The International Institute of the Polish Academy of Sciences
European Regional Centre for Ecohydrology
under the auspices of UNESCO
Department of Applied Ecology
University of Łódź

Ecohydrology for elimination of water threats and to amplify opportunities for sustaianbale development

Maciej Zalewski

International Conference
Ecohydrological Processes and Sustainable Floodplain Management
Opportunities and Concepts for Water Hazard Mitigation, and Ecological and Socioeconomic Sustainability in the Face of Global Changes

Tylna 3, 90-364 Lodz, Poland
Tel: (+48) 42 681 70 07
Fax: (+48) 42 681 30 69
www.erce.unesco.lodz.pl

Content of presentation:

1. Introduction: water, ecosystems and humanity- global perspective

2. Ecohydrology integrative problem solving science: concept and principles

3. Ecohydrology of floodplain: new tool for IWRM

4. Ecohydrology of urban areas for reduction of flood, improvement of human helth and quality of life

5. Does large dams if constructed according ecohydrology principles can be friendly for ecosystems and societies?

6. Mathematical modeling of ecohydrological procesess for decision support systems

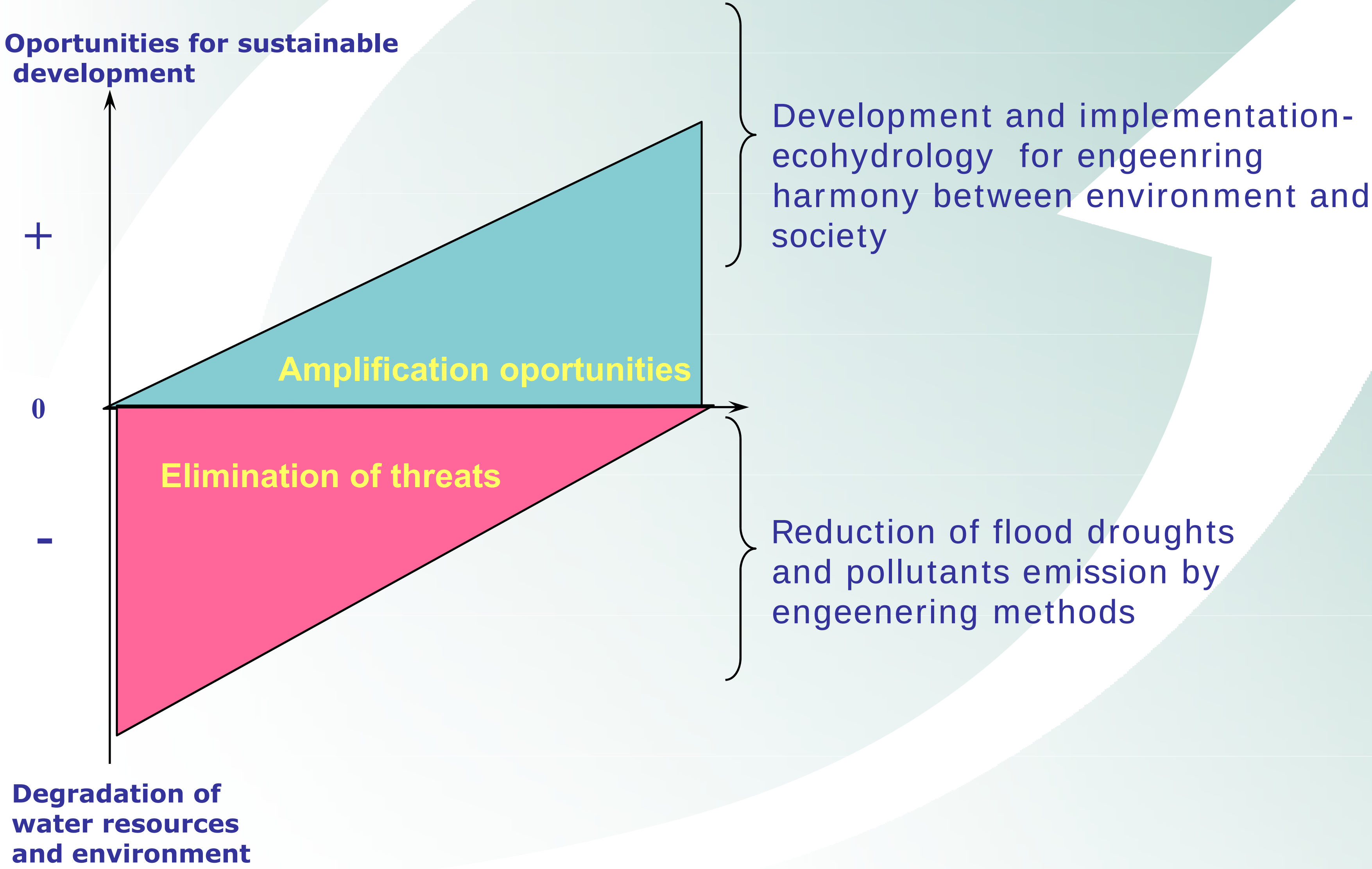
7. Foresigth methodology for engeenering harmony between water resources, ecosysems and societies toward sustainable future.

Global water resources at the begining of XXI Century

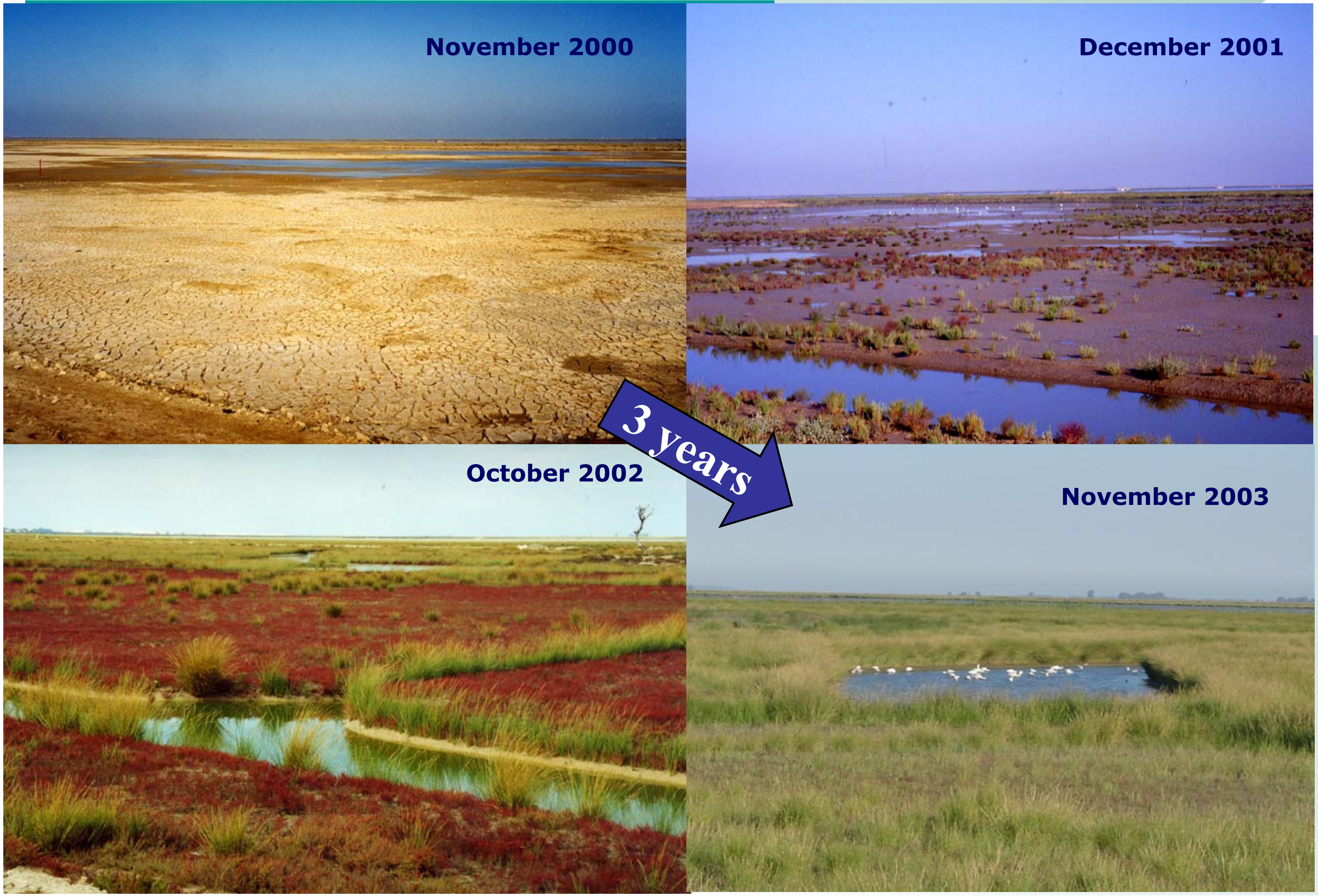
- Almost 80% of the surface of the Earth modified by Man, so that recent era is called Anthropocene
- Freshwater ecosystems situated in the lowest point of the landscape – exposed to cumulative impact due to varius forms catchment exploitation
- According to Maybeck (2001) rivers are one of the most modified aquatic ecostystms

Tylna 3, 90-364 Lodz, Polska
Tel: (+48) 42 681 70 07
Fax: (+48) 42 681 30 69
www.erce.unesco.lodz.pl

Strategy of sustainable water resouces, ecosystems and societies



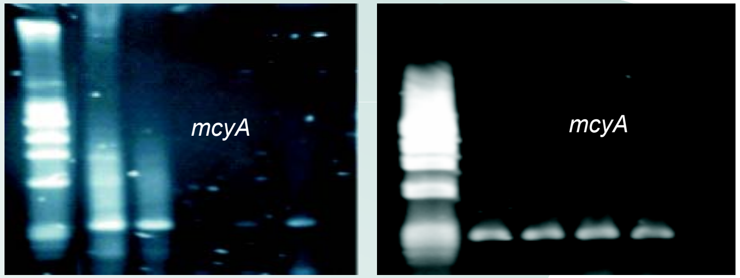
Flood and groundwater level at river valley, key factor for recovery of aquatic and terrestial biodiversity - Donyana case



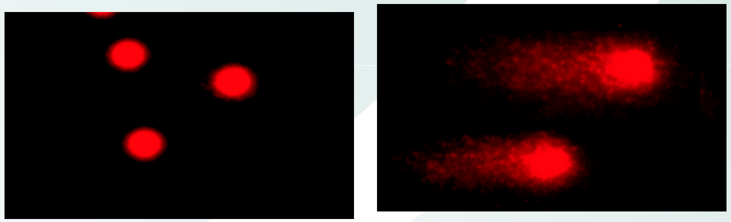
Eutrophisation -Monitoring of threats

Application of molecular methods for risk assessment and an early warning system

Blue-green algae blooms due to reservoir eutrophication



Molecular monitoring as an early warning system againist toxic blue-green algae blooms



Cells after green algae toxins treatment

Demaged DNA in human limphocyts

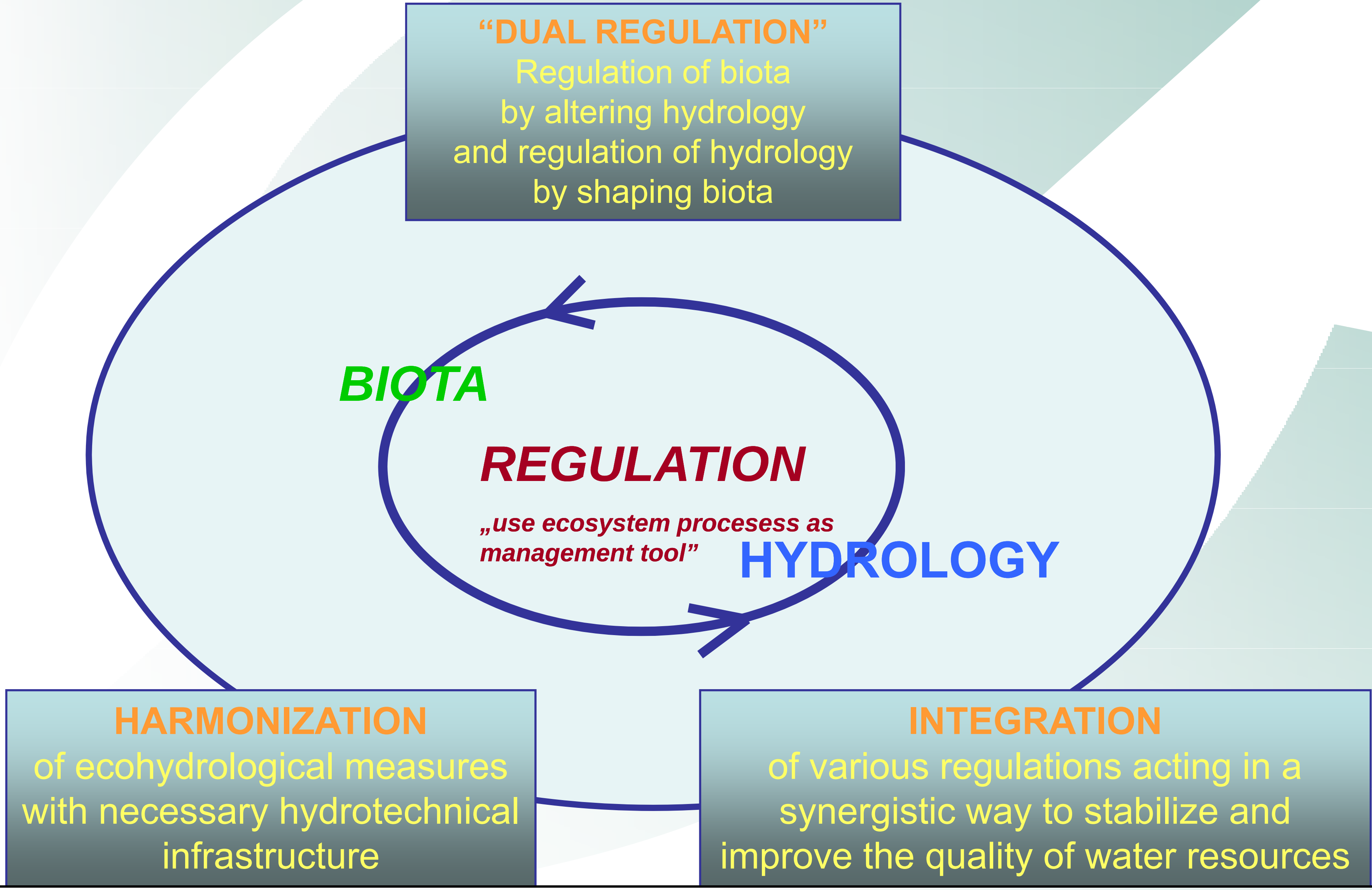
(Zalewski 1999: Mankiewicz et al.. 2005)

Vision

Many options exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.

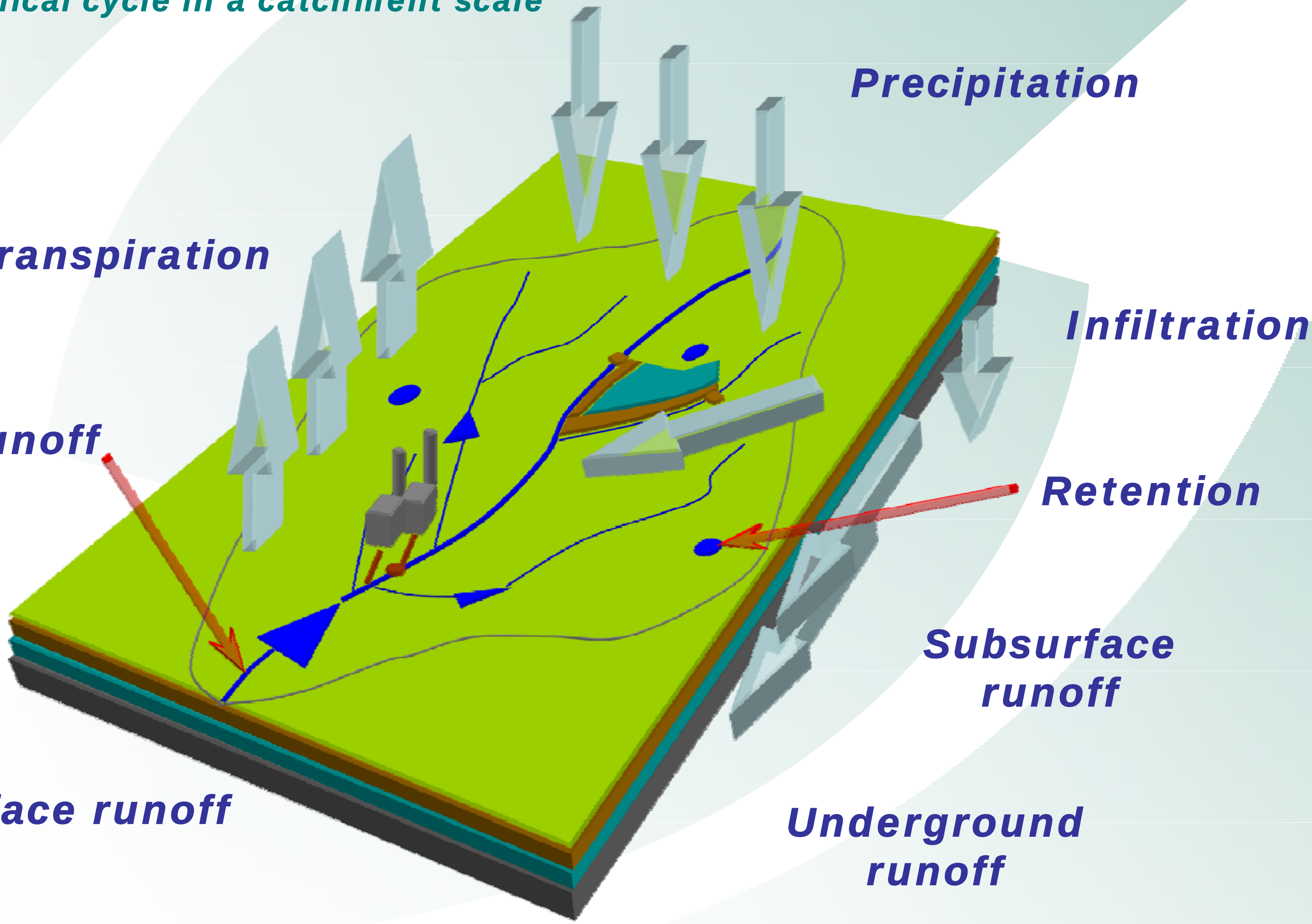
Millenium Ecosystem Assessment

The major body of the Ecohydrology theory



I – FIRST PRINCIPLE

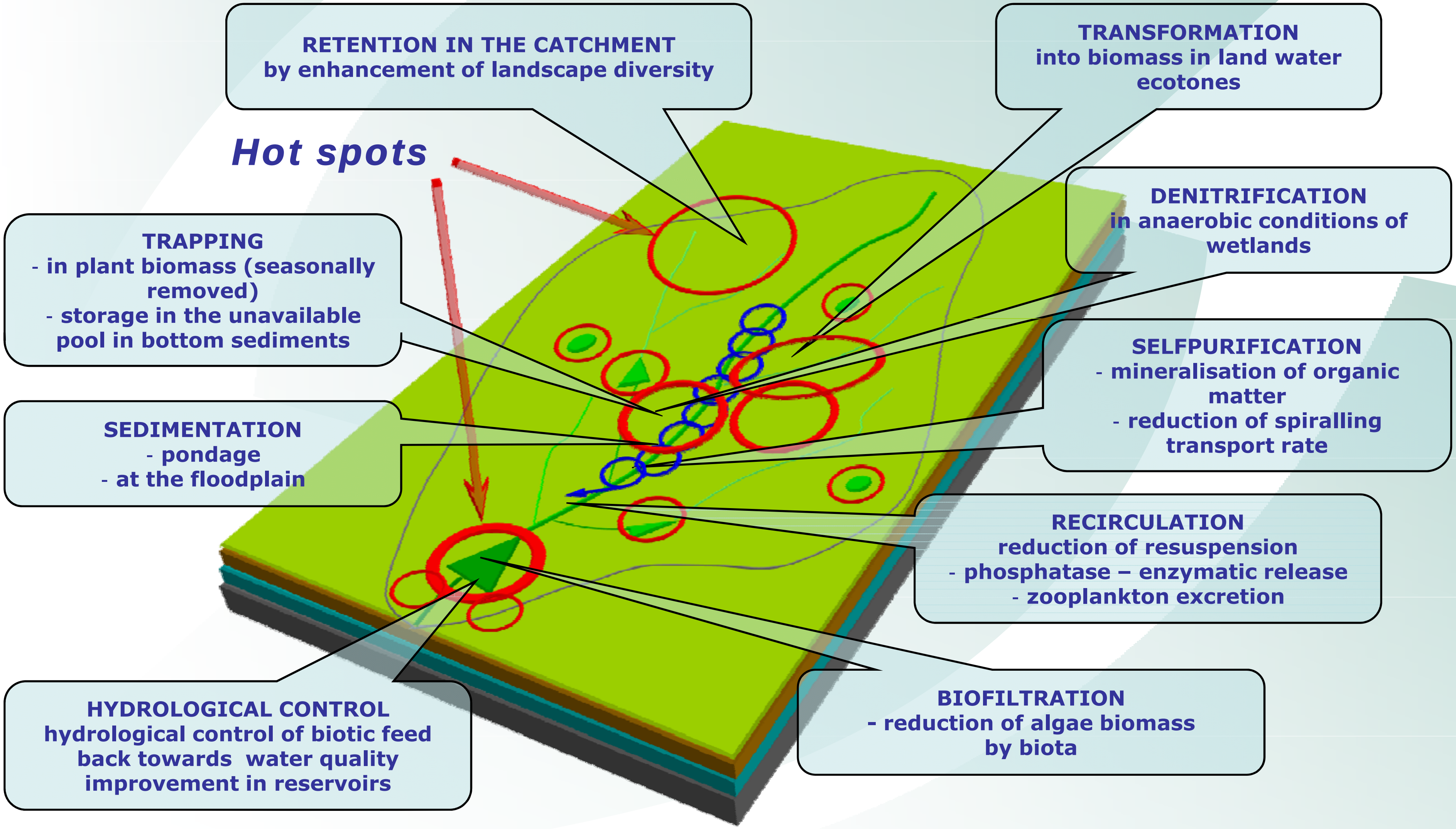
„Quantification of hydrological cycle as a template for biogeochemical cycle in a catchment scale”



Zalewski 2008

II – SECOND PRINCIPLE

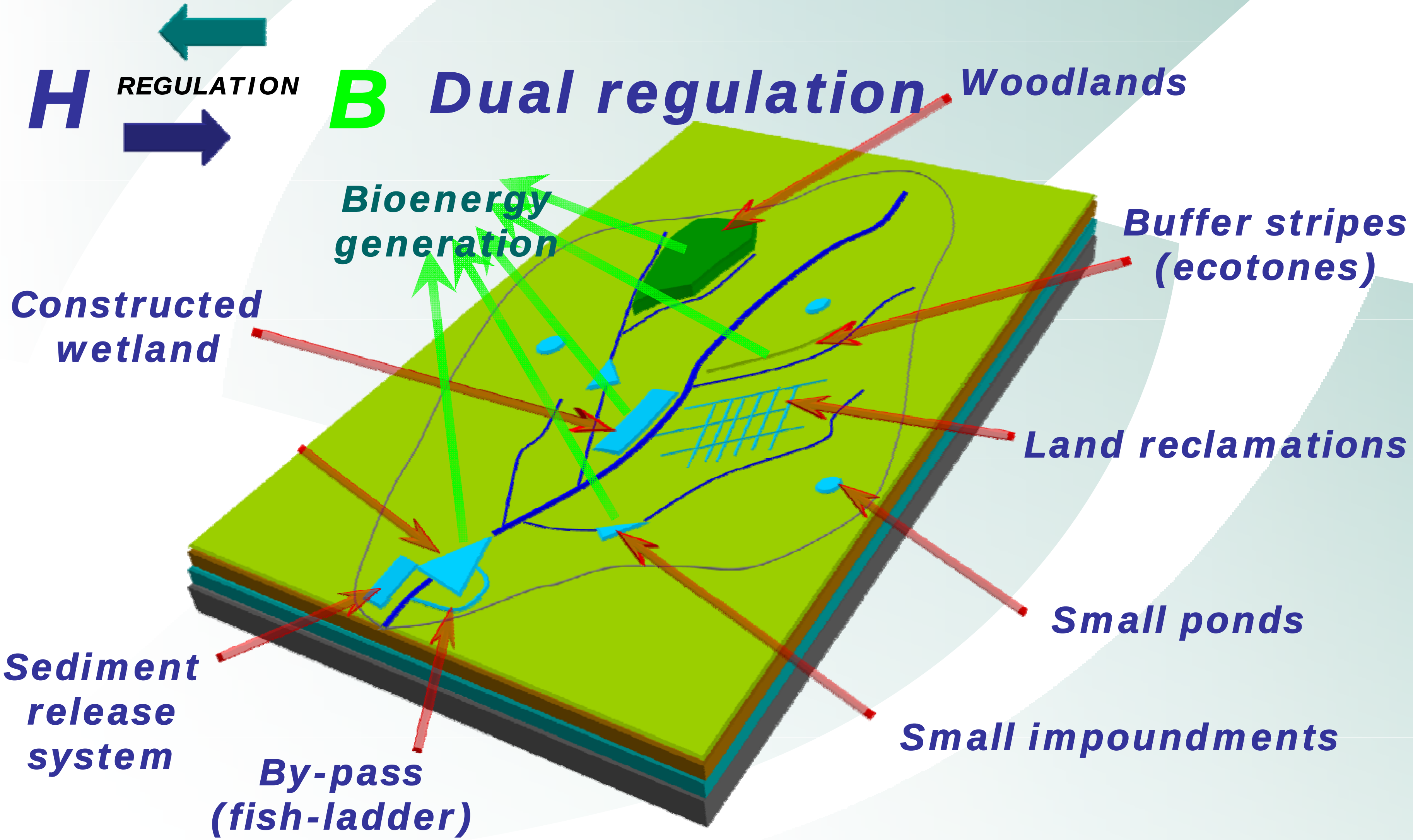
„Identification of the potential areas for the enhancement of ecosystem carrying capacity”



Zalewski 2008

III – THIRD PRINCIPLE

„The using of biota to control hydrological processes and vice versa, using hydrology to regulate biota"

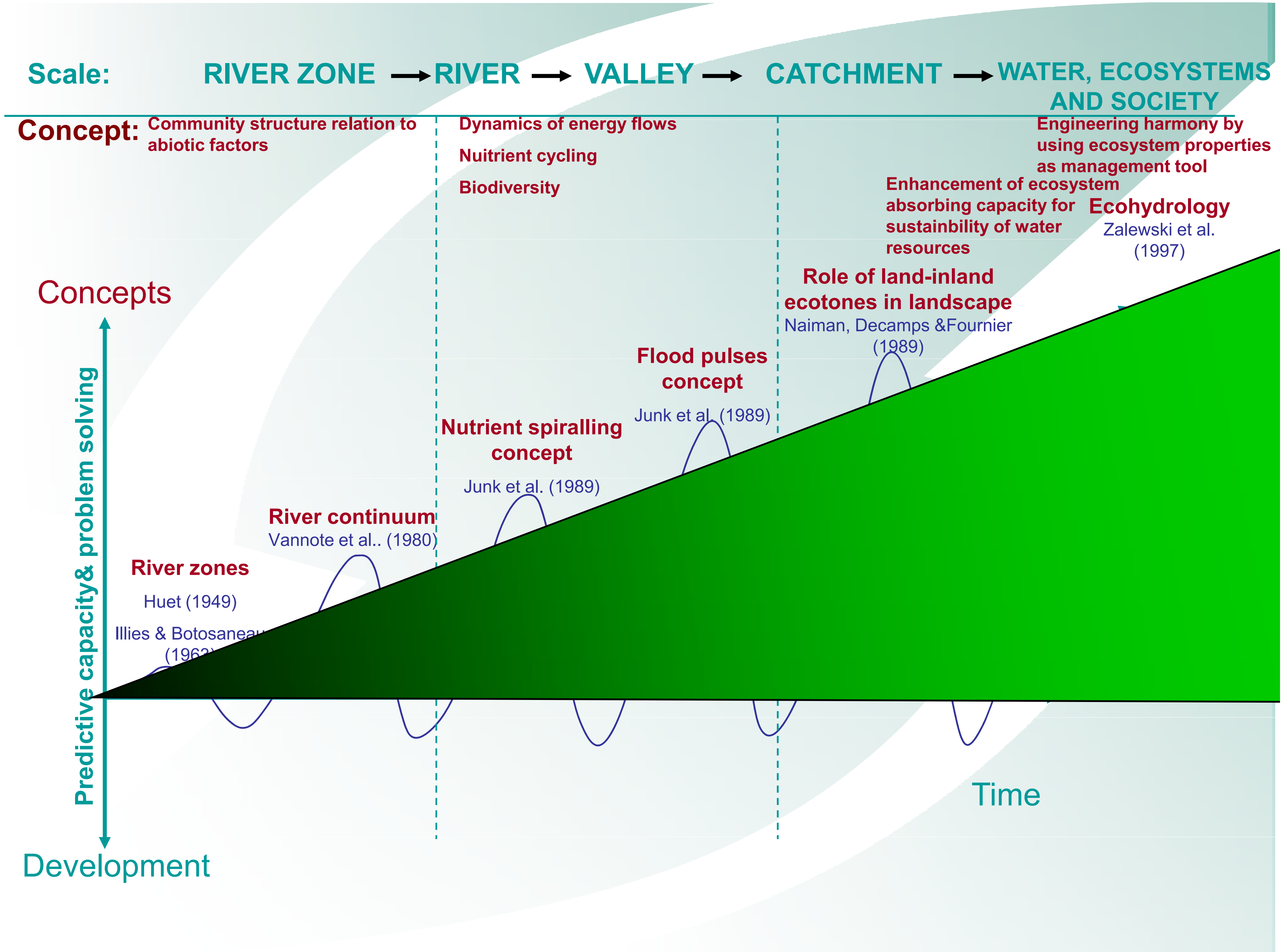


Zalewski 2008

Ecohydrology for IWRM

„Dual regulation" as ecological engineering technique

- To maintain the ecological flow with flood pulses, which can be done by science, conflict resolution and law enforcement;
- Overloading the freshwater ecosystems by nutrients and pollutants. Additionally to reduction of emission from point source pollution and good agricultural practices, the „dual regulation" has to be used for enhancement of resilience of ecosystems against human impact and the conversion of the excess nutrients and pollutants at aquatic ecosystems into non available pool.
- To prevent floods and droughts



Scale:
RIVER ZONE
RIVER
VALLEY
CATCHMENT
WATER, ECOSYSTEMS AND SOCIETY
Concept:
Community structure relation to abiotic factors
Dynamics of energy flows
Nuitrient cycling
Biodiversity
Engineering harmony by using ecosystem properties as management tool
Enhancement of ecosystem absorbing capacity for sustainability of water resources
Ecohydrology
Zalewski et al. (1997)
Role of land-inland ecotones in landscape
Naiman, Decamps &Fournier (1989)
Flood pulses concept
Junk et al. (1989)
Nutrient spiralling concept
Junk et al. (1989)
River continuum
Vannote et al.. (1980)
River zones
Huet (1949)
Illies & Botosaneau (1963)
Concepts
Predictive capacity& problem solving
Development
Time

a) Understanding of the past (e.g. paleohydrology, ecological succession patterns)

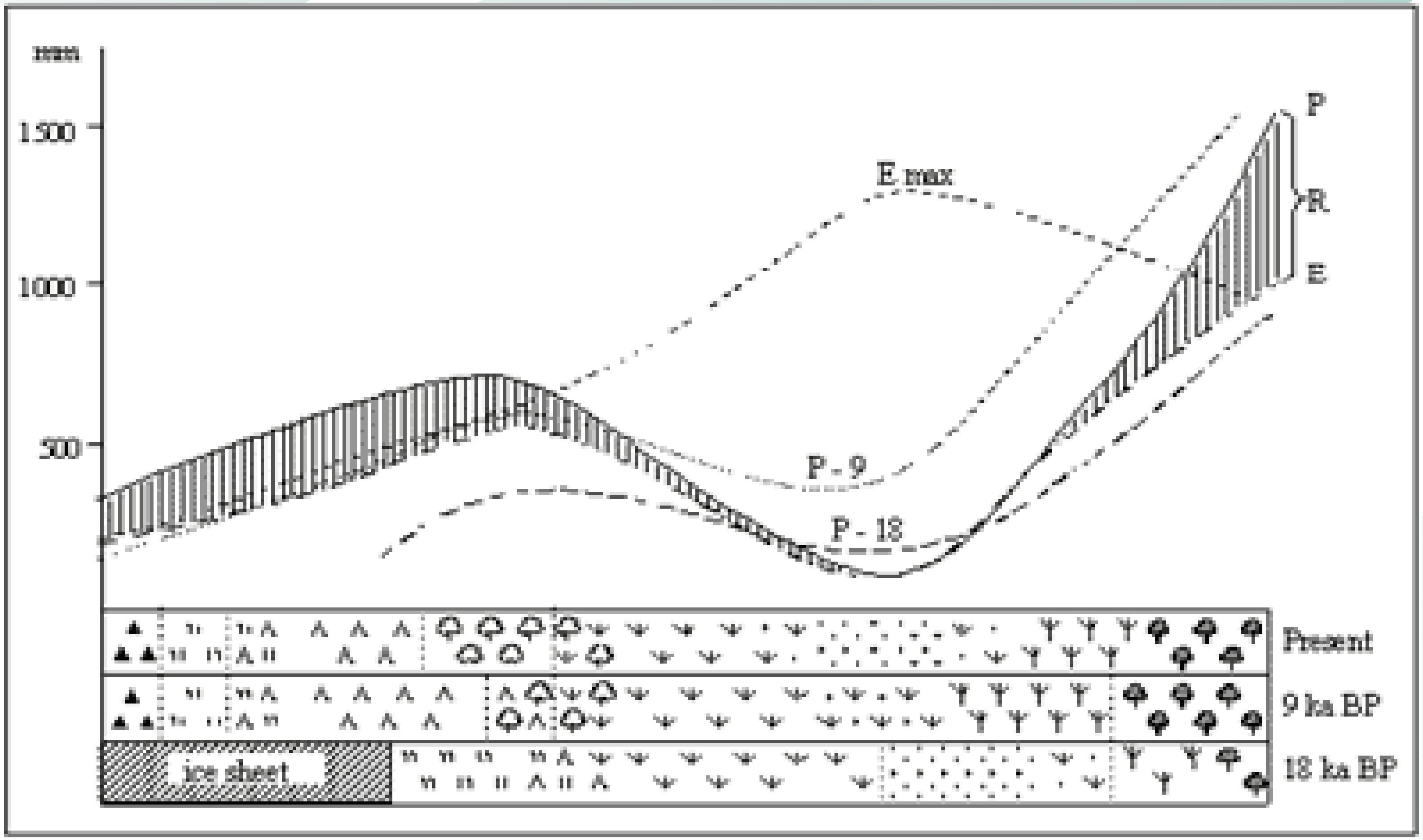
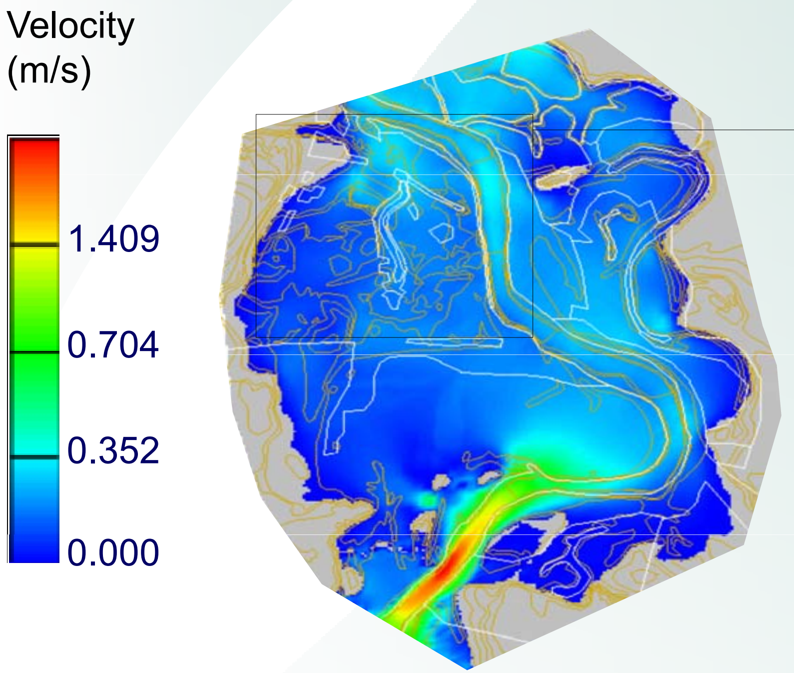


Fig. Changes in the rates of precipitation (P), runoff (R), and evaporation (E) along a European - African transect: 18,000 years BP, 9,000 years BP, and at present. Emax = present day potential evaporation (changed from Starkel 1988)

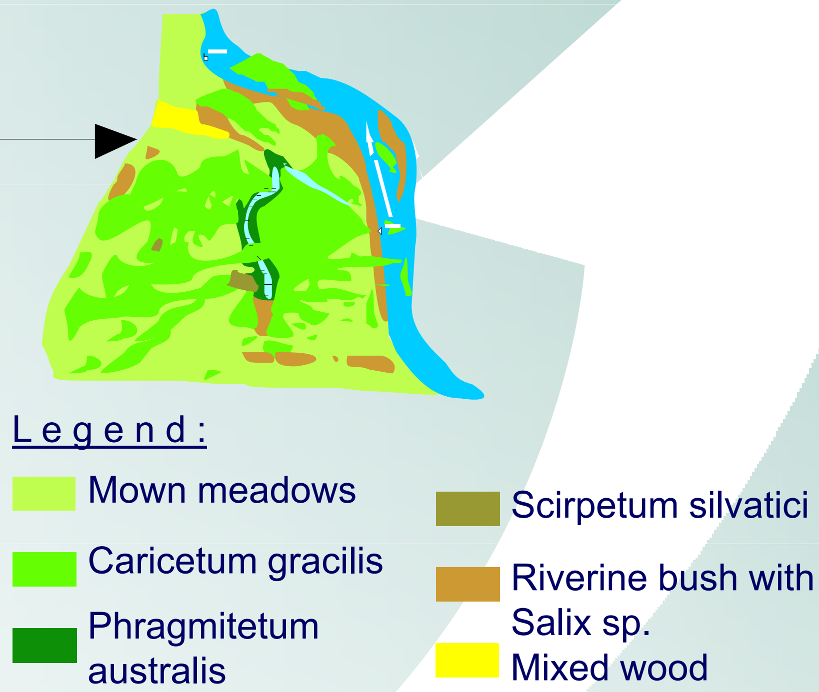
b) Integration of specific knowlegde of various disciplines

OPTIMIZATION OF THE BIOLOGICAL STRUCTUREOF THE PILICA RIVER FLOODPLAIN

for the enhancement of self-purification



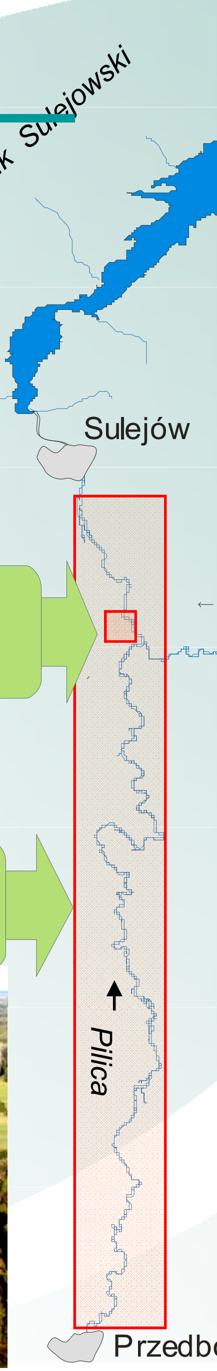
Distribution of water velocities on the floodplain during floods and high discharges



Distribution of wetland vegetation corresponding to the sequence of floodplain inundation

(Magnuszewski et al.. 2005; Kiedrzyńska et al., in press)

STUDY AREA

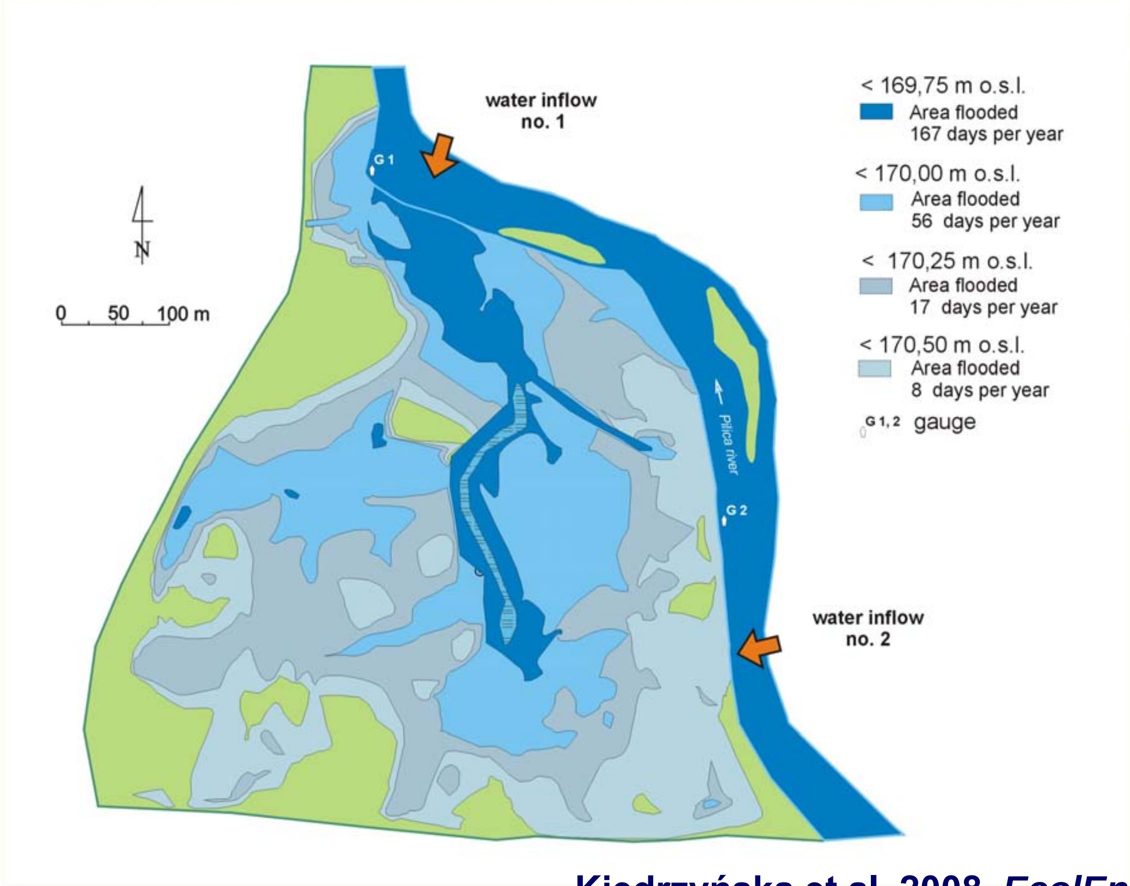


Area I
Experimental
Pilica River floodplain

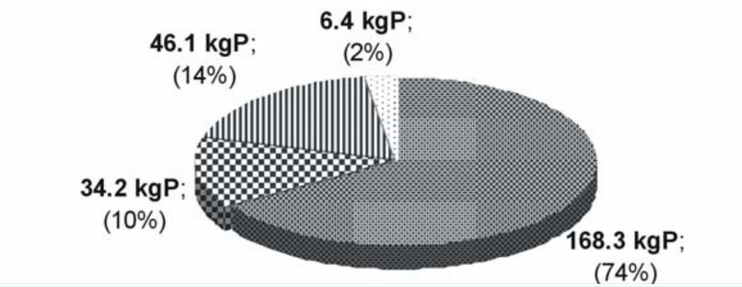
Area II
30 km section of the valley
between Przedbórz and Sulejów

Total phosphorus accumulation in the floodplain biomass

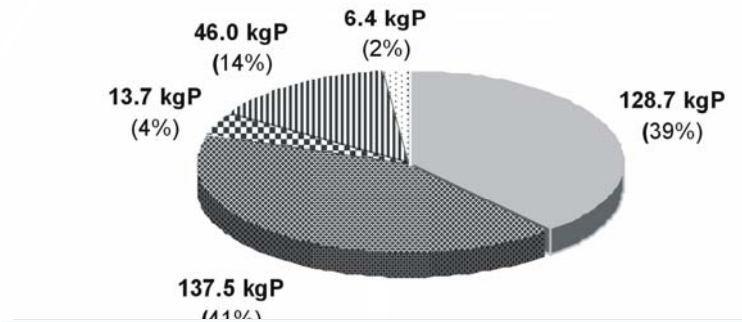
Enhancement of absorbing capacity of the floodplain for phosphorus accumulation



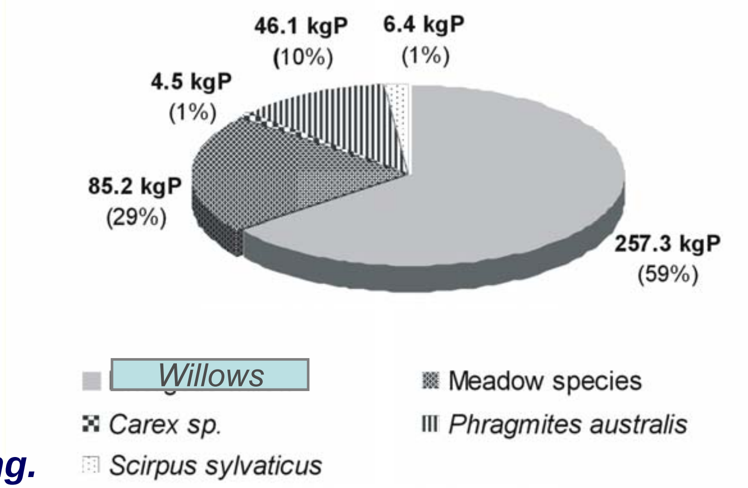
Present – macrophytes accumulation 255 kg P per floodplain



24% of area with willows 332 kg P per floodplain



48% of area with willows 399 kg P per floodplain

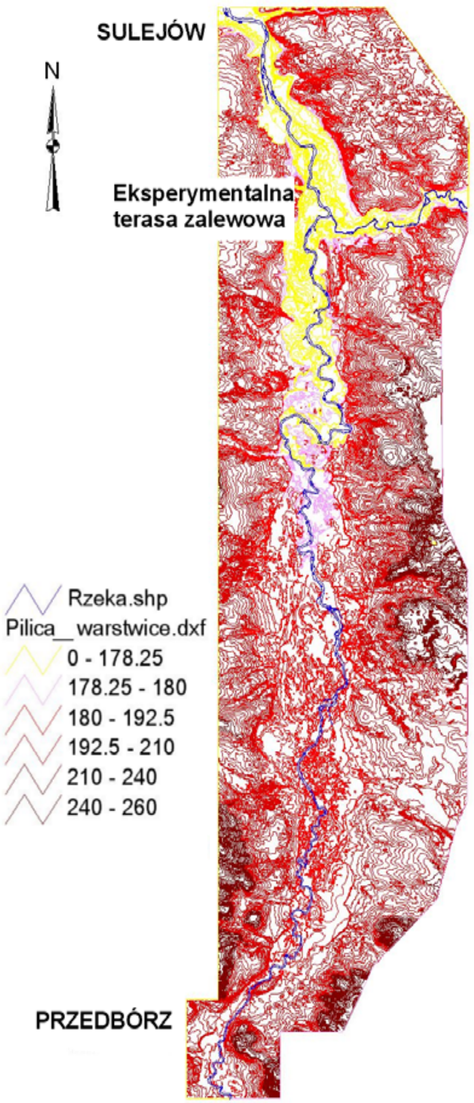


Kiedrzyńska et al. 2008. *EcolEng.*

Identification of the flooding areas in the valley and retention of nutrients and suspended sediment load

Digital Terrain Model of the Pilica River valley

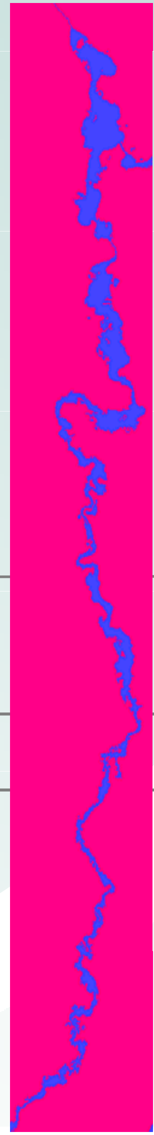
(30 km section between Przedbórz-Sulejów)



Models of the flooding for characteristic water level

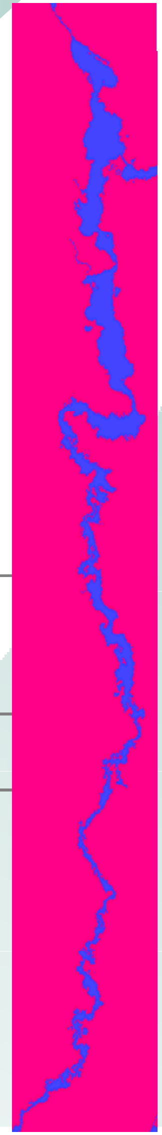
Average Water (248 cm)

818,3 ha



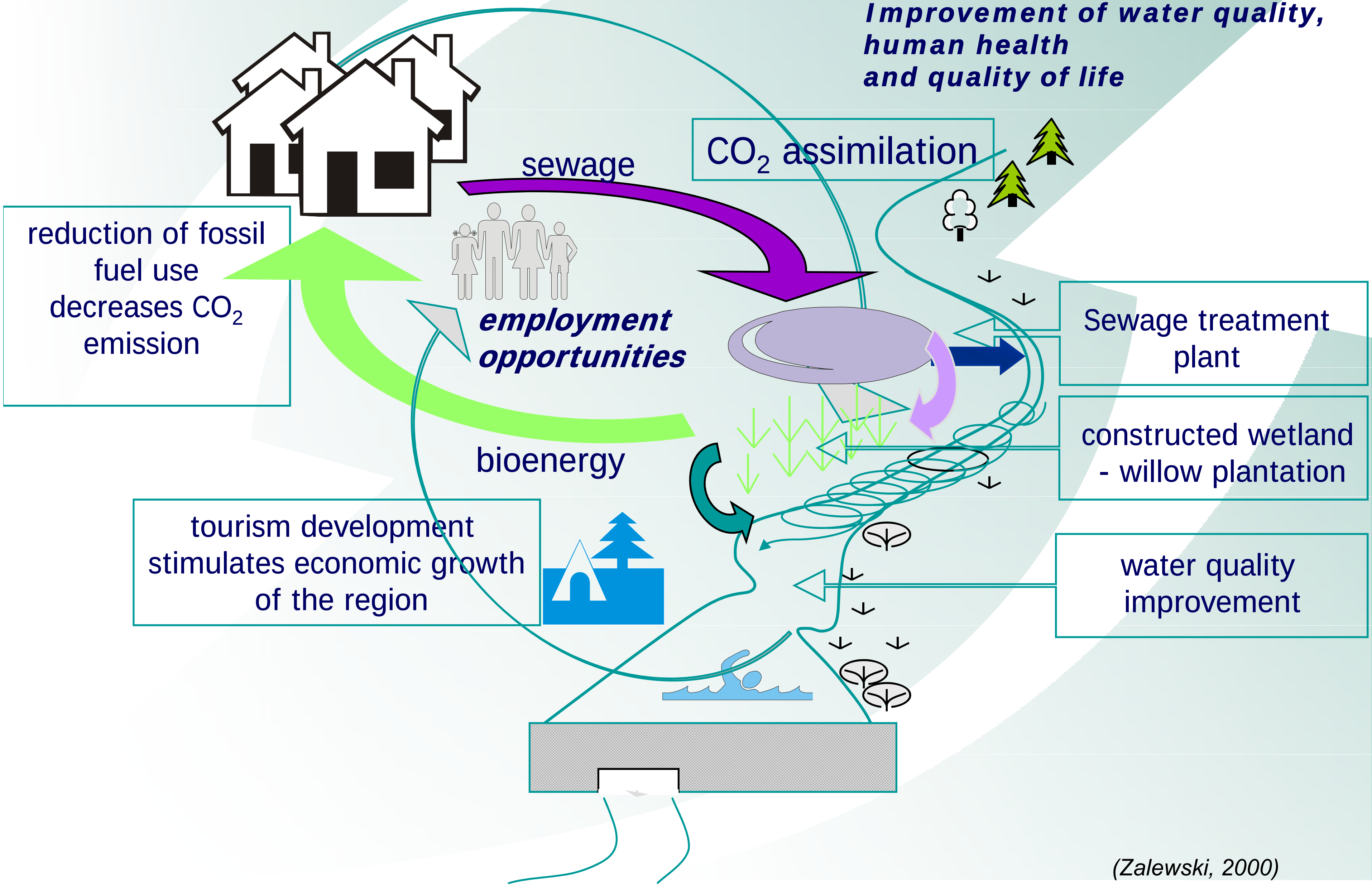
The Highest Water (260 cm)

1006,6 ha



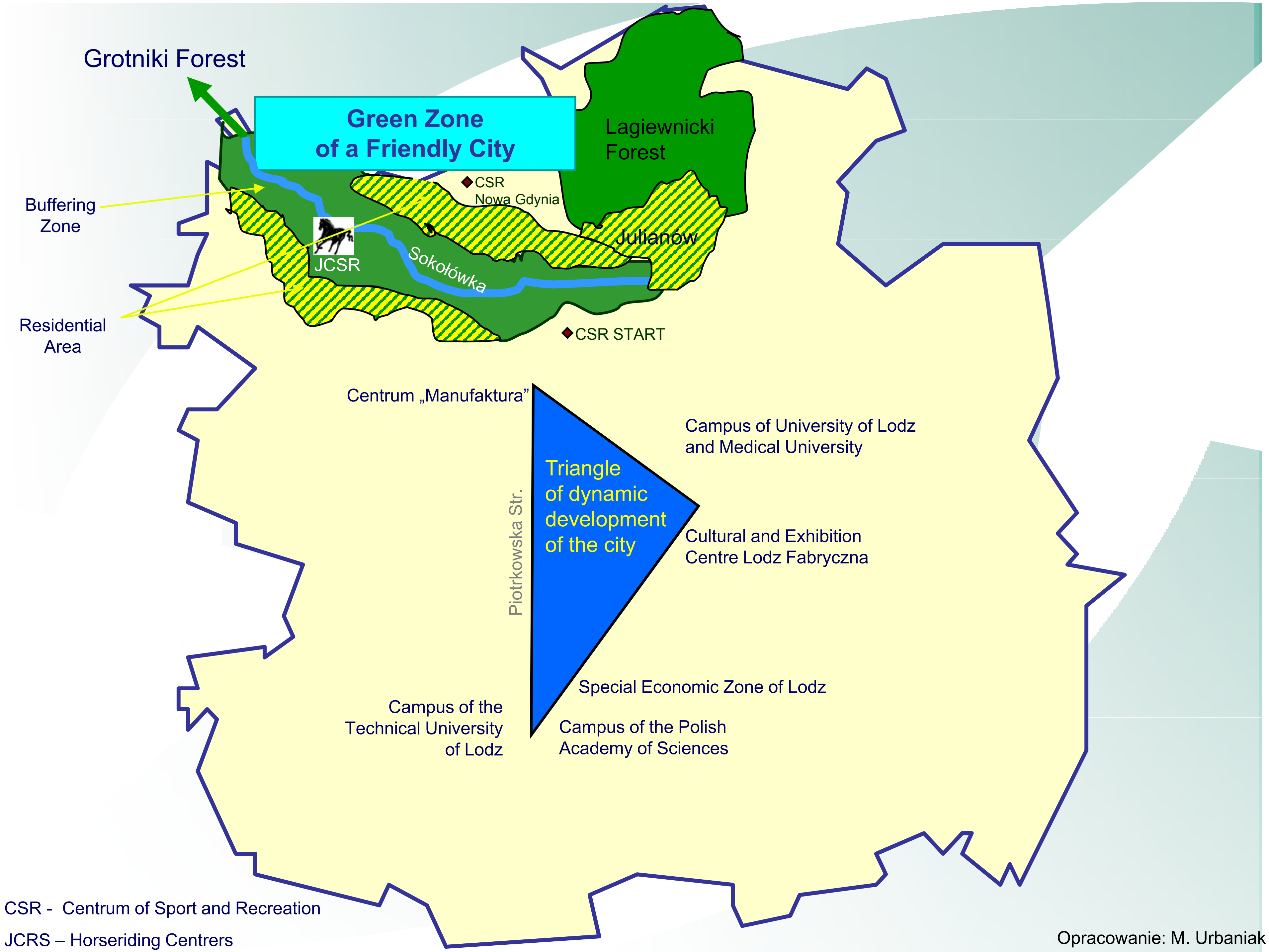
	Average Water (248 cm)	The Highest Water (260 cm)
Flooding areas	818 ha	1007 ha
Retention suspended sediment load	455 tons	560 tons
Retention TP	7 tons	8 tons
Retention TN	105 tons	129 tons

System solutions



(Zalewski, 2000)

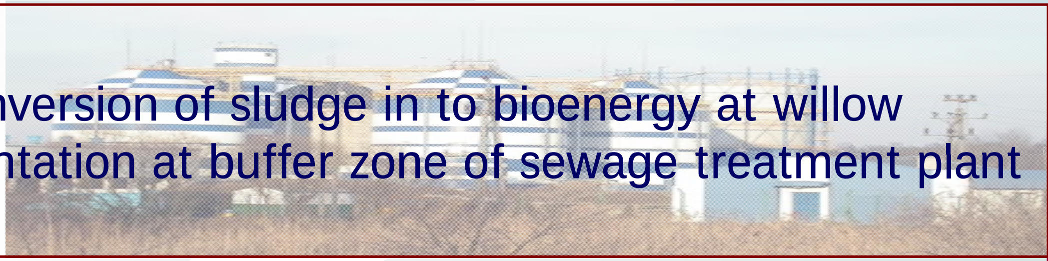
LODZ – the City of Water



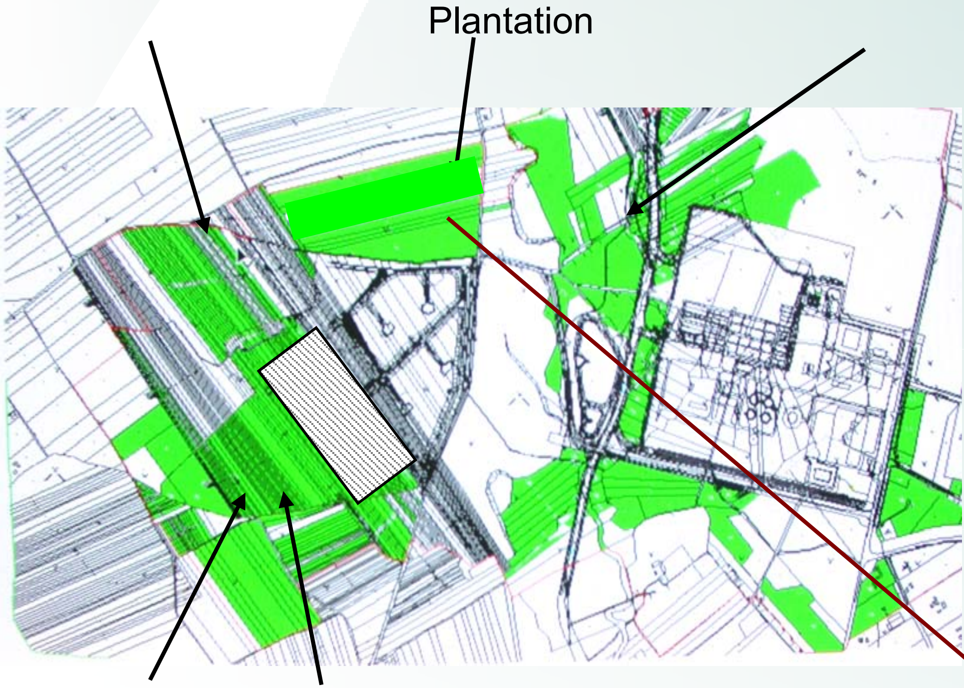
Grotniki Forest
Green Zone
of a Friendly City
Lagiewnicki
Forest
Buffering
Zone
CSR
Nowa Gdynia
Julianów
JCSR
Sokołówka
Residential
Area
CSR START
Centrum „Manufaktura"
Campus of University of Lodz
and Medical University
Triangle
of dynamic
development
of the city
Piotrkowska Str.
Cultural and Exhibition
Centre Lodz Fabryczna
Special Economic Zone of Lodz
Campus of the
Technical University
of Lodz
Campus of the Polish
Academy of Sciences
CSR - Centrum of Sport and Recreation
JCRS – Horseriding Centres
Opracowanie: M. Urbaniak


A = 0,44 ha

c) Considering the society’s priorities vs. ecosystem carrying capacity



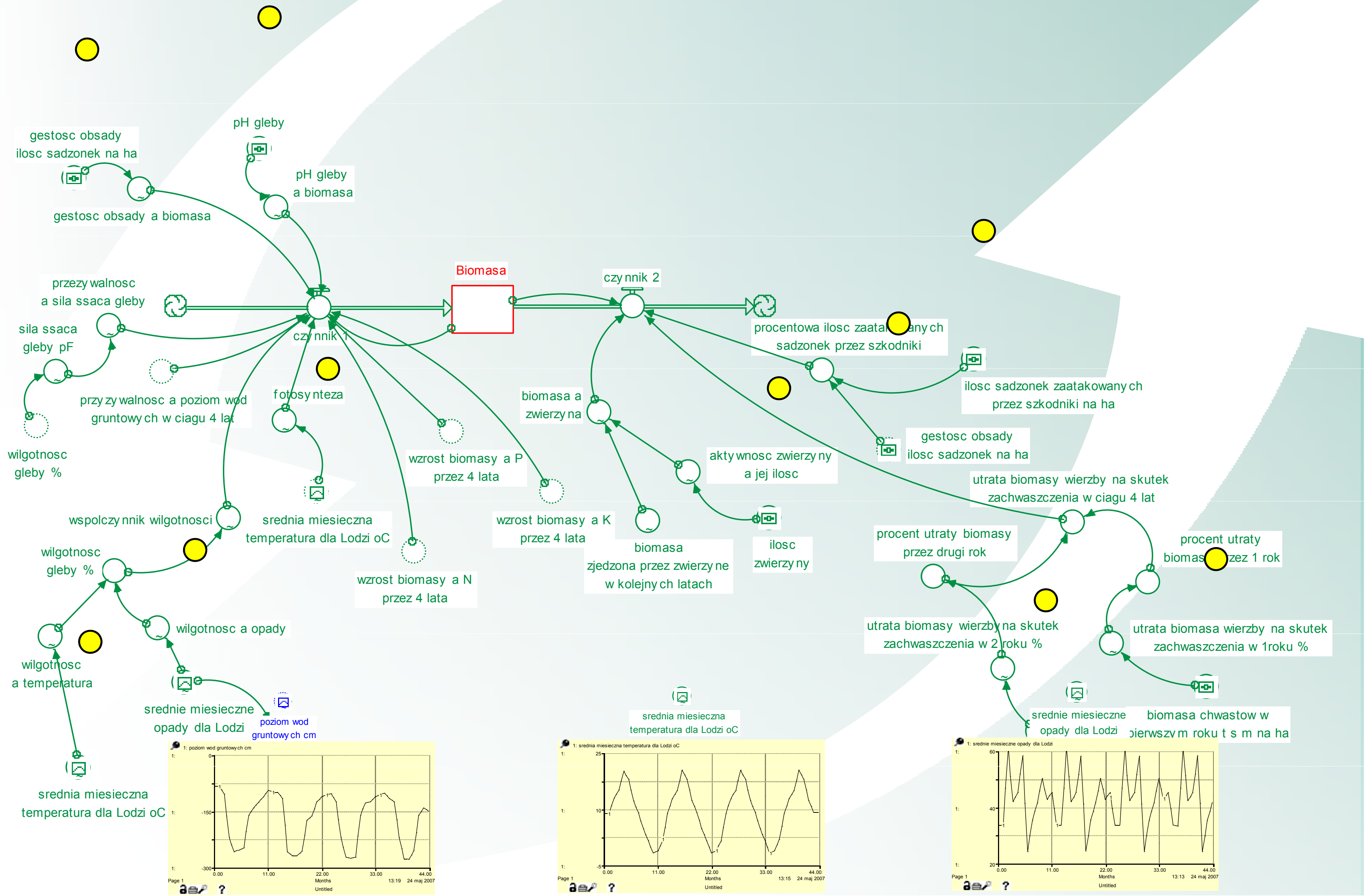
Conversion of sludge in to bioenergy at willow plantation at buffer zone of sewage treatment plant



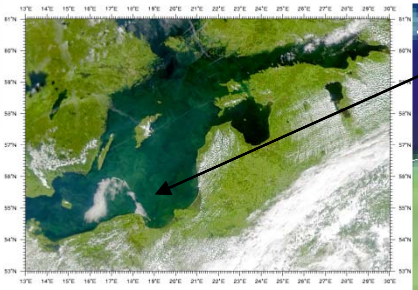
Comparative experiments on different species and varieties of willow

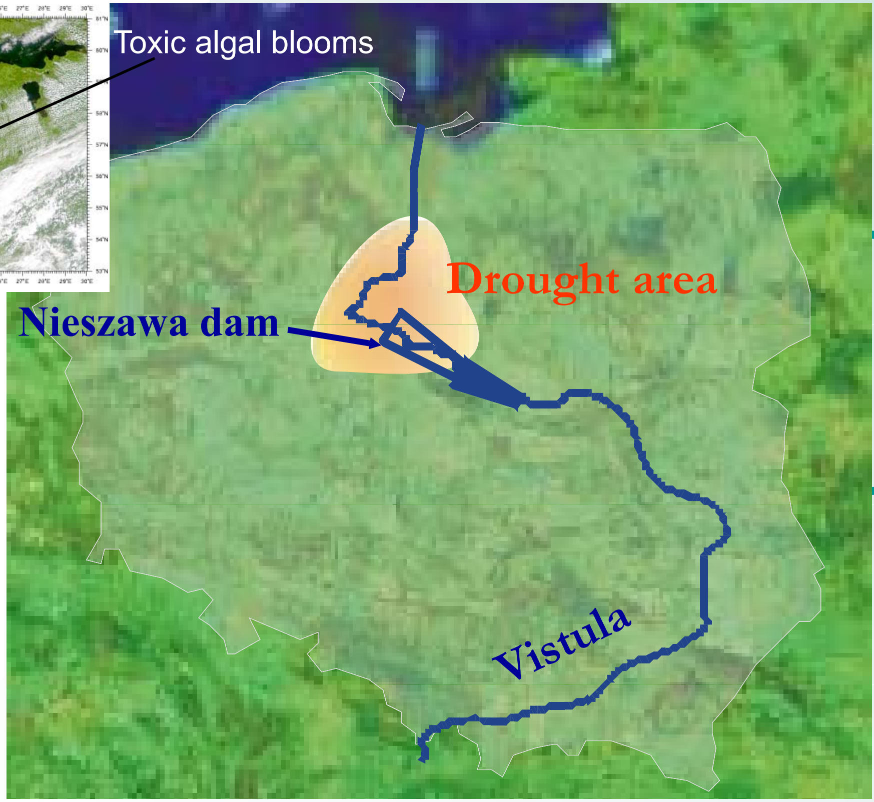
I: Salix viminalis clones;
II: Tordis (Salix schwerini x S. viminalis) x S. viminalis;
III: Salix viminalis gigantea;
IV: Salix viminalis (clone 192)

The algorythm of the mathematical model for optimisation the sludge use at bioenergy plantation



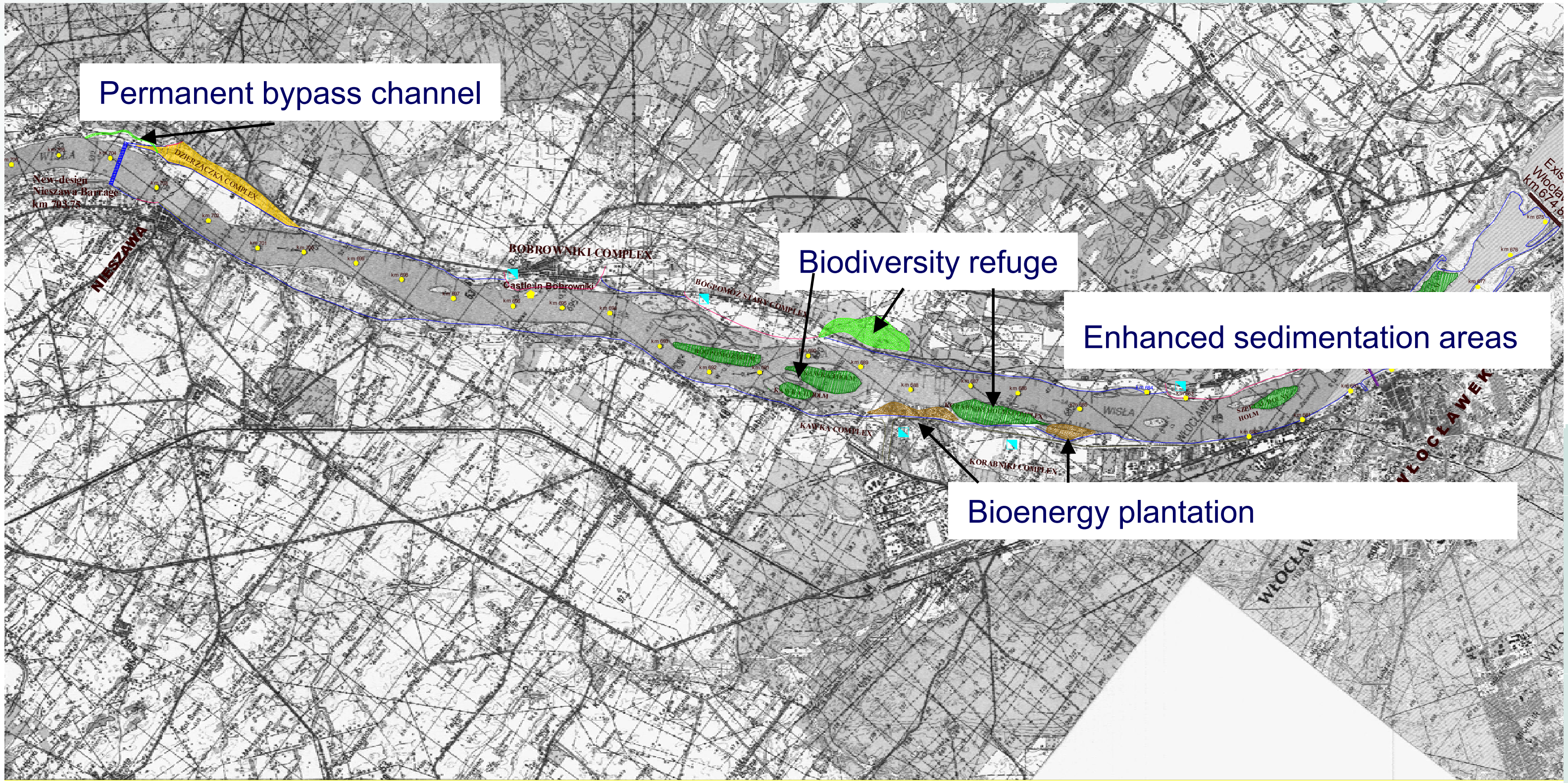
Ecohydrological approach for sutainability of Nieszawa dam construction (Vistula River)





- Reduction of blue-green algae blooms in Baltic main tourist zone : *6 mln tourists = 6 bln $*
- Elimination of the danger of flood up to 1 bln $
- Use of water for agriculture 0.3 bln$
- Hydro energy (*100 mln $ annually*) = zero CO_2 emission
- Elevation of ground water level for biodiversity maintenance in the area of hydrological drought

Implementation of ecohydology for harmonisation of new dam reservoir on Vistula river with Water Framwork Directive of UE



LORIS VISION
Regional Technological Foresight

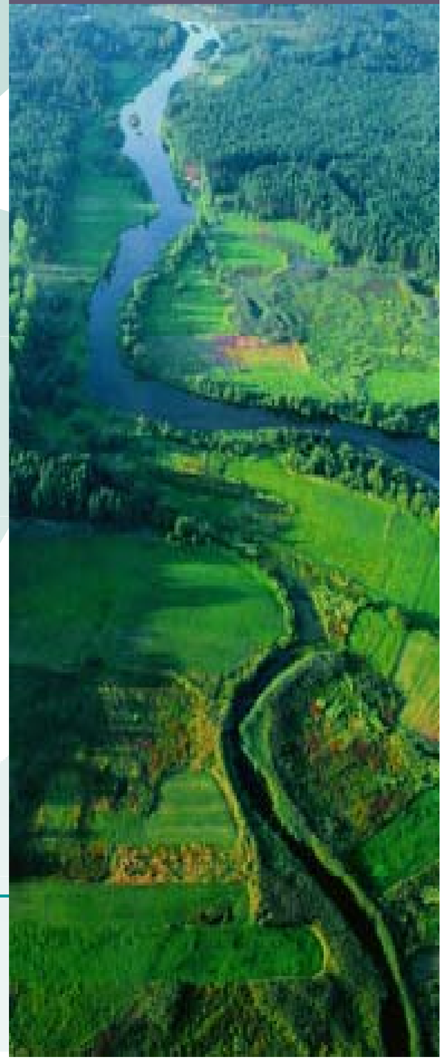
Technological Foresight is the system approach for evaluation of new trends on the basis of knowledge and technologies from the point of wiev economy, quality of life and sustainable development.

Technological Foresight has 3 main goals:

1. **FORECAST OF FUTURE – enable of undertaking the adaptative attempts, preparation for unpredictable events, reduction of negative consequences of events that can not be changed**

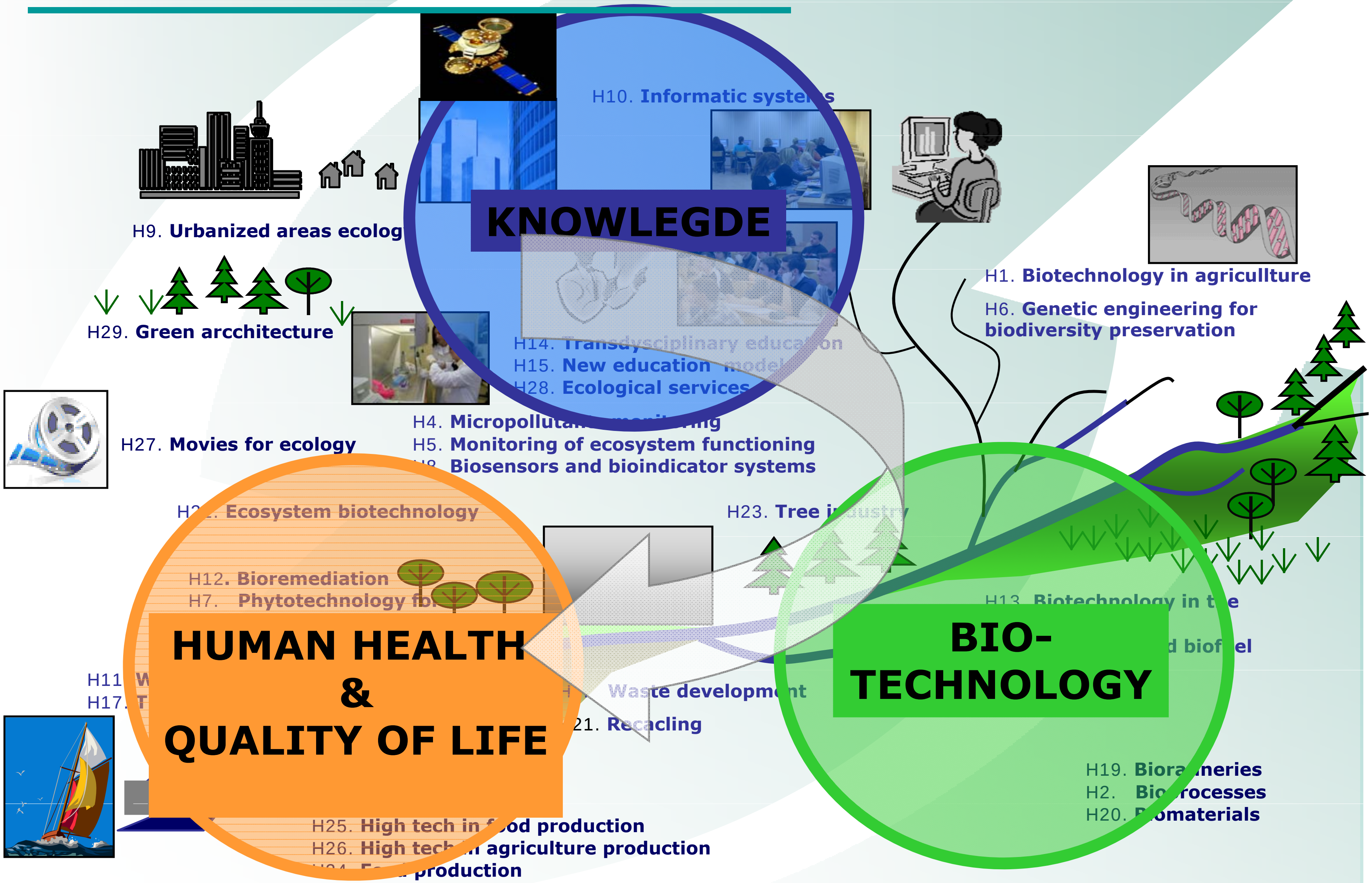
2. **MANAGEMENT OF FUTURE – means the proactive *(management of probable crisis)* and positive *(mangement by goals)***

3. **CREATION OF FUTURE – means mainly the proactive creation of needed vision of future**



Tylna 3, 90-364 Lodz, Polska
Tel: (+48) 42 681 70 07
Fax: (+48) 42 681 30 69
www.erce.unesco.lodz.pl

Identification of the future scenarios for Łódż region by using „foresight" methodology



Ecohydrology for sustainable water, biodiversity ecosystem services & preventing of floods and droughts

PROBLEM

Floods, droughts, water quality and sustainablity of ecosystem services

VISION
Millenium Development Goals

POLICY
eg. Water Framework Directive

ASESSMENT
- Ecological status
- Hydrology
- Hydrochemistry
- Biomonitoring

Considering remote sensing data of catchment and specific of its antropogenic modifications from the point of view of integrity

ECOHYDROLOGY

Integrative analysis of
DYNAMICS OF HYDROLOGICAL AND BIOLOGICAL PROCESSES

Identification of
REGULATORY FEEDBACS
between hydrology and biota for potential application in water management

INTEGRATION AND HARMONISATION
all range of regulatory feedbacks (E-H) and hydrotechnical facilities in basin scale for restoration and enhancement of carrying capacity considering socio-economic and climatic scenarios

ADAPTATIVE IMPLEMENTATION
The use of ecosystem properties as an complementary tool to hydrotechnical solutions:
- Consultation with authorithies, stakeholders
- Adaptative assessment and management

GOAL
MDG of UN, Good ecological status

(Zalewski 2004)

What Ecohydrology propose in respect to above challenge

For ECOLOGY:
enhancement of ecosystem carrying capacity understand as improvement of water quality, biodiversity and ecosystem services

For SOCIETY:
low-cost high technologies for sustainable water and ecosystems;

For WATER SCIENCE:
use of ecosystem properties as a management tool;

Implementation

For implementation of new approach and solutions for sustainable floodplain management, three steps, have to be done:

- **The decision makers and society environmental consciousness has to be expanded by education– (e.g., ecological engineering, ecohydrology)**
- **Foresight methodology has to be applied for development of scenarios toward sustainable future**
- **Legal framework has to be adopted to the recent progress in environmental sciences**