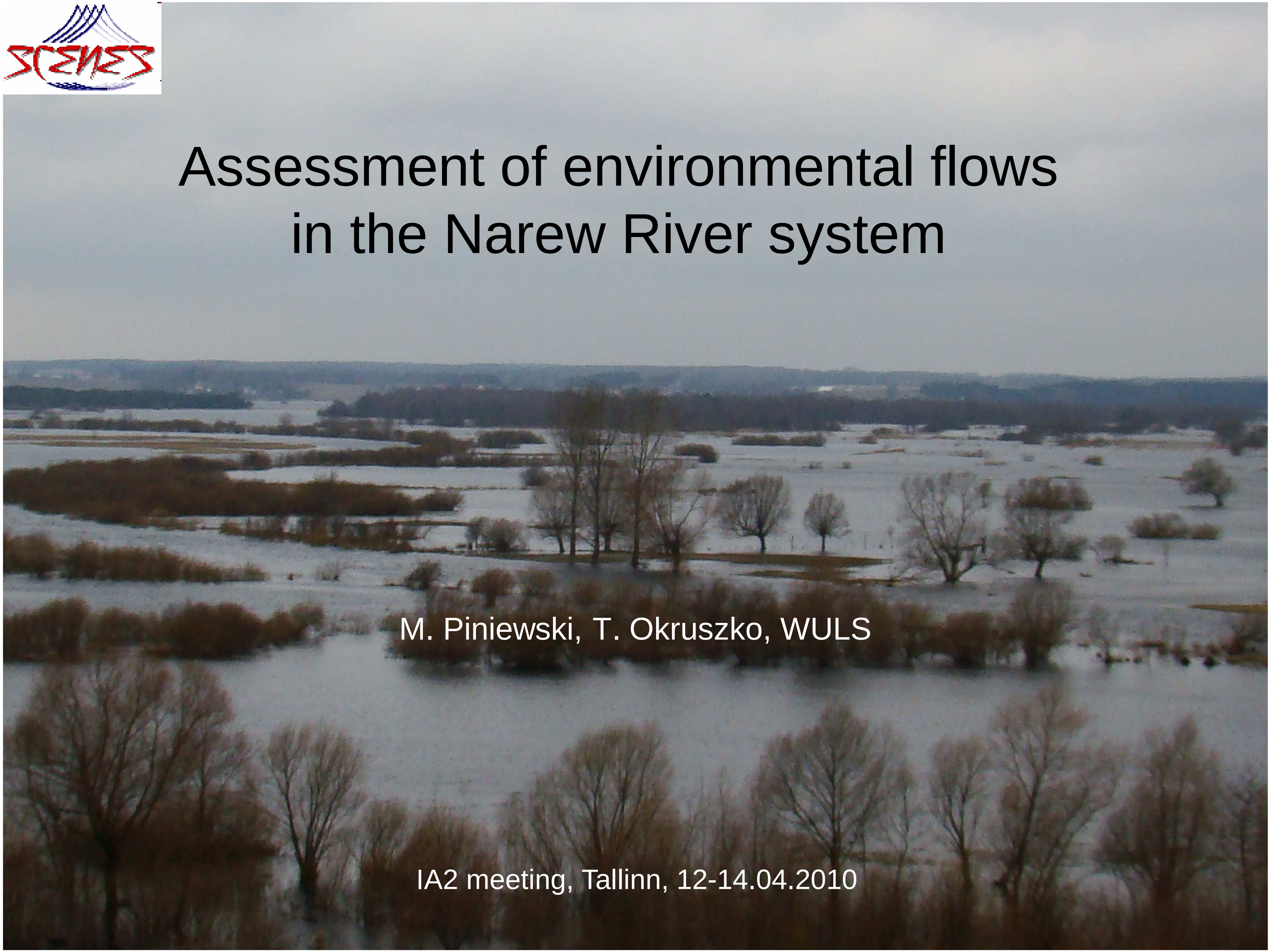
Assessment of environmental flows in the Narew River system



M. Piniewski, T. Okruszko, WULS

IA2 meeting, Tallinn, 12-14.04.2010

Outline

- Context
- Environmental flows estimations
- BBM for the Narew River
- Way forward
- SWAT for the Narew River (optionally)
- Final picture

Objectives & motivation

- Objectives:
  - assessment of environmental flows in the major stretches of the Narew River system using the adapted Building Block Method
  - impact assessment of SCENES scenarios on environmental flows
  - cross-scale comparison with the Pan-European „Water for Nature” indicators
- Motivation:
  - term „environmental flows” hardly unknown in Poland, current instream flow requirements don’t take into account real ecosystems demands
  - most of environmental flows studies on heavily impacted rivers
  - WFD context

Overview of methods

Group of methods	Examples	Duration of assessment (months)	Major advantages	Major disadvantages
Hydrological index	Tennant method, Q_{95} index method	½	Low cost, rapid to use	Not site-specific, ecological links assumed
Hydraulic rating	Wetted perimeter method	2-4	Low cost, site-specific	Ecological links assumed
Habitat simulation	IFIM, PHABSIM	6-18	Ecological links included	Extensive data collection and use of experts, high cost
Holistic	**Building Block Method (BBM)**	12-36	Covers most aspects	Requires very large scientific expertise, very high cost, not operational

Tharme (2003), Dyson et al. (2003), King, Brown & Sabet (2003), Acreman & Dunbar (2004)

Adaptation of the BBM for Narew

- No discussion panels as in original BBM, but engaging **experts** from different fields: fish ecologist, wetland ecologists, ecohydrologists, hydrologists
- Assumption: healthy **fish** population and **wetland** vegetation reflects a wider ecological health, therefore only these 2 ecosystem components were considered
- Building blocks formed of 3 components:
  - Fish => 1st building block (optimum flow values for different fish life history stages)
  - Wetlands => 2nd building block (bankfull flow & duration of inundation)
  - Additionally: *instream flows* in force according to the Polish law (simple look-up table method known as *Kostrzewa method*) => 3rd building block

River type	Drainage basin area km²	k
Lowland	< 1000 1000 – 2500 > 2500	1.00 0.58 0.50
Mixed / Highland	< 500 500 – 1500 1500 – 2500 > 2500	1.27 0.77 0.52 0.50

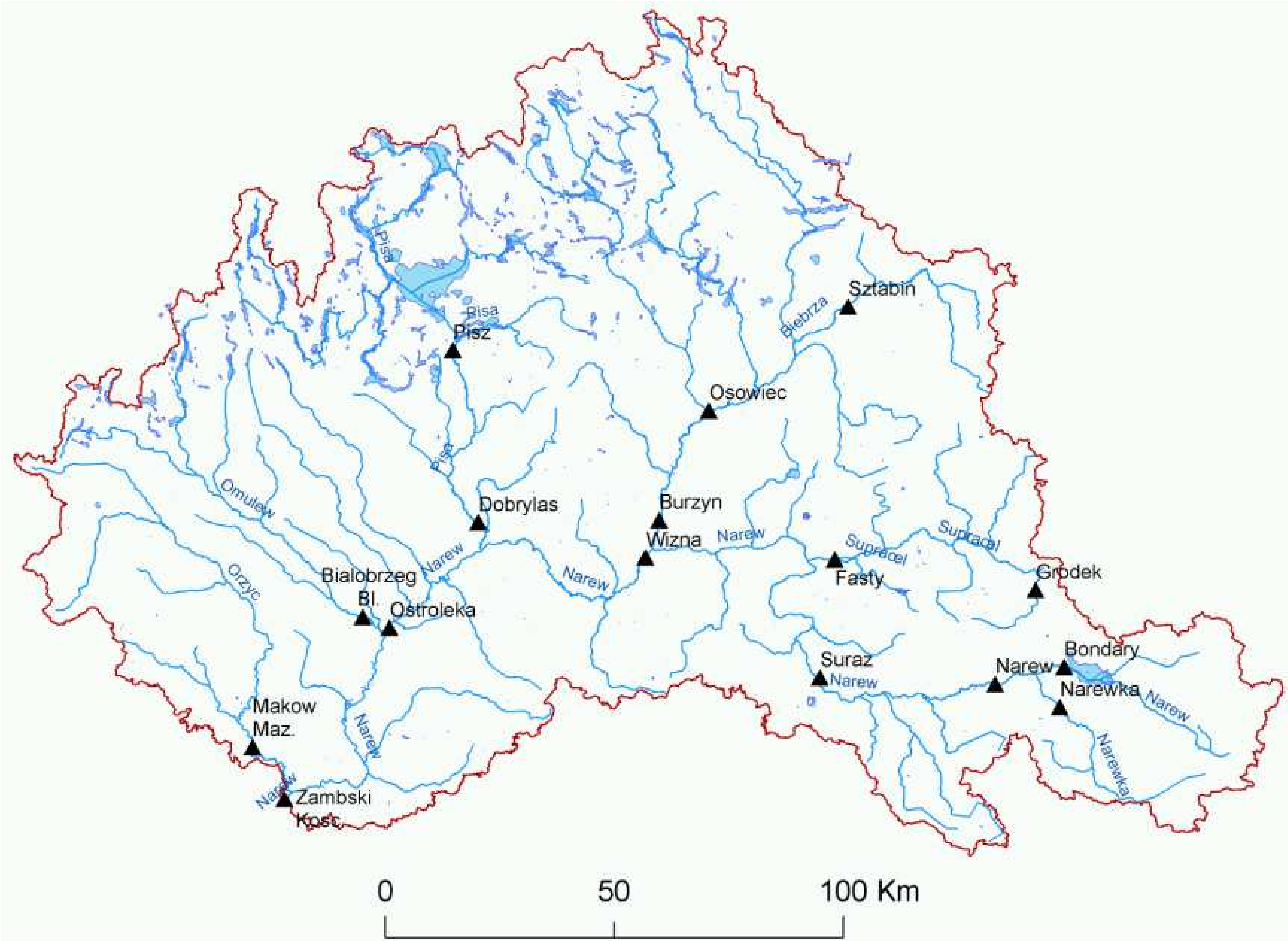
$$Q_{Kos} = \max \{k \cdot Q_{min,av}, Q_{min,abs}\}$$

$Q_{min,av}$ – average annual minimum flow
k – empirical coefficient
$Q_{min,abs}$ - absolute minimum flow

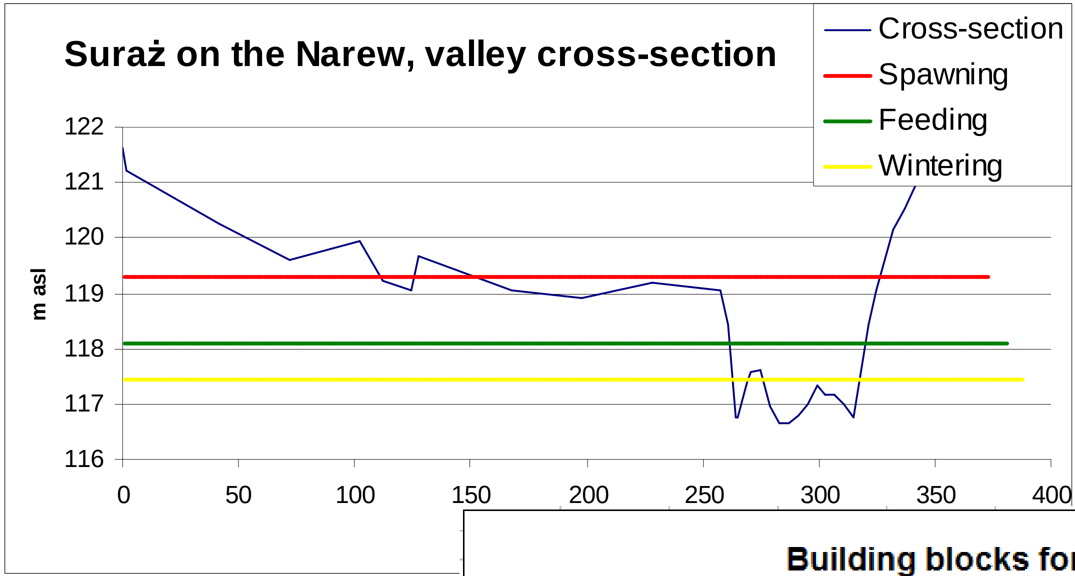
Environmental flows for fish – undertaken approach

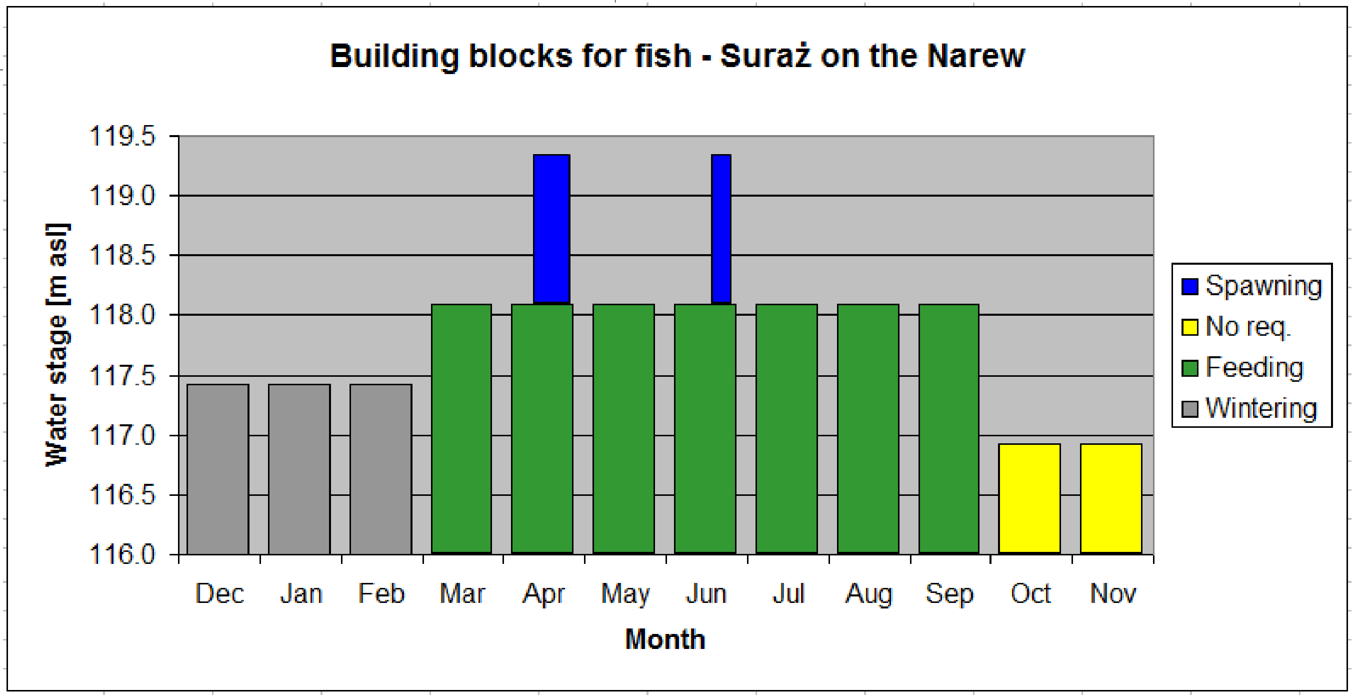
- A number of gauged sites (16) representing hydrological and ecological diversity of the Narew River system selected
- A thorough literature review made by the fish ecologist to assess the probable fish fauna composition in each site
- Key species for each site selected (most frequently: pike, wels & rheophiles)
- 3 major fish life history stages taken into account: spawning, wintering and feeding
- Valley and channel cross-sections & water stage records used to determine optimum water stages for each site and period
- Water stages transformed into flows (ongoing)

Location of gauged sites selected for the study



Example – Suraż on the Narew

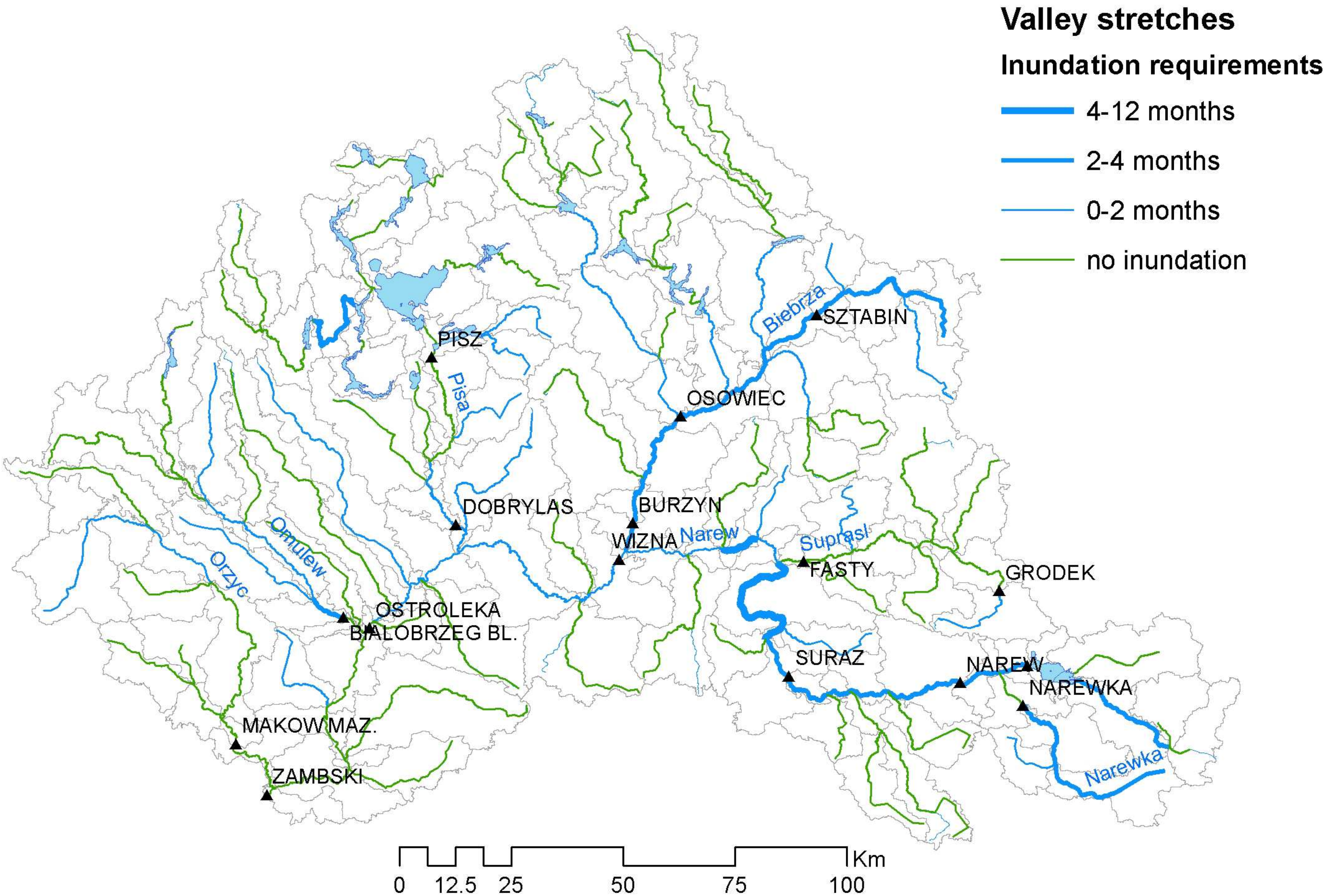




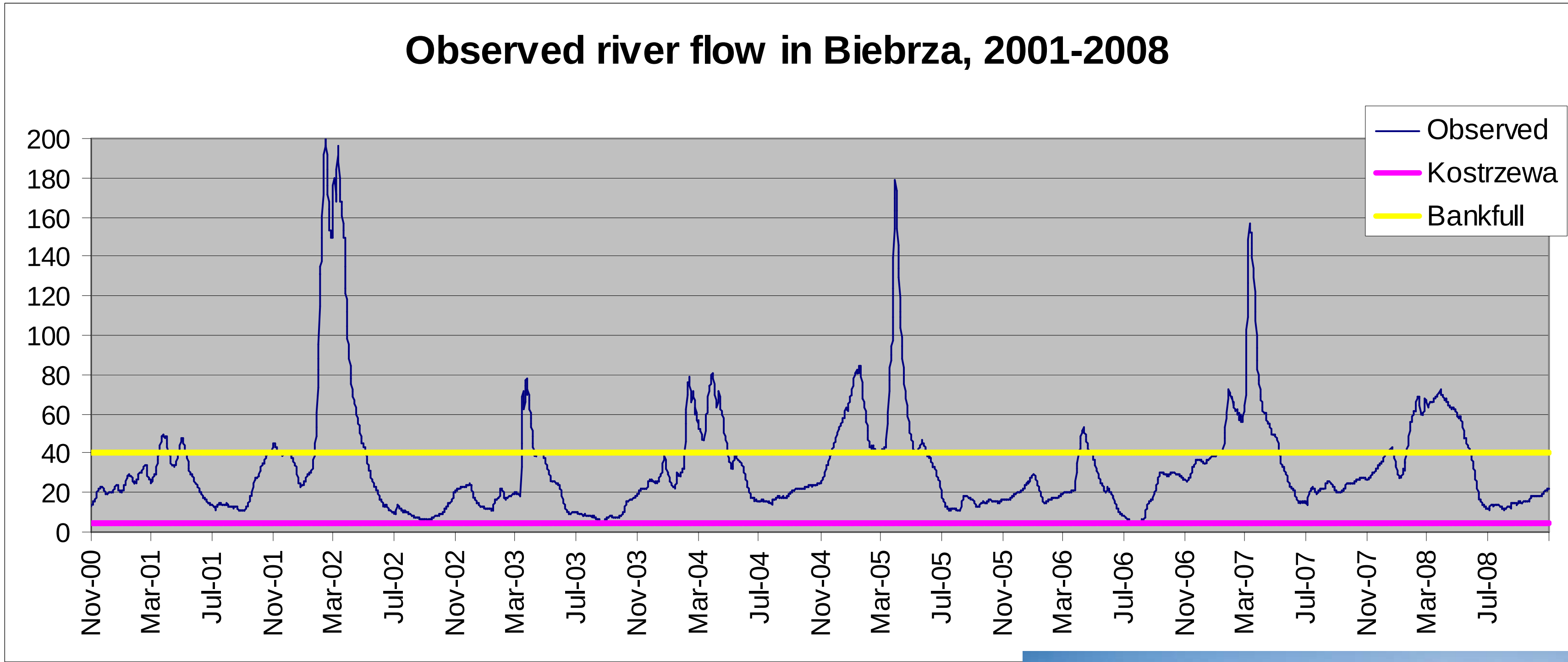
Environmental flows for wetland vegetation – undertaken approach

- Analysis of hydrogenic habitats in major valleys of the Narew river system
  - Spatial analysis of hydrogenic habitats
  - Analysis of spatial diversity of vegetation growing on hydrogenic habitats
  - Identification of areas **requiring inundations in order to support habitats of high natural value**
- The final selection of areas requiring inundations was based on dominating wetland vegetation type:
  - Rushes => Long-term inundation (up to 1 year)
  - Sedges => Medium-term inundation (2-4 months)
  - Molinia meadows, shrubs, alder forests => Short-term inundation (0-2 months)
  - Fresh meadows => No inundation

Valley stretches requiring inundation to support habitats of high natural value



Example – Burzyn on the Biebrza



Inundation requirements for wetland vegetation determined by the ecologists: medium-term (2-4 months)

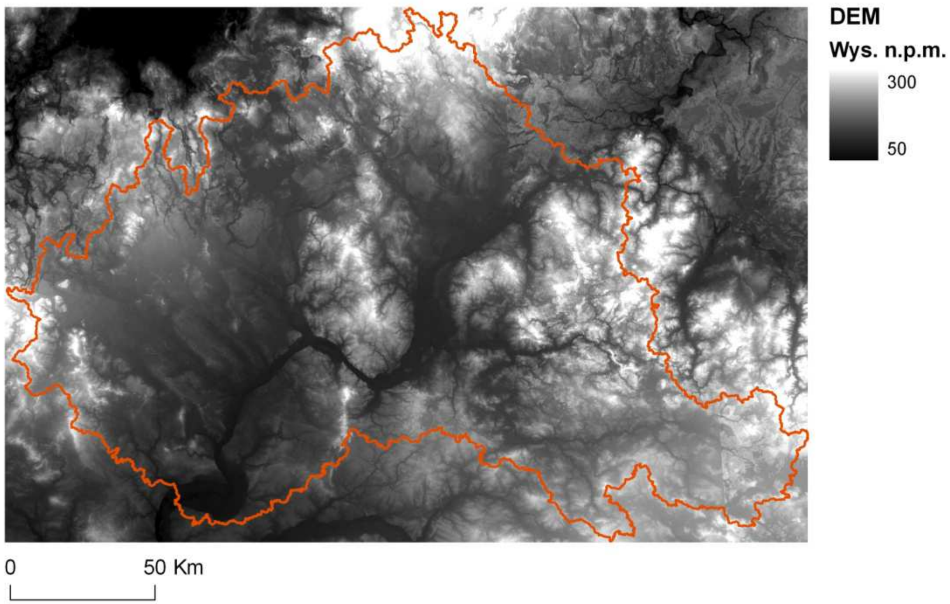
Remaining steps

- Setting measures of compliance of flow series with a determined environmental flows regime (indicators)
- Assessment of actual state based on analysis of flow series for 2001-08
- Environmental flows under SCENES scenarios – study based on 30-year runs of SWAT model
- Cross-scale comparison of SWAT & WG results on enviromental flows indicators

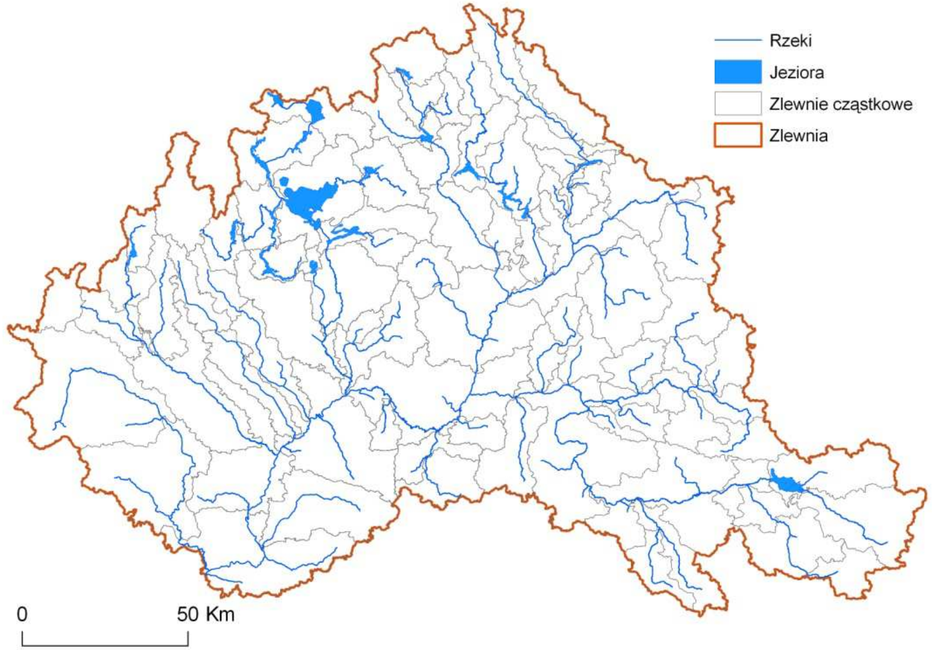
SWAT model - basic features

- Soil & Water Assessment Tool is a river basin model consisiting of hydrologic and water quality components
- Distributed, physically-based, continuous time model coupled with GIS
- River basin divided into subbasins which are then divided into Hydrologic Response Units (HRUs)
- Its main purpose is to quantify the impact of land management practices in large, complex river basins

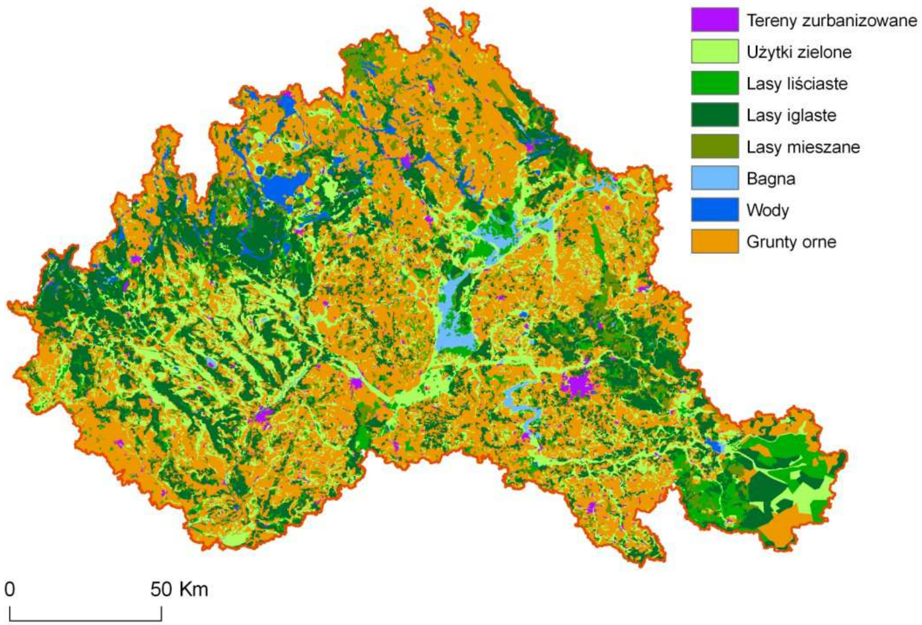
Numeryczny model terenu



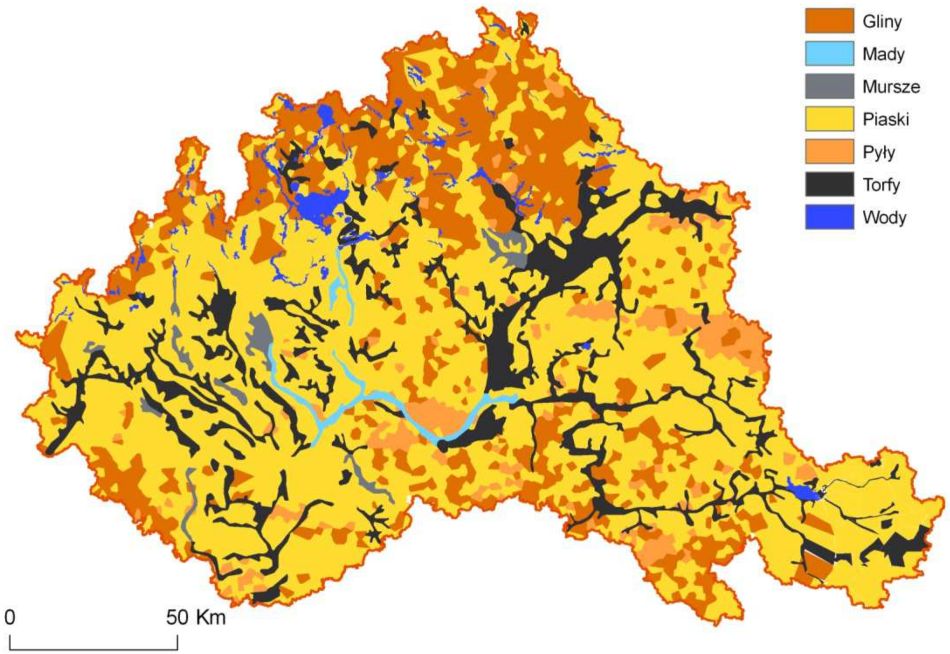
Hydrografia



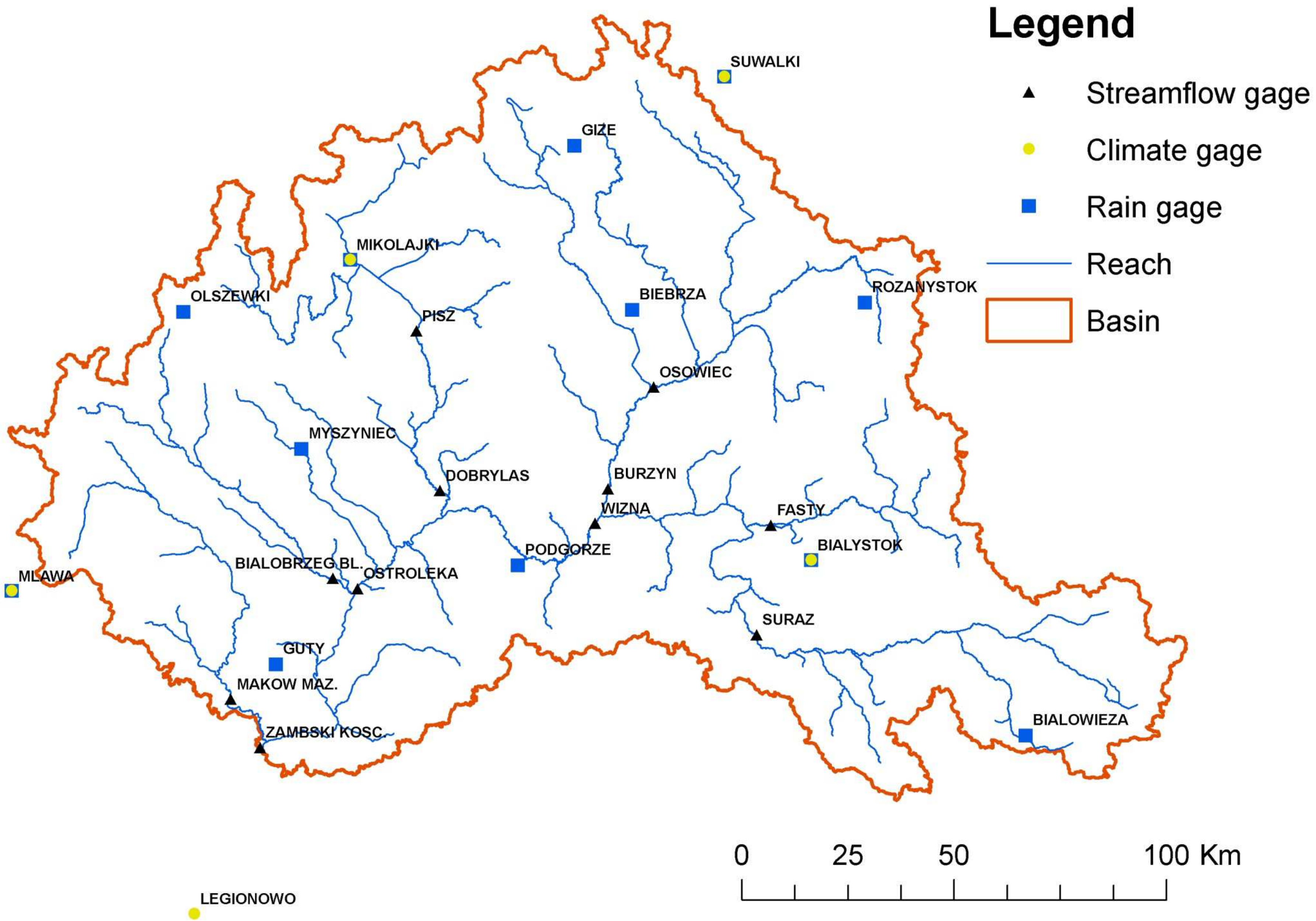
Użytkowanie terenu



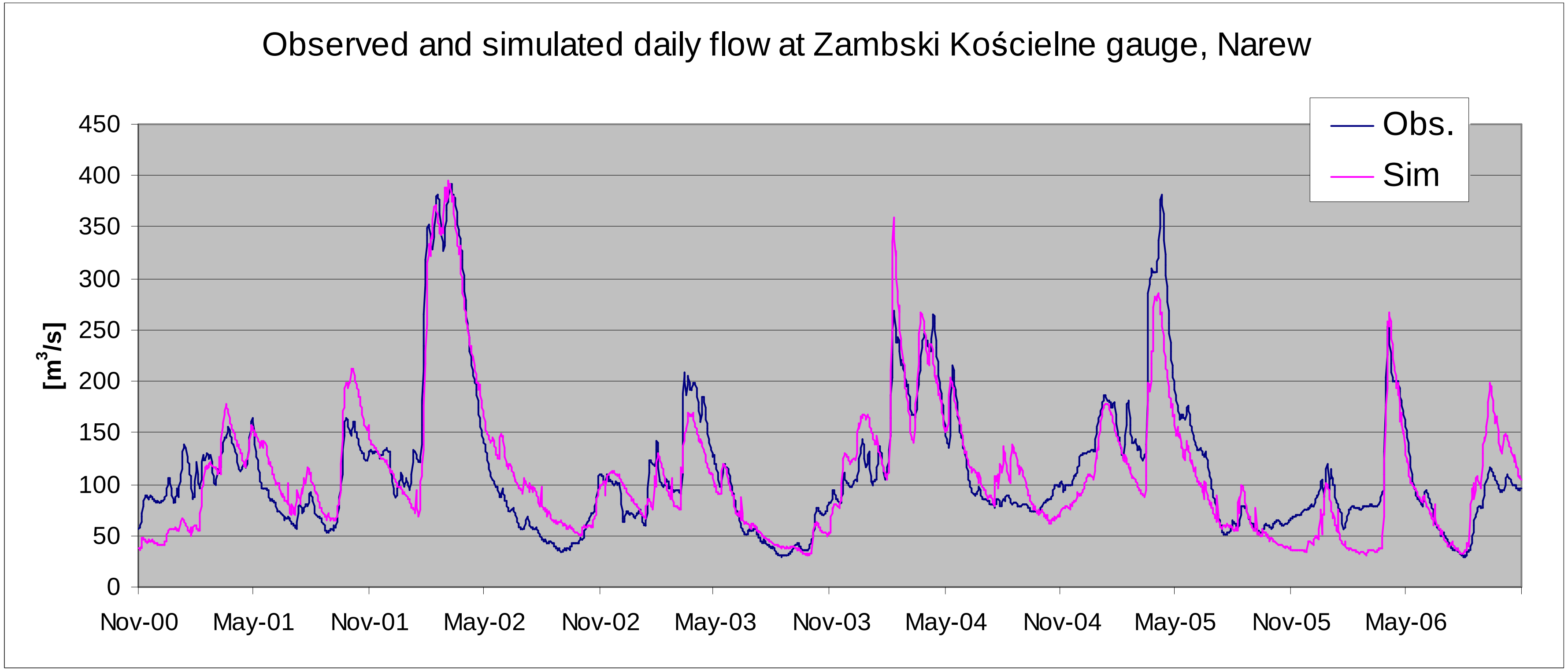
Gleby



Climate and streamflow gages location



Model evaluation



Nash-Sutcliffe Efficiency (daily) = 0.82

Average observed flow = 114 m^3/s

Average simulated flow = 111 m^3/s

Root Mean Squared Error = 29 m^3/s

Model setup - summary

- 151 subbasins => av. subbasin area = 180 km^2
- 8 land use classes
- 27 soil classes
- 1131 HRUs => av. area = 24 km^2
- Climate:
  - 12 rain gauges
  - 6 climate (temperature + wind speed + humidity) stations
  - 1 solar radiation station
- Warm-up 1998-2000; simulation period 2001-2006, validation period 2007-2008
- Daily time step
- Manual calibration + SWAT Autocalibration Tools applied


Burzyn, Biebrza, 2 weeks ago