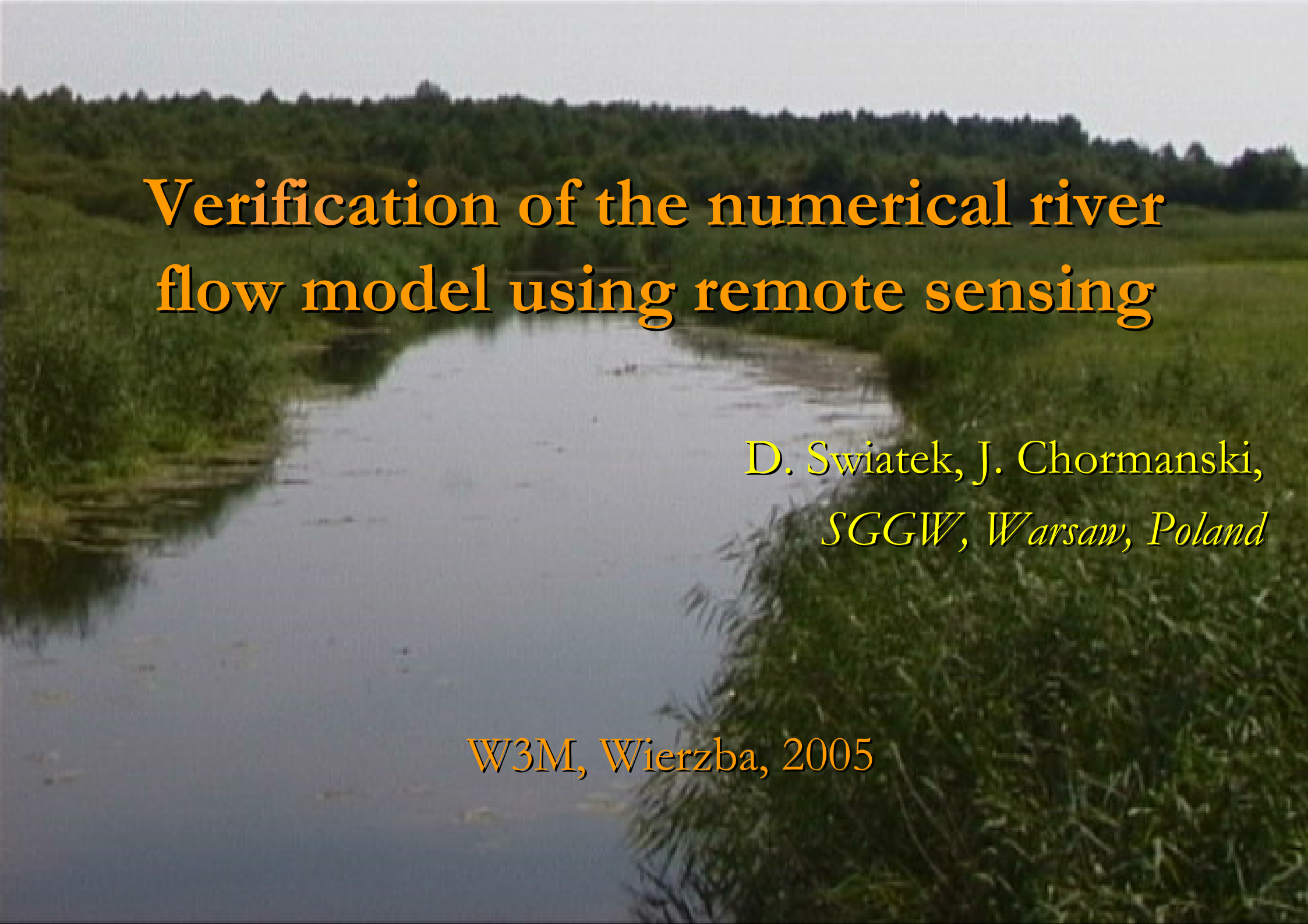


Verification of the numerical river flow model using remote sensing

D. Swiatek, J. Chormanski,
SGGW, Warsaw, Poland

W3M, Wierzba, 2005

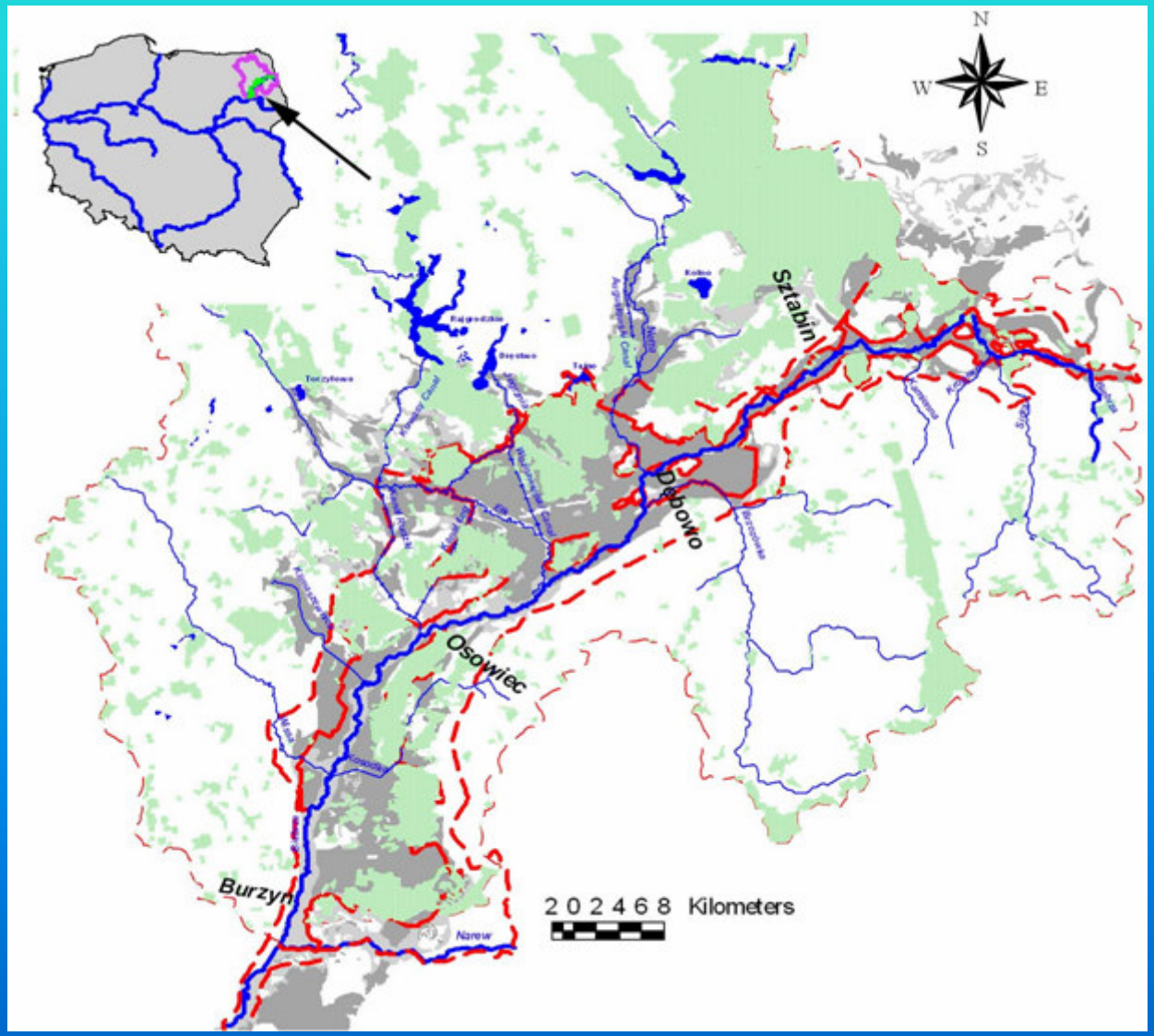
OUTLINE OF THE PRESENTATION

- Context and aim of the work
- Digital Elevation Model
- 1D hydrodynamic river flow model
- Processing of satelite images
- Results and conclusions

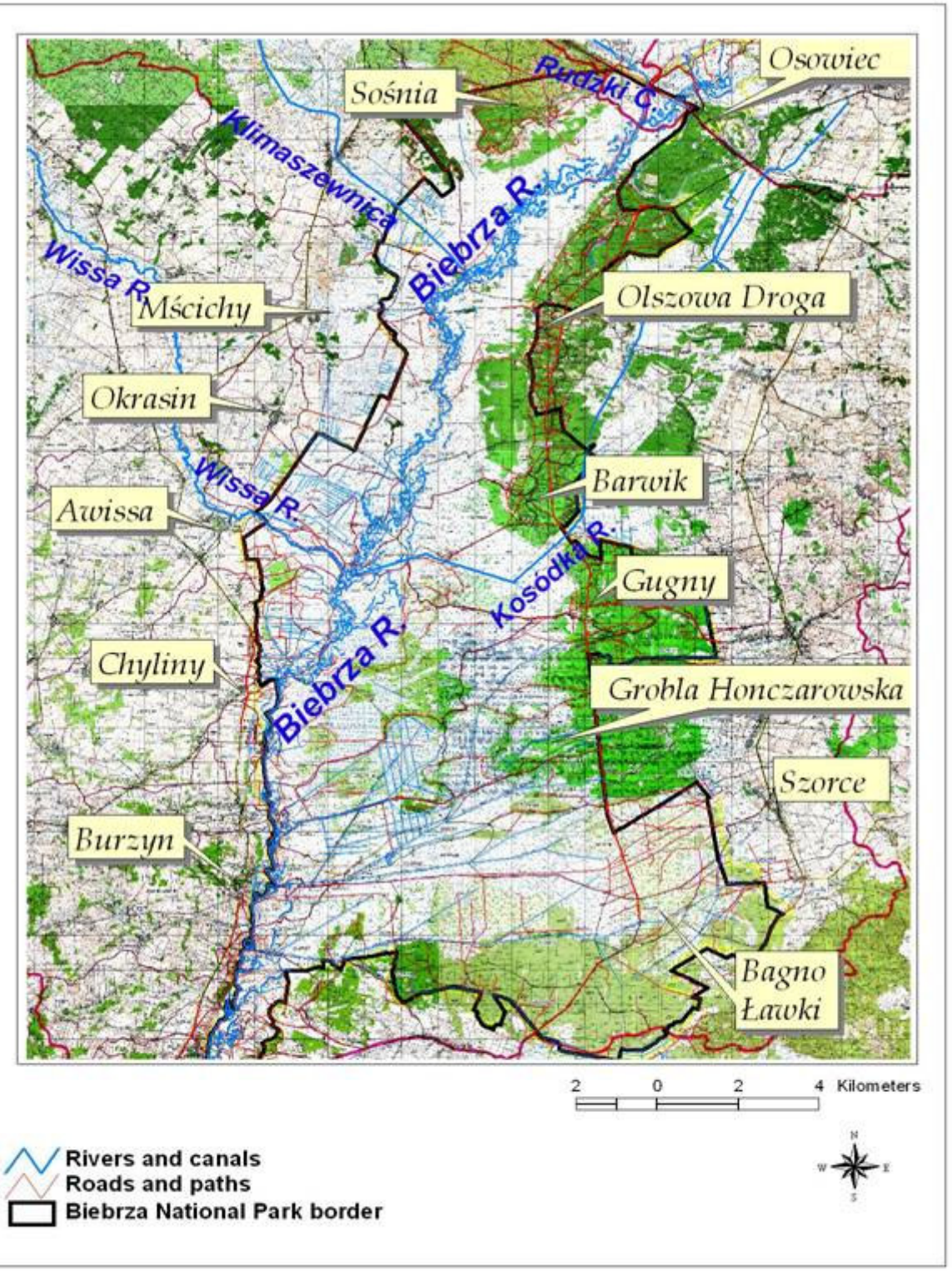
CONTEXT AND AIM OF THE WORK

- The development of the accurate and reliably hydrodynamic model which well describes surface flow on main channel and floodplain.
- This model can be use as a tool of water management for analysis both flood aspects in wetland: hydrological and ecological.

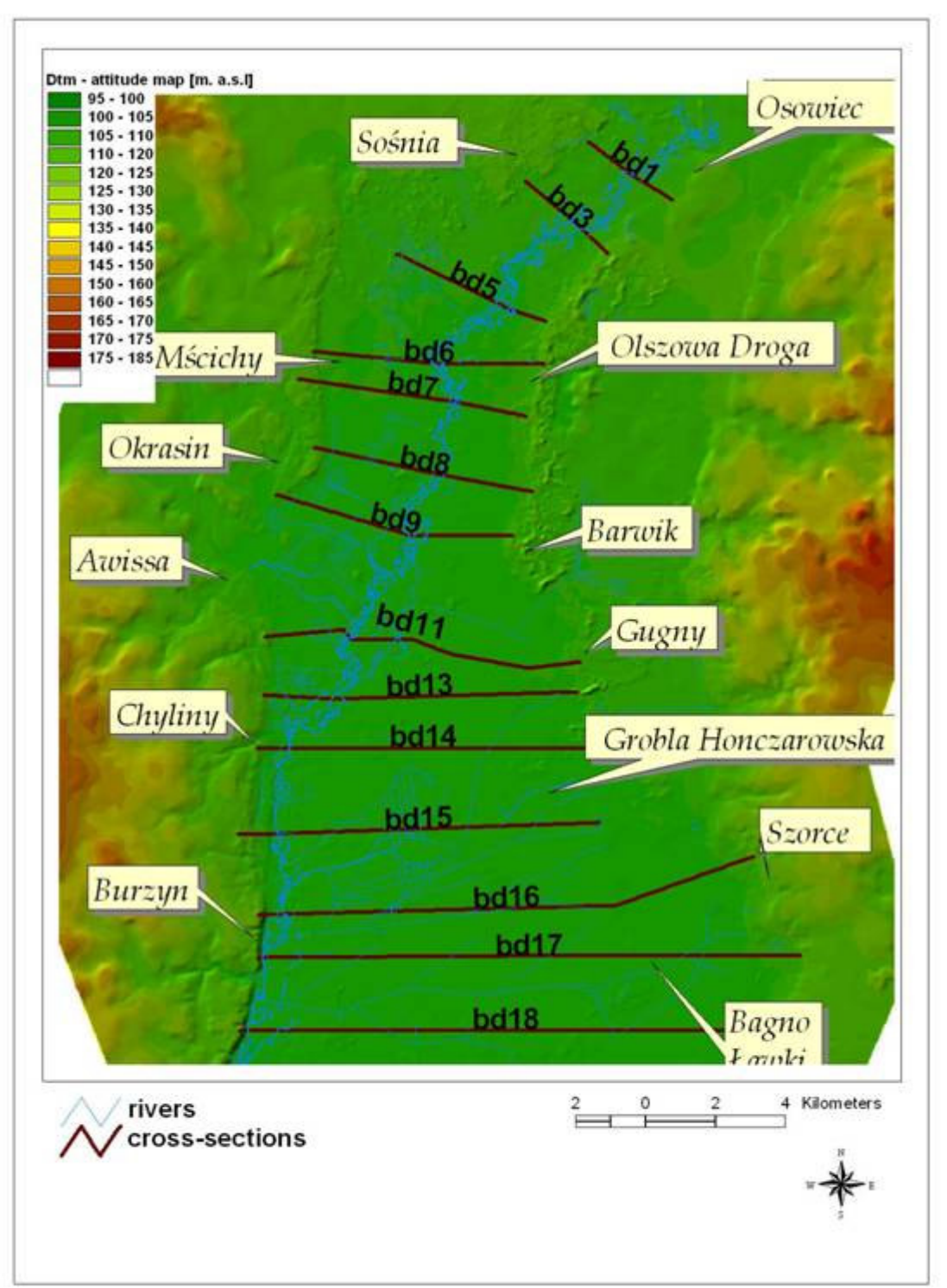
BIEBRZA VALLEY



Hydrography of the Lower Biebrza Basin



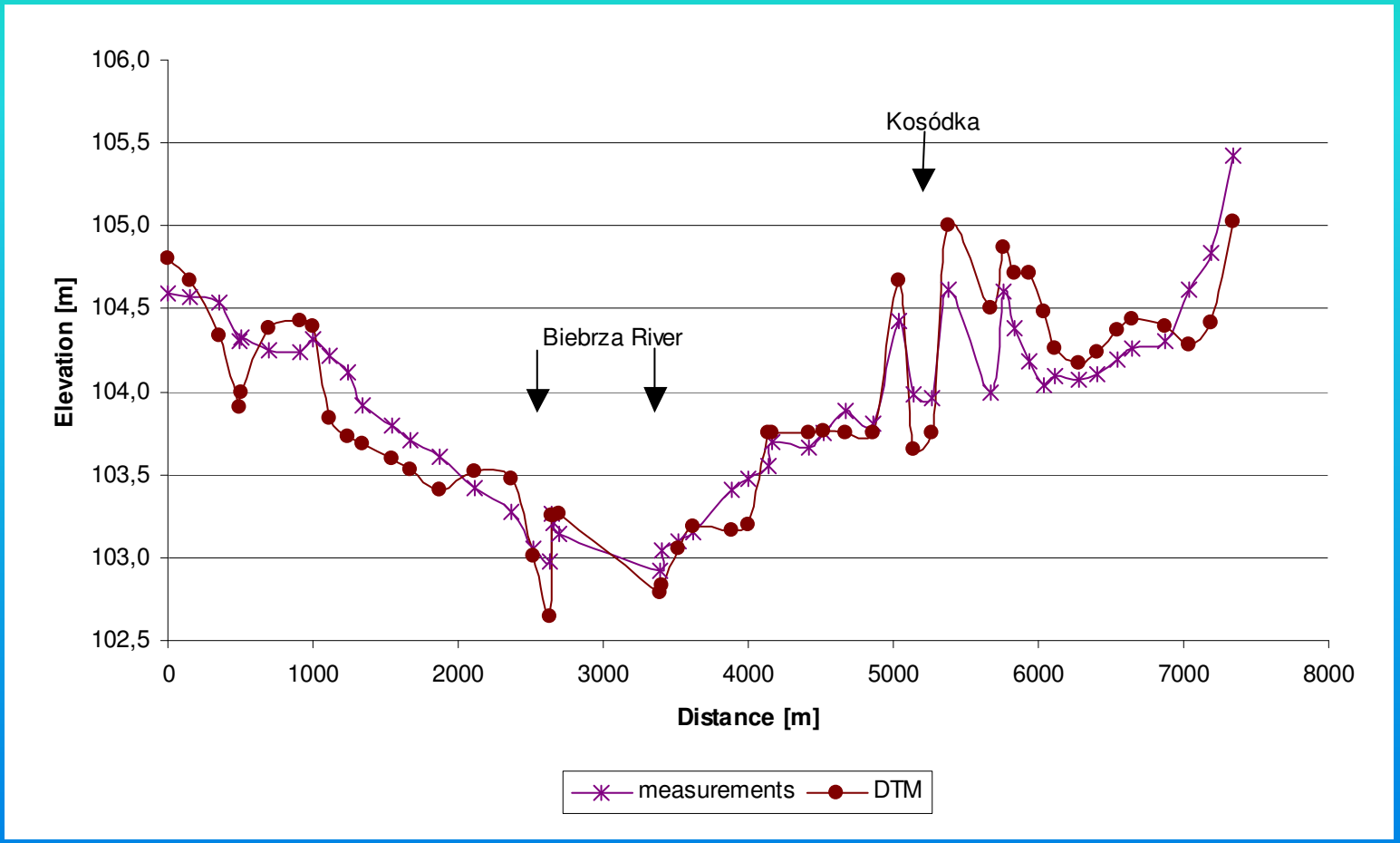
- Biebrza River in Lower Basin (from the Rudzki channel outlet to its outlet to the Narew River) :
  - 50 km-long-stretch
  - width varies from 10 to 34 m,
  - its average depth is 1.8 m;
  - mild slopes (in average about 10 cm per 1km)
- Asymmetric position - the river courses the valley from east to west in the final 20 km, and then, follows its course of the west side, right adjoined to the valley margin.
- Tributaries:
  - larger inflows: the Rudzki channel (border), the Wissa River, the Kosódka River, the Klimaszewnica River,.
  - main ditches of a reclamation system, which drain the floodplain on the left side of the Biebrza River



DIGITAL ELEVATION MODEL

The DEM of the Lower Basin was generated by the ArcInfo Topogrid method during an interpolation process.

Quality of the DEM

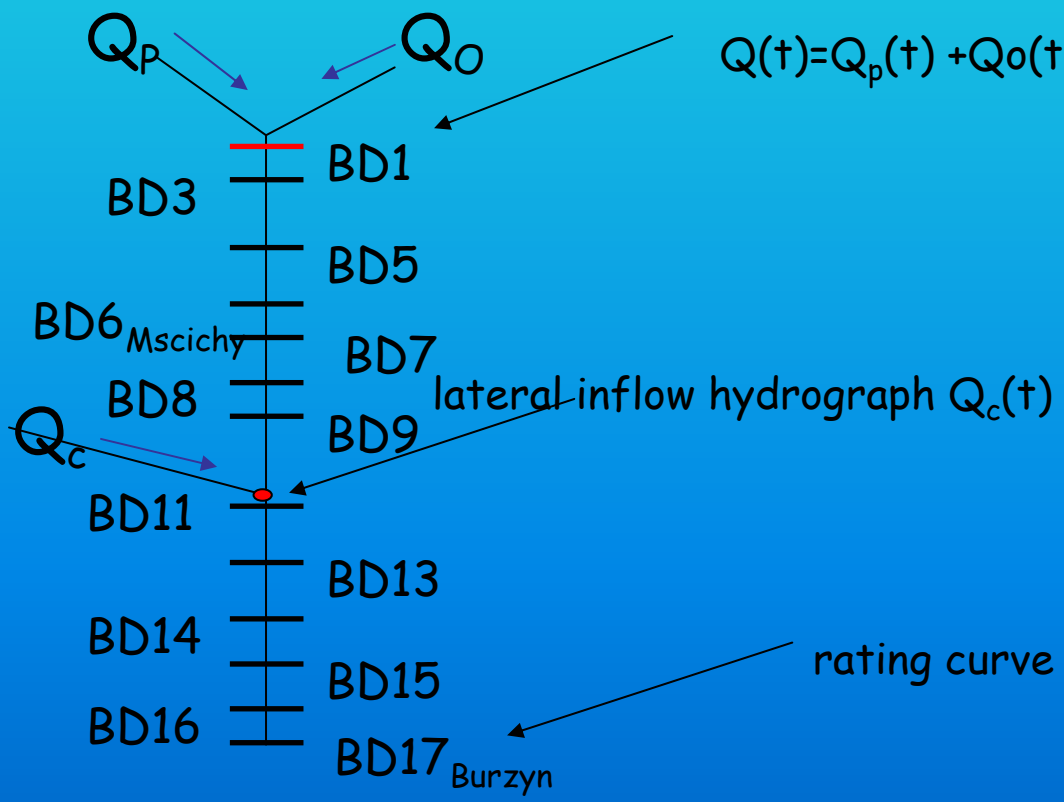


- Model verified by two measured valley cross-section
  - Levelling in 50 meters (90 points in two cross-sections)
  - Verification of DEM (RMS Error = 0,35m)

Hydraulic model topological scheme

Unsteady 1-D hydraulic model – Full St., Venant equations

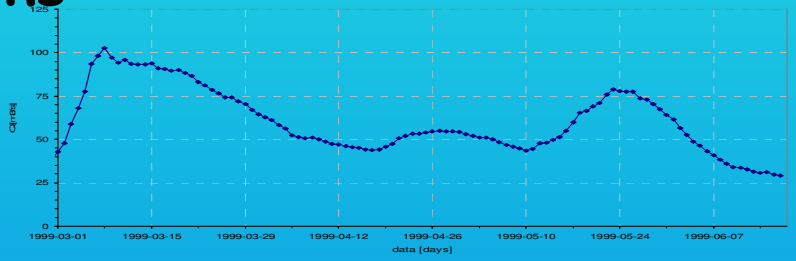
Boundary conditions

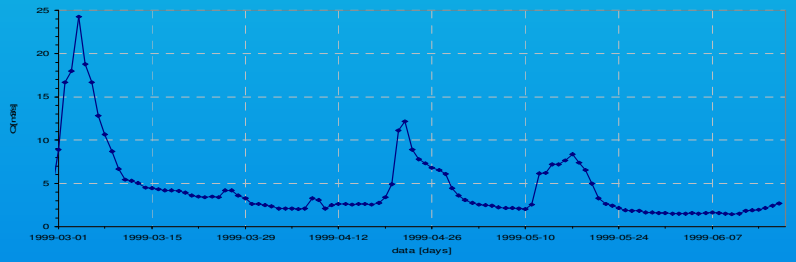


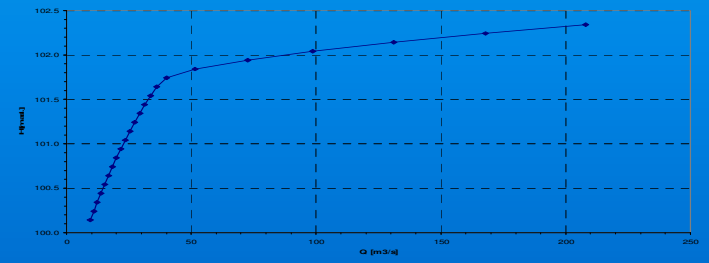
$Q(t)=Q_p(t)+Q_o(t)$

lateral inflow hydrograph $Q_c(t)$

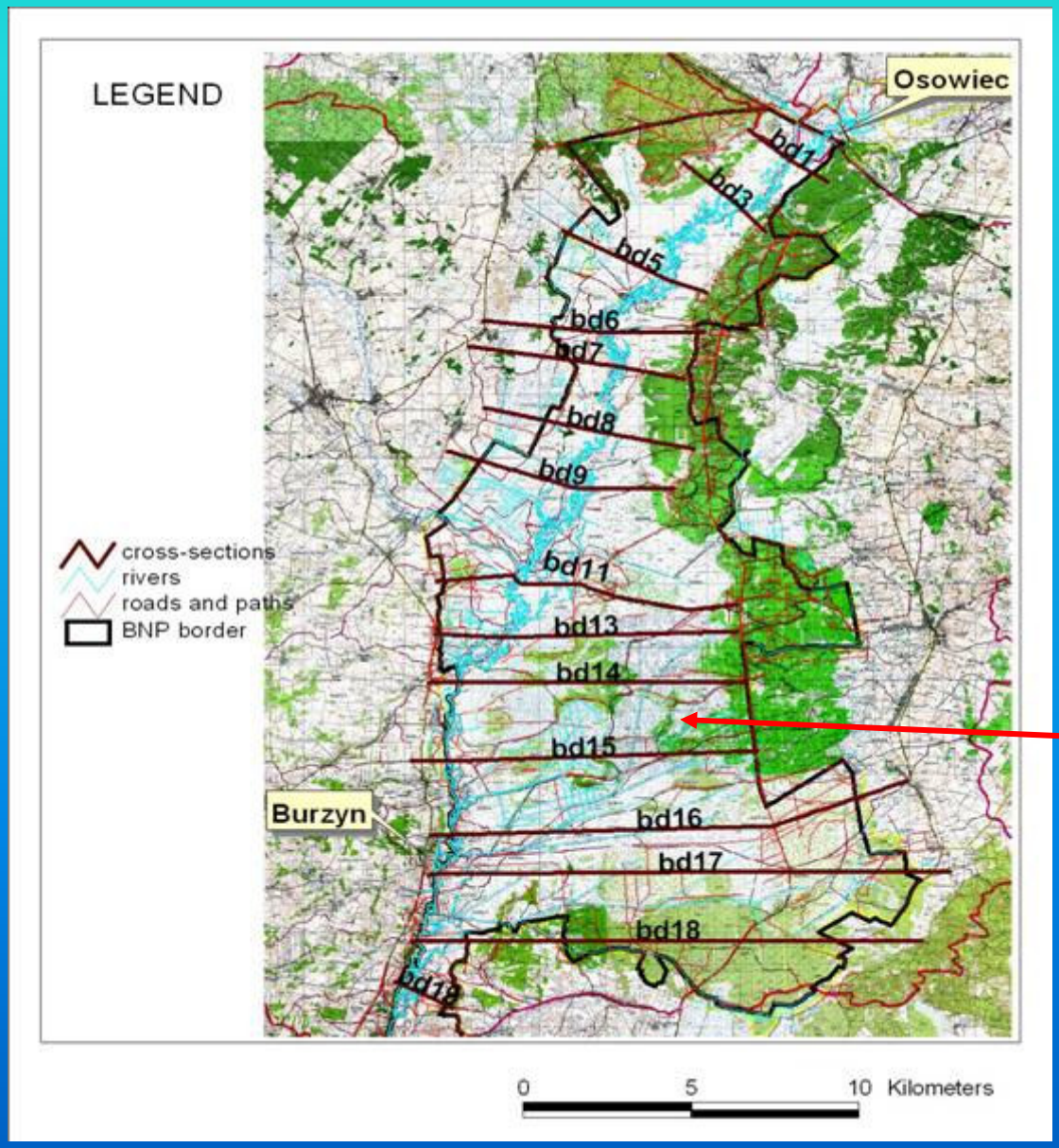
rating curve



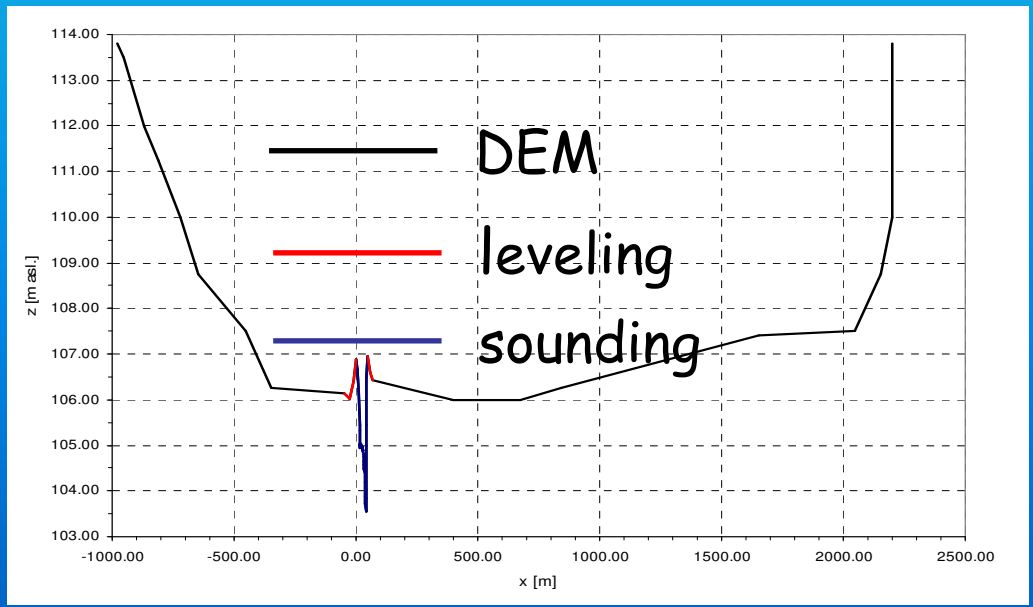




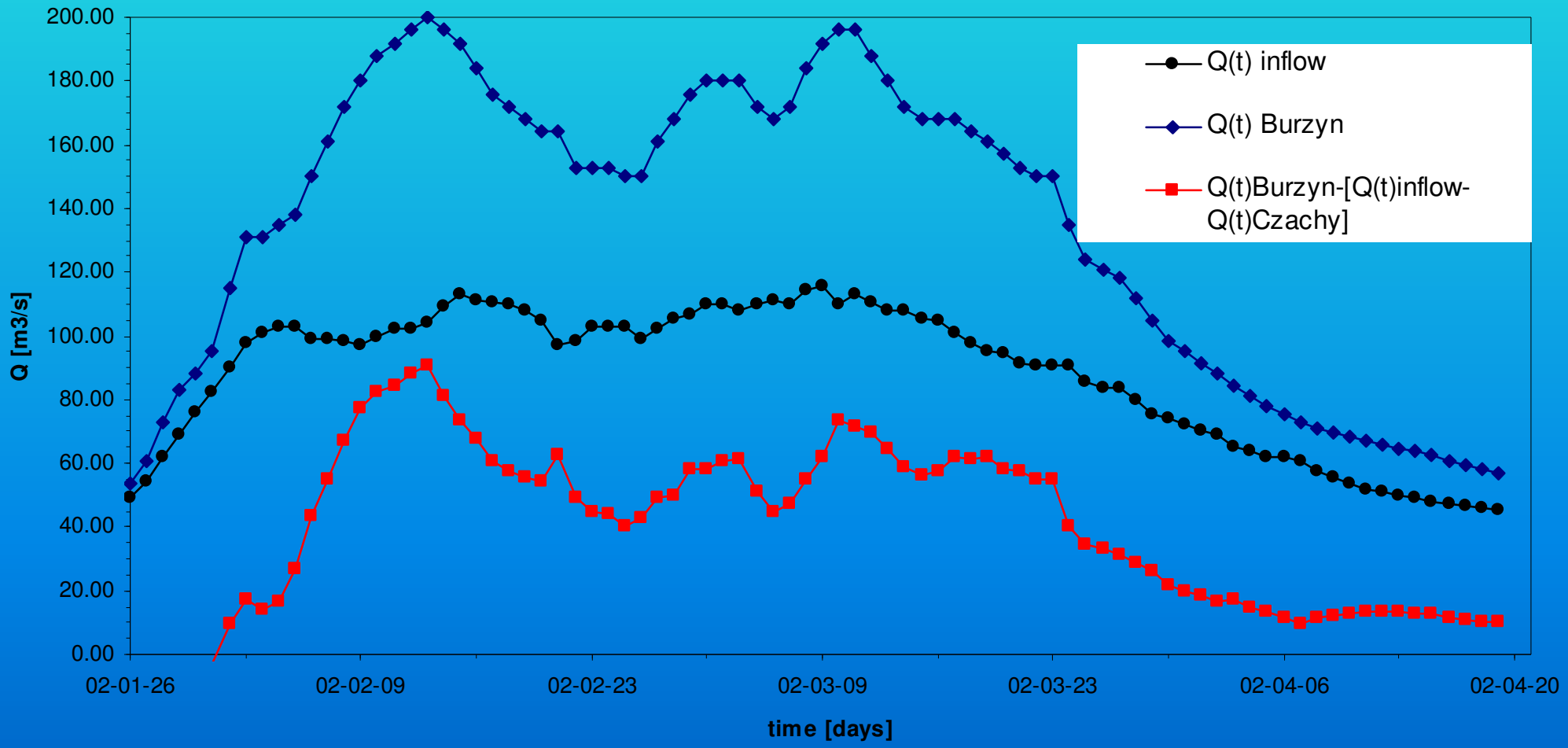
CROSS-SECTIONS CREATION METHOD



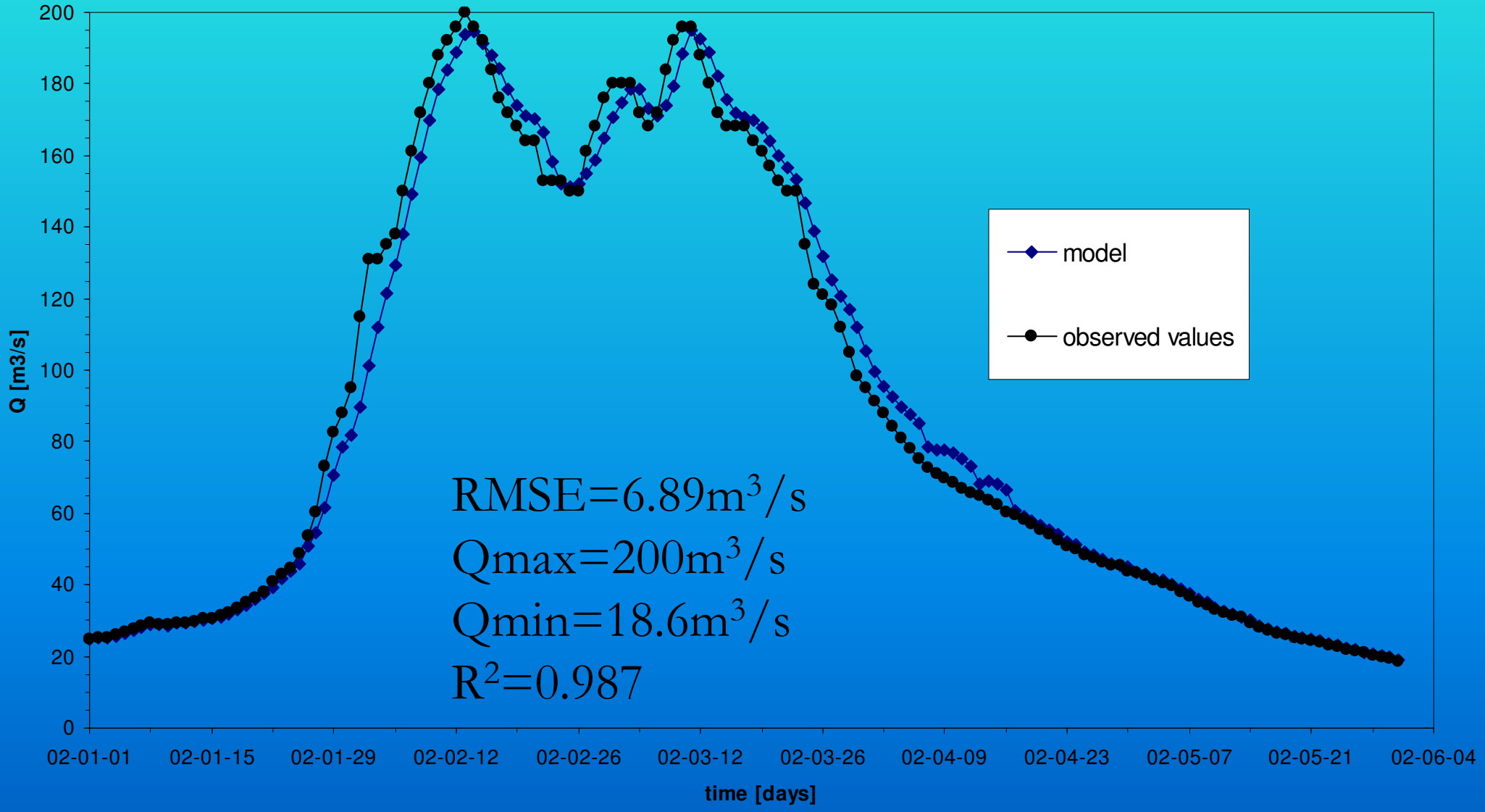
- The river channel - Manual suonding
- A part of the valley located close to the river channel - Topography measurements
- The rest of the valley - captured from DEM



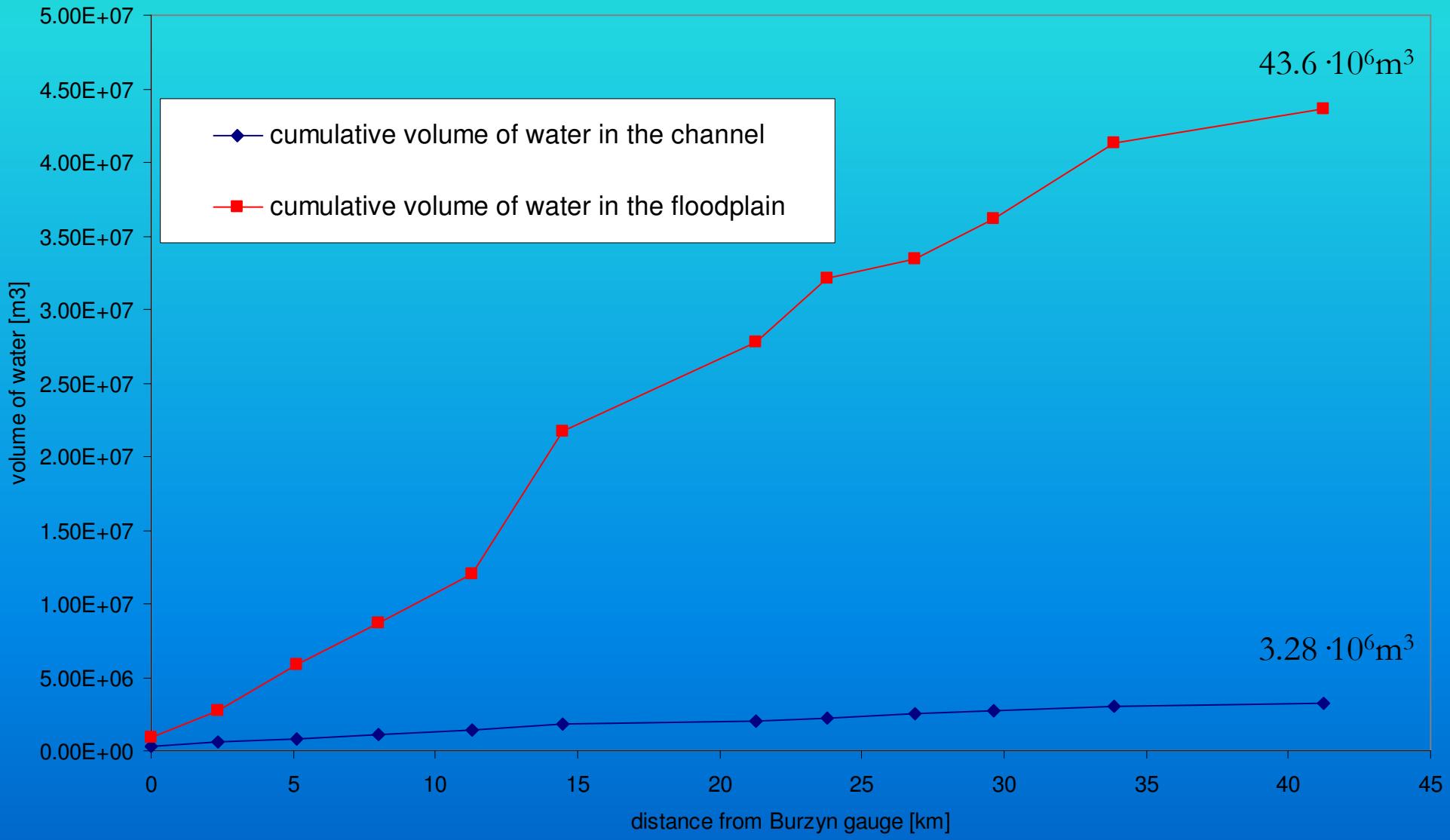
COMARISON INFLOW AND OUTFLOW FROM THE CATCHMENT – flood event 2002



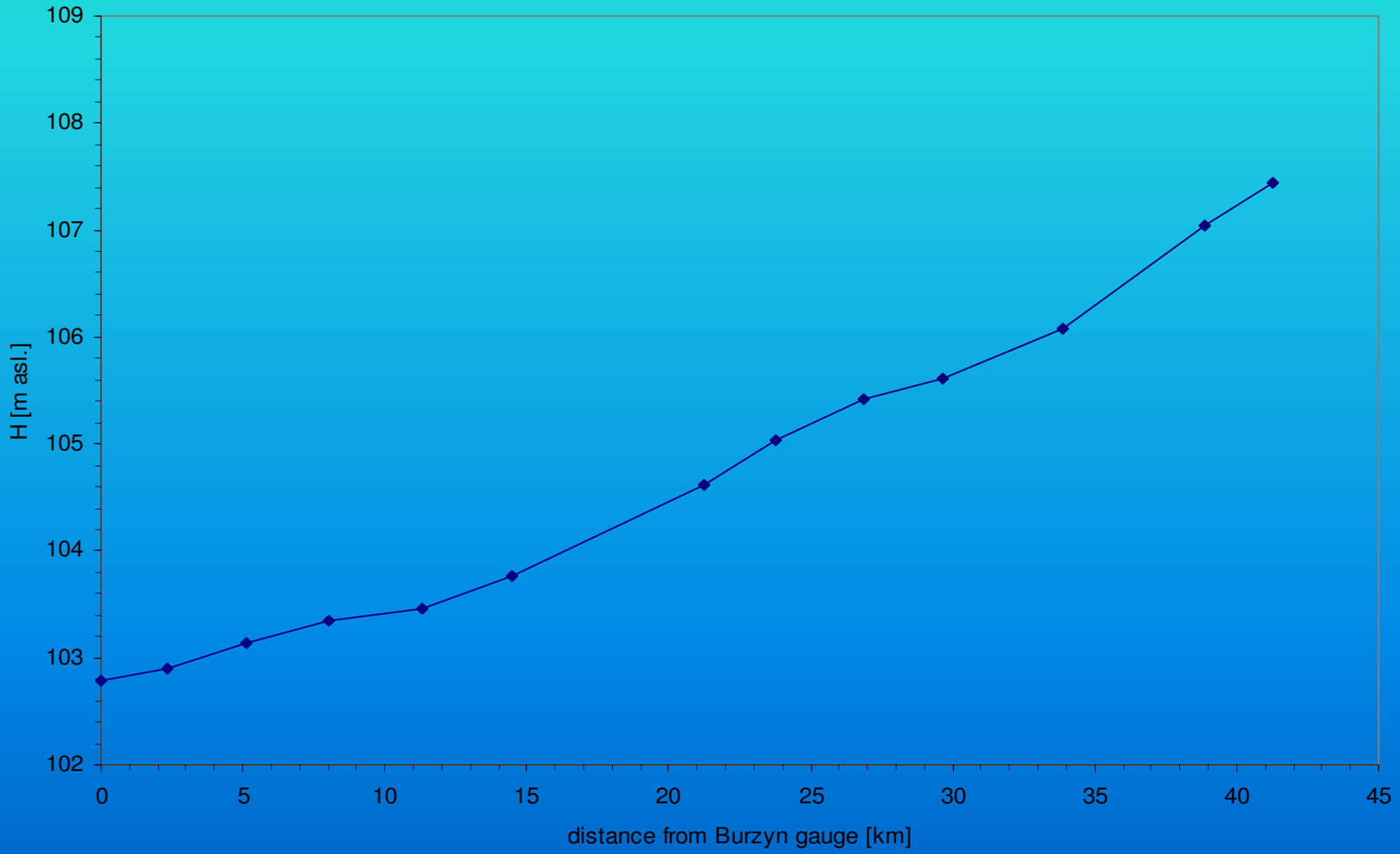
MODEL VALIDATION (OBSERVED AND CALCULATED DISCHARGE AT BURZYN GAUGE)



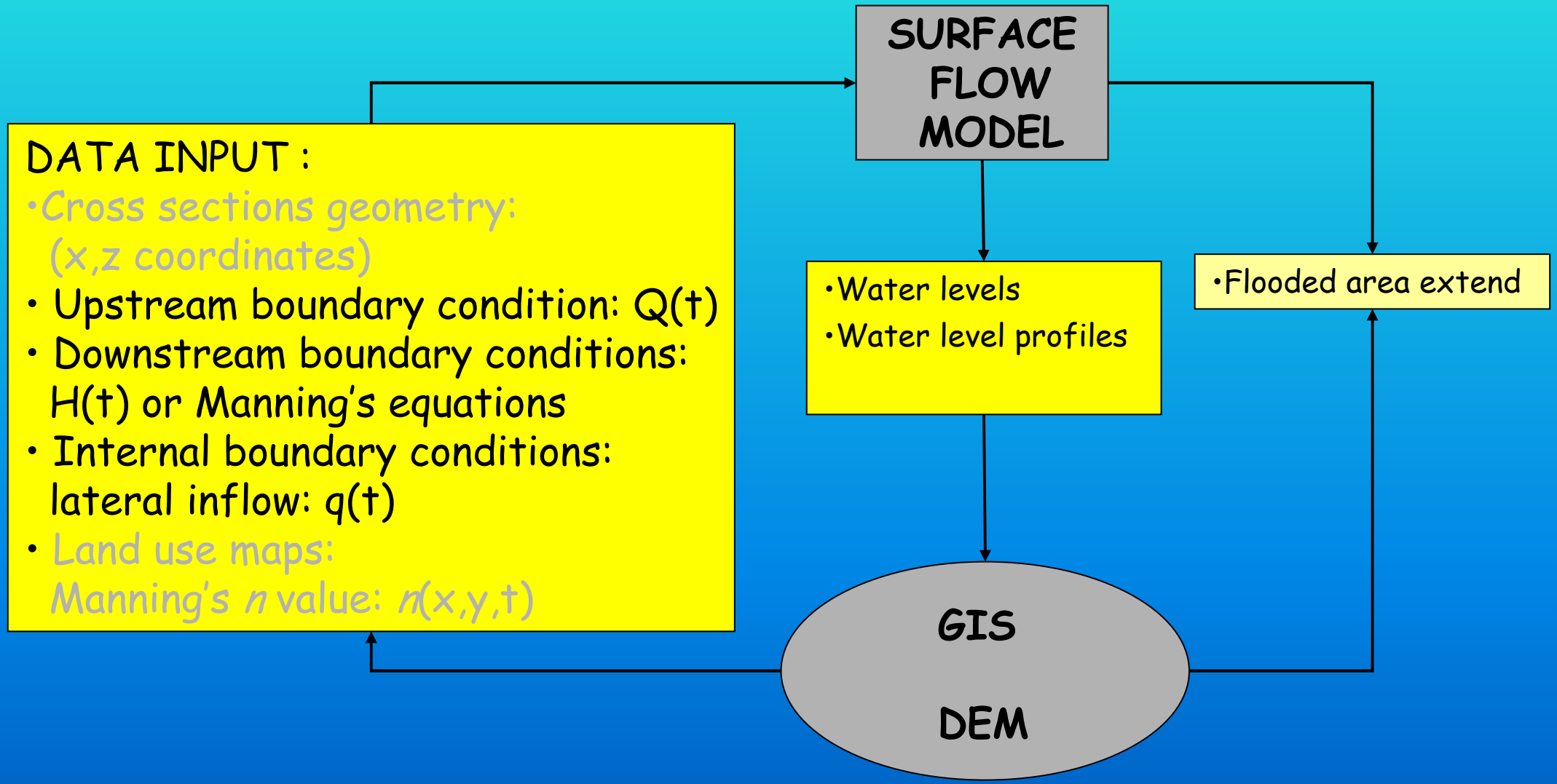
COMPARISON VOLUME OF WATER IN THE RVER AND FLOODPLAIN 13.02.2002



WATER LEVEL ALONG THE RIVER
(13.02.2002 Qmax=200m^3/s)



Surface water model and GIS connection



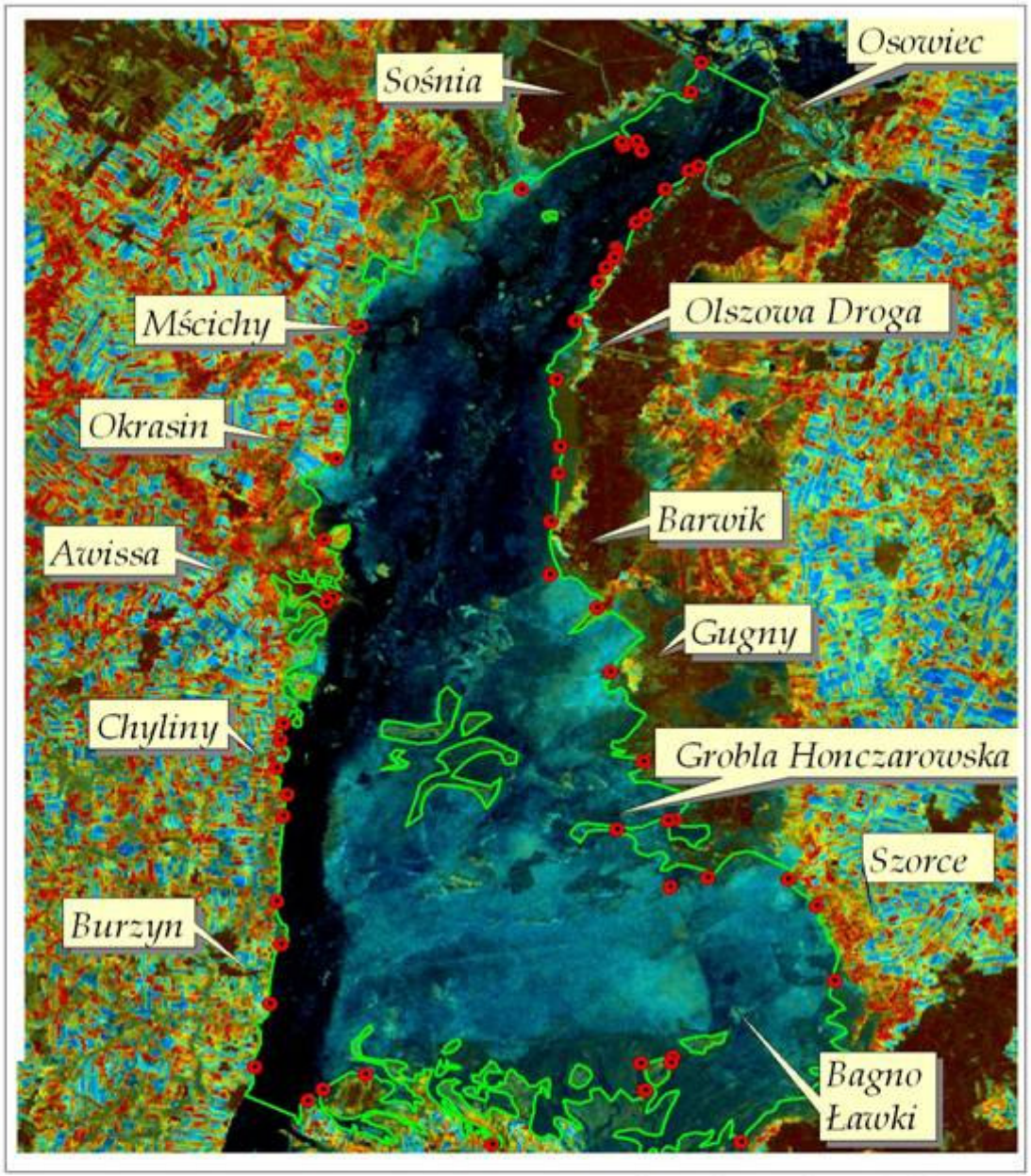
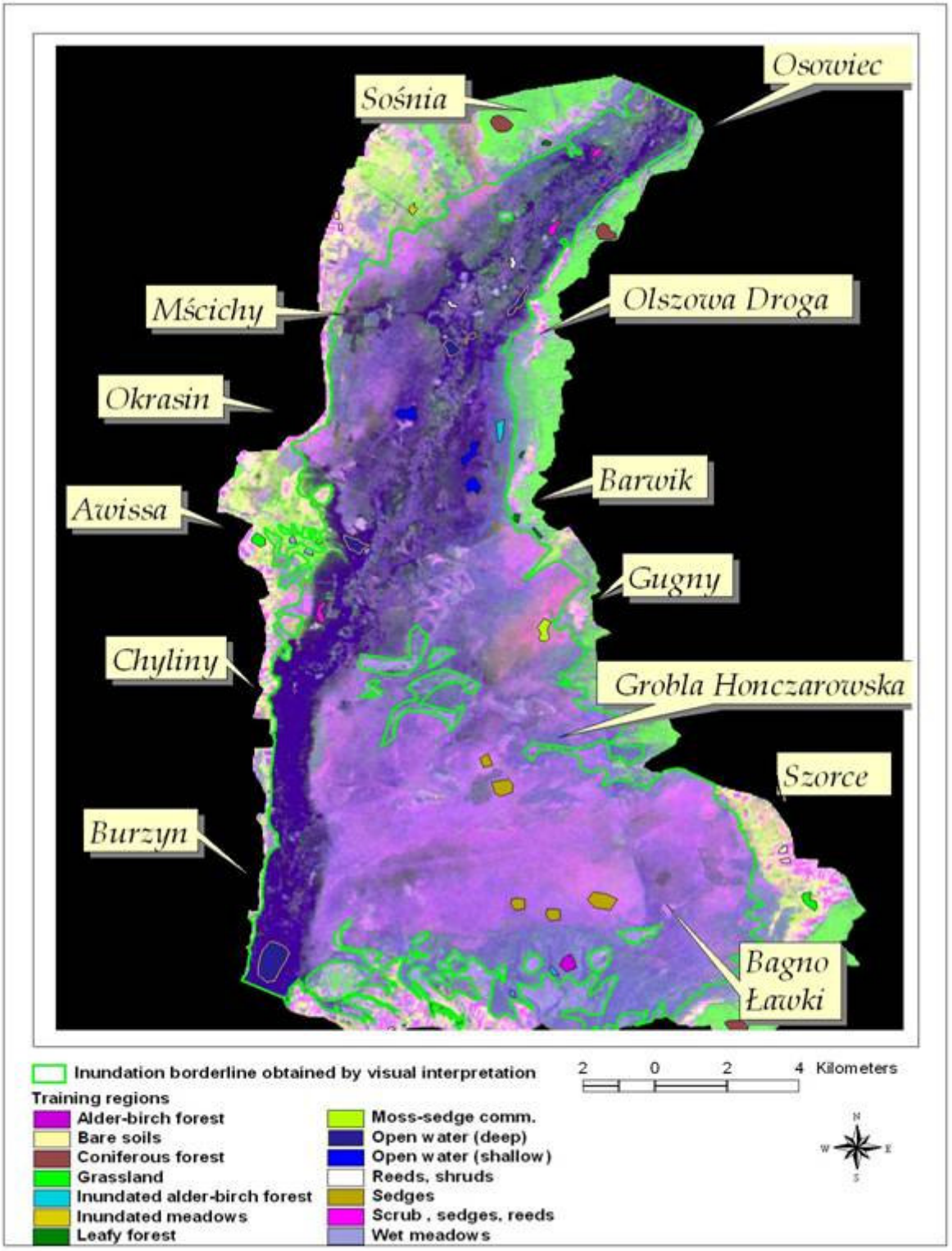


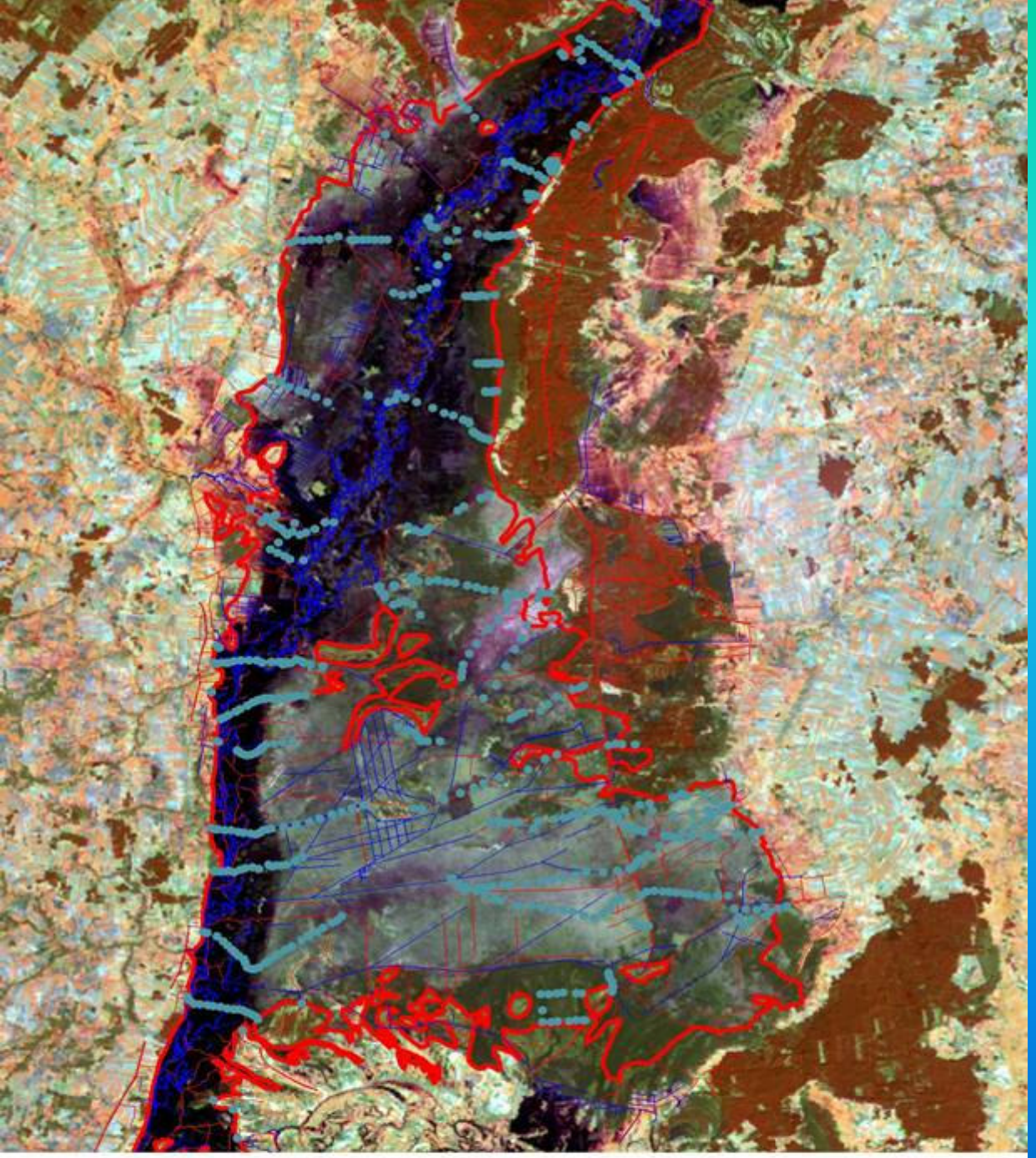
Image transformations (1) and Visual interpretation (2)

The processed Landsat ETM image captured 17th March 2002 visualised with the NDVI in pseudo colour scale and the PC1 as an intensity layer; inundation borderline obtained by visual interpretation compared to the GPS measurements of the inundation extent



Supervised classification (3) training fields determination

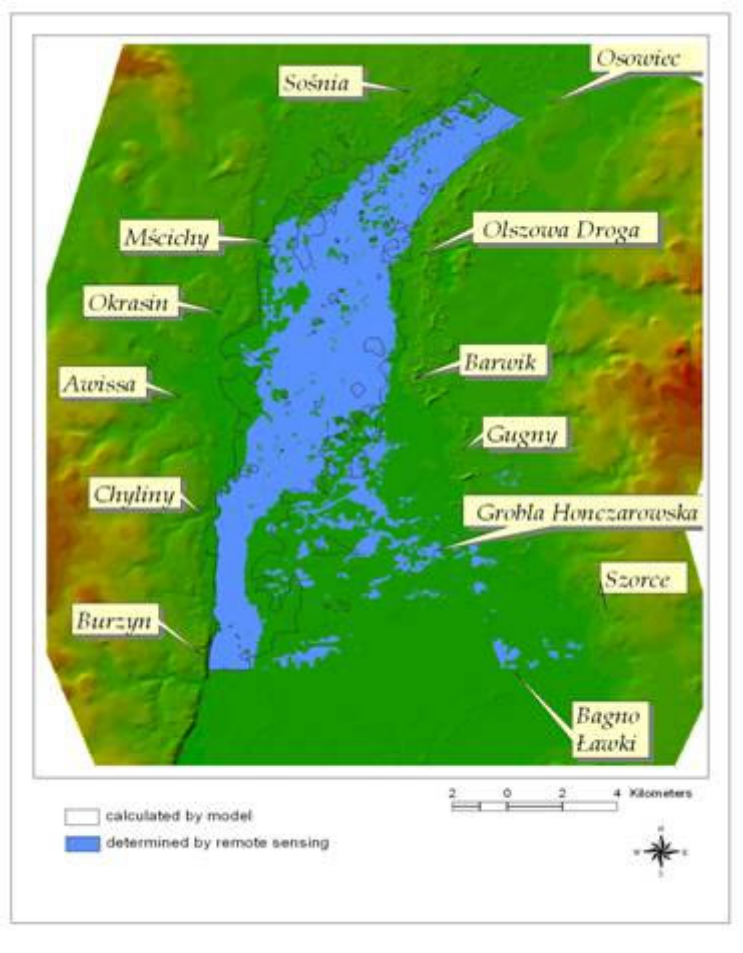
- Location of training fields – particular regions define different landuse-water classes
- Image transformed and visualised in RGB composition as follows: NDVI in *Red*, PC1 in *Green* and ratio 7/4 in *Blue*,
- Inundation borderline obtained by visual interpretation.

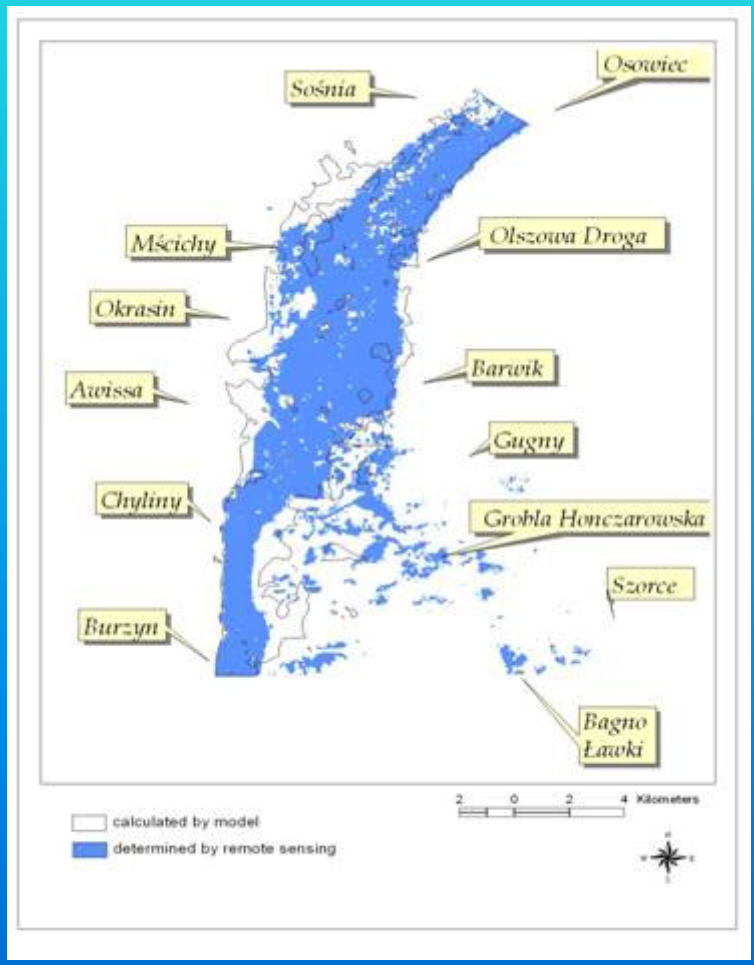


Verification points location

- A total of 796 points of known cover type were used in the verification process.
- The overall accuracy equal to **88%** reflects that categorization of the image into representative subsets (training regions) was performed well.
- In general, the higher values of both the user's and producer's accuracy were obtained for dry classes; the lowest values were obtained for classes which represent different wetland vegetation species.
- The KHAT value calculated for this classification is equal to **0.86**. Such a high value reflects the good quality of performed classification, which is 86 % better than the randomly performed categorisation

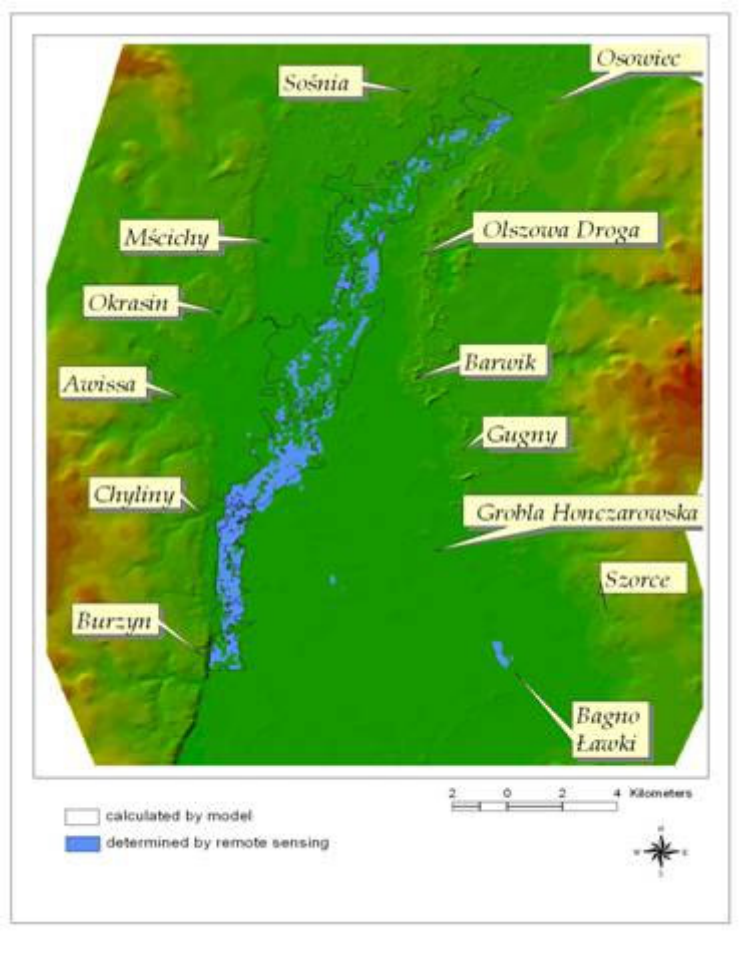
2002-03-17

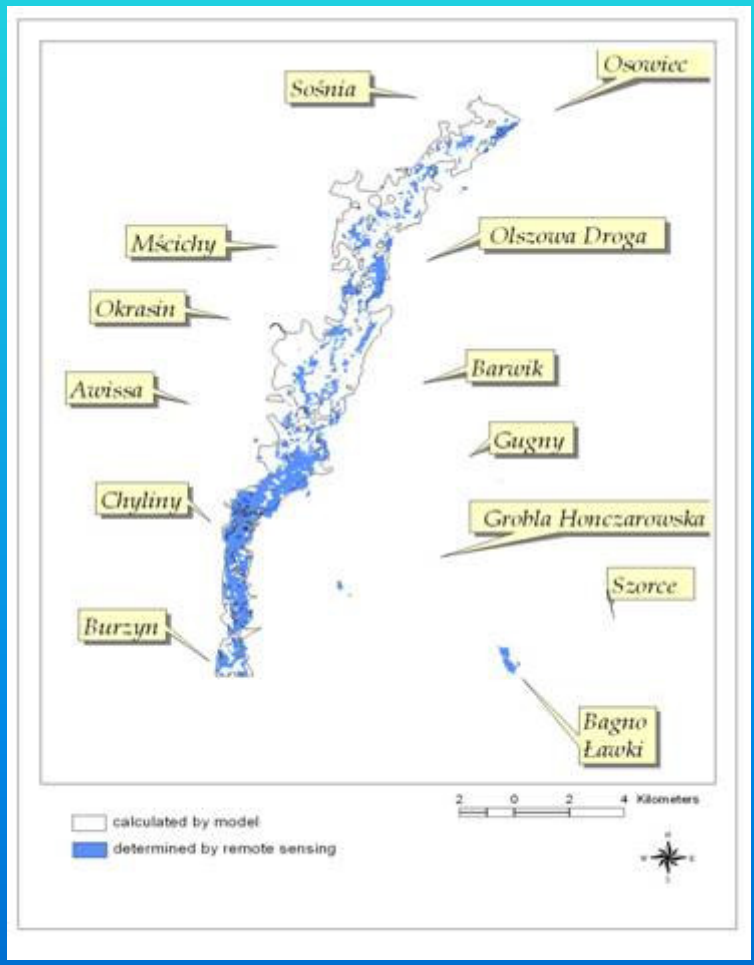




High water level, good result

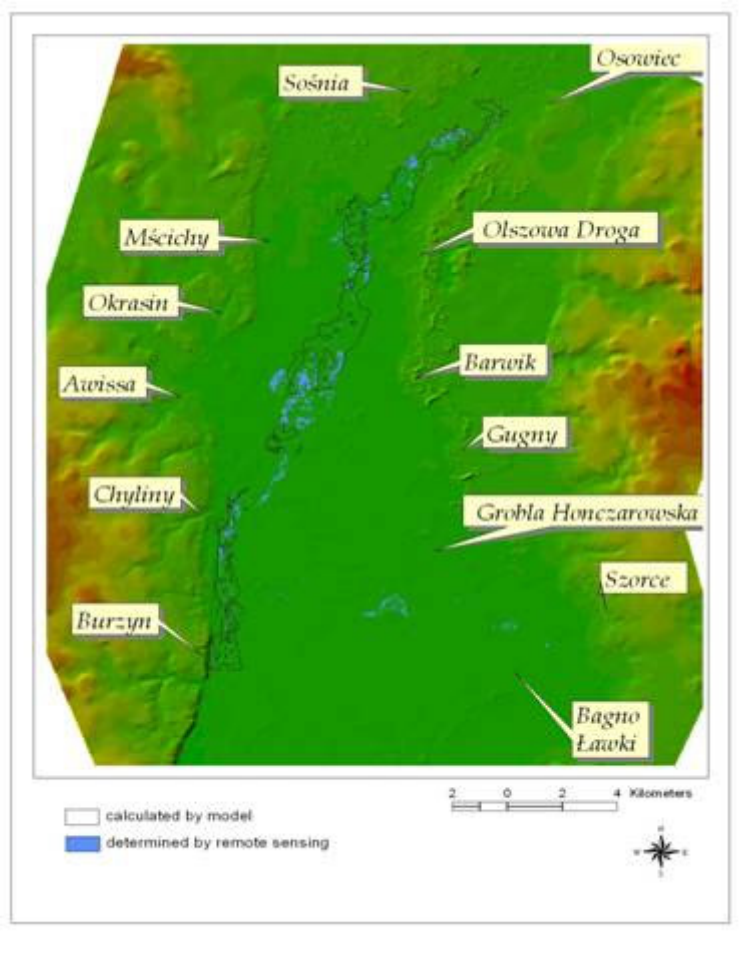
1988-05-15

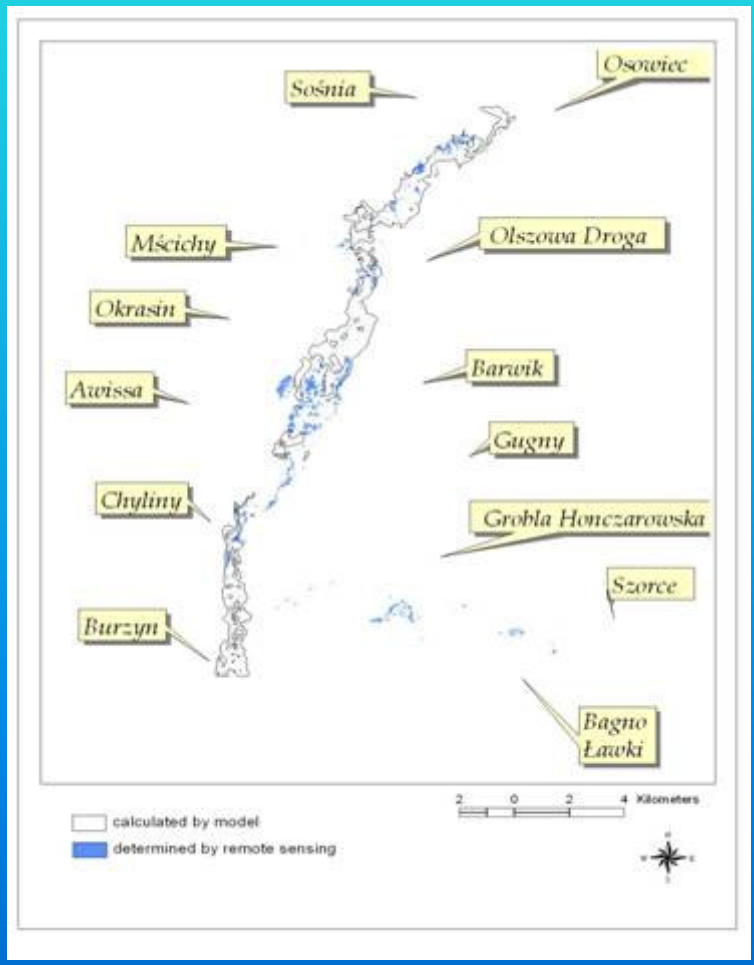




Relativelly high water level, good convergence in the south part of area;
Worse result in north and central part of area due to natural vegetation influence

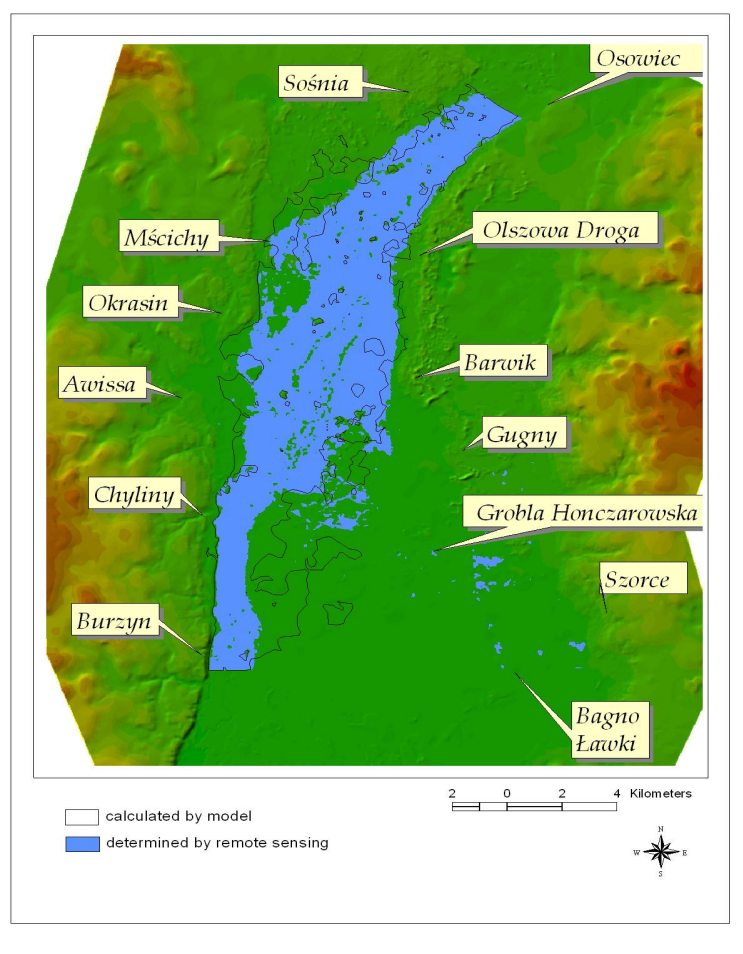
1997-05-16

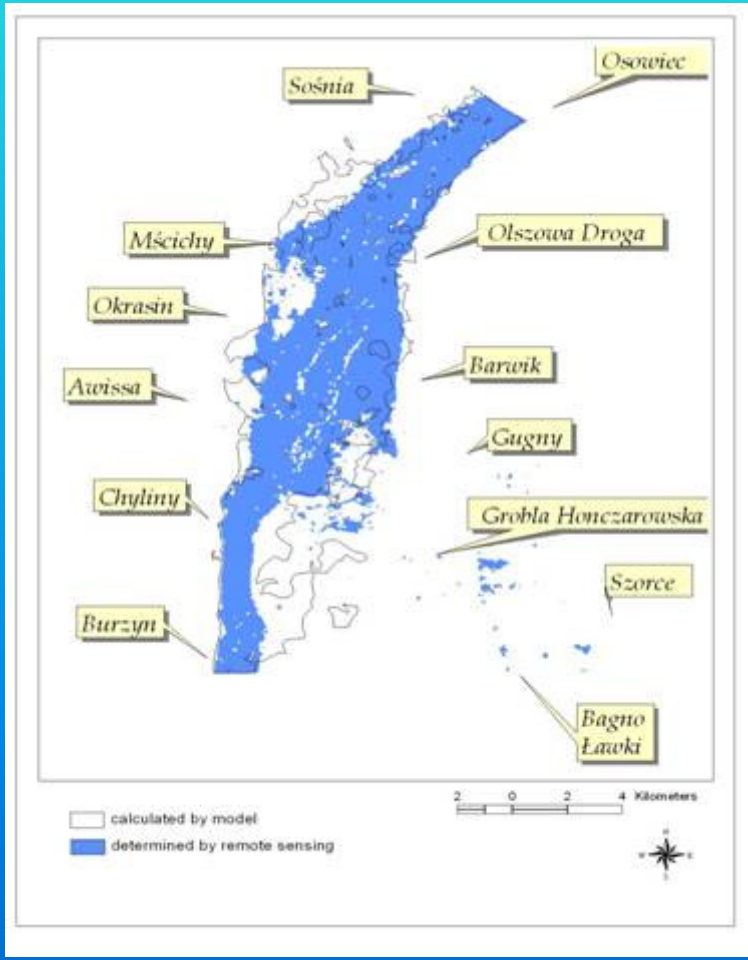




Low water level, Poor result probably due to the quality of DEM and vegetation influence

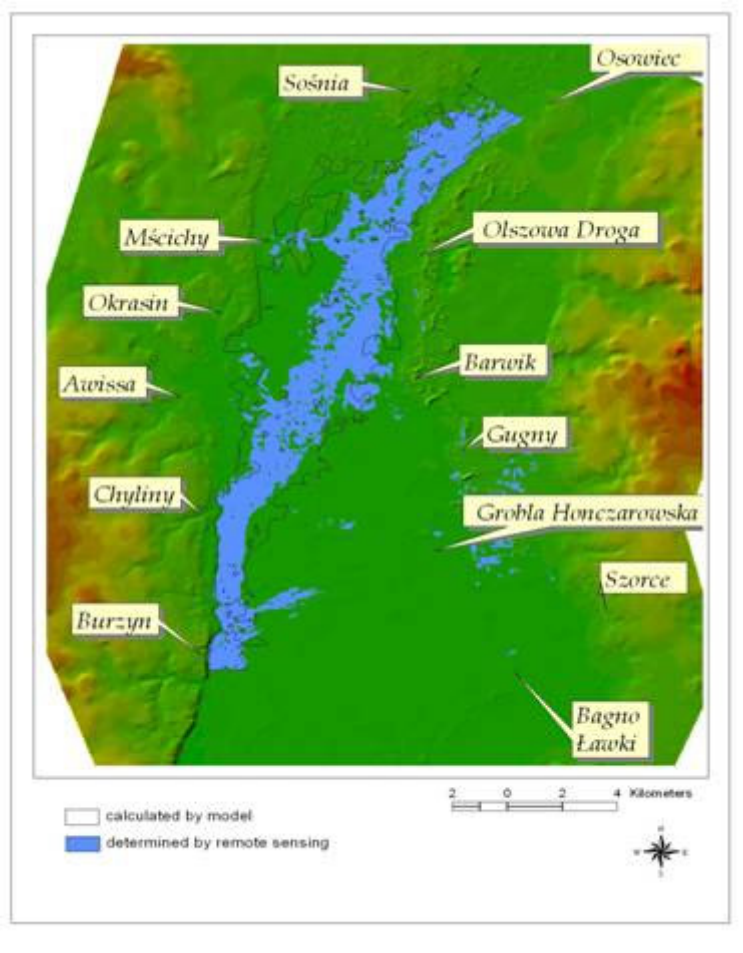
1999-03-19

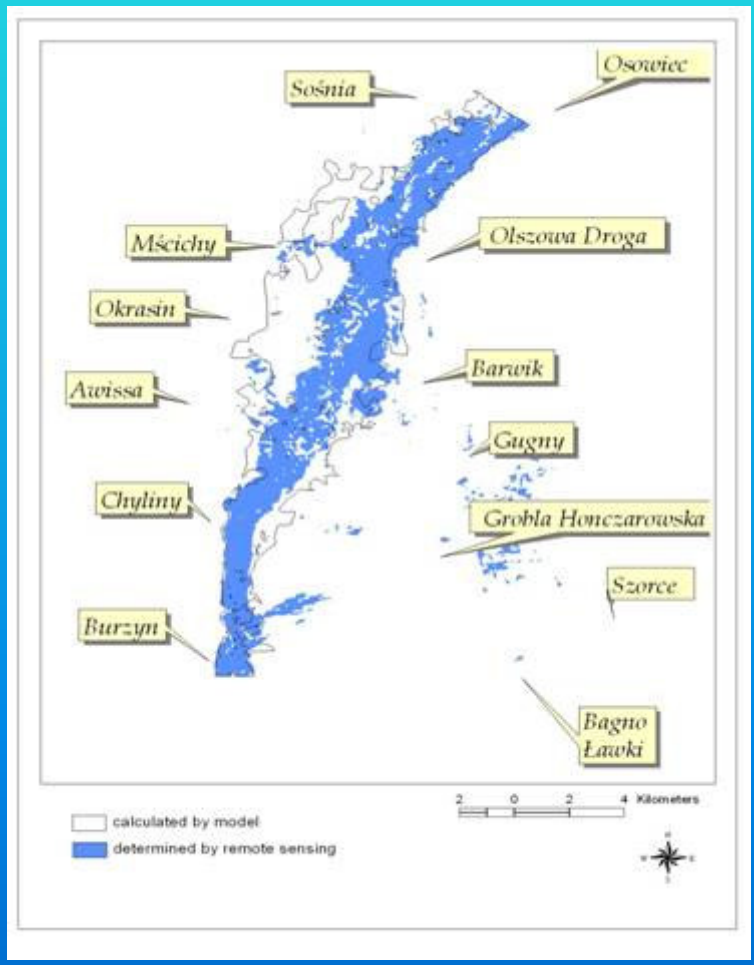




High water level, good result

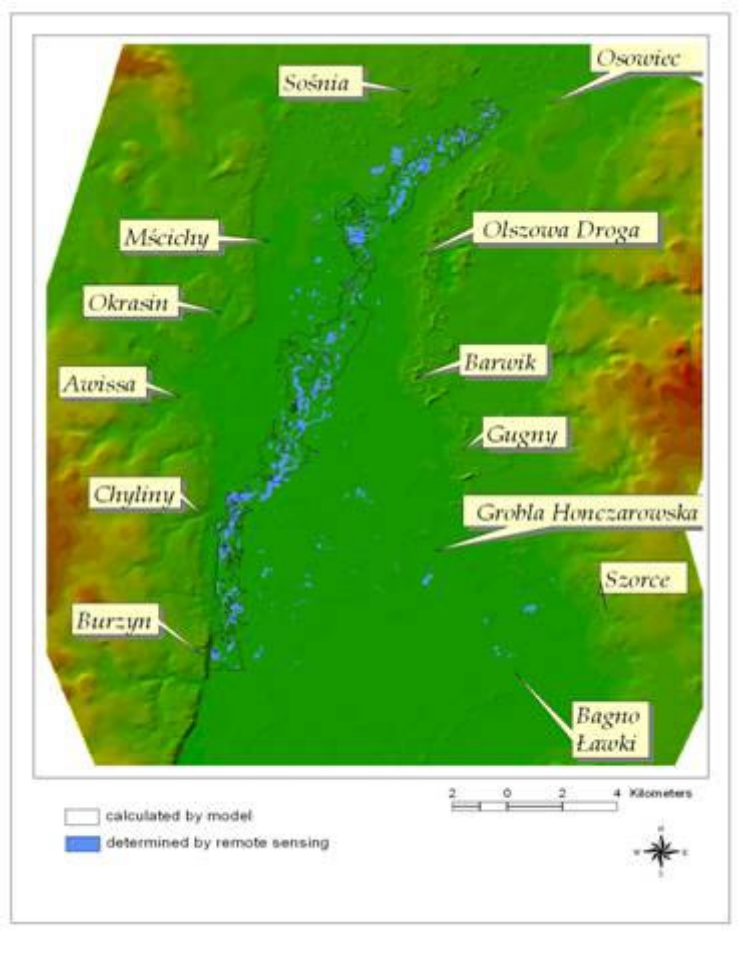
2000-03-20

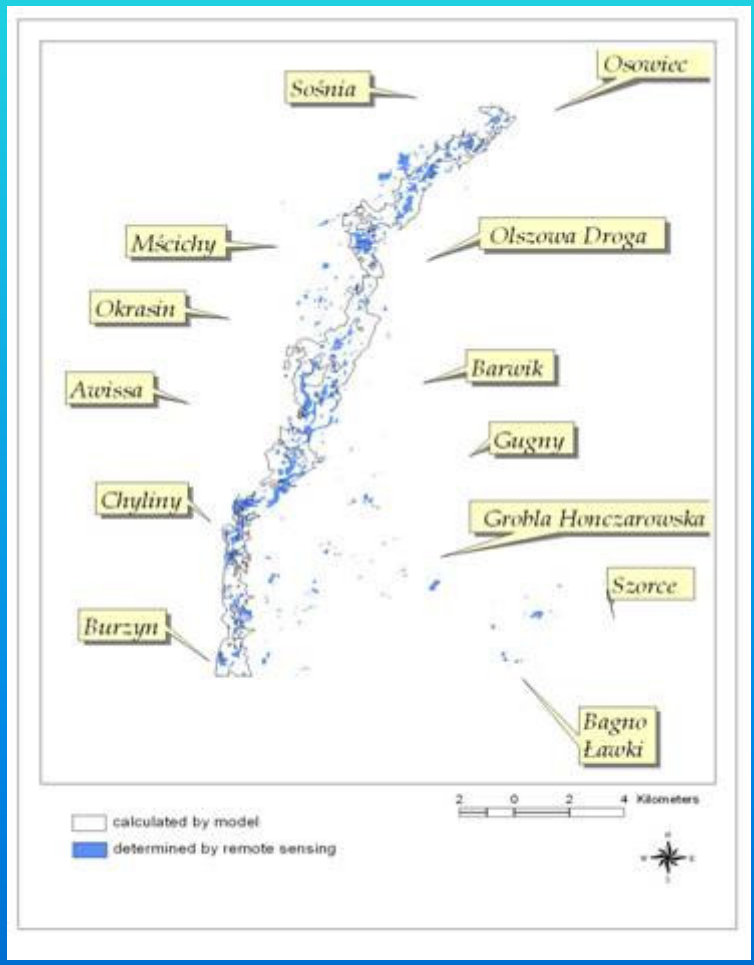




High water level, good result in suth and north part, poor in central due to cloud's obstacle

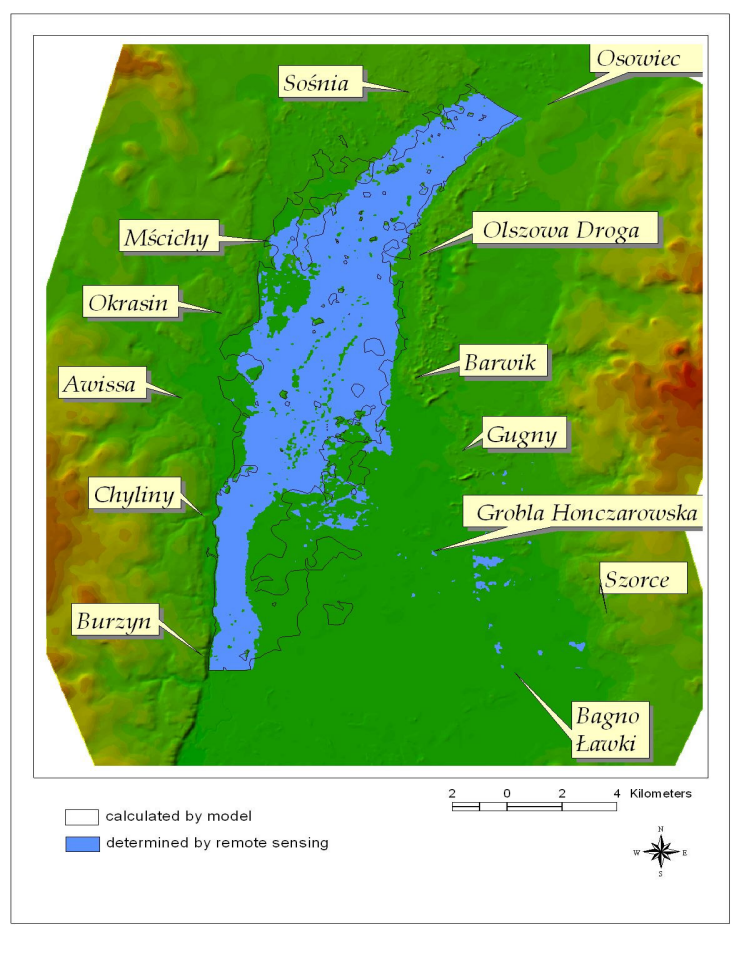
2000-05-07

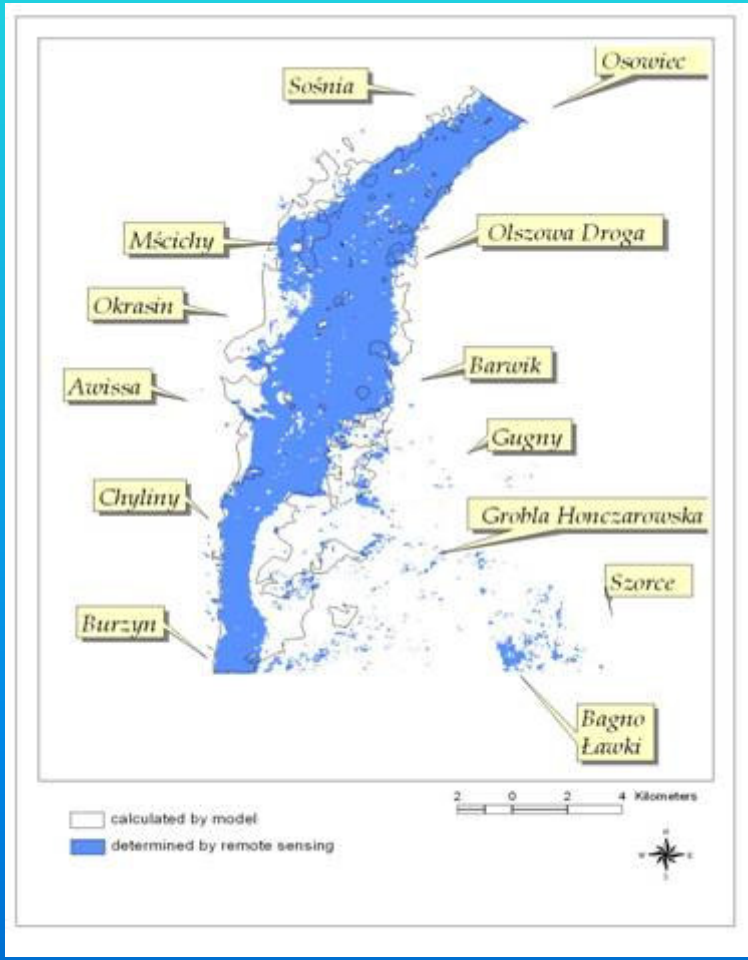




Low water level, Poor result probably due to the quality of DEM and vegetation influence

2002-02-15





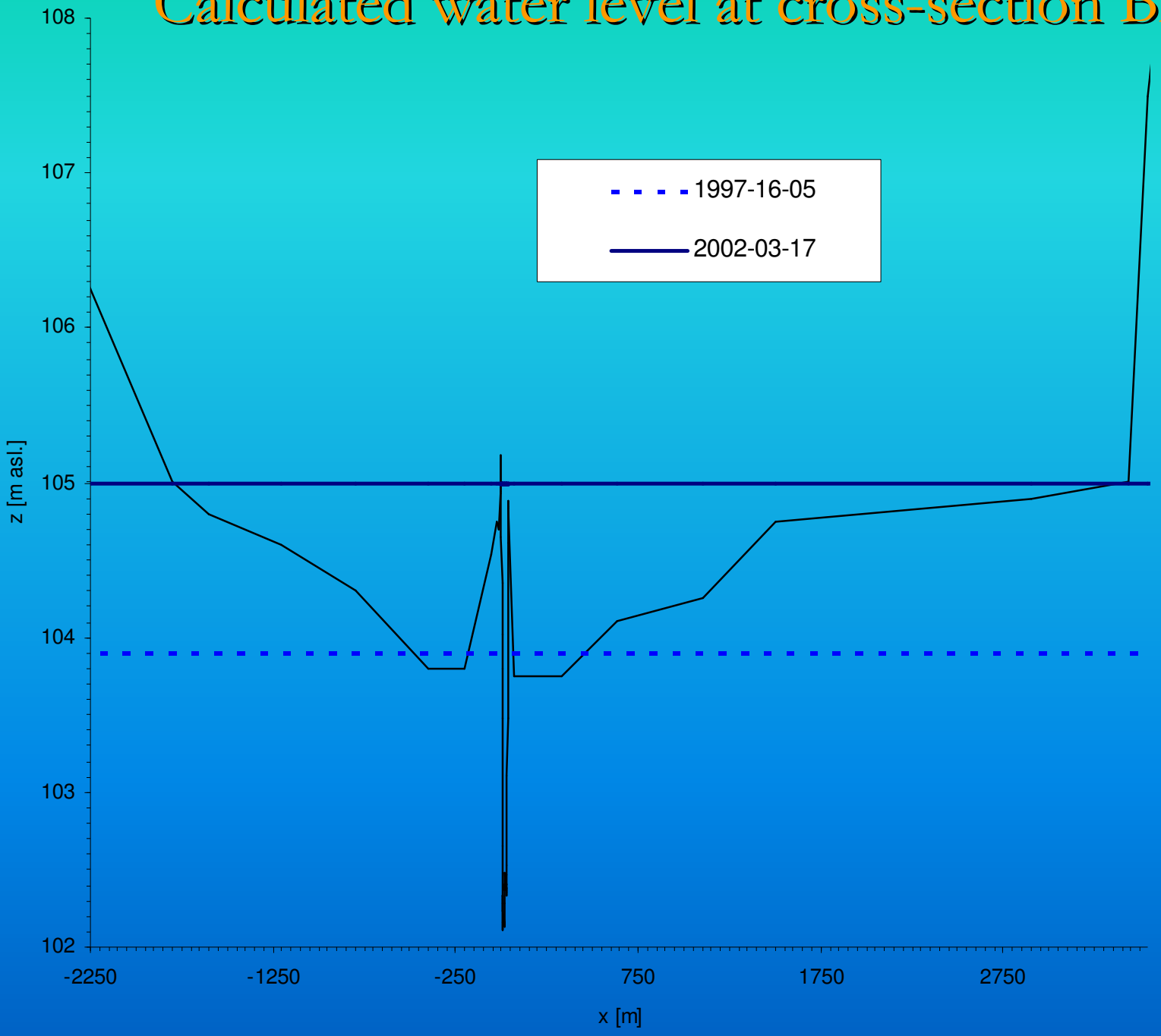
High water level, good result

The variation of the flooded area

Date of image capturing	Flooded area in sq km		error [%]	Q_{Burzyn} [m^3/s]		H_{Burzyn} [m asl.]	
	A_{model}	A_{RS}		M	O	M	O
2002-03-17	83.60	77.51	8	170.5	168	102.25	102.24
2002-02-15	88.41	74.37	19	191.5	192	102.30	102.31
2000-05-07	20.63	8.12	154	36.2	34.8	101.60	101.54
2000-03-20	66.46	45.87	45	76.2	80.3	101.96	101.97
1999-03-19	86.63	71.99	20	194.8	184	102.31	102.29
1997-05-16	14.32	3.22	345	29.3	29.6	101.3	101.36
1988-05-15	37.15	14.53	156	48.0	48	101.77	101.87

$$Error=(A_{model}-A_{RS})/A_{RS})$$

Calculated water level at cross-section BD8



Conclusions

- The 1D hydraulic model obtains quite promising results for information collected about water flow regime in Lower Biebrza up to now.
- RS is the good method for high flood and not enough for the low water levels (influence of clouds and vegetation).
- DEM quality has influence on results, especially during low water stages.
- The water levels calculated by 1D hydraulic model cannot be automatically mapped in whole floodplain using the DEM in GIS software.