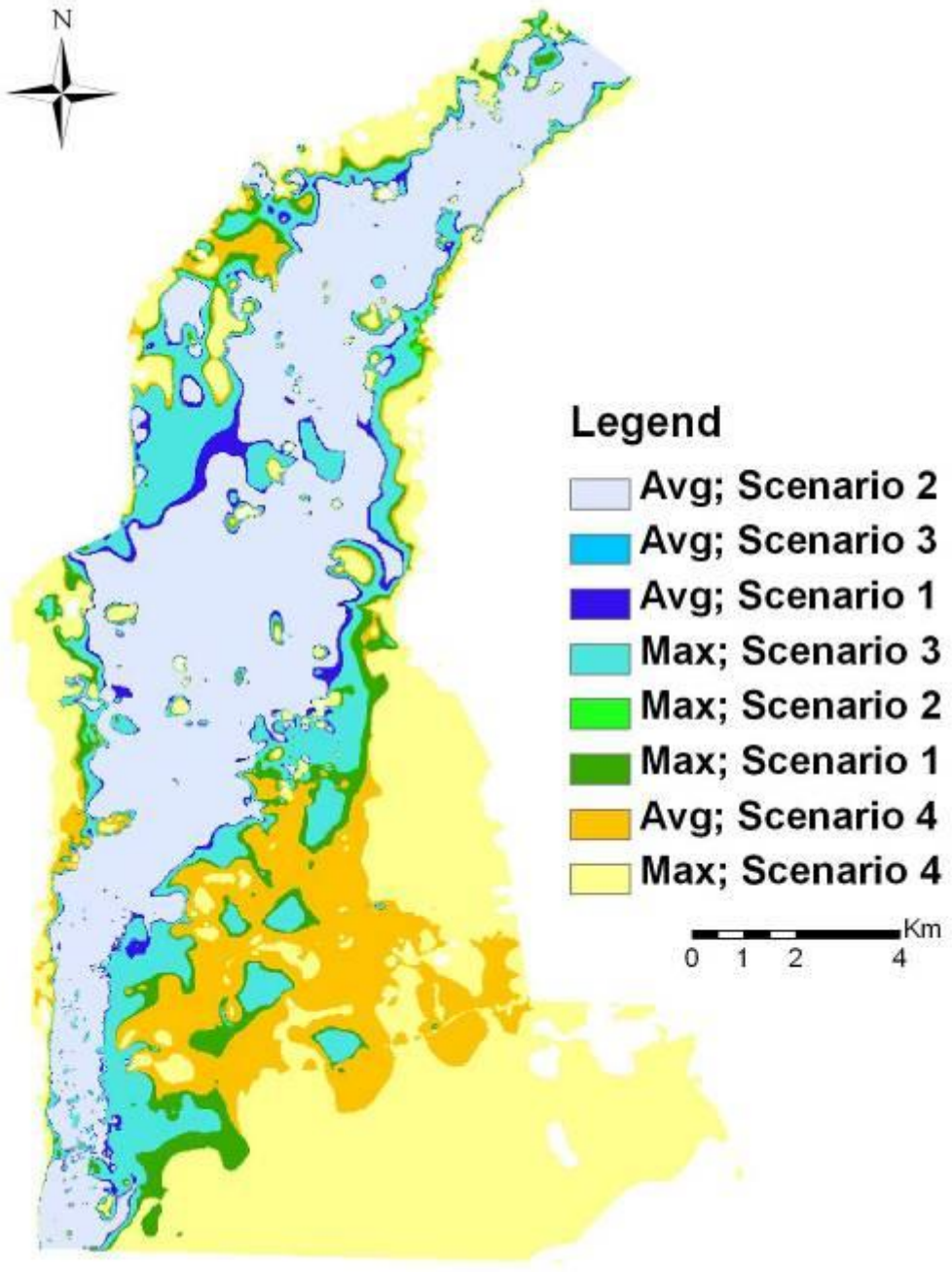
Vegetation type	Roughness height k_s [m]		
	during vegetation period		beyond vegetation period
	no activity	active protection	no activity
Grasses	0.5	0.1	0.3
Grasses and loose tussock sedges mosaic	0.6	0.1	0.4
Loose tussock sedges	0.6	0.15	0.4
Loose and compact tussock sedges mosaic	0.6-1.2	0.2	0.5
Compact tussock sedges	1.2	1.2	0.5
Reed	1.2	0.2	1.2
Glycerietum maximae	0.6-1.2	0.2	0.4
Phalaridetum arundinaceae	0.6-1.2	0.2	0.4
Willow shrubs	0.4	0.4	0.4
Swampy birch forest	0.8-1.6	-	0.8
Black alder forest	0.8-1.6	-	0.8
Deciduous or coniferous tall forest	0.4	-	0.3


Loose tussock sedges
Loose tussock sedges
Meadow
Shrubs
Forest
Alder forest
Tussock sedges
Shrubs
Manna-grass
Reed
Manna-grass
Tussock sedges
Reed
Loose tussock sedges
Reed
Loose tussock sedges
Meadow
Loose tussock sedges
Meadow
Scenario 1: actual state


Loose tussock sedges
Loose tussock sedges
Meadow
Shrubs
Forest
Alder forest
Tussock sedges
Shrubs
Manna-grass
Reed
Manna-grass
Tussock sedges
Reed
Loose tussock sedges
Reed
Loose tussock sedges
Meadow
Loose tussock sedges
Meadow
Scenario 2: reed. meadow. manna grass and sedge mowing


Loose tussock sedges
Loose tussock sedges
Meadow
Shrubs
Meadow
Forest
Alder forest
Tussock sedges
Shrubs
Manna-grass
Reed
Manna-grass
Tussock sedges
Reed
Loose tussock sedges
Reed
Loose tussock sedges
Loose tussock sedges
Meadow
Scenario 3: willow shrubs and trees cutting


Meadow
Shrubs
Reed
Shrubs
Forest
Alder forest
Tussock sedges
Shrubs
Manna-grass
Reed
Tussock sedges
Reed
Shrubs
Reed
Alder forest
Shrubs
Meadow
Scenario 4: natural succession



Variation of the flooded area and the water depth on the floodplain for different land use scenarios (MAX Q=229.20 m3/s. AVG Q=70.51 m3/s).

No Sc	Flooded area[km^2]	Average depth[m]	Flow condition
1	93.29	0.65	MAX
2	83.84	0.61	MAX
3	83.21	0.60	MAX
4	179.55	1.44	MAX
1	61.35	0.49	AVG
2	56.54	0.46	AVG
3	56.27	0.45	AVG
4	113.74	0.68	AVG

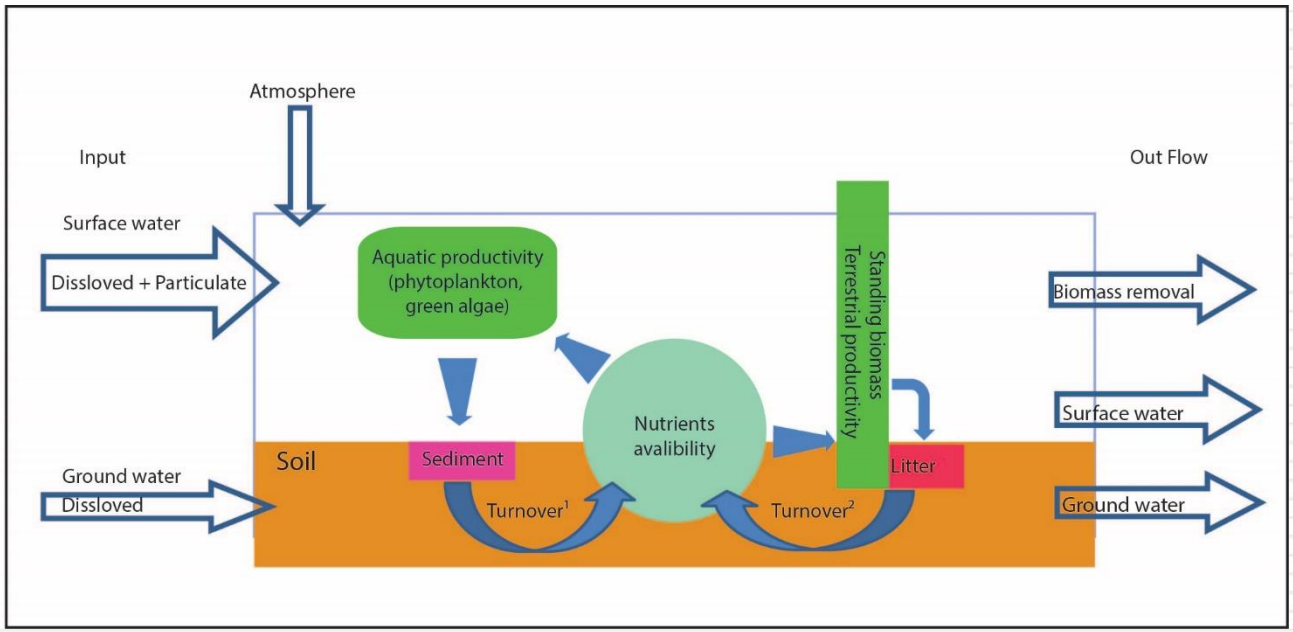
Conclusions 1

- Inundation often results from interaction of water from different sources (atmosphere, river and groundwater);
- Water sources, floodplain processes and vegetation are interacting;
- In our long term models we should incorporate also vegetation dynamics;
- Comparison of different systems will give us crucial novel insights.

Conclusions 2 and perspectives

- Scientific relevance: Rivers and floodplains are exciting dynamic eco-hydrological systems
- *Societal relevance: floodplains provide important ecosystem services but are threatened globally*
- Ecological and hydrological processes in floodplains operate on various temporal and spatial scales
- Analyzing these processes in rivers and floodplains and linking them to catchment hydrology provides policy support for water management and land use planning
- Combination of measuring and modeling is important
- Needed: standardized methodology applied to rivers across the globe

Conceptual model for analyzing nutrient budgets in river floodplains



- Input of external nutrients
  - Surface water (dissolved + particulate)
  - Ground water
  - Atmospheric deposition
- Internal process and exchange
  - During flood period
  - During dry period
- Out flow of the nutrients from the system
  - Biomass removal
  - Surface water
  - Ground water

Ławki marsh, Biebrza Lower Basin, 18 June 2006, 4 a.m.

Short-cut study

Aims of the study – using existing pre- and post- disturbance data on flow and vegetation:

- Assessment of threshold flow (overbank) which still impacts habitat
- Identify possible trajectories of floodplain vegetation change
- Strengthening of arguments for flood pulse ecosystem protection.

Some assumptions:

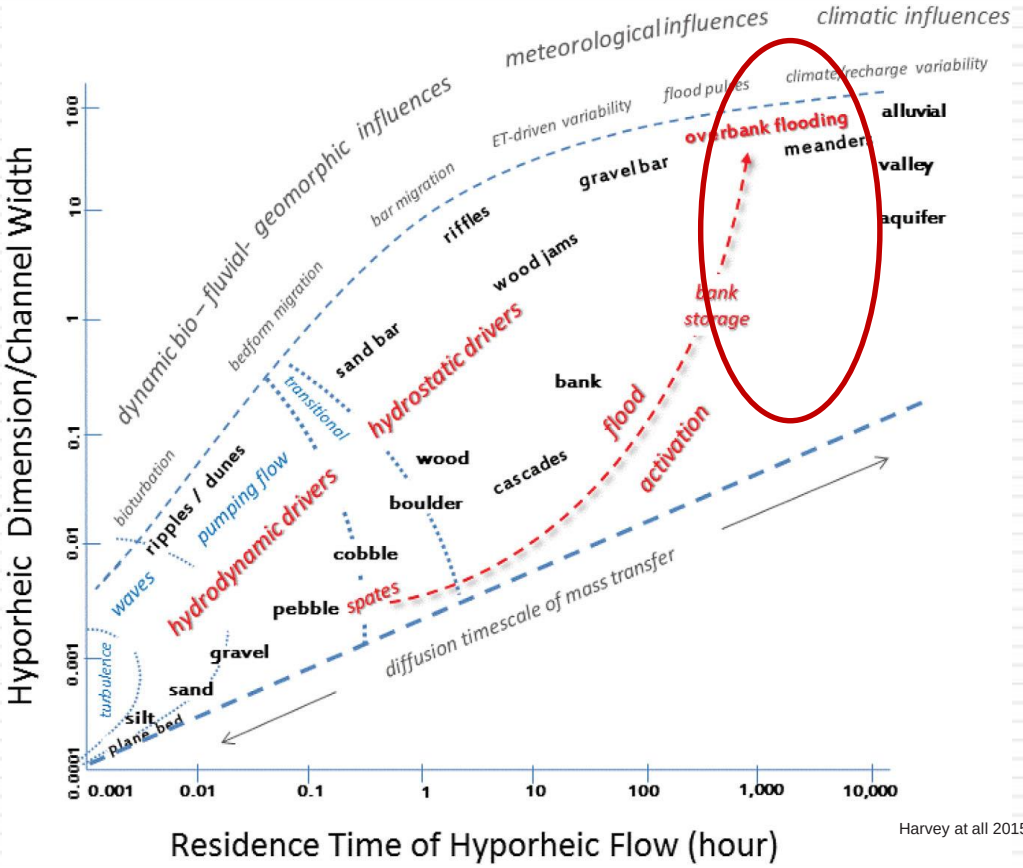
- Data driven study – so extension of scientific questions depends on # and diversity of cases,
- Flood pulse should be smaller but existing, so semi-natural conditions still observed,
- Two observation periods min. 10 years for flow changies calculations and vegetation observations,
- Flow data in the floodplain or in the short distance allowing for extrapolation,
- Vegetation data on the level – for trajectory…

Variant	Flow	Groundwater	Humans	Vegetation	Remarks
0	Q	GQ	HP	FV	historical
1	Q’	GQ	HP	FV1	
2	Q’	GQ’	HP	FV2	
3	Q	GQ	HP’	FV3	change of land use
4	Q’	GQ’	HP’	FV4	
5	Q’	GQ’	HP’	FV5	

	Primary variable	Addtiional	Measure of change
Q	Omax, Q10, Tin	Cumulative freequency curve	% of change, deviation
GQ	Average in mm	Groundwater use from aquifer	% of change
HP	Area and kind of		descriptive
FV	Map of…?		

Other variables to describe change

River Connectivity Index (RCI) $DCI_P = \sum_{i=1}^{n} \frac{v_i^2}{V^2} * 100$	The size of disconnected river fragments between dams in relation to the total size of the original river network, based on Cote *et al.* (2009) DCI; size can be described in terms of volume (example at left), length, or other variables	Grill *et al.*, 2014



Harvey at all 2015, Boano et al., 2014,

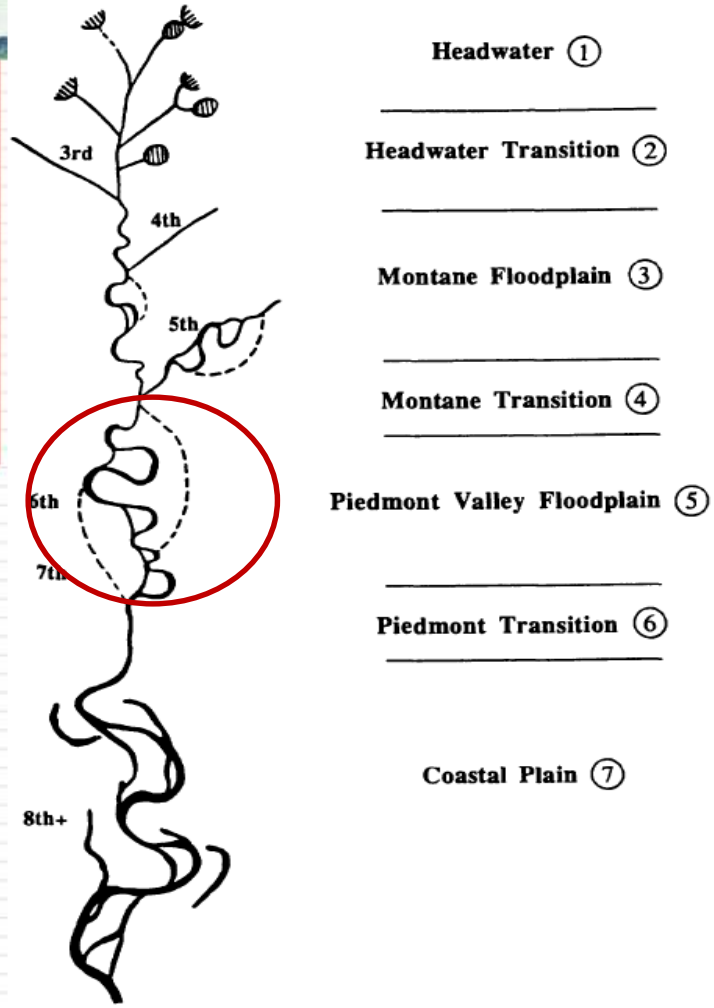
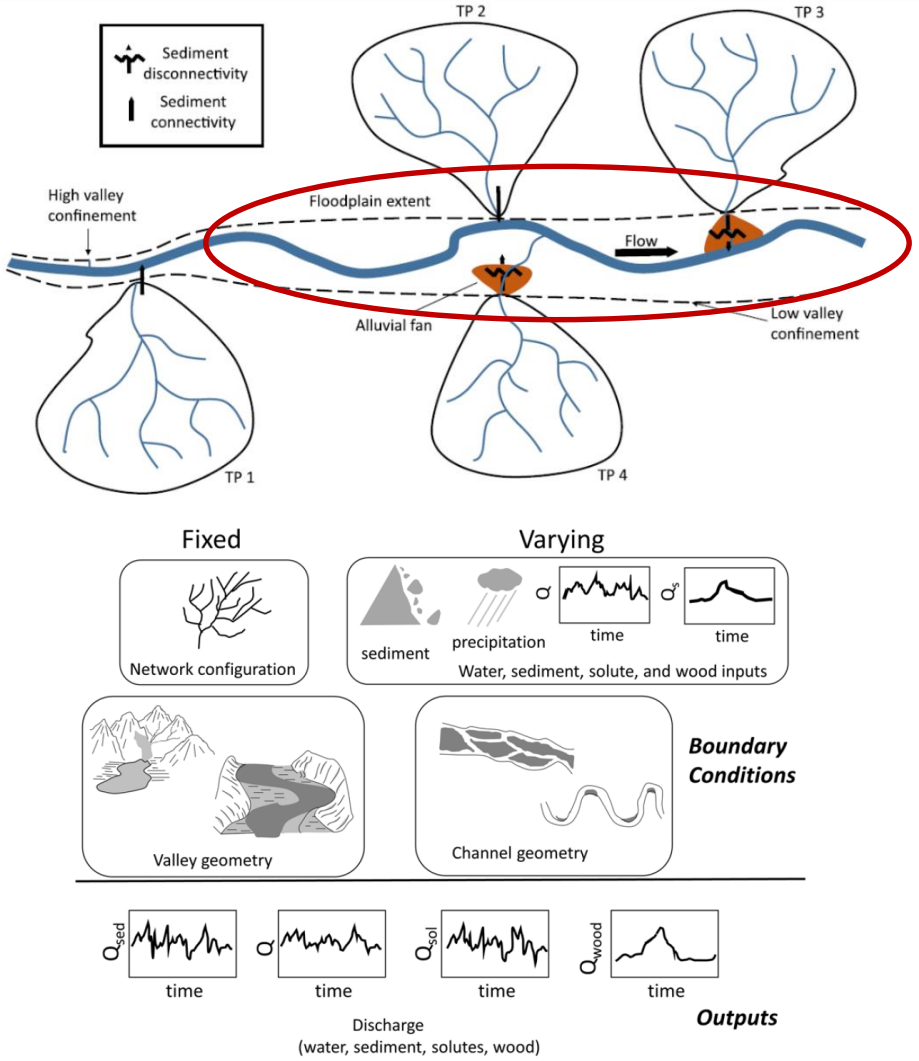


FIG. 5. The hyporheic corridor of the river continuum. Strahler stream orders (3rd–8th+) are shown; circled numbers relate major features in Figs. 5 and 6.



An Ecosystem Perspective of Alluvial Rivers: Connectivity and the Hyporheic Corridor
Author(s): Jack A. Stanford and J. V. Ward
Source: Journal of the North American Benthological Society, Vol. 12, No. 1 (Mar., 1993), pp. 48-60

EARTH SURFACE PROCESSES AND LANDFORMS
Earth Surf. Process. Landforms **44**, 4–26 (2019)

Result

- Aiming on paper „ Flood pulse study – European wide assessment of its impact on floodplain vegetation”

- 1year – so need for existing study & data,
- My guess – 15+ cases could make the job (depends on heterogeneity of sites)

- If discussion positive to be presented in Thessaloniki