



United Nations  
Educational, Scientific and  
Cultural Organization



European Regional  
Centre for Ecohydrology  
Under the auspices  
of UNESCO



POLISH ACADEMY of SCIENCES

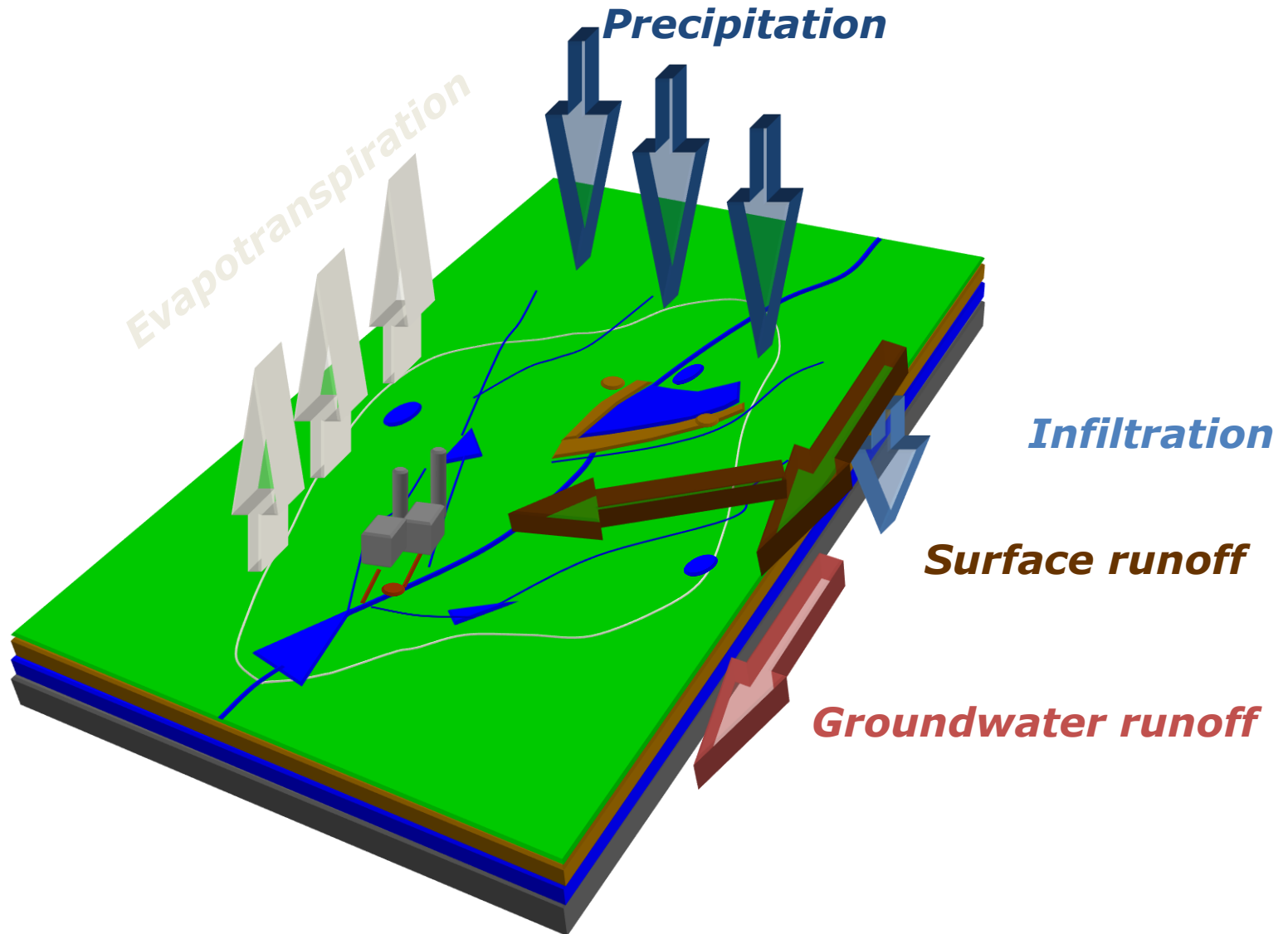


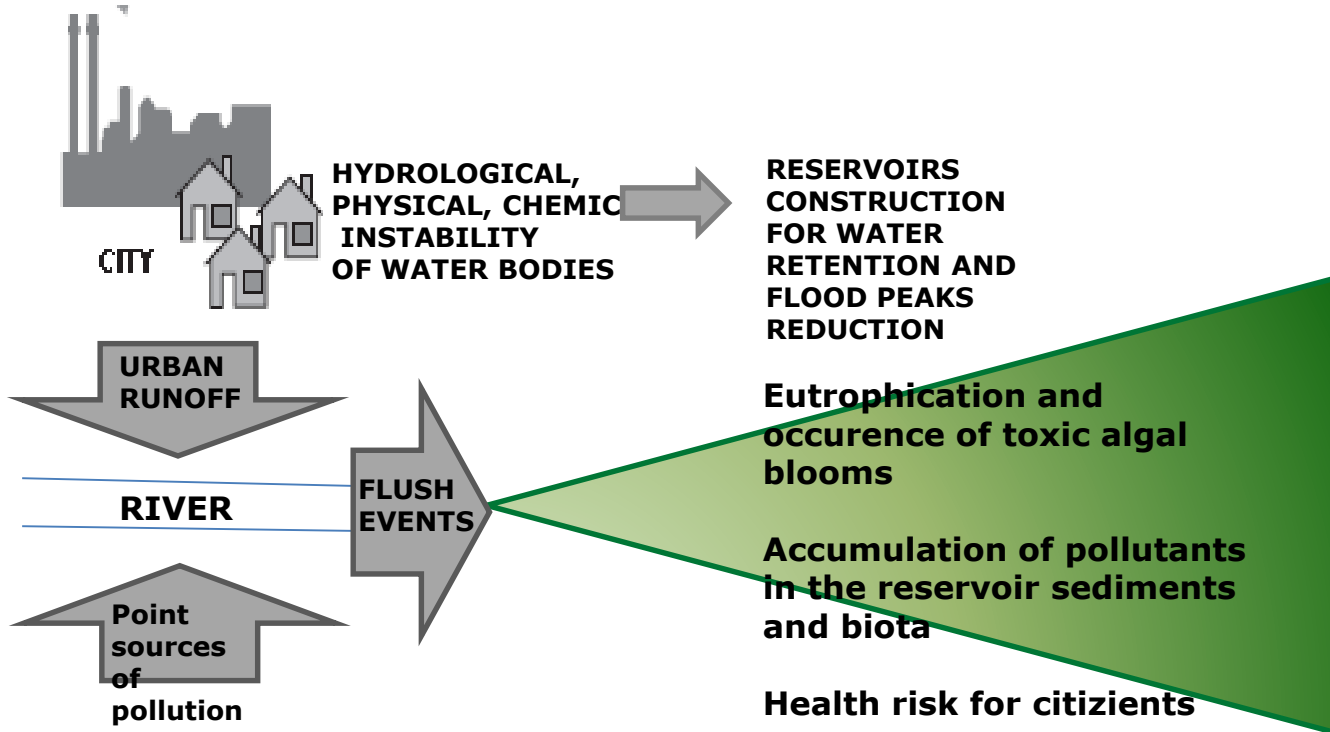
Forum Klastra  
Bioenergia dla  
Regionu

# Zastosowanie rozwiązań ekohydrologicznych dla redukcji zagrożeń i poprawy jakości środowiska

**Dr Magdalena Urbaniak**

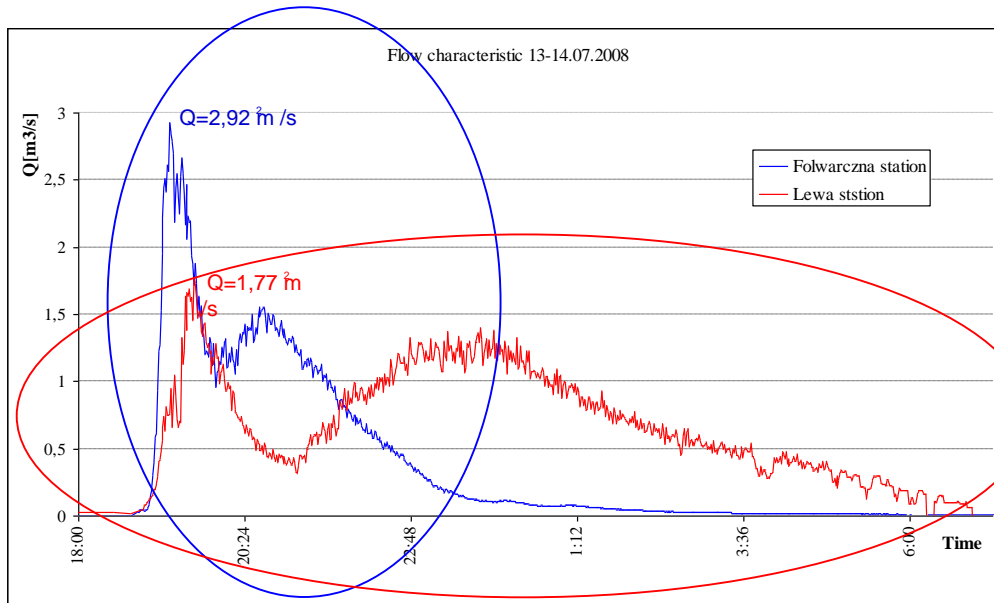
**European Regional Centre for Ecohydrology  
Polish Academy of Sciences**





# RESULTS

## FLOW PEAK CHARACTERISTIC



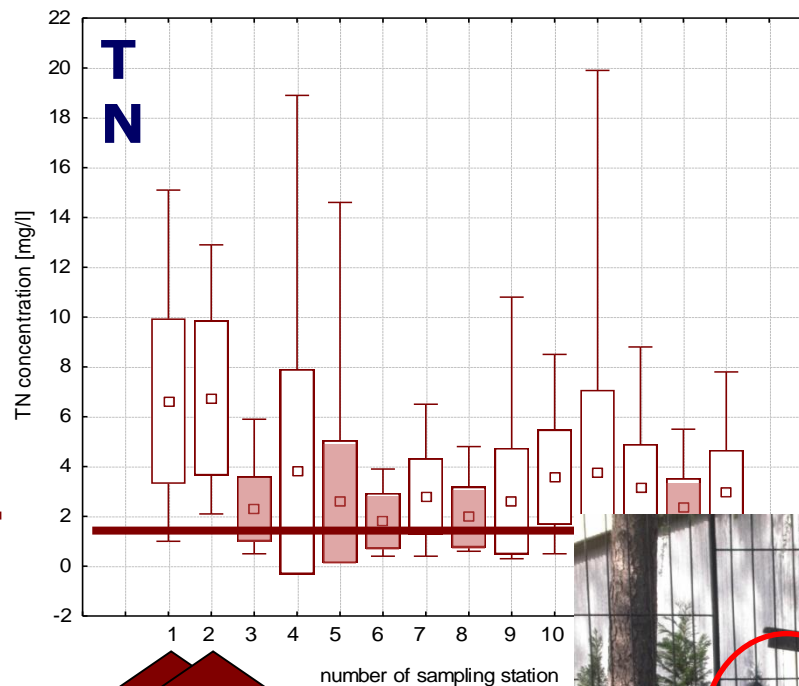
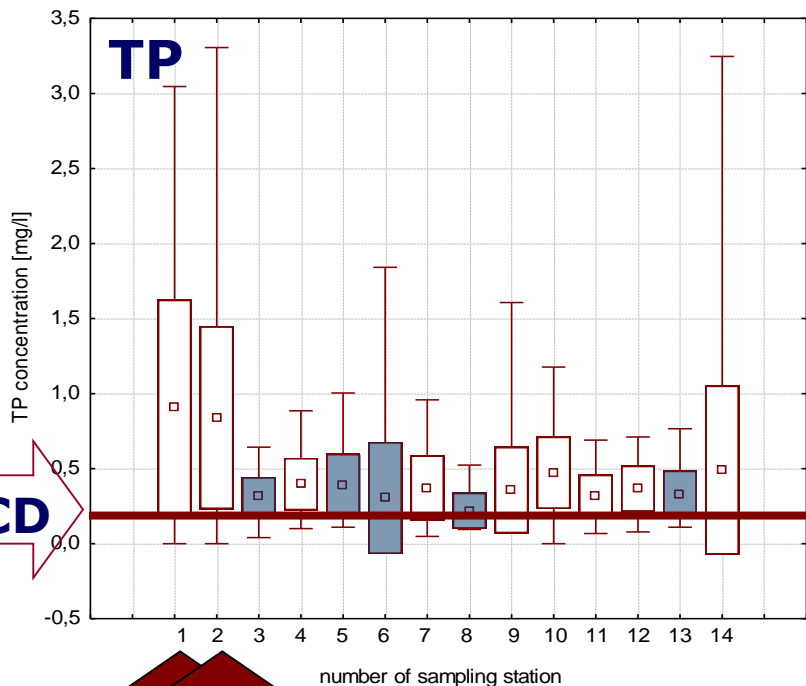
Urban area



Semi natural area

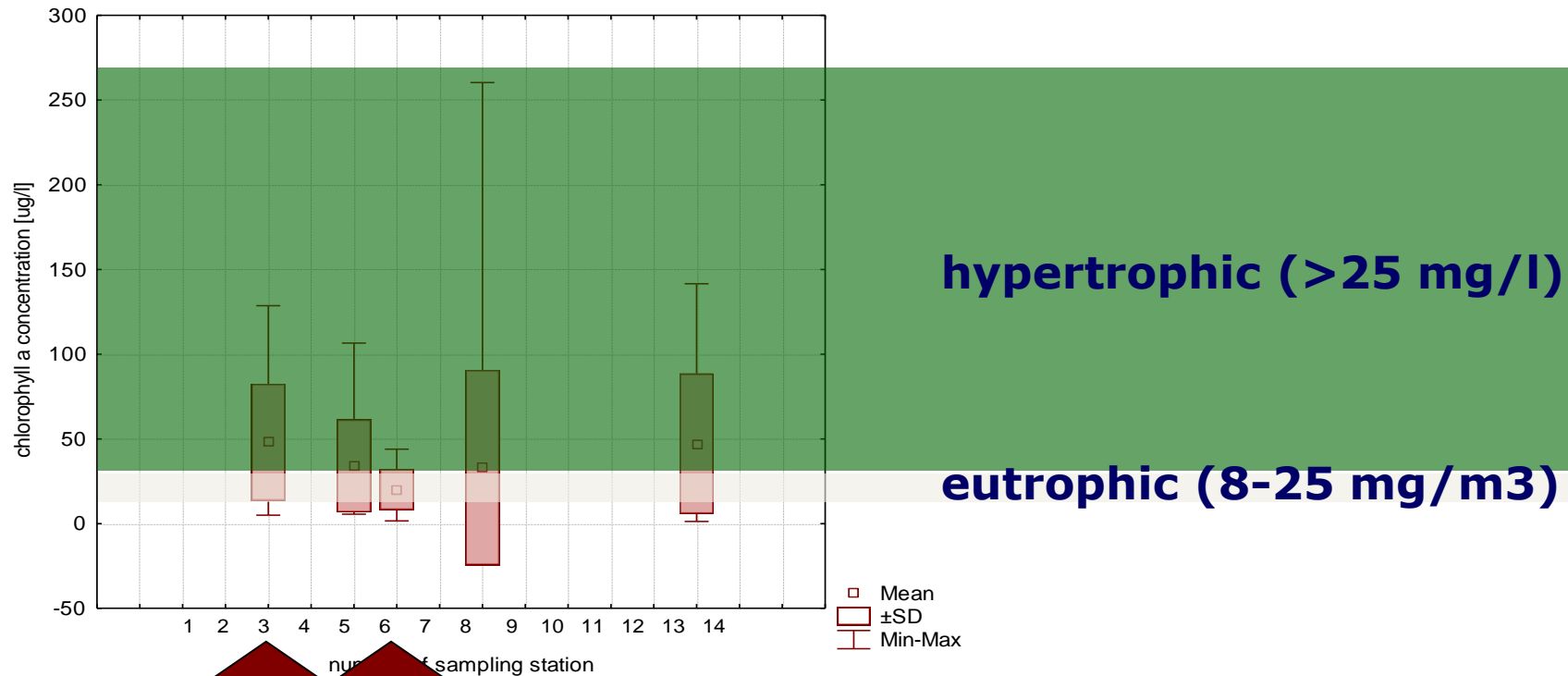
Study site		H	V	Q
		[m]	[m/s]	[m <sup>3</sup> /s]
Folwarczna	min.	0	0	0
	max.	0,9	1,82	<b>2,9</b>
Lewa	min.	0,1	0,02	0,001
	max.	0,6	0,9	<b>1,77</b>

# NUTRIENTS CONCENTRATIONS



septic tank seepage, combined sewer overflows, illegal sewer overflow

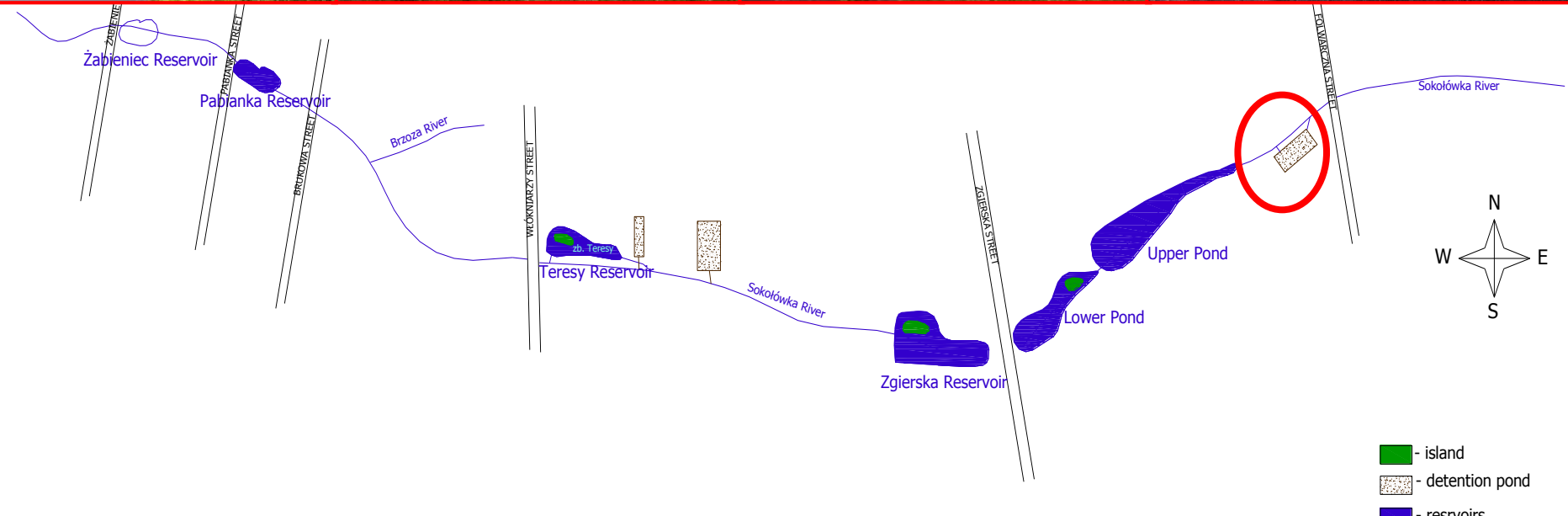
# CHLOROPHYLL *a* CONCENTRATIONS



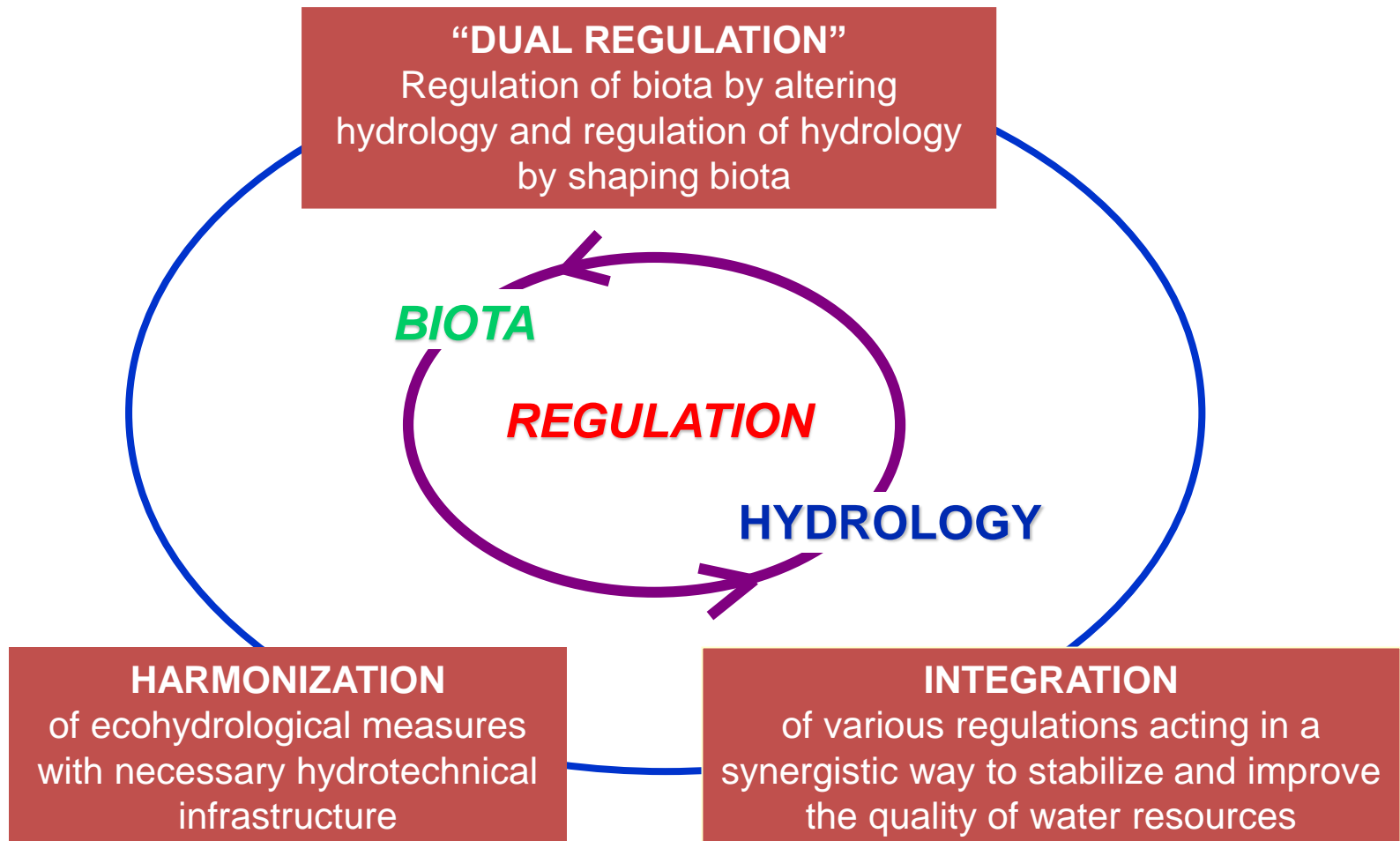
↑ ↑ Nutrients allocation in macrophytes

low isolation (**intermediate complexity concept**)  
 and high zooplankton pressure (**top-down control**)

**2002 - Constructed for protection of reservoirs cascade (sedimentation process only)**



## Ecohydrology – the major body of the theory





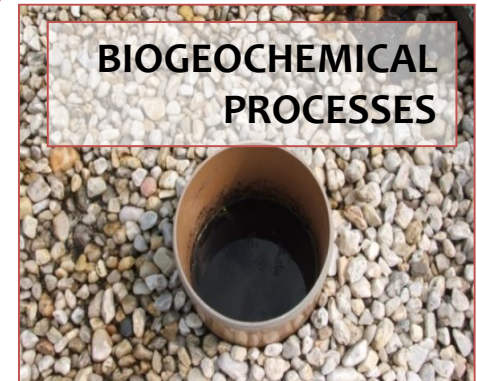
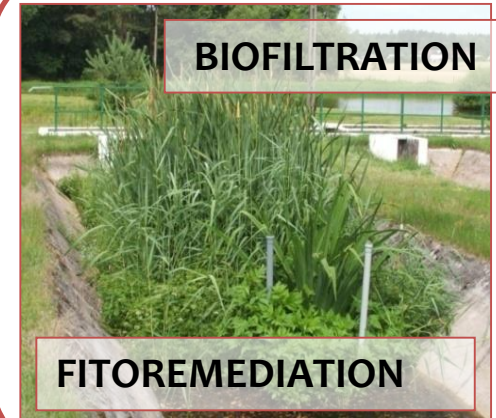
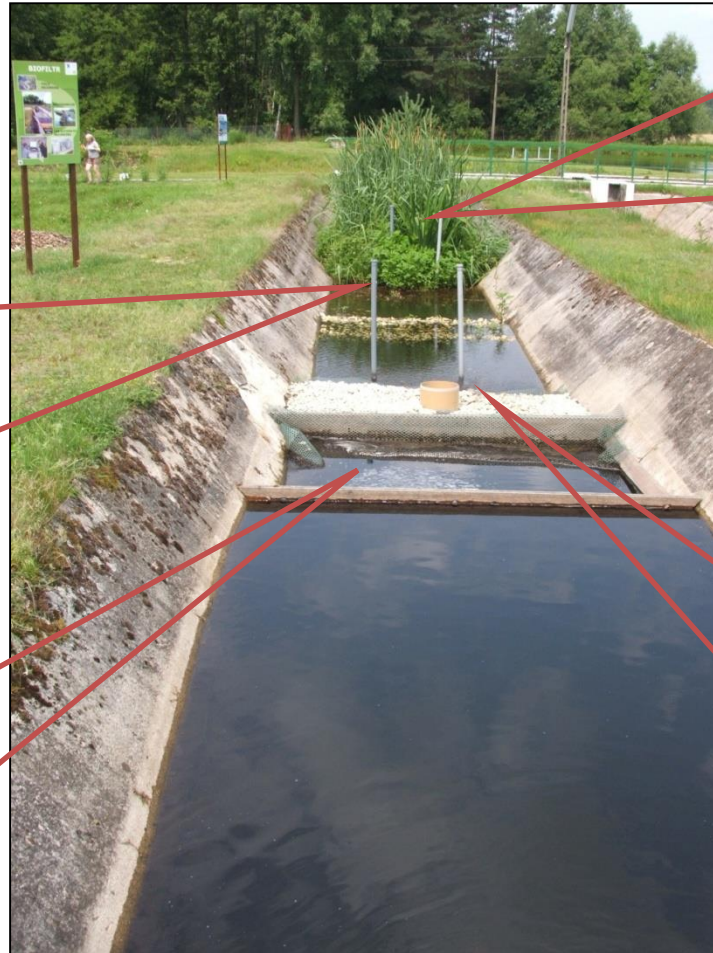


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Oświaty, Nauki i Kultury

Europejskie Regionalne  
Centrum Ekohydrologii  
pod auspicjami UNESCO

# Ecohydrological Biotechnologies

The prototype of the sequential biofiltration system for urban stormwater purification in Tresta



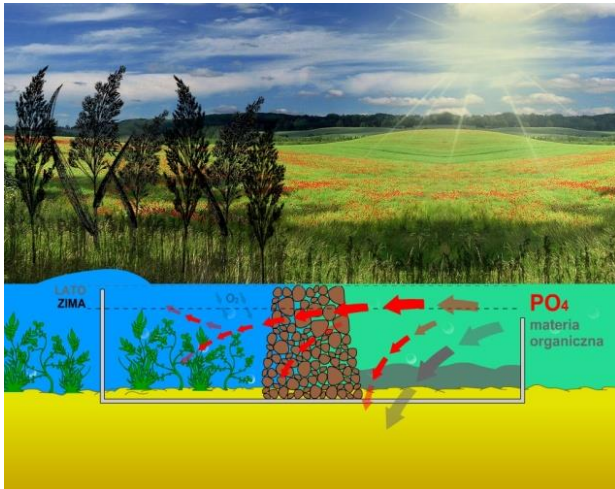
# Detention pond for reservoirs protection



**Present form of the sedimentation pond functioning is not efficient element for prevention of reservoirs cascade on the Sokolowka River**

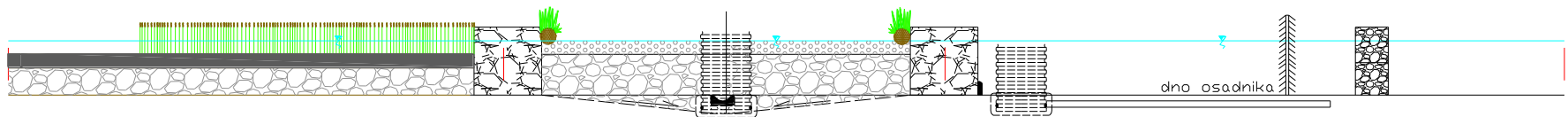
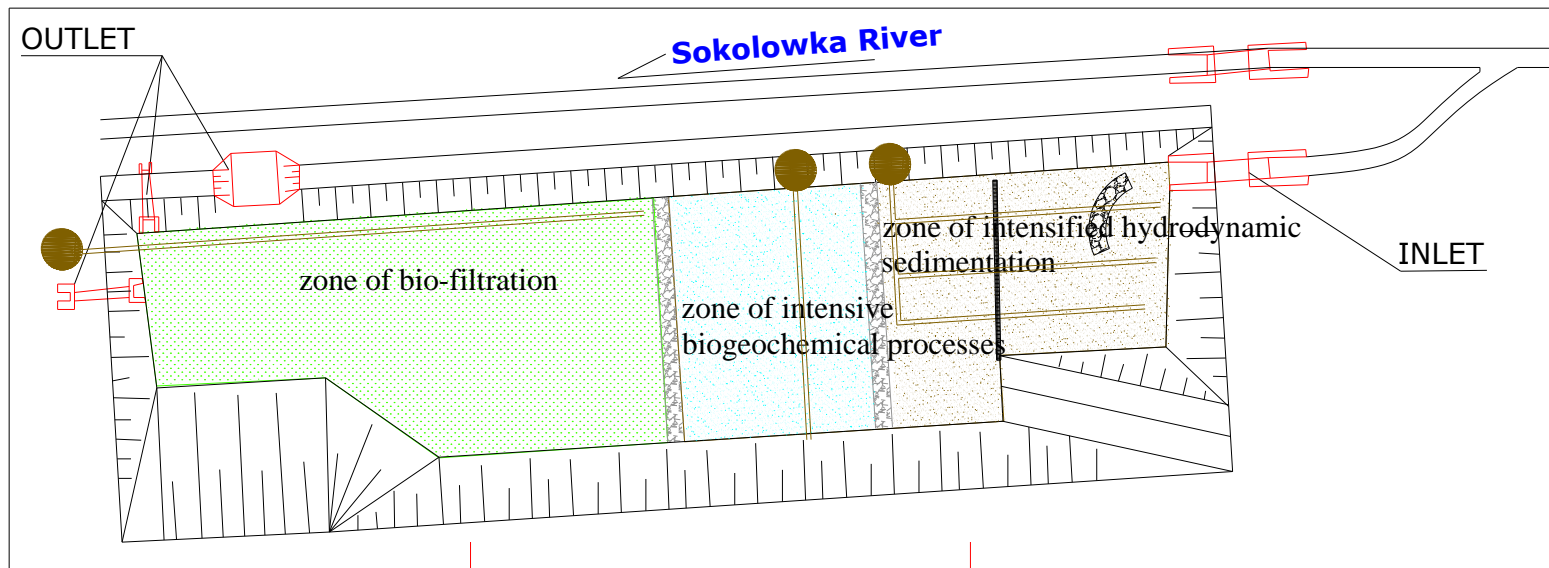


**The new concept of MCBS**



**Achievement of good ecological potential the cascade of reservoirs on the Sokolowka River.**

# Application of Principles of Ecohydrology for Multi-Chamber Sedimentation Biofiltration System (MCSB) in restoration of a municipal river





# The role of biofiltration –sedimentation system in water purification

Stormwater inflow



Suspended matter sedimentation in **sedimentation zone** – anaerobic zone



**Biogeochemical barrier** for reduction of phosphate in water and binding heavy metals with calcium and phosphorus



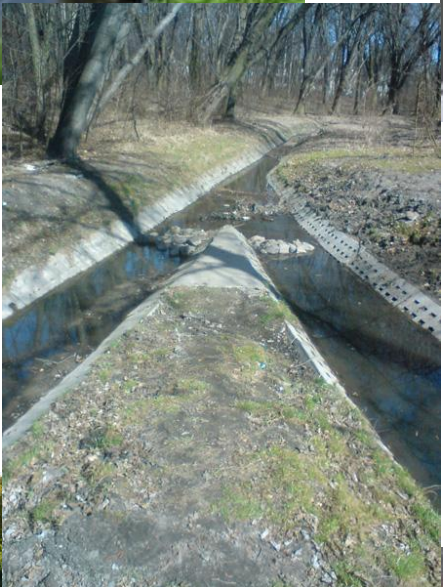
**Biofiltration zone** – assimilation of nitrogen by macrophytes and mineralization processes, phytoremediation and rhizoremediation of micropollutants

The role of biotechnology in enhancement of purification efficiency



**Outflow of purified water**



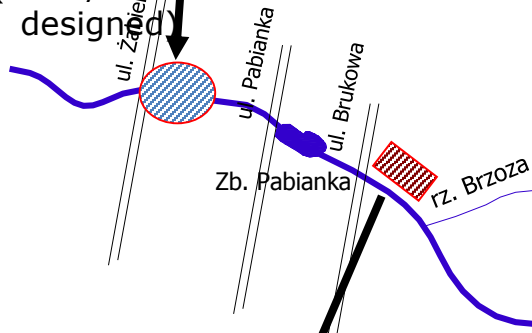




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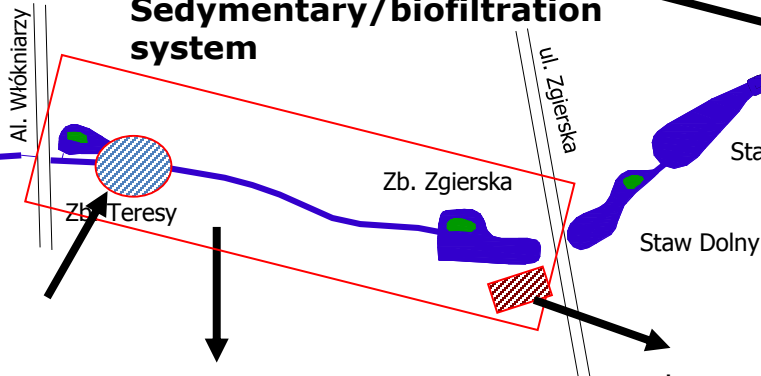
**Żabieniec Reservoir**  
(2008/2009 -  
design)



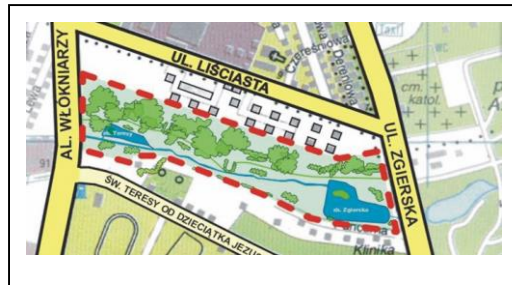
**Tree Development**  
stormwater BMPs and river  
rehabilitation (planned & up-



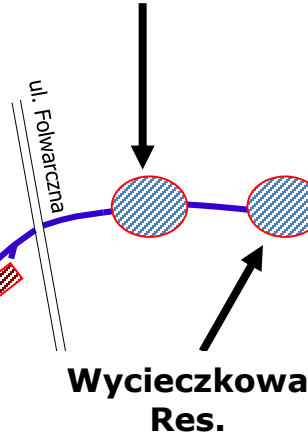
**Sedimentary/biofiltration system**



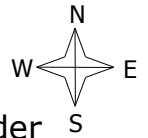
**Park Sokołówki**  
(planning in progress)



**Wasiak Res.**



**Marina**  
stormwater BMPs – under  
construction



# ECOHYDROLOGY –harmonization of hydrotechnical and biological solutions

Construction of buffer zones including biogeochemical barriers as well as construction of floating islands in order to reduce nutrients



Ecohydrological adaptation of the reservoirs in order to intensify the process of water self-purification



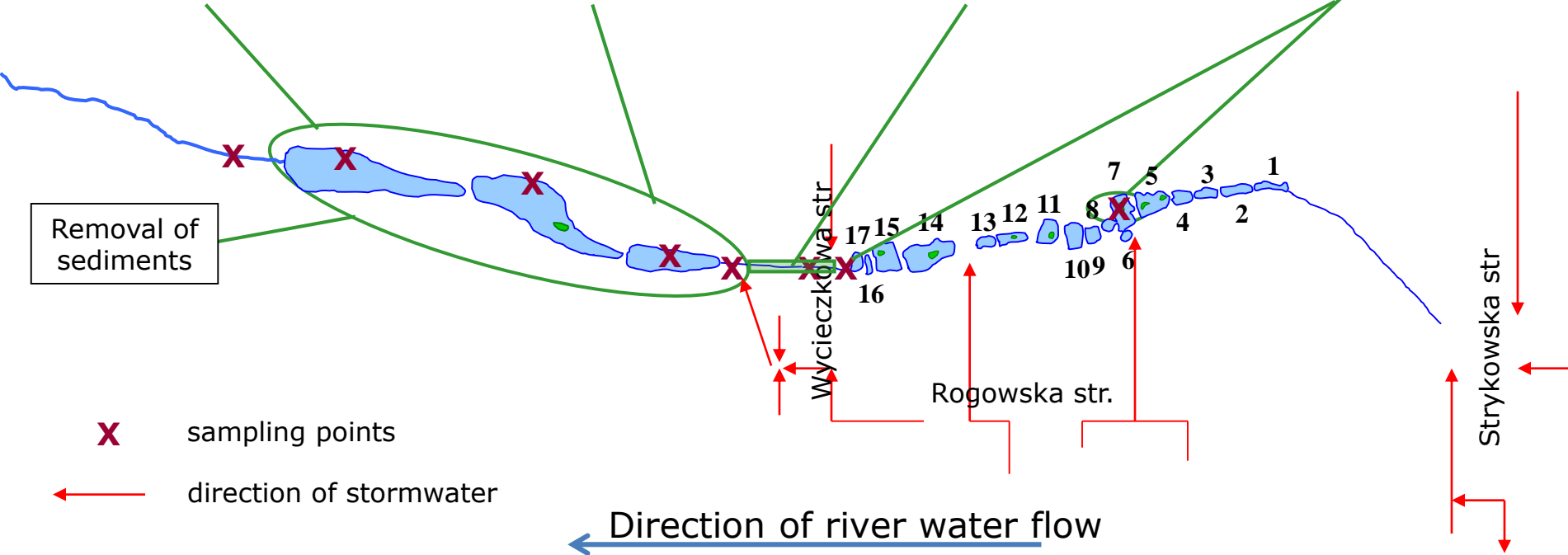
Construction of the biofiltration sequential system (BSS) in order to reduce the hazard posed by rainwater



Ecohydrological adaptation of small retention reservoirs in terms of intensification of river self-purification capacity



Removal of sediments



X sampling points

← direction of stormwater

← Direction of river water flow

Wycieczkowa str.

Rogowska str.

Strykowska str.



# Ecohydrological adaptation of Upper Arturówek reservoir in order to enhance the purification of rainwater



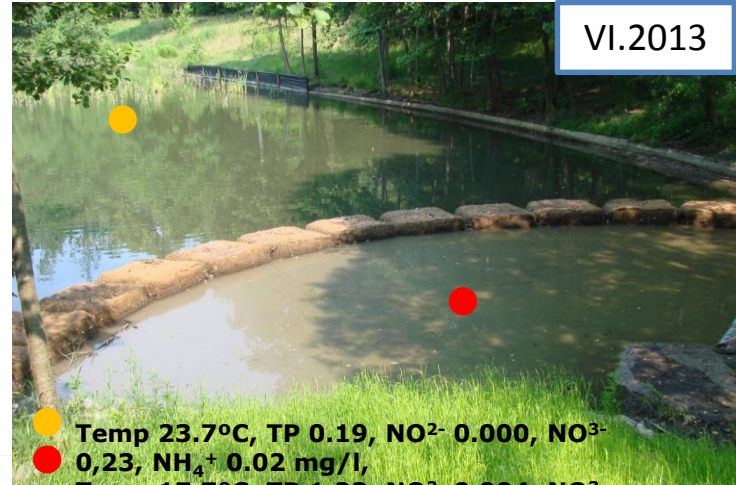
V.2012



IV.2013



V.2013



VI.2013

● Temp 23.7°C, TP 0.19, NO<sub>2</sub><sup>-</sup> 0.000, NO<sub>3</sub><sup>-</sup> 0,23, NH<sub>4</sub><sup>+</sup> 0.02 mg/l,  
● Temp 17.7°C, TP 1.22, NO<sub>2</sub><sup>-</sup> 0.004, NH<sub>4</sub><sup>+</sup> 0.82







# The construction of buffer zones together with the biogeochemical barriers for reduction of nutrients and suspensions



IV.2012



V.2013



VI.2013



VI.2013

www.arturowek.pl



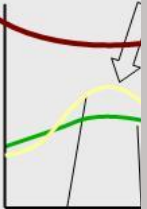
# Development Ecohydrological System Solutions for the City of the future –

## „Blue-Green Network”

### RESTORATION OF MUNICIPAL RIVER. MULTIDIMENSIONAL

#### BENEFITS

Effect of restoration  
hydropeaking and  
efficiency storm  
Sewage Treatment



Sewage treatment

Willow plantation

bypass canal

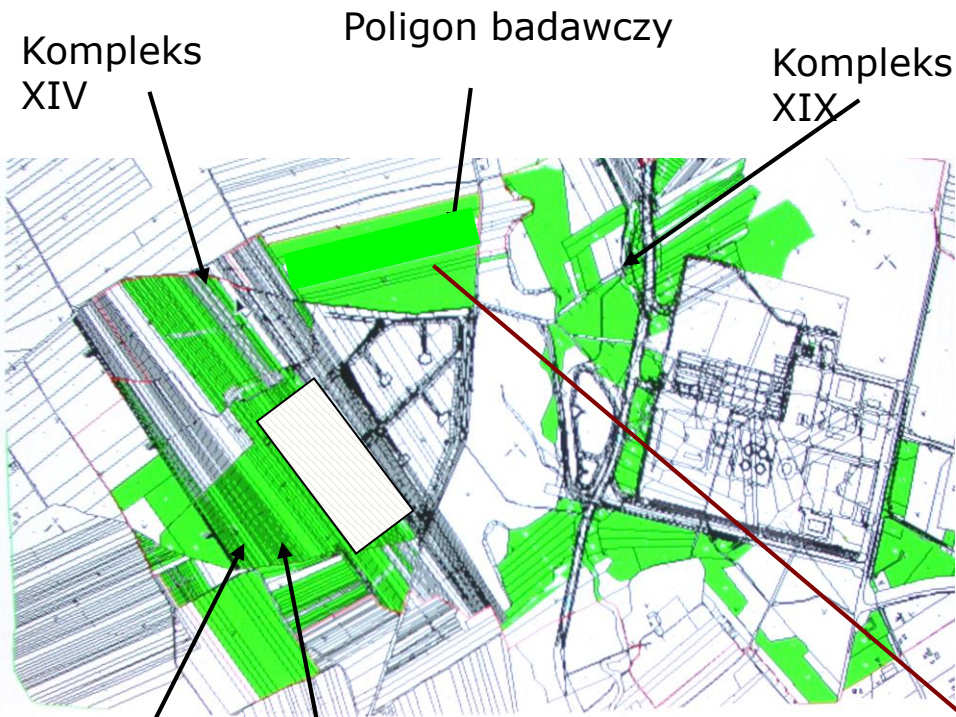
Reduce transpiration

Use bioenergy production



## Ner/GOŚ

# Zastosowanie fitotechnologii do utylizacji osadów ściekowych i produkcji bioenergii



Kompleks XI    Komplex XII



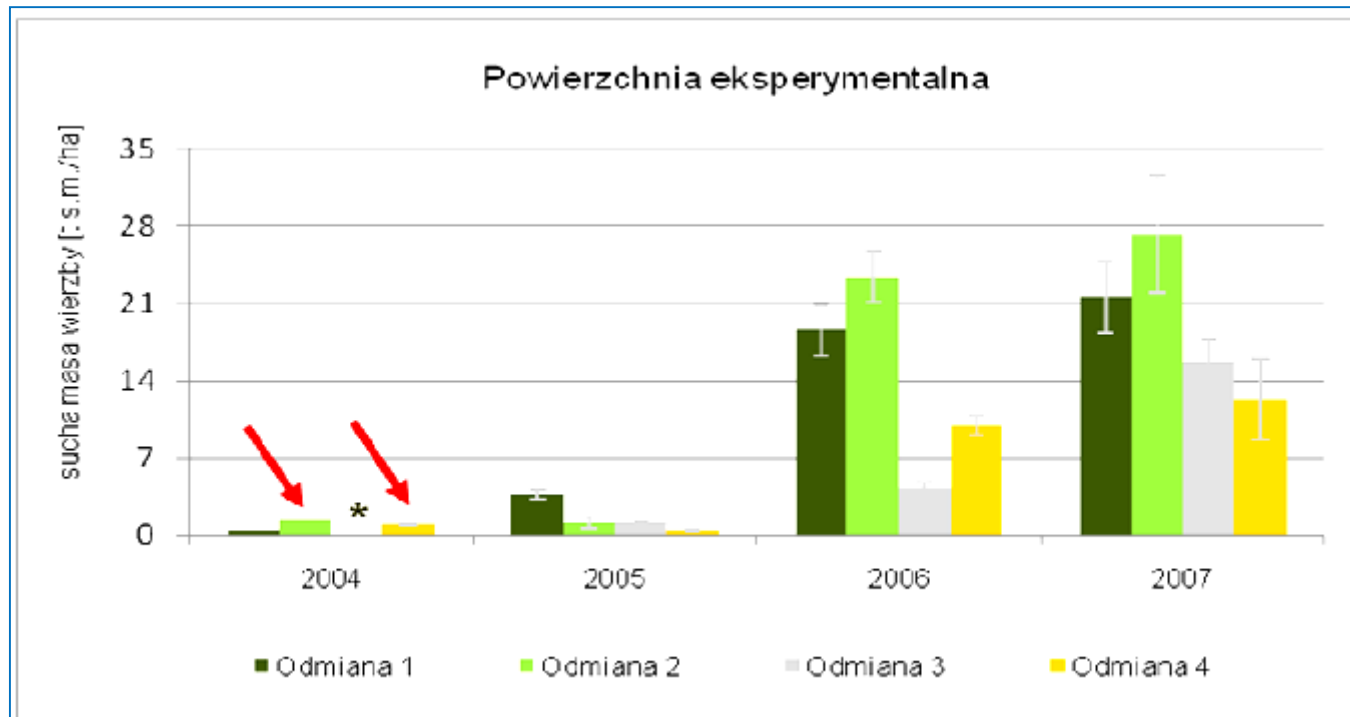
Eksperymentalna plantacja wierzby (64 ha) w strefie buforowej

Eksperyment z różnymi gatunkami i odmianami wierzby

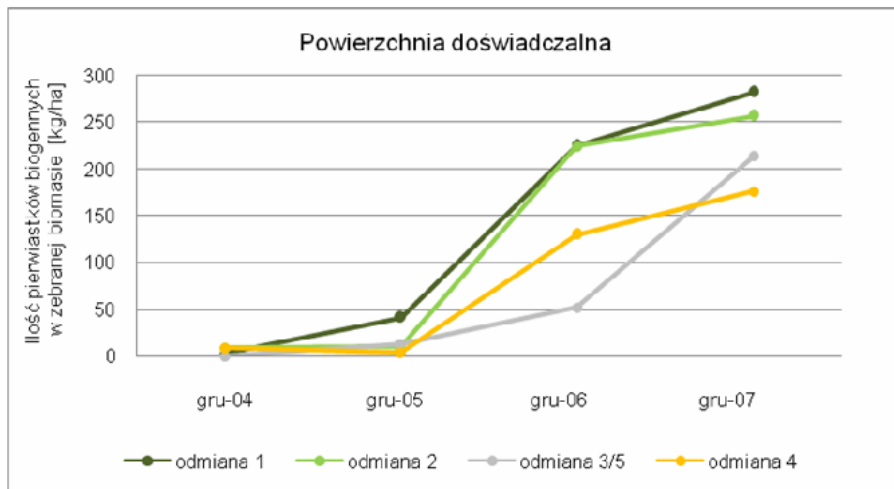
- I: *Salix viminalis* clones;
- II: Tordis (*Salix schwerini* x *S. viminalis*) x *S. viminalis*;
- III: *Salix viminalis gigantea*;
- IV: *Salix viminalis* (clone 192)

## Wzrost biomasy wierzby wraz z jej wiekiem.

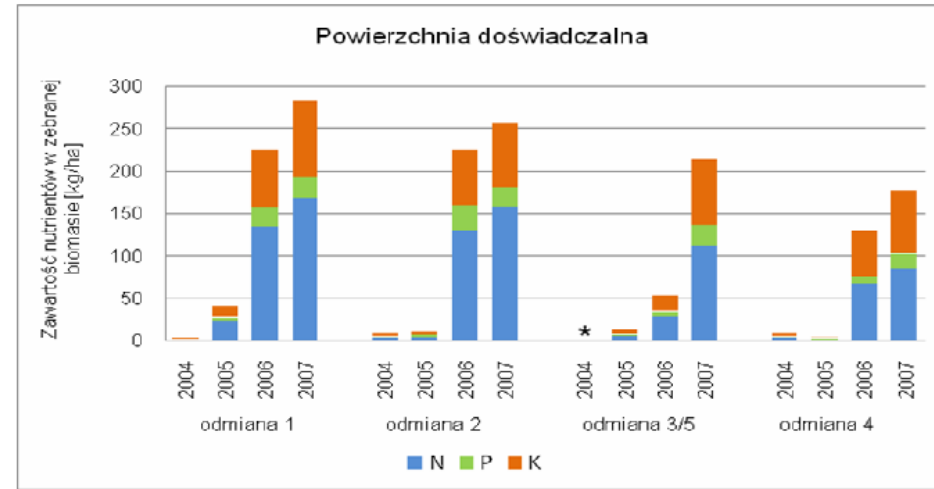
W pierwszym roku badań największą biomasę wierzby otrzymano w przypadku odmiany nr 2 i nr 4.



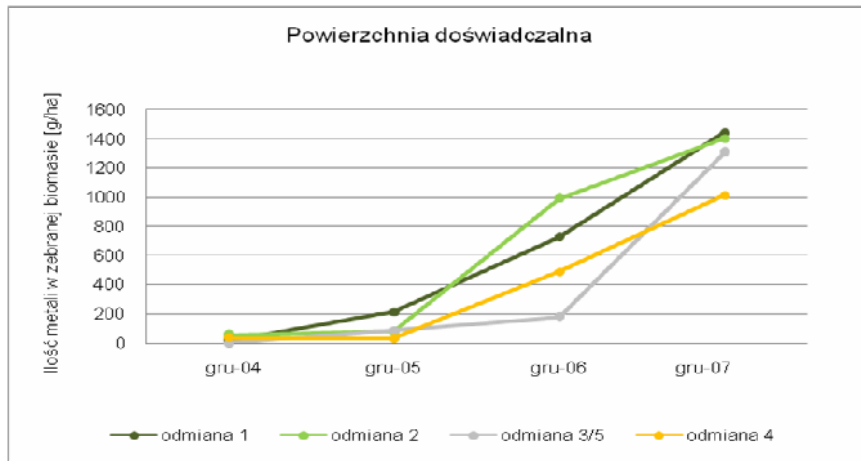
## Wzrost rzeczywistego poboru pierwiastków biogenych



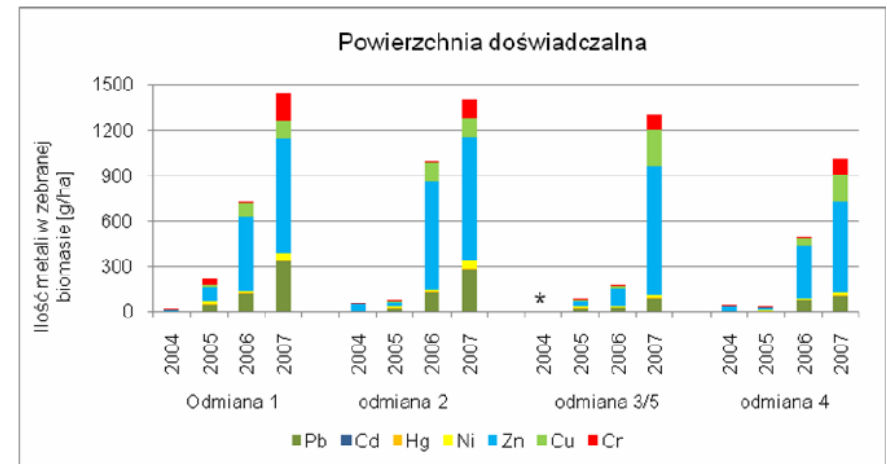
## Wzrost efektywności poboru pierwiastków biogenych



## Wzrost rzeczywistego poboru metali ciężkich



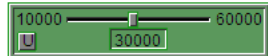
## Wzrost efektywności poboru metali ciężkich



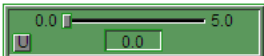
## MODEL MATEMATYCZNY OPTIMALIZACJI FUNKCJONOWANIA PLANTACJI WIERZBY ENERGETYCZNEJ Z WYKORZYSTANIEM OSADU ŚCIEKOWEGO

### MODUŁ "PRODUKCJA BIOMASY"

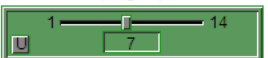
gestosc obsady  
ilosc sadzonek na ha



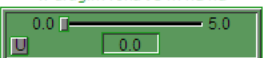
biomasa chwastow w  
pierszym roku t s m na ha



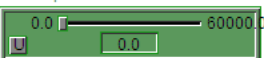
pH gleby



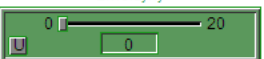
biomasa chwastow  
w drugim roku t s m na ha



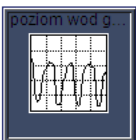
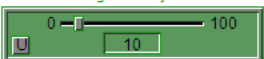
ilosc sadzonek zaatakowanych  
przez szkodniki na ha



ilosc  
zwierzyny

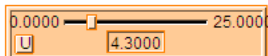


zawartosc materii  
organicznej %

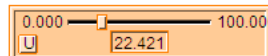


### MODUŁ "UTYLIZACJA OSADÓW POŚCIEKOWYCH"

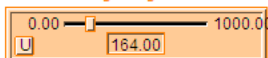
Cd mg na kg osadu



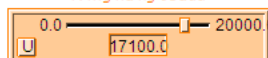
Sucha masa osadu %



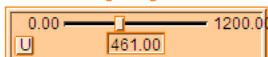
Cr mg na kg osadu



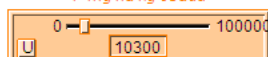
N mg na kg osadu



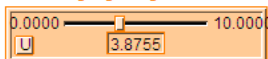
Cu mg na kg osadu



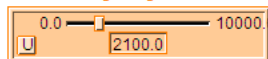
P mg na kg osadu



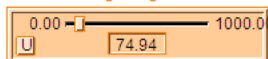
Hg mg na kg osadu



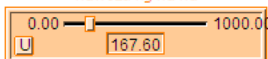
K mg na kg osadu



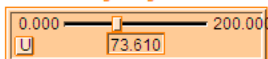
Pb mg na kg osadu



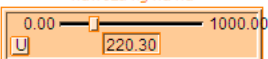
N dostarczany w postaci  
nawozu kg na ha



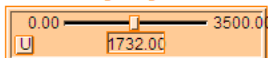
Ni mg na kg osadu



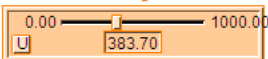
P dostarczany w postaci  
nawozu kg na ha



Zn mg na kg osadu



K dostarczany w postaci  
nawozu kg na ha



ilosc N przy zastosow... 132.4

ilosc P przy zastosow... 79.7

ilosc K przy zastosow... 16.3

Brakujacy N 167.6

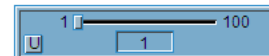
Brakujacy P 220.3

Brakujacy K 383.7

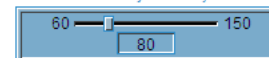
Min mokra t na ha na ... 11.5

### MODUŁ "EKONOMIKA"

ha



cena rynkowa za tone  
suchej biomasy



Kalorycznosc plantacji 134.38

Wartosc energetyczn... 22.9

sprzedaz biomasy 11034

Interface

Map

Model

Equation

“Implementation of Ecohydrology – a  
transdisciplinary science  
for integrated water resources  
and sustainable development in Ethiopia”

**Degradation of buffering  
zones**



**Erosion / pollutants transport**



**Reservoir  
siltation/eutrophication**





# Use of ecohydrology based systemic solutions for reduction lake siltation, eutrophication and dioxin-induced toxicity in the Asalla BioFarm Park lake

