Ecohydrological system solutions to enhance ecosystem services:

The Pilica River - Global Reference Site
for UNESCO IHP Ecohydrology

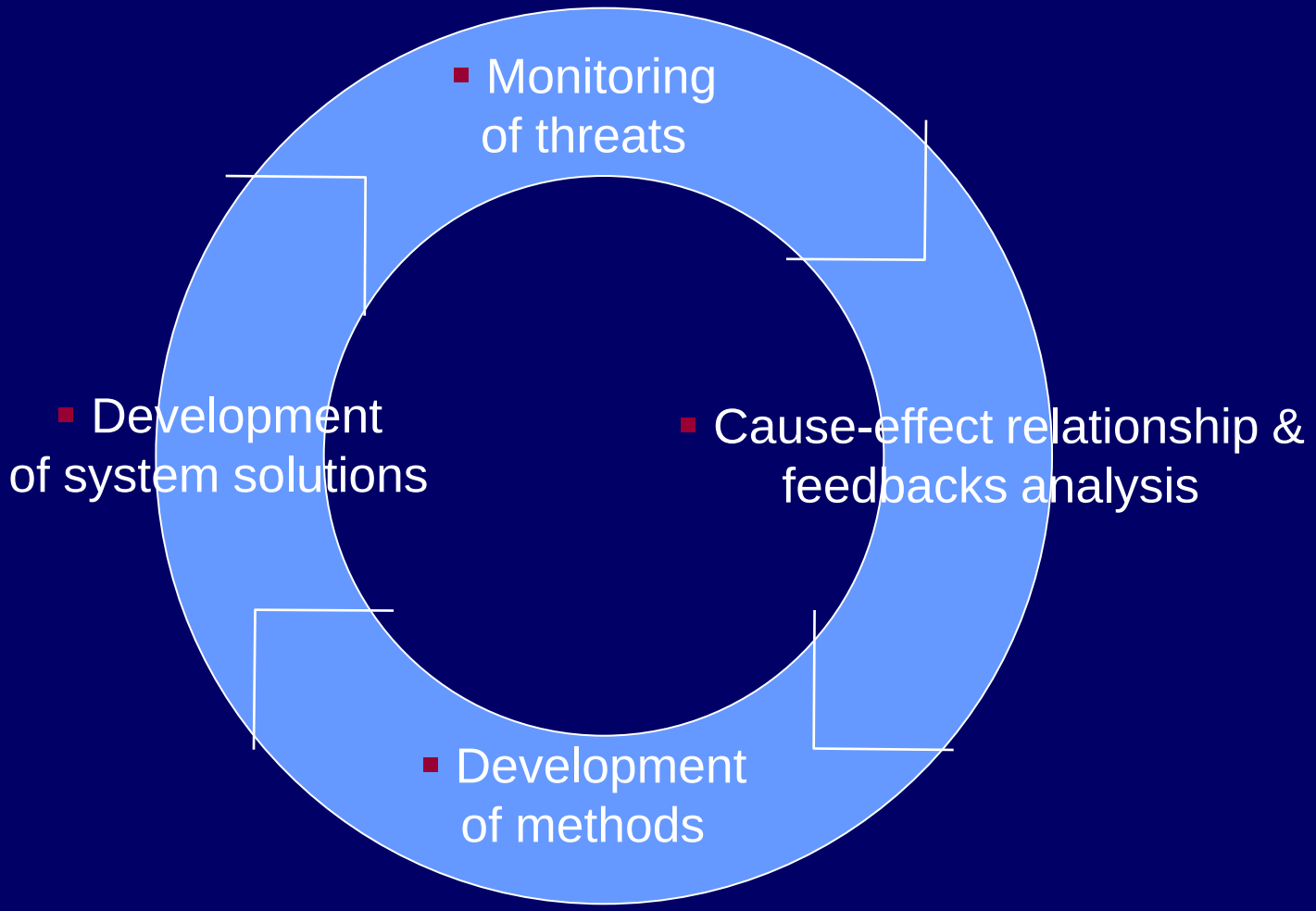
K. Izydorczyk, W. Fratczak, I. Wagner, M. Zalewski

The International Institute of Polish Academy of Sciences
EUROPEAN REGIONAL CENTRE FOR ECOHYDROLOGY
under the auspices of UNESCO



Ecohydrology

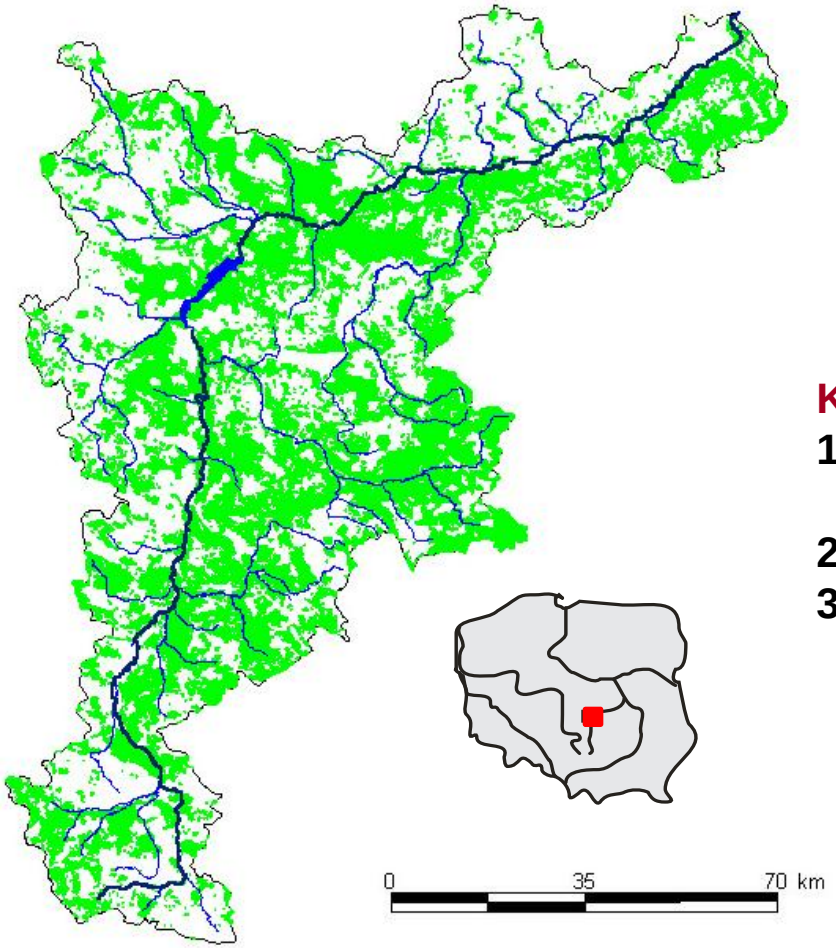
methodology for implementation in IWRM



(Zalewski 2002, Wagner et al. 2009.)



PILICA RIVER & KEY ISSUES



Catchment

Total area: **9245 km^2**
Land use: agricultural - **64 %**
forest - **31%**

The Pilica River

Overall length: 342 km

Mean discharge: 18,51 m^3 s^{-1} (1984-1996)

Key ecological problems:

1. **Non-point sources pollution** resulted from agricultural usage of the catchment
2. **Point sources pollution**
3. **Toxic cyanobacterial blooms in the Sulejów Reservoir** which restrict use of the reservoir as drinking water supply and recreation area





Ecohydrology

methodology for implementation in IWRM

- Monitoring of threats

- identification and quantification of a threat,
- its seasonal and/or spatial dynamics
- monitors both the threat and its drivers and causes

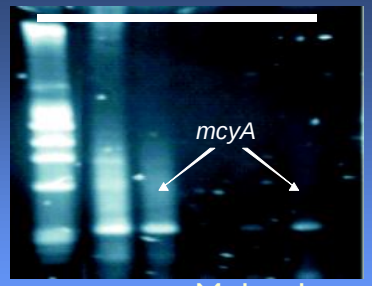
(Zalewski 2002, Wagner et al. 2009.)

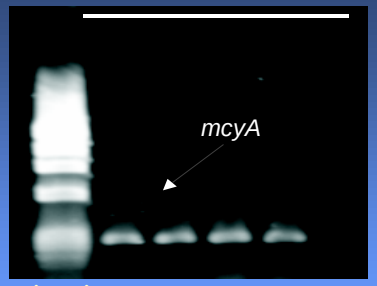


Early warning system using molecular methods

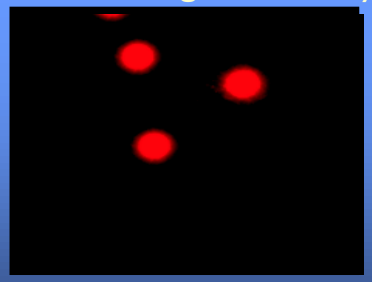


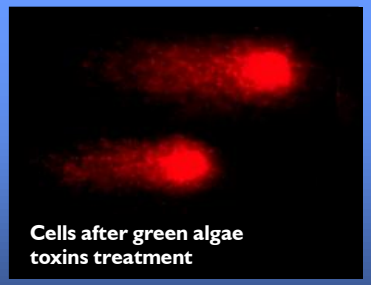
Blue-green algae blooms due to reservoir eutrophication





Molecular monitoring as an early warning system against toxic cyanobacterial blooms





Demaged DNA in human limphocyts

(Mankiewicz et al., 2005, Mankiewicz et al. 2011)

Ecohydrology

methodology for implementation in IWRM

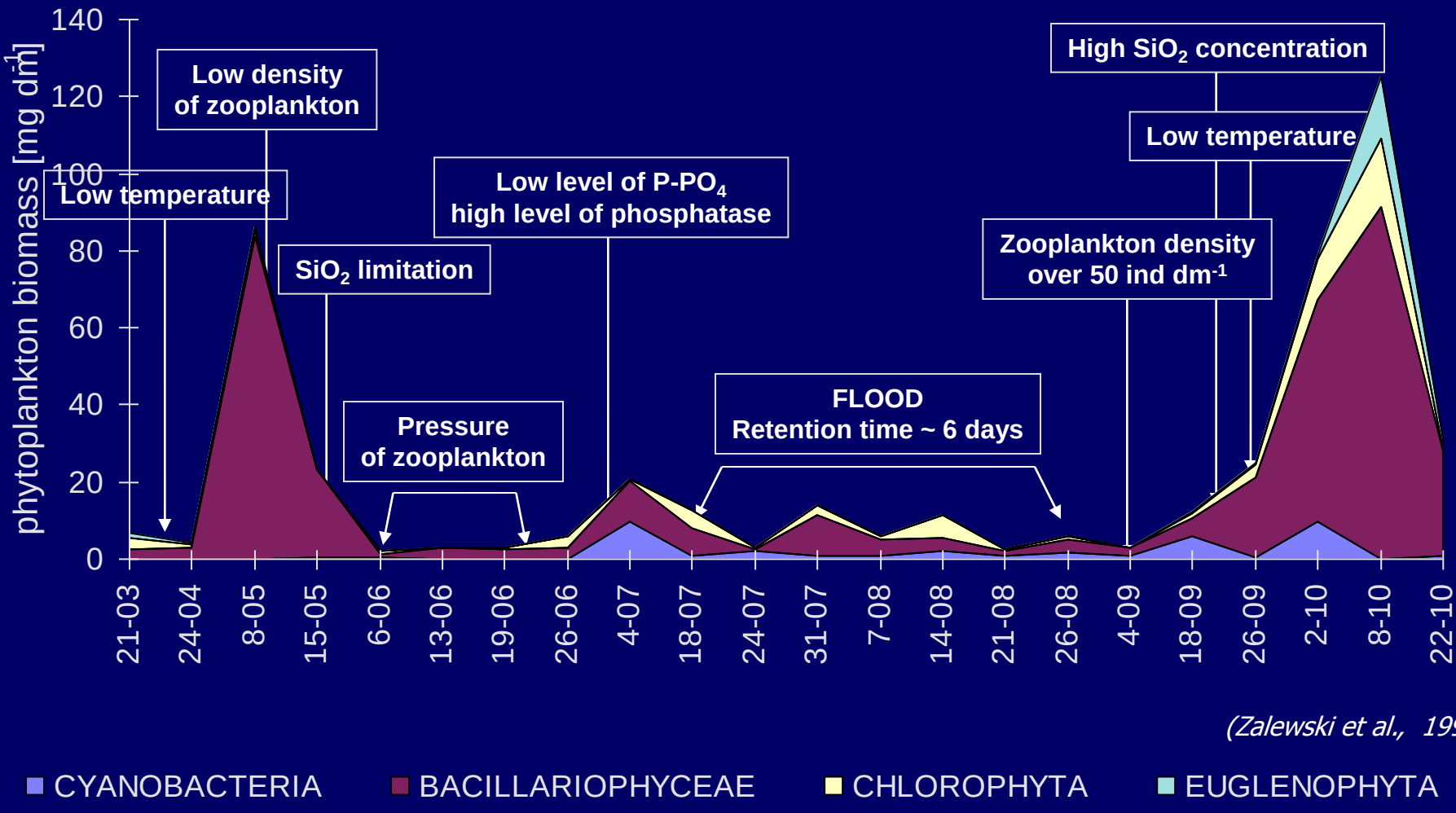
- quantification of the cause-effect relationship determining the threat and its causes ;
- identification of the hierarchy of factors influencing the dynamics of the threat ;
- quantification of the resilience (or resistance) of the catchment and/or their individual elements

- Cause-effect relationship & feedbacks analysis

(Zalewski 2002, Wagner et al. 2009.)

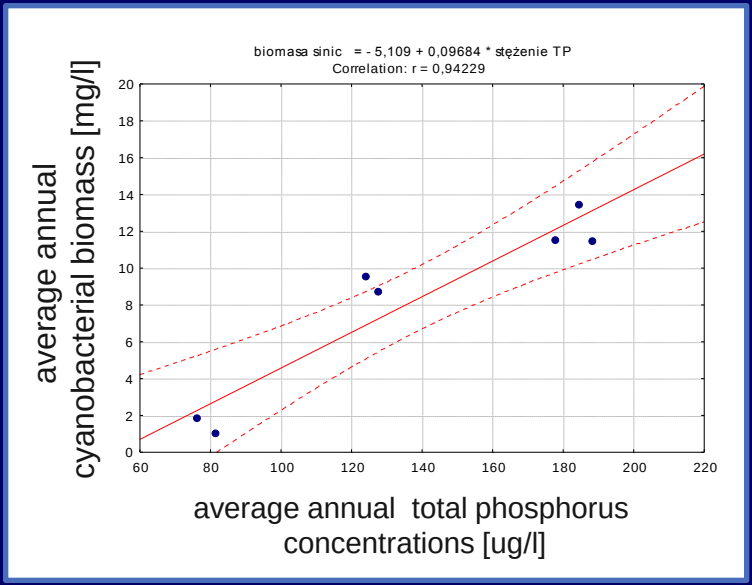


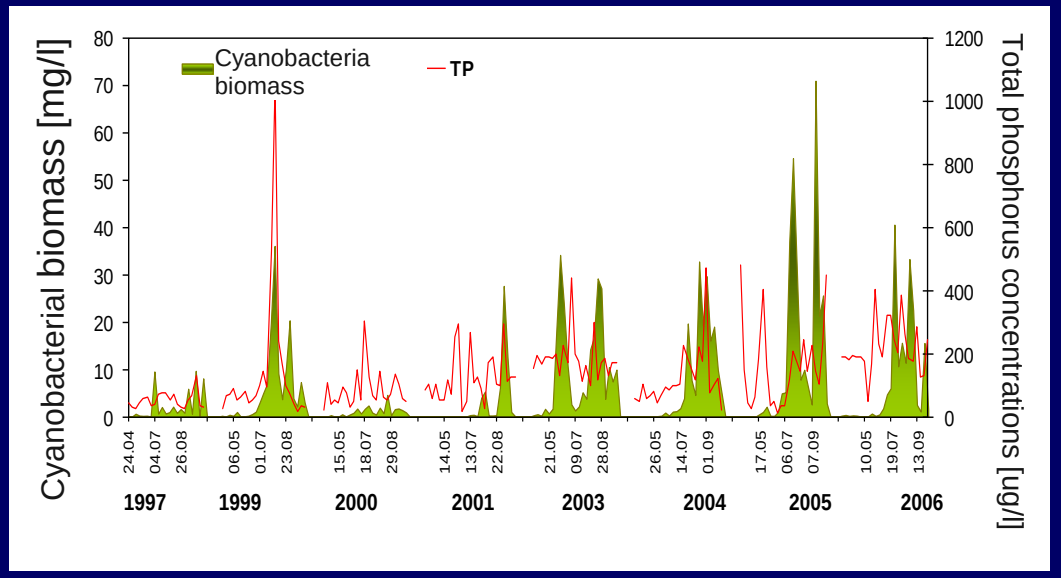
Identification of the hierarchy of factors influencing toxic cyanobacterial blooms



(Zalewski et al., 1999)

Increased phosphorus concentration leads to increase in frequency and intensity of cyanobacterial blooms

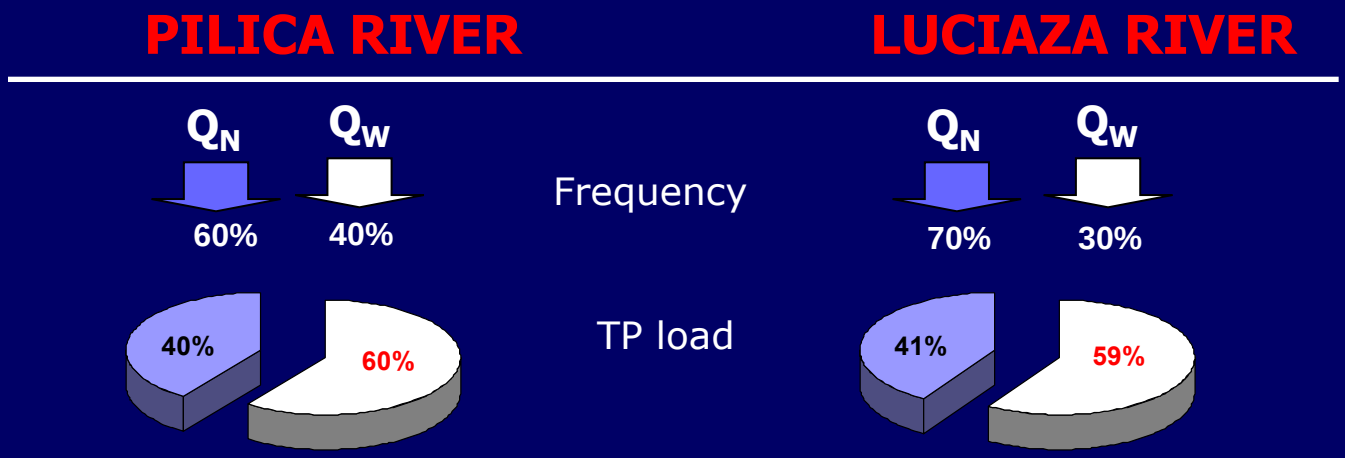


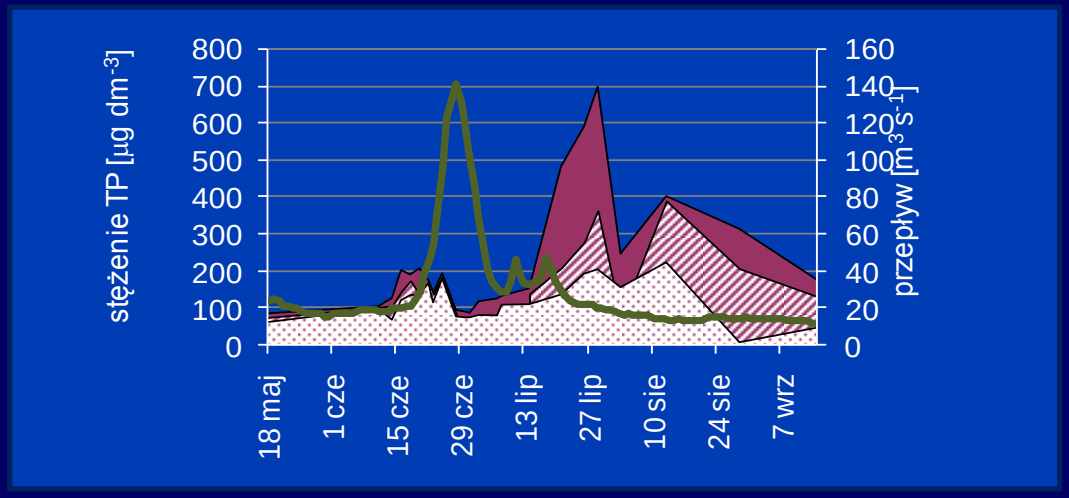




(Izydorczyk, Zalewski, in preparation)

Hydrochemical composition of waters inflowing via tributaries significantly differs from the pattern of water discharge





(Wagner 2000)

Identification and quantification of point and non-point (diffuse) nutrient sources

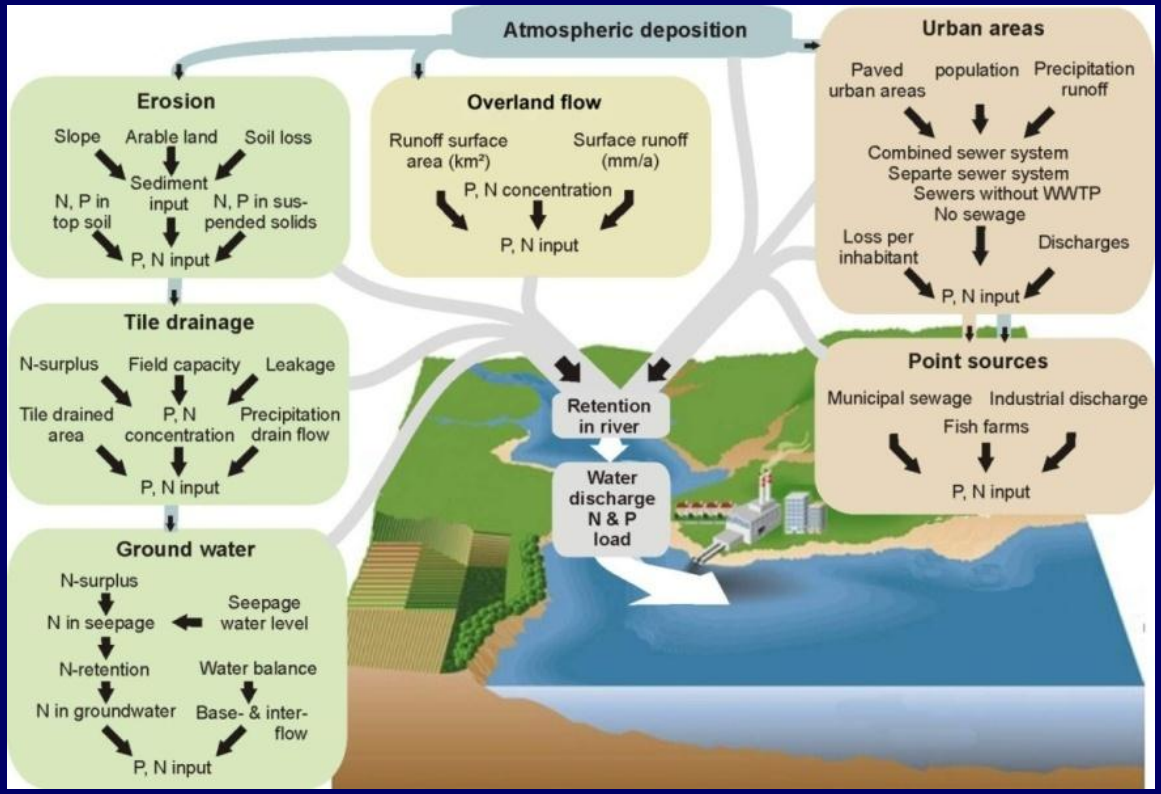
MONERIS Model

MOdeling **N**utrient **E**missions in **RI**ver **S**ystems

Input spatial data (e.g.):
- Digital elevation model
- River network
- Soil
- Hydrogeology
- Land use
- Hydrometeorology

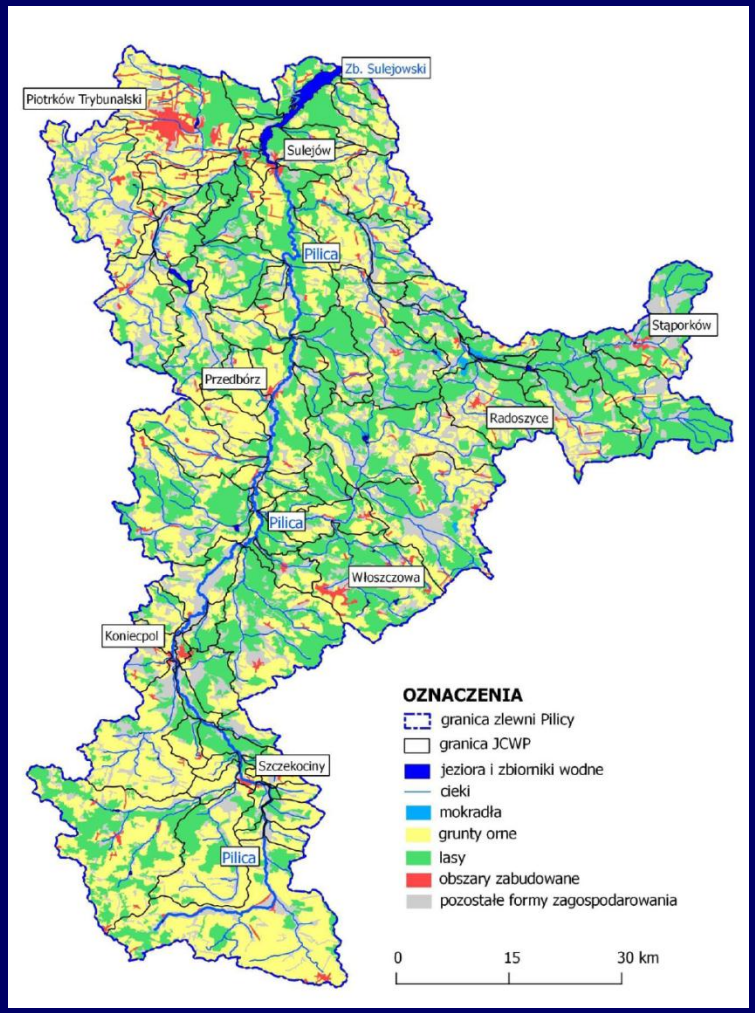
Data from administrative units (e.g.):
- Population
- Agriculture
- Waste water statistic

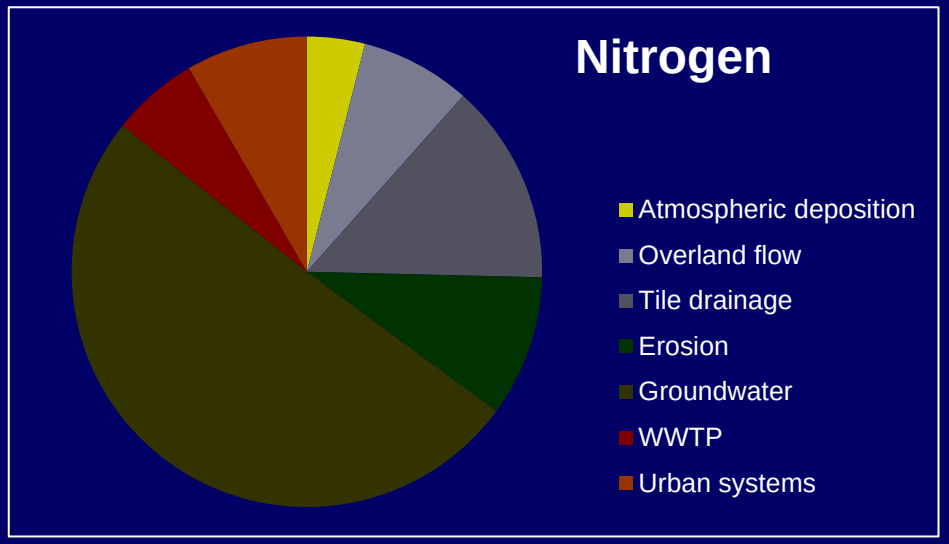
Data for goe-referred issues:
- Data from water quality measuring points
- Data from water discharge measuring points
- Data from precipitation

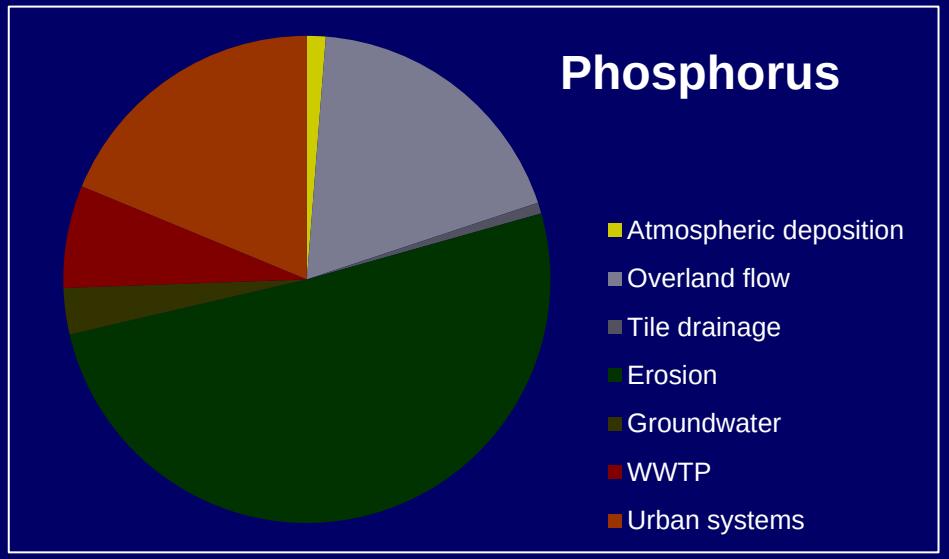


(Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Germany)

Nutrients emission from different ways into Sulejow Reservoir

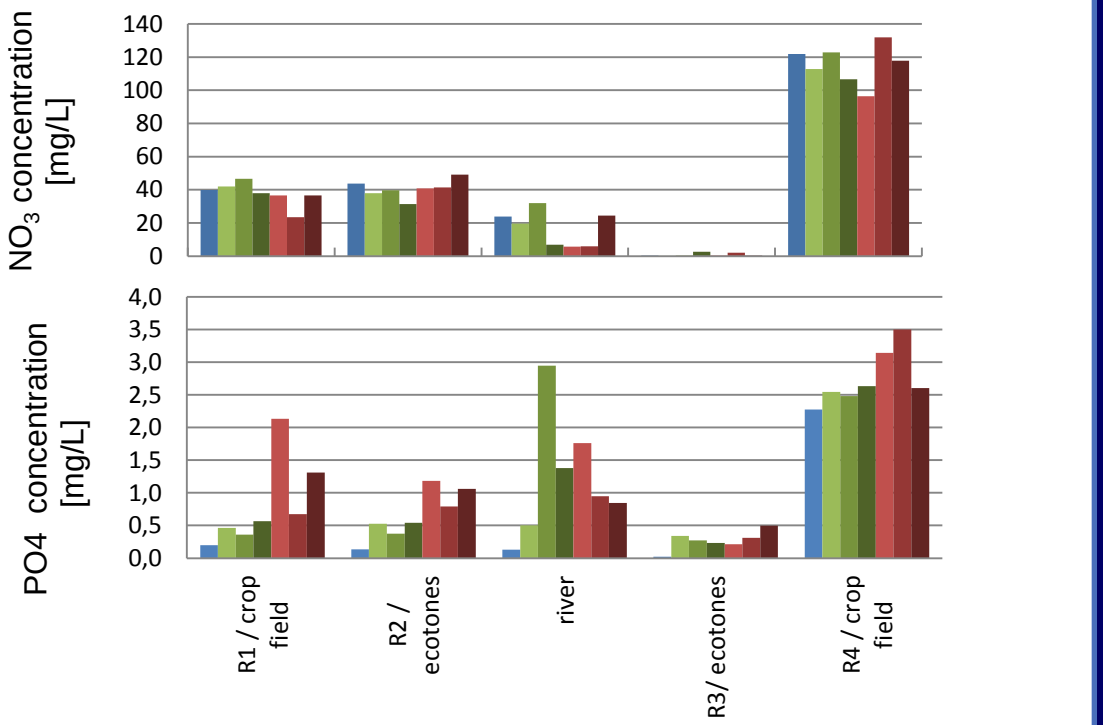






(Kowalkowski 2012)

Impact of hydrogeological conditions on nutrients migration from fertilizers into groundwater









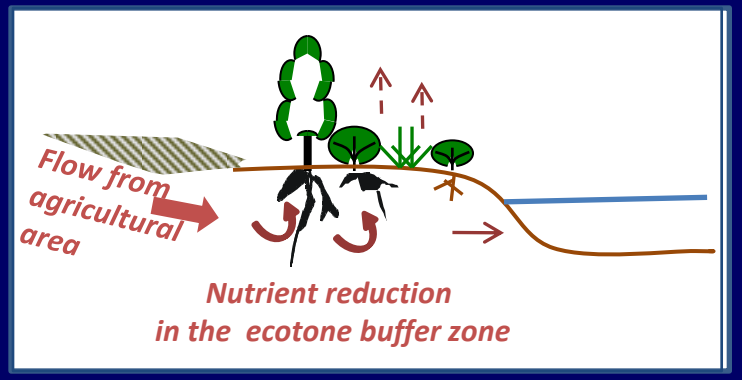
EKOROB

Riparian buffer zones as tools for reduction of diffuse pollution

- To maintain or improve water quality by trapping and removing various nonpoint source pollutants from both overland and shallow subsurface flow;
- To protect banks of water bodies against erosion
- To improve the microclimate by regulation water temperature and light penetration to a river bed
- To create new habitats and migration corridors and stepping stones

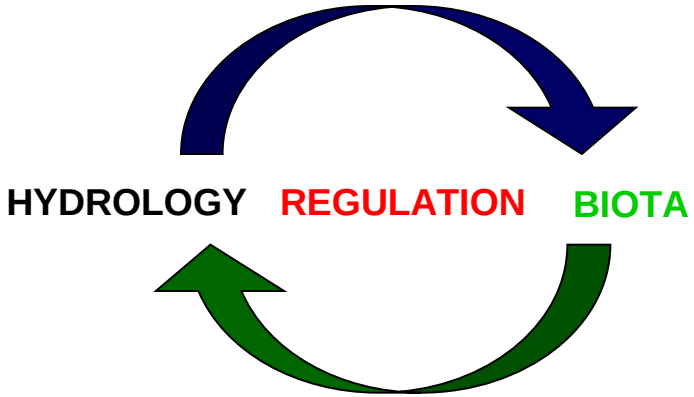






Ecohydrology: is the sub-discipline of hydrology focused on ecological aspects of hydrological cycle (Zalewski et al.1997)

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



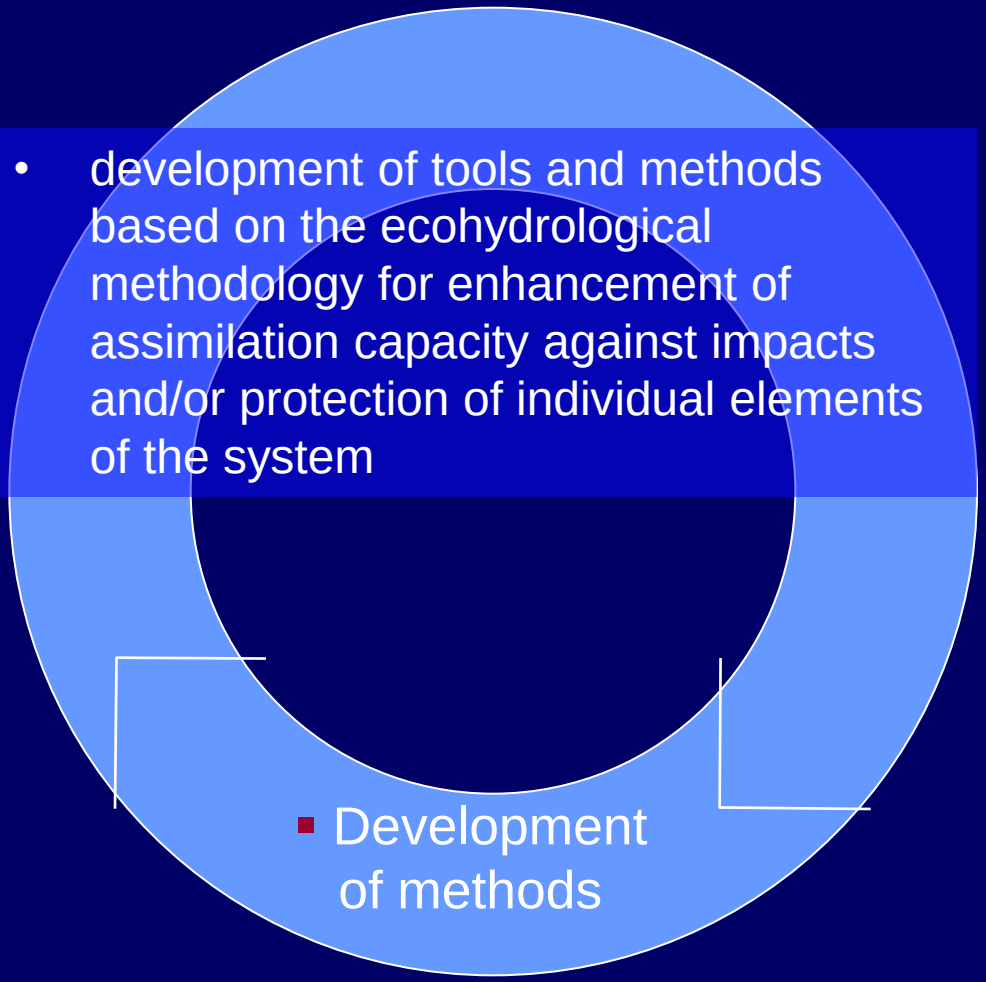
Shaping of biological structure
of an ecosystem/ecosystems in a catchment,
to regulate hydrological processes

Zalewski 2000, 2006

Ecohydrology

methodology for implementation in IWRM

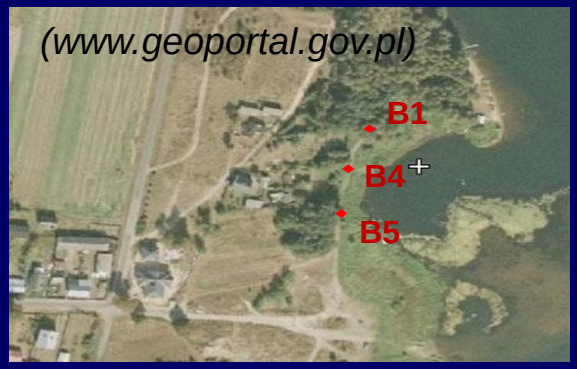
- development of tools and methods based on the ecohydrological methodology for enhancement of assimilation capacity against impacts and/or protection of individual elements of the system



(Zalewski 2002, Wagner et al. 2009.)



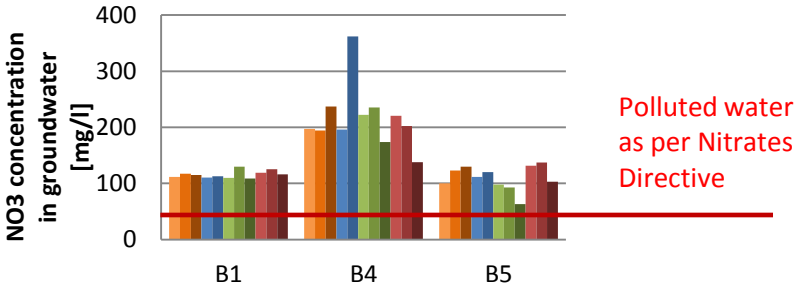
Implementation of ecohydrological biotechnology for reduction of diffuse nitrogen pollutions:

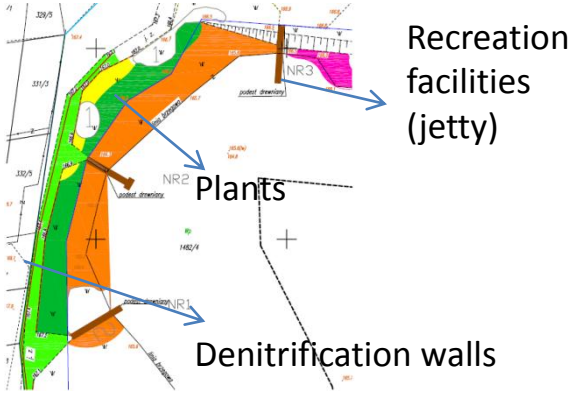




EKOROB

Nitrogen pollutions





(Izydorczyk, Frątczak, Zalewski 2011)

Denitrification wall

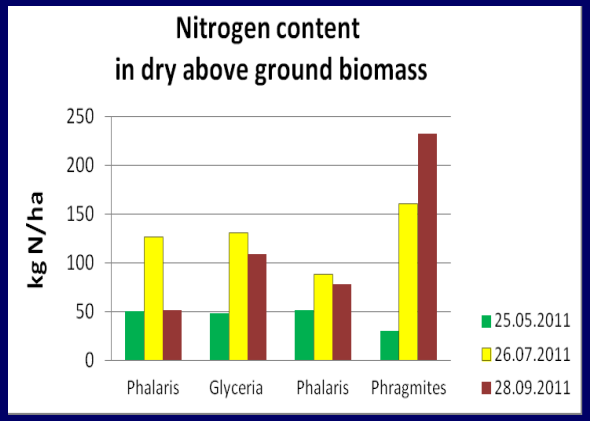
- Denitrification wall was constructed by digging a trench perpendicular to groundwater flow and mixing pinus sawdust with soil.
- Degradation of added organic material stimulates growth of denitrifing bacteria, thus conversion of nitrate to nitrogen gas by denitrification occurs.
- After the construction work, the wall is not visible.

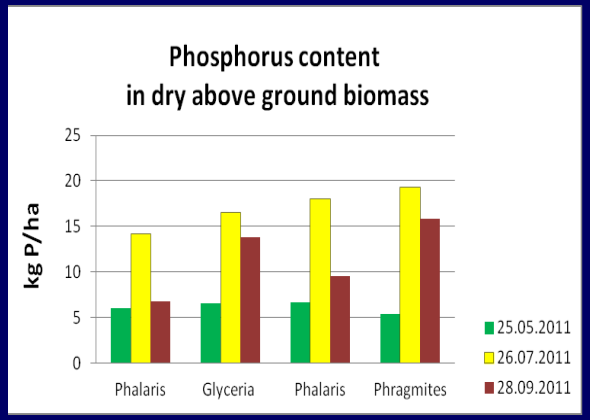





EKOROB

Harvesting biomass as a tool for increasing efficiency of buffer zone





During the mowing of vegetation in ecotones zone within the area of approximately 0.5 ha

with mown biomass was removed:

about 50 kg of nitrogen

equivalent of 150 kg of ammonium fertilizer

about 5 kg of phosphorus

equivalent of 25 kg of phosphate fertilizer.





Demonstration site of LIFE+ EKOROB project





EKOROB

Life

NFOŚiGW

Implementation of knowledge, Recreation, Education

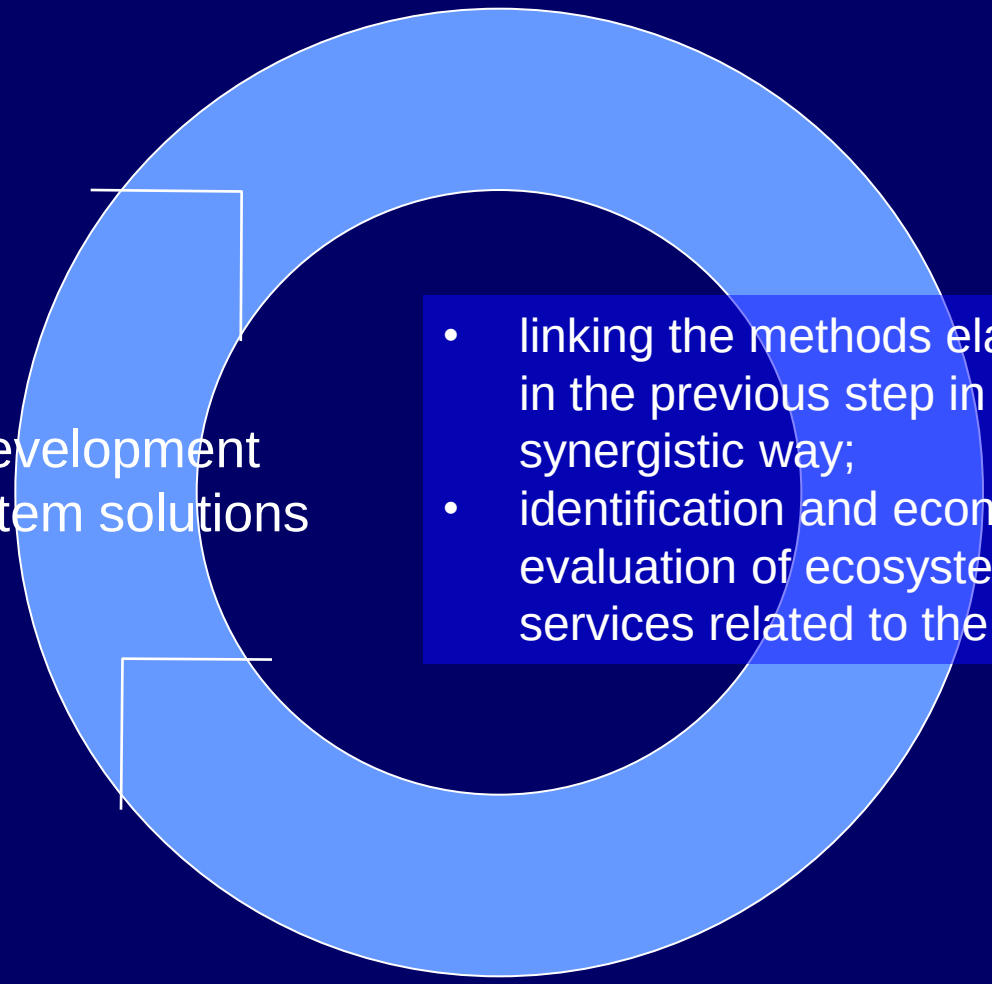






Ecohydrology

methodology for implementation in IWRM



- Development of system solutions

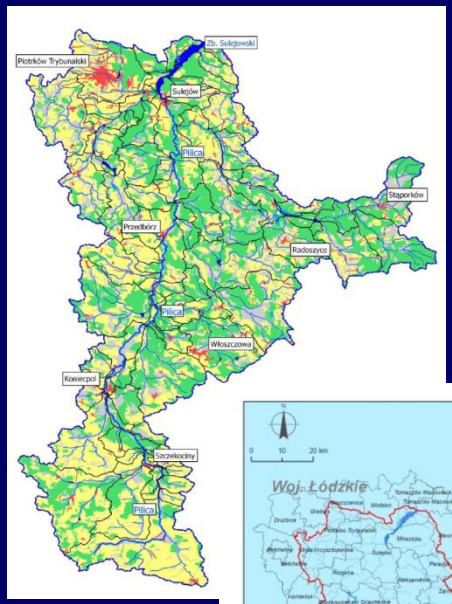
- linking the methods elaborated in the previous step in a synergistic way;
- identification and economical evaluation of ecosystem services related to the system;

(Zalewski 2002, Wagner et al. 2009.)



Development of Action Plan for reduction of diffuse pollution in the Pilica River catchment

- usage of innovative ecohydrological biotechnologies
- promotion Code of good agricultural practice
- additional measures as legal, administrative and economic instruments.







Cooperation with Regional Water Management Authority in Warsaw

Multi-stakeholder platform as a tool for transfer of knowledge between scientists and decision-makers

Identification and integration of the stakeholders:
regional authorities, local authorities, scientists, NGOs,

Platform helps to create independent space for discussion, share experience, transfer know-how







Raise the environmental awareness of local society

- public meetings for inhabitants,
- educational activities for school children
- training for specialists, decision makers and teachers











Thank you for your attention!

