Inclusion of ecohydrology concept as integral component of IUWM

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Modern cities, with patches of ecosystems in the landscape, create a complex of interactions consisting of multidirectional flow of water, matter, pollutants and energy.

It is necessary to understand the flow paths of all these components, in order to control them and achieve a high quality of life in the city.

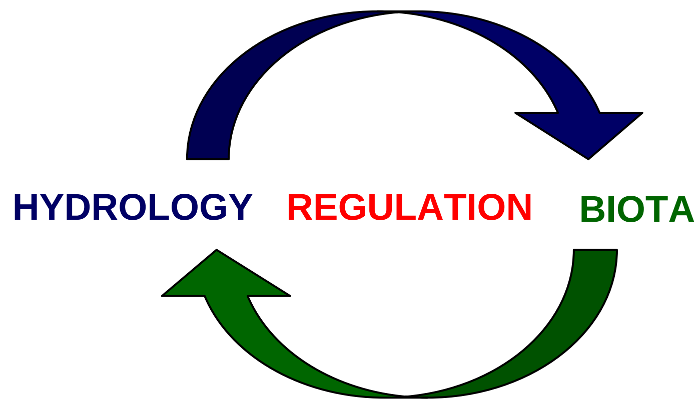
They should be organized based on the rules governing natural ecosystems.

ECOHYDROLOGY APPROACH

INCREASES ABSORBING CAPACITY OF ECOSYSTEMS BY:

- **DUAL REGULATION** of hydrology and biota
- **HARMONISATION** of hydrotechnical solutions with ecological biotechnologies
- **INTEGRATION** of various measures in a catchment for sustainable development

Management of hydrological parameters
of an ecosystem/ecosystems to control biological processes



Shaping of biological structure
of an ecosystem/ecosystems in a catchment,
to regulate hydrological processes

Zalewski et. All. 1997, 2000

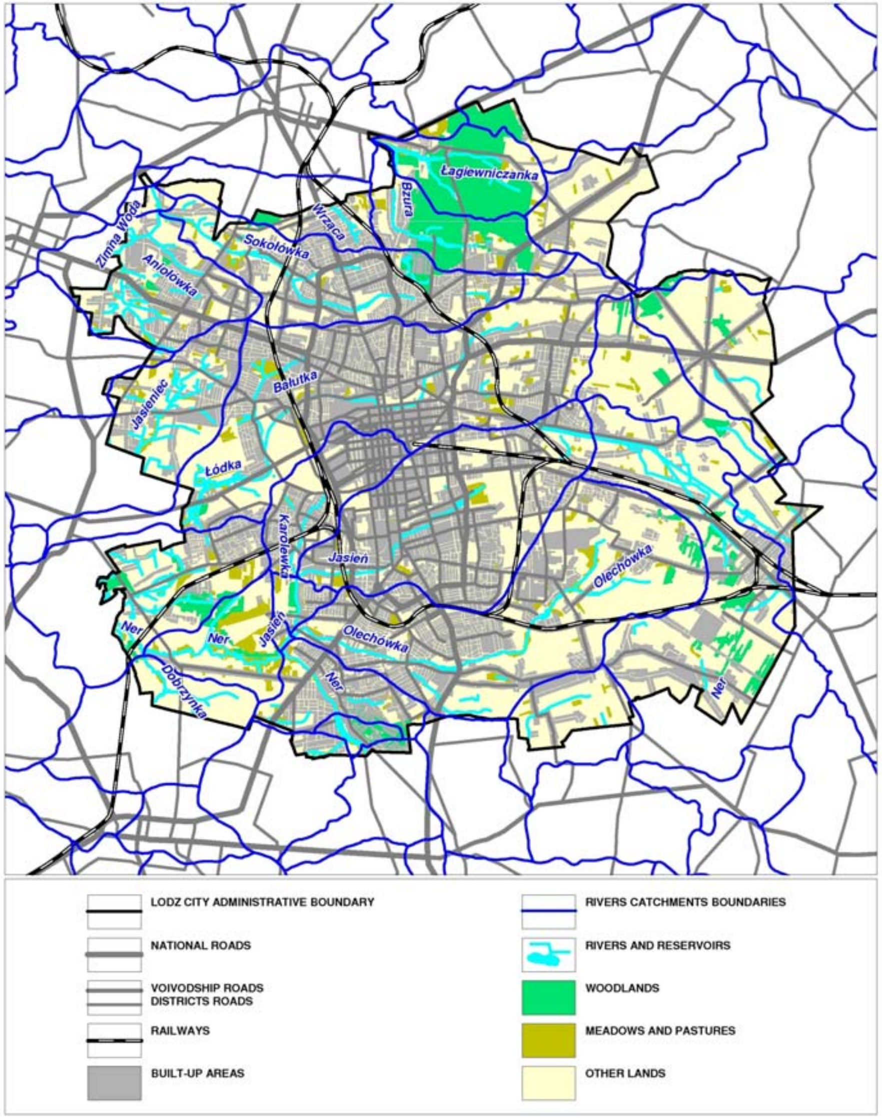
The City of Lodz

central Poland;

an example of urban area that expensed very rapidly in the first quarter of the XIX Century, based on natural resources (water, forests) essential for establishing textile industry in this area;

800 thousand inhabitants;

has no big rivers but its area is divided into 18 small city catchment with stream of mean discharge below $1m^3s^{-1}$



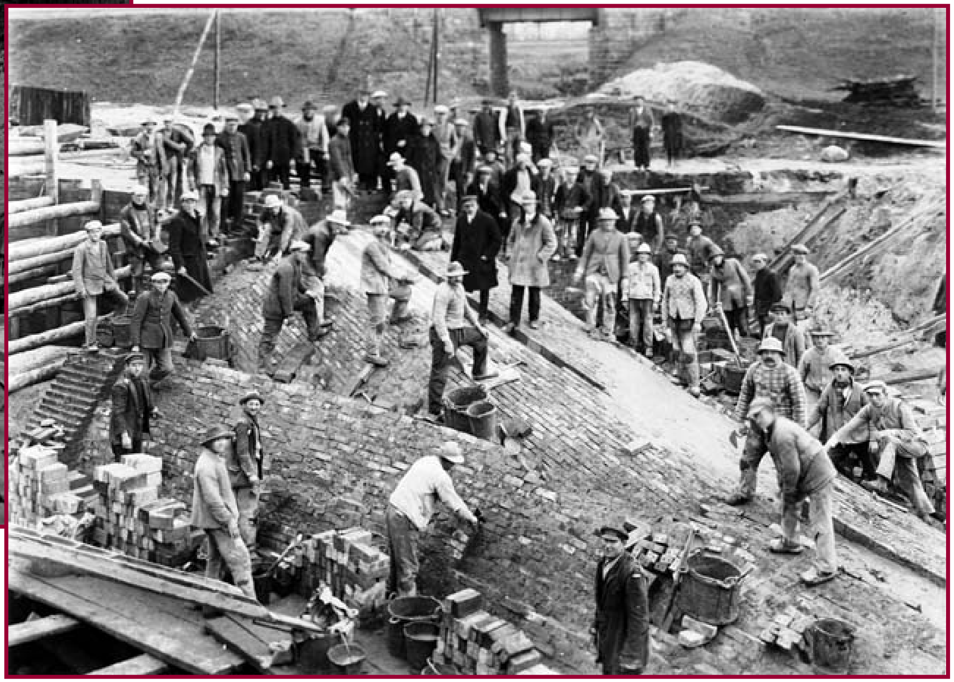
POST-INDUSTRIAL CITY LANDSCAPE

- 18 small city streams (aver. Q < 1 $m^3 s^{-1}$) receiving stormwaters;

- rivers channelisation in early 30's

Jasien River, 1931

Karolewka River, 1930



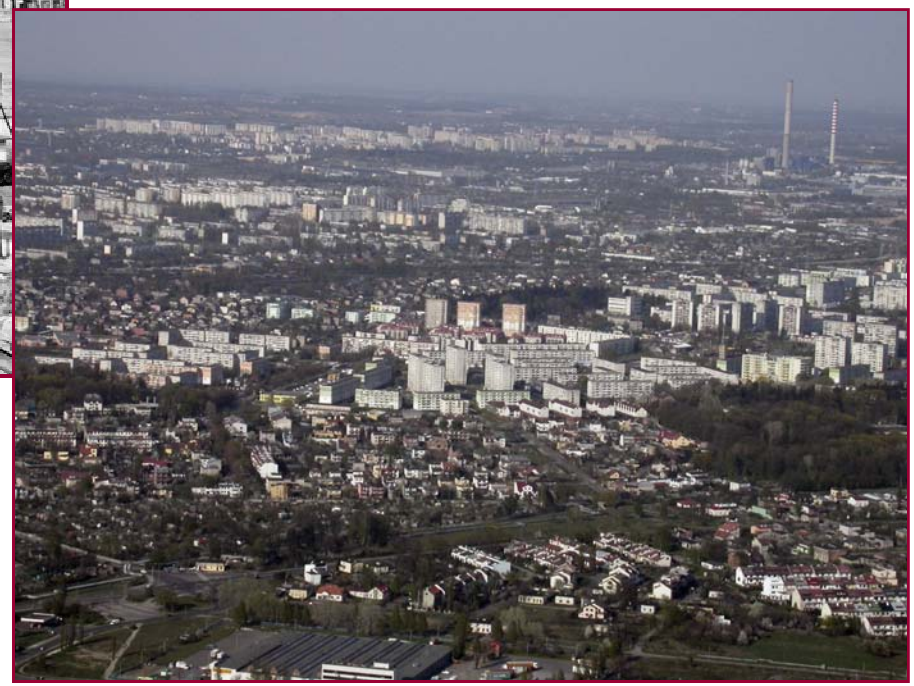
- **reduced ability of water retention in the landscape;**
- **impacted rivers hydrological and ecological stability**

CHANGE OF THE CITY CHARACTER & DEVELOPMENT

The City of Lodz in
1928
INDUSTRY

The City of Lodz in
2006
HIGH-THECHNOLOGY, SCIENCE, EDUCATION

Change of landscape and society expectations



Compacted, highly impermeable historical development

OVERALL GOAL OF THE RTD ACTIVITIES

Scientific basis for ecohydrology implementation as an integral element of the IUWM in Lodz

- adaptation of small city rivers/catchments for interception of large stormwater and pollution loads;
- elaboration of comprehensive concept of wastewater treatment plant management addressing issues of sewage sludge conversion into biomass, and river rehabilitation;
- providing socio-economic feedbacks based on use of ecosystem resources of regenerated urban ecosystems.

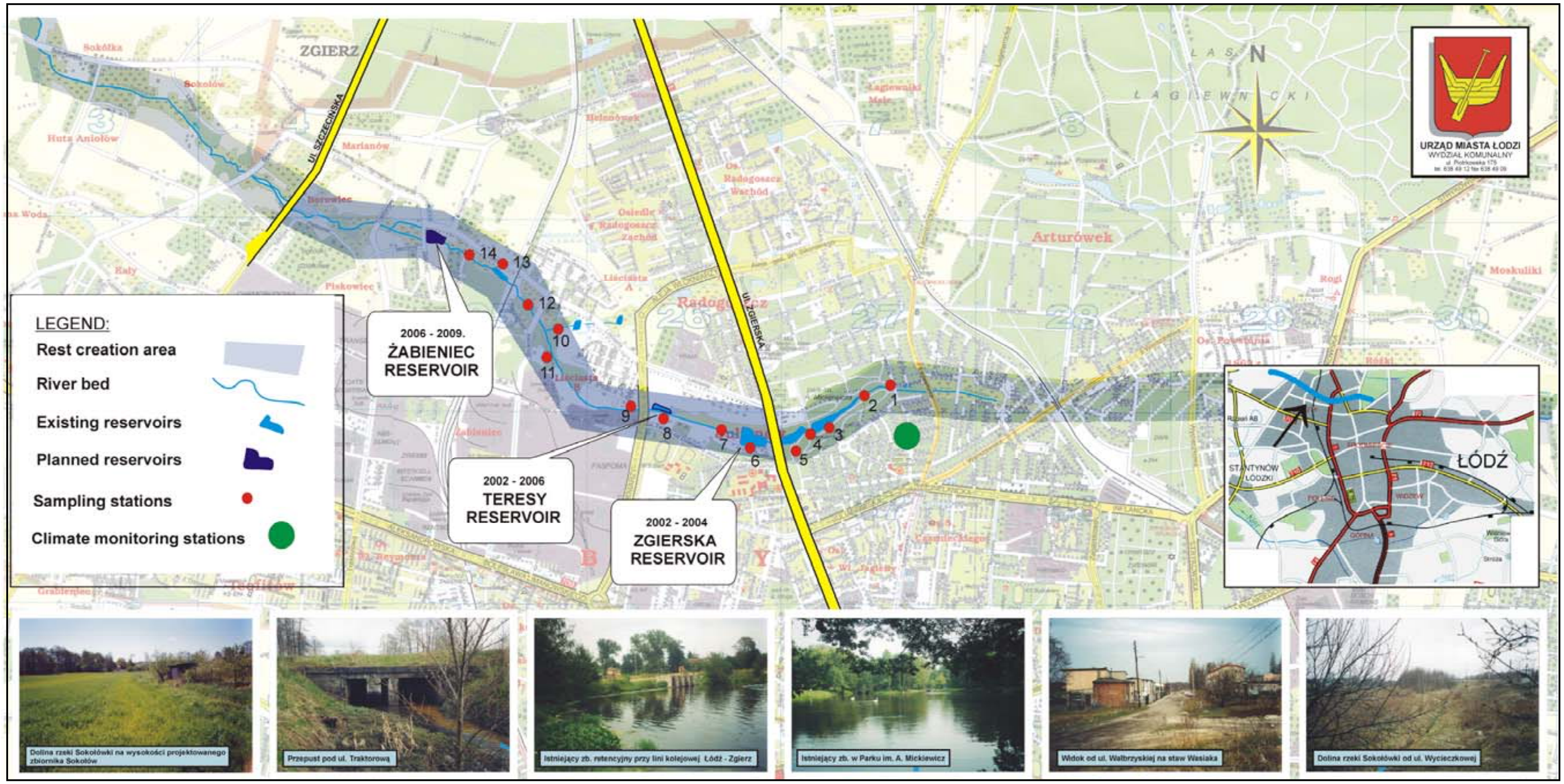
PROJECT 1

Sokolowka River

Restoration of a municipal river
for stormwater management,
increase of water retentiveness
and improvement of quality of life

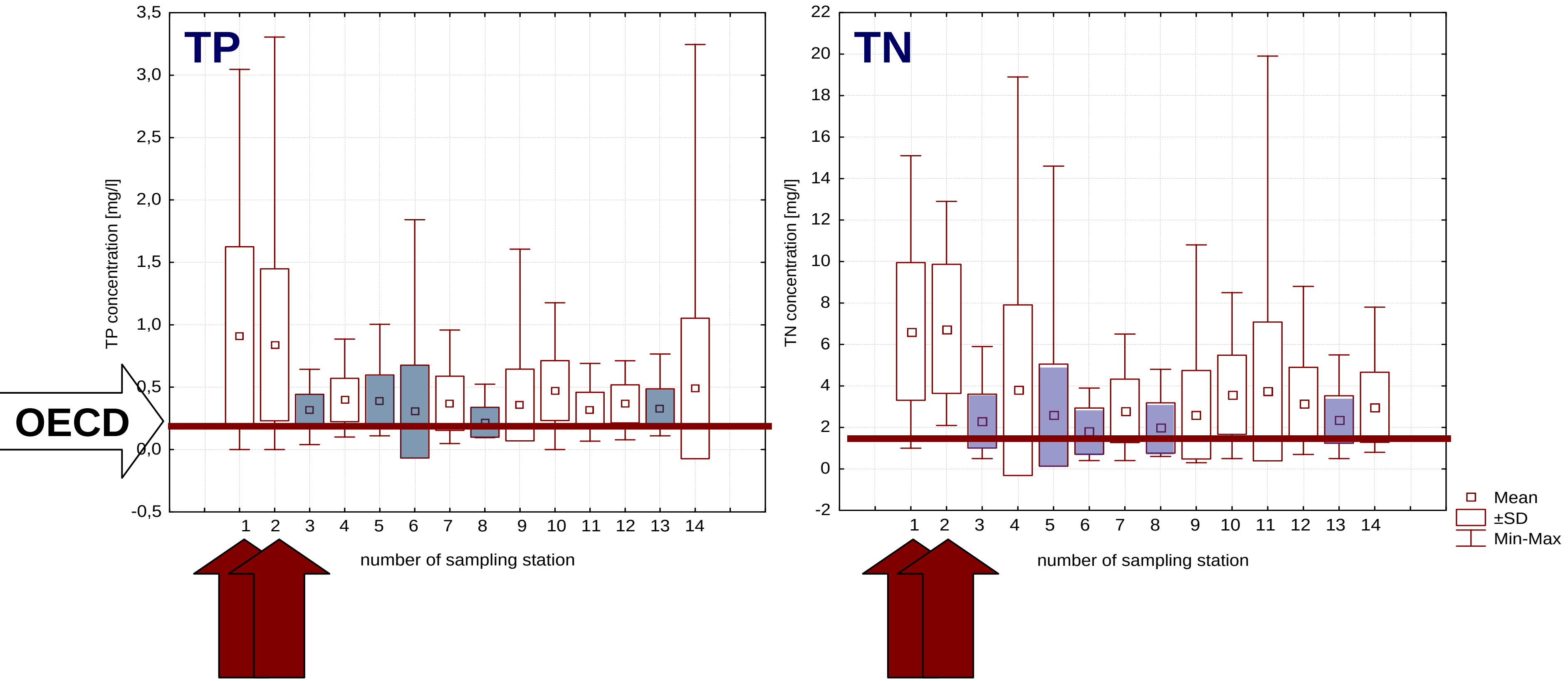
METHODS

- **physical** (temperature, oxygen, concentration, pH, conductivity, mineral and organic suspended mater content);
- **chemical** (TP, TN, P-PO4, N-NH4, N-NO3, heavy metals);
- **biological** (zooplankton, phytoplankton, chlorophyll-a)



RESULTS

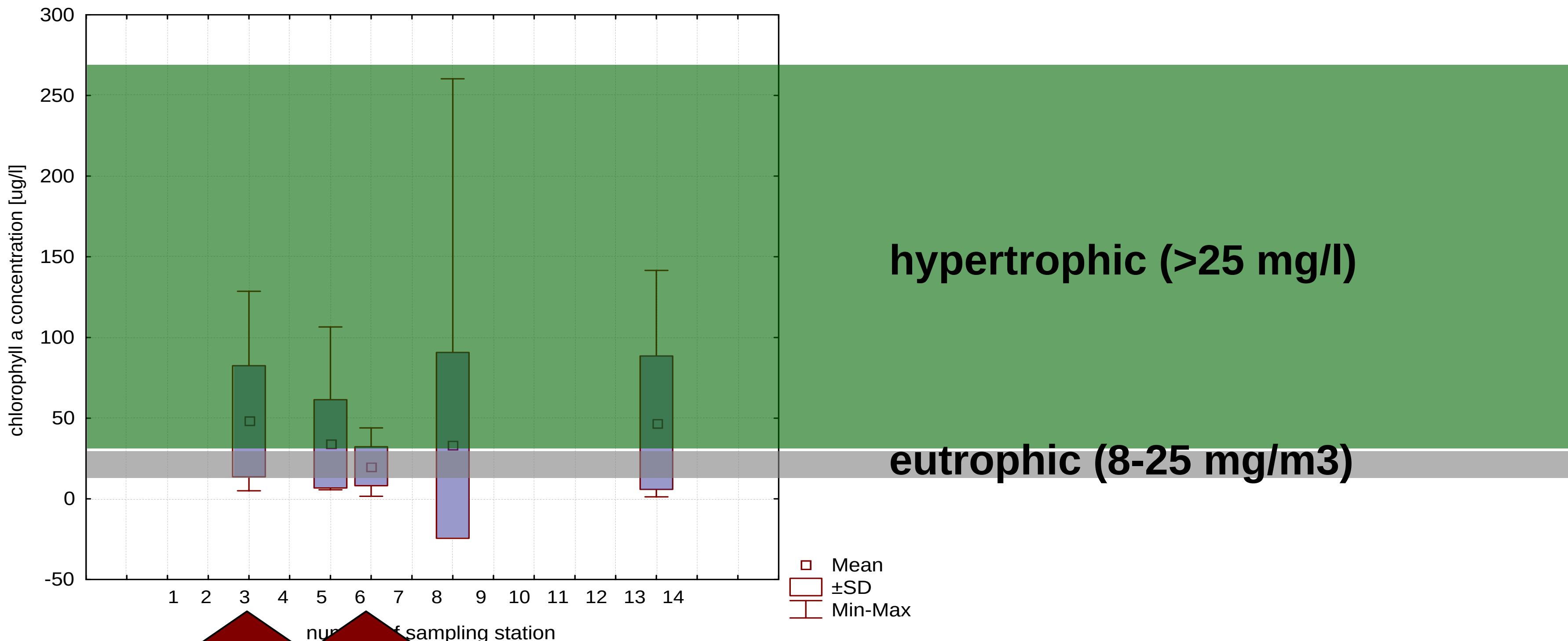
NUTRIENTS CONCENTRATIONS



septic tank seepage, combined sewer overflows, illegal sewer overflows

RESULTS

CHLOROPHYLL *a* CONCENTRATIONS



Nutrients allocation in macrophytes

low isolation (**intermediate complexity concept**)

and high zooplankton pressure (**top-down control**)

CONCLUSIONS

1. Storm sewer outlets deteriorate water quality and ecological stability of ecosystems. **Construction of biofilters and allocation nutrients on storm sewer outlets into unavailable biomass pool can reduce this problem.**

2. Reservoirs cascade reduces pollutants load along the river course. **Regulation of water dynamics in various parts of the catchment by adaptation of hydrotechnical infrastructure can modify hydrokinetic processes, physic-chemical properties and biota dynamics increasing assimilative capacity of the system.**

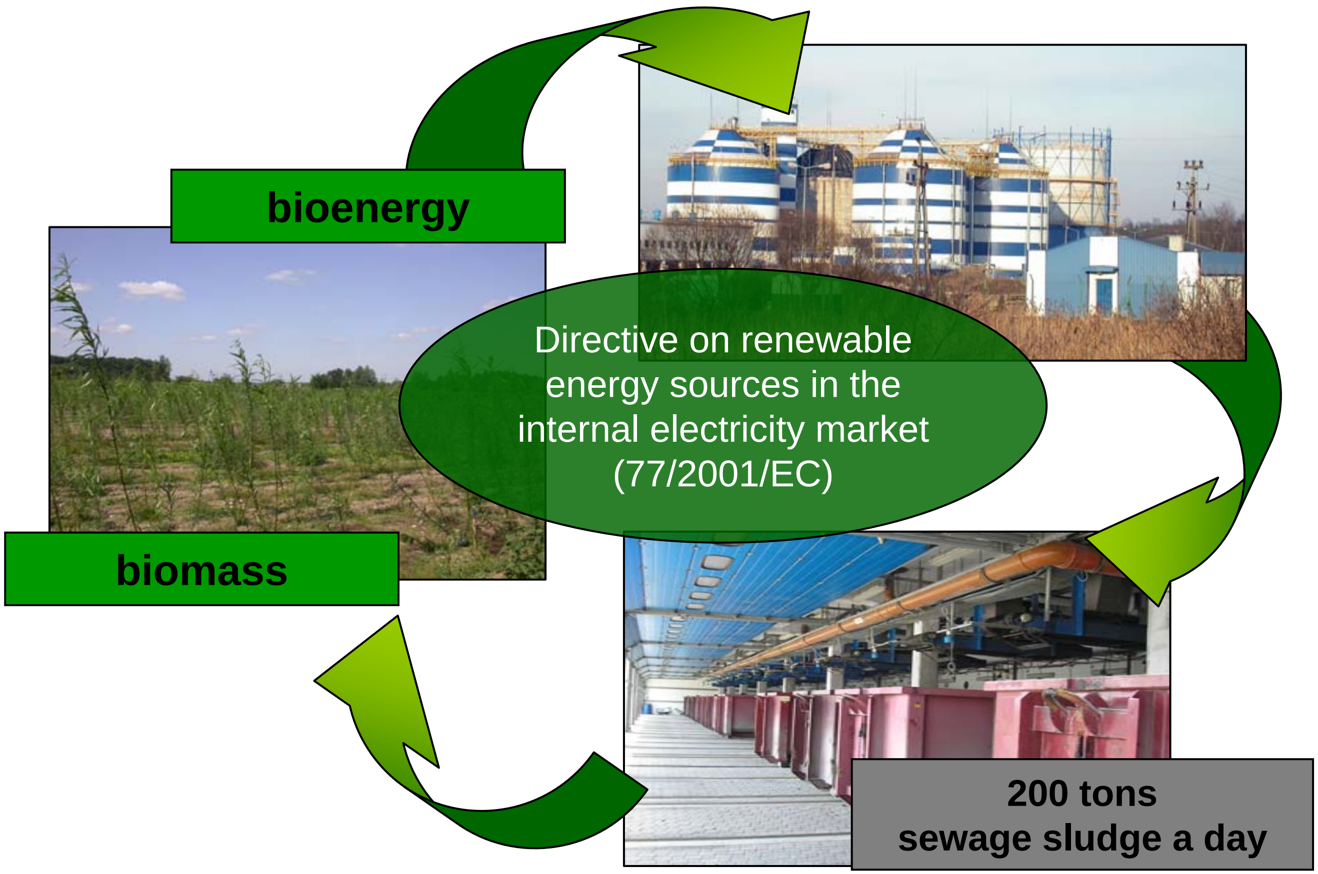
3. The highest reduction of TP&TN concentrations was observed in the first reservoir (39%, St.3). However **high sediment accumulation in the reservoir increase danger of internal load and algae blooms appearance.**

PROJECT 2
Ner River
Sewage system management for environment quality and positive socio-economic feedbacks

- limited capacity of sewage treatment system for stormwater purification;
- disposal of treated sewage (2,5 m^3 s^{-1}) into a river of natural flow < 0,3 m^3 s^{-1},
- high contamination of the floodplain with heavy metals and organic compounds;
- sewage sludge utilization.

GOAL

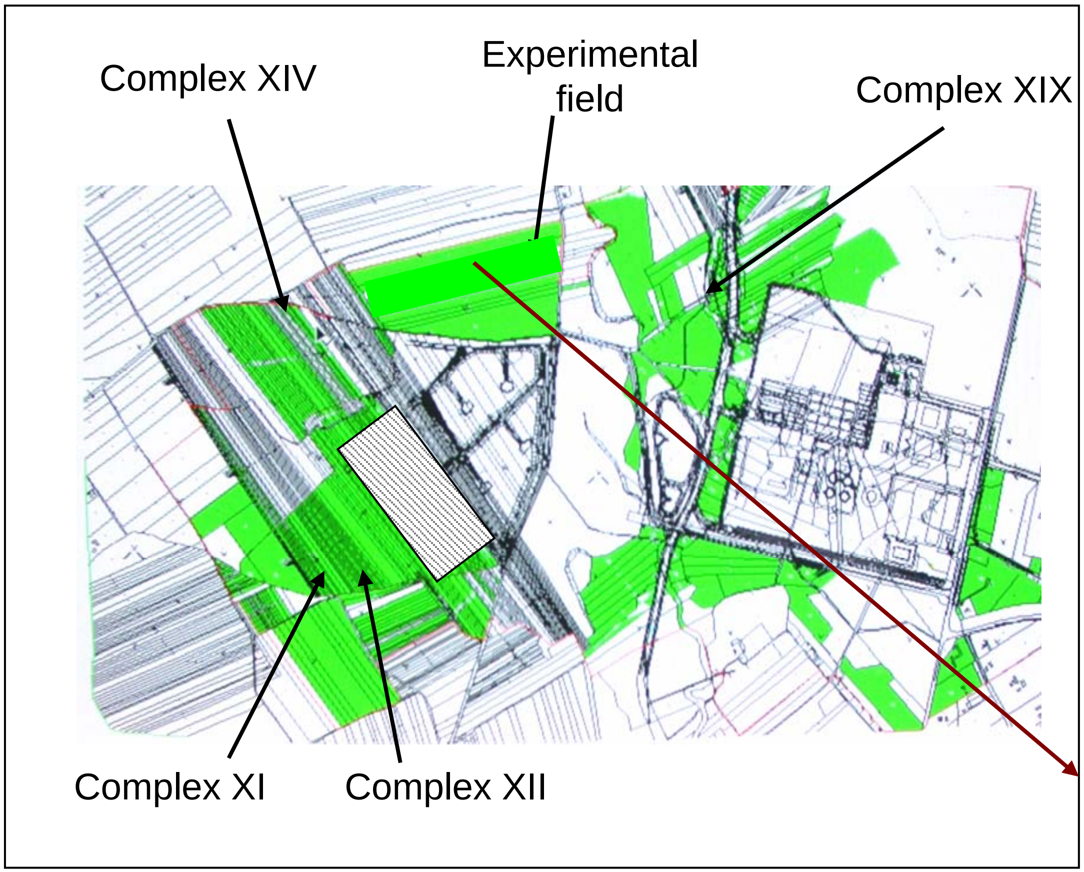
use of sewage sludge and compost for fertilization of bioenergetic plantations in the protective zone around the WWTP for bioenergy production.



METHODS

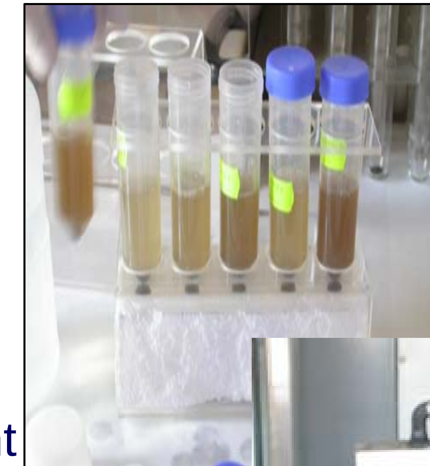
Experimental Plantation (64 ha) in the protective zone of the WWTP

Comparative experiments on different species and varieties of willow



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

METHODS



Soil and sludge analyses:

- Organic matter content,
- pH,
- Water content,
- Phosphorus, nitrogen
- Heavy metals (Zn, Ni, Pb, Cd, Cu, Co, Cr) content (by the atomic absorption spectrometry - AAS);

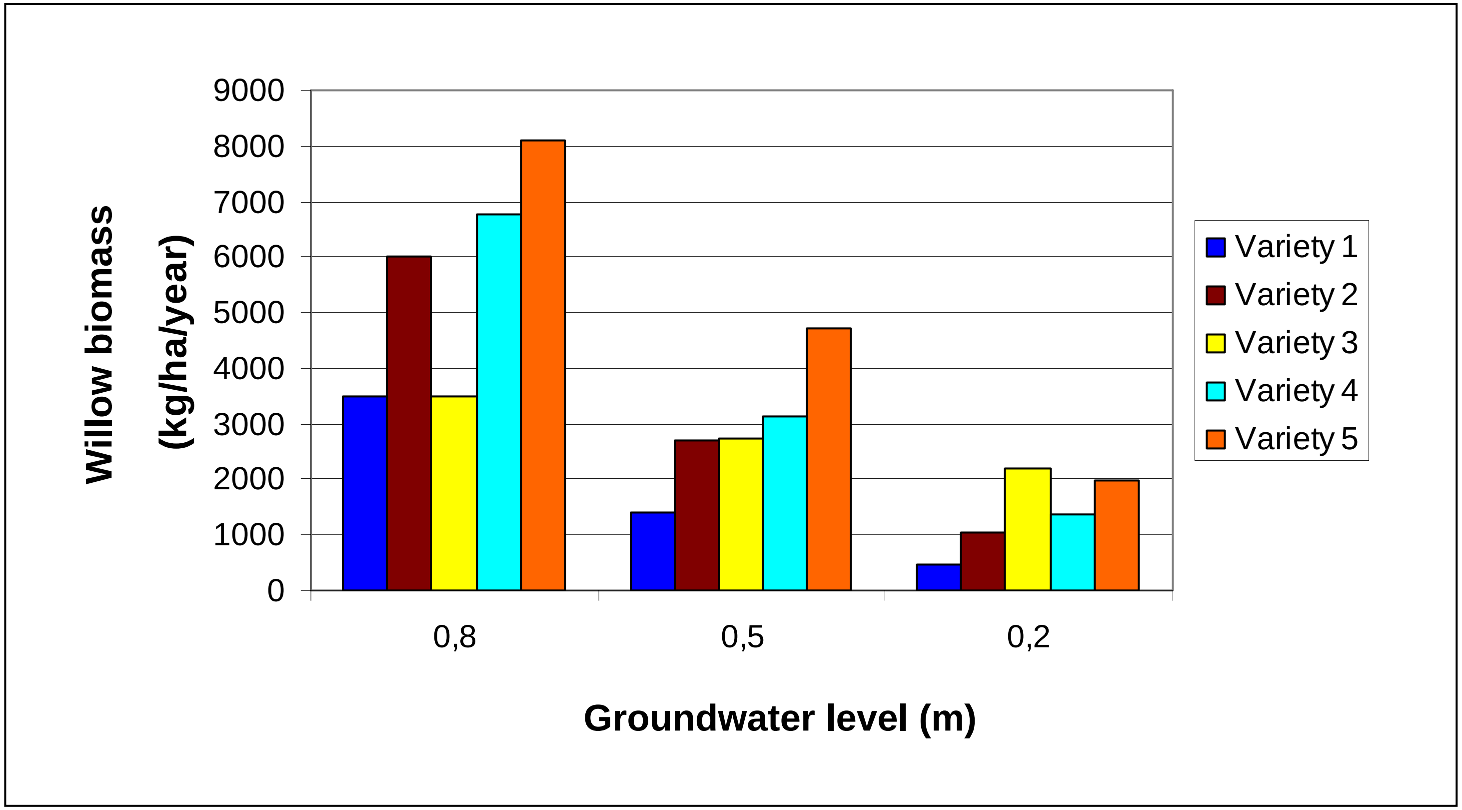
Vegetation analyses:

- Biomass production;
- Survivability of willow;
- Condition of willow;
- Rate of P, N assimilation;
- Rate of heavy metals (Zn, Ni, Pb, Cd, Cu, Co, Cr) - assimilation (by atomic absorption spectrometry);

Biological analyses:

-Soil metabolism (OxiTop®);
-Toxicity soil tests (Microtox - with *Vibrio fischeri;*
Phytotoxkit – with plant seeds)

Ground water level regulation as a key factor for bioenergy yield and economic efficiency



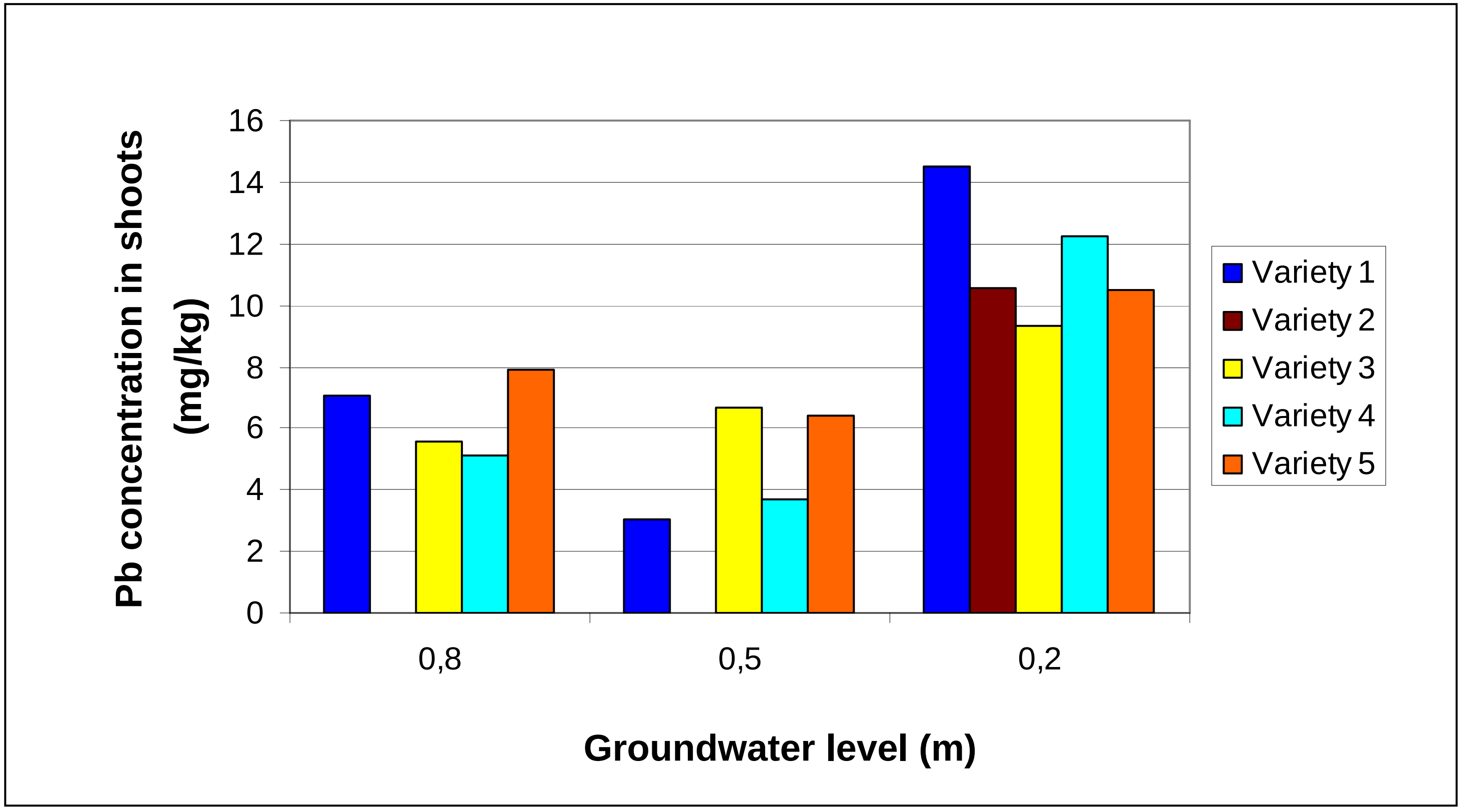
Min.

470

Max.

8100

Ground water as a key factor for heavy metals phytoextraction



Min.

3,1

Max.

14,5

Further study will evaluate:

1. Activity of the soil microorganisms (soil metabolisms) at different dose of sewage sludge;

2. Toxicity of soil after sewage sludge application (Phytotoxkit, Microtox)

3. Efficiency of heavy metals absorbing in the rhizospheres (rhizotron, rhizobox);

4. Overall balance for heavy metals remediation, biomass and energy production for the plantation;