The role of forest in the water balance of wetland habitats

Tomasz Okruszko
Jarosław Chormański
Dorota Mirosław-Świątek
Okke Batelaan*
Mateusz Grygoruk

WARSAW UNIVERSITY OF LIFE SCIENCES, POLAND
*FREE UNIVERSITY BRUSSELS, BELGIUM

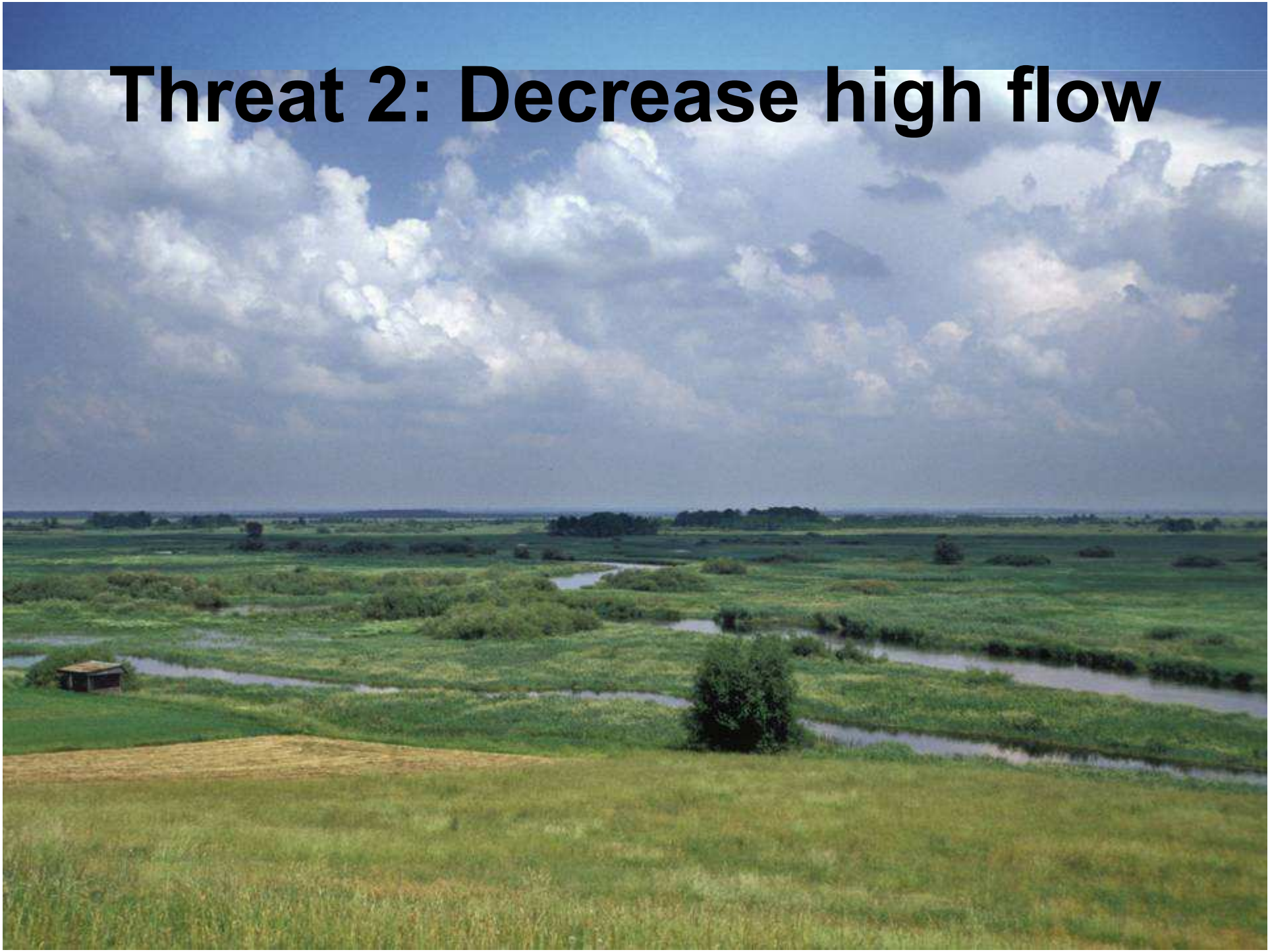
2nd ICFW, Raleigh, North Carolina, 14 -16 September 2009

Contents

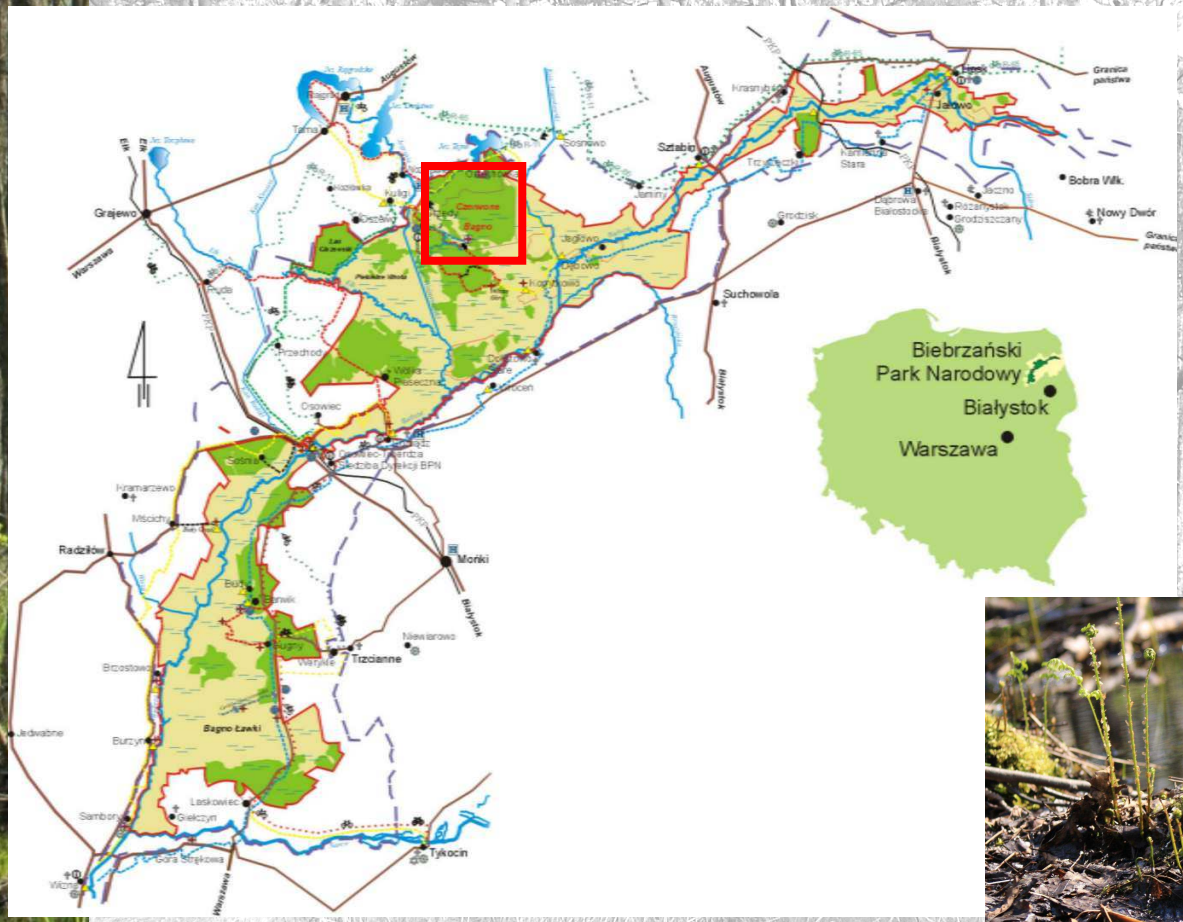
- Context
- Examples
  - Forest on mire
  - Forest on the floodplain
- Conclusions

Threat 1: Bush encroachment

Threat 2: Decrease high flow



Red Bog

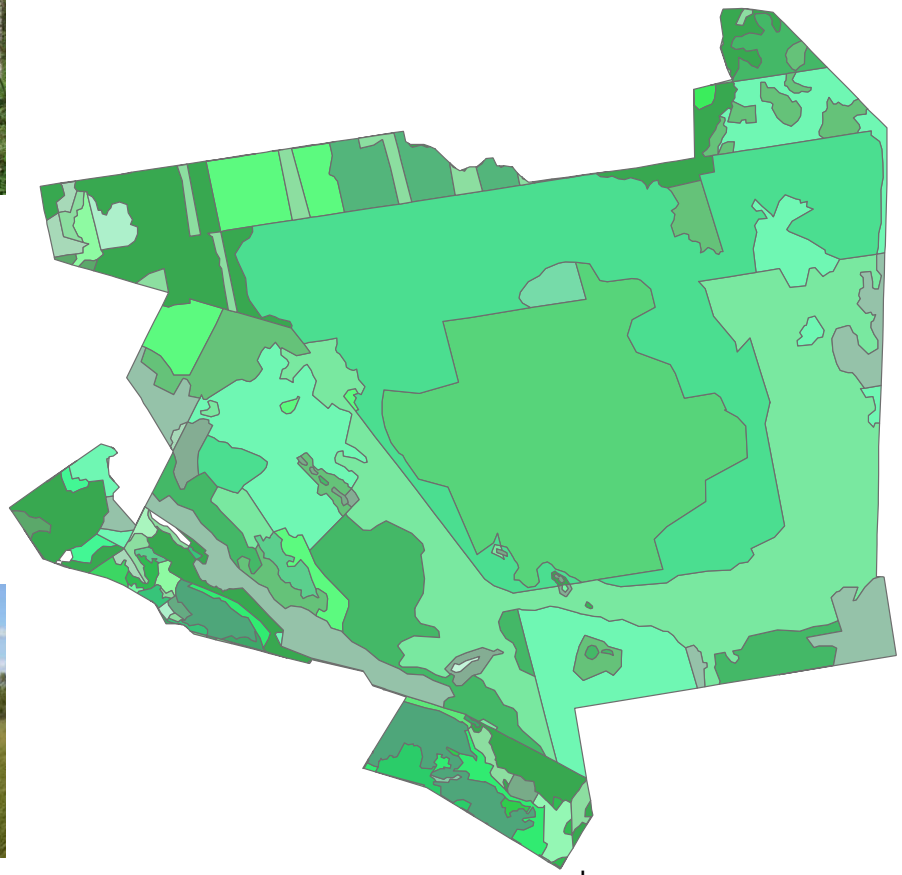

Grajewo
Sztabin
Suchowola
Jasiówo
Bobra Wlk.
Nowy Dwór
Radziłków
Mońki
Trzcianne
Tykocin
Biebrzański
Park Narodowy
Białystok
Warszawa

Vegetation map

Birch forest

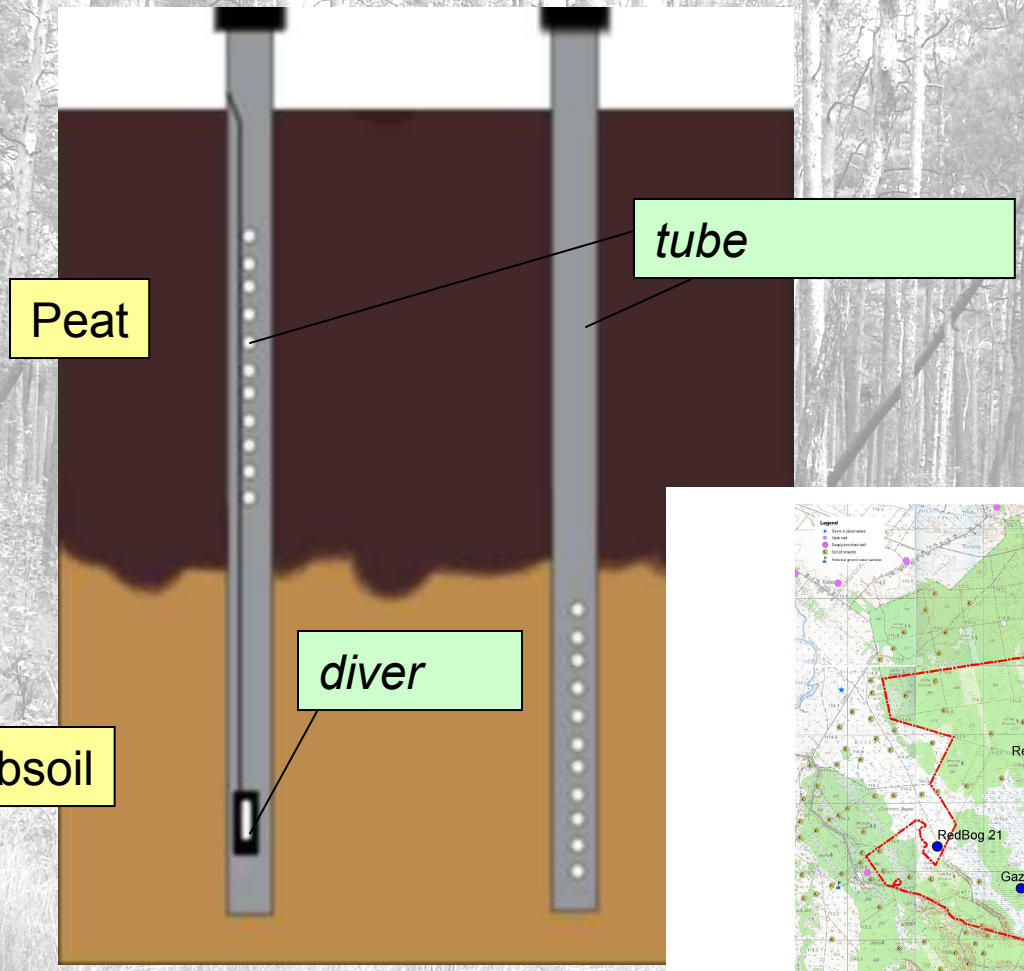
Pine forest

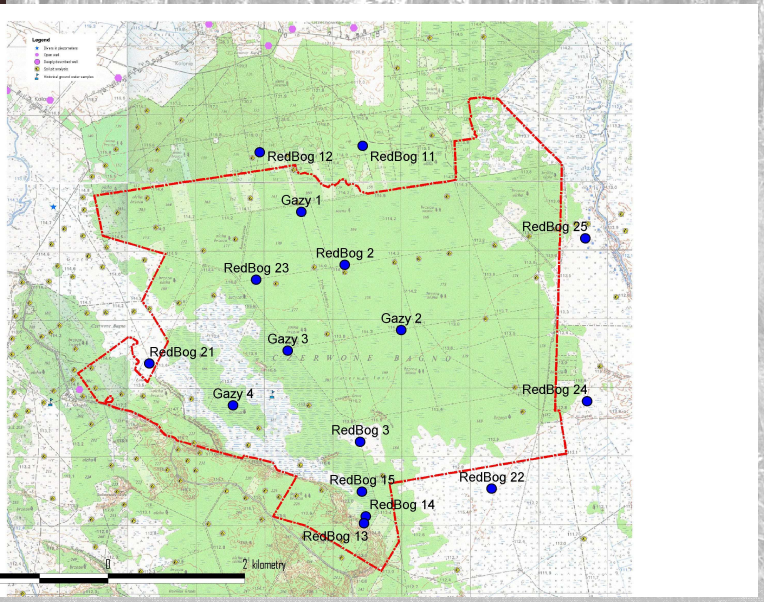
Sedges



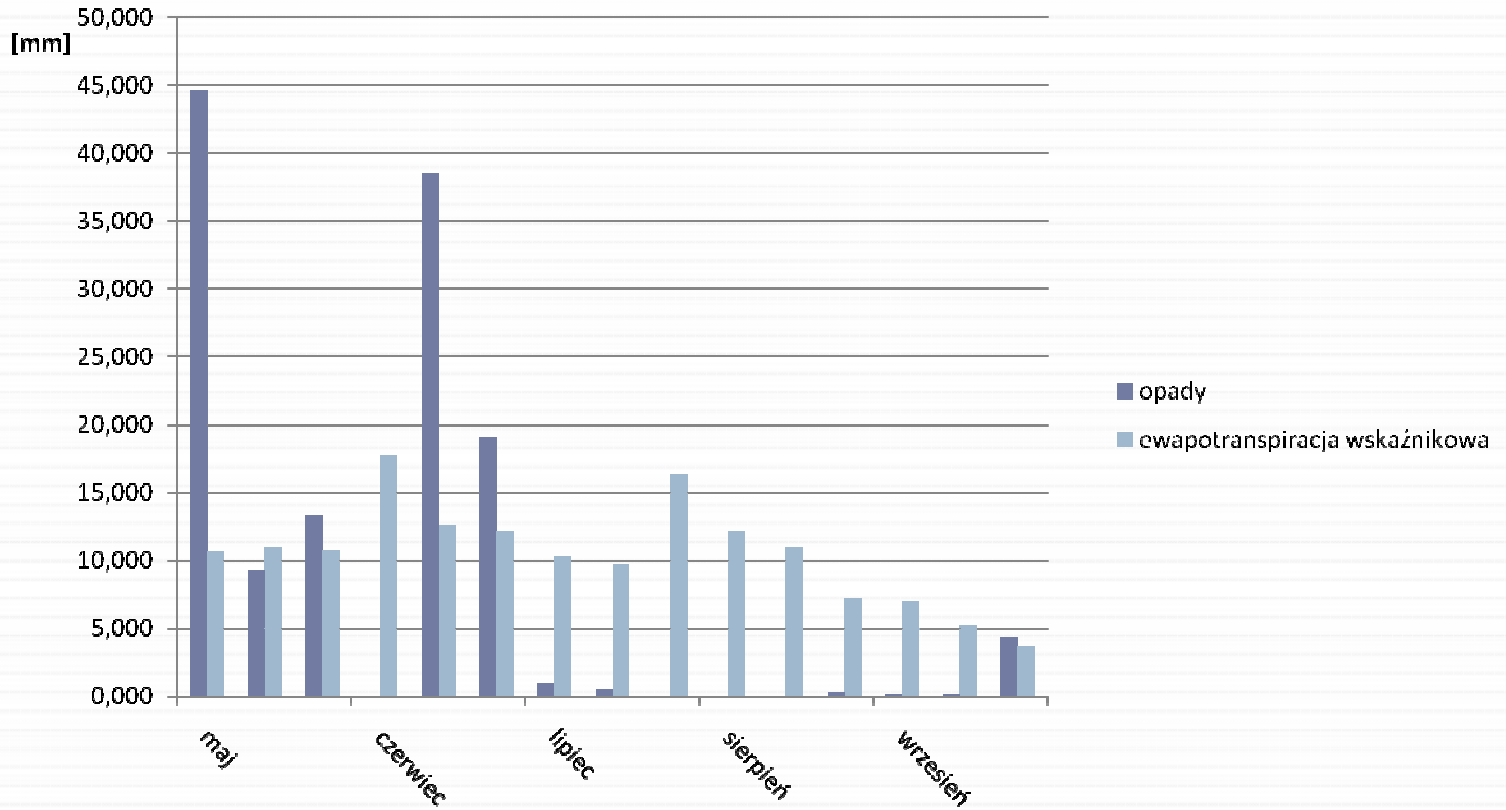
0 1 2 4 km

- Alnus-Urtica typ.
- Alnus-Urtica v.Melampyrum
- Betula-Anemone
- Betula-Calamagrostis
- Betula-Stellaria
- Betula-Urtica v.Carex elongata
- Betula-Vaccinium
- Carici chordorrchizae-Pinetum
- Carici chordorrchizae-Pinetum typ.
- Carici elongatae-Alnetum
- Carici elongatae-Alnetum ribetosum
- Carici elongatae-Alnetum sphagn.
- Carici elongatae-Alnetum typ
- Equisetum-Alnus
- Eu-Piceetum typ.
- Ficario-Ulmetum
- Molinia-Betula
- Peucedano-Pinetum
- Peucedano-Pinetum typ
- Pino-Quercetum typ.
- Pinus-Oxalis
- Pnius-Calamgrostis arund.
- Querco-Piceetum typ.
- Salicetum pentandro-cinereae
- Salici-Betuletum plytrichetosum
- Salici-Betuletum typ.
- Sphagno girgensohnii-Piceetum thelypt
- Thelypteri-Betuletum typicum
- Tilio-Carpinetum calamagrostietosum
- Tilio-Carpinetum caricetosum
- Tilio-Carpinetum corydaletosum
- Tilio-Carpinetum typ.
- Vaccinio myrtilli-Pinetum
- Vaccinio myrtilli-Pinetum typ.
- Vaccinio uliginosi-Pinetum
- młodnik
- porębowy
- szuwary turzycowe i trzcinowe


tube
Peat
diver
Mineral subsoil

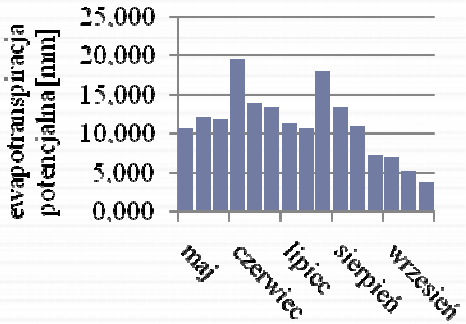

RedBog 12
RedBog 11
Gazy 1
RedBog 25
RedBog 2
RedBog 23
Gazy 2
Gazy 3
RedBog 21
RedBog 24
Gazy 4
RedBog 3
RedBog 15
RedBog 22
RedBog 14
RedBog 13
kilometry

Precipitation vs. potential ET summer 2008

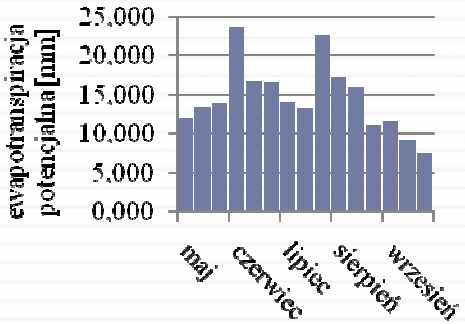


Potential ET for different vegetation types

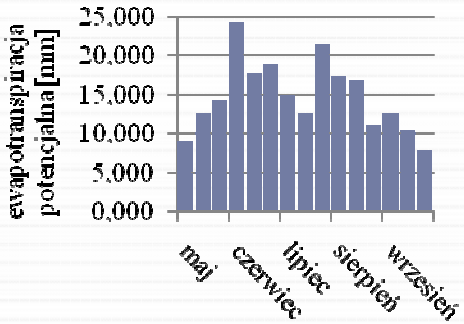
PINE



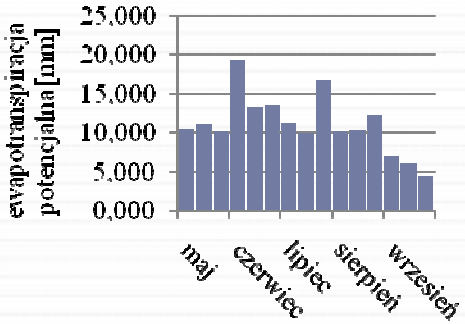
ALDER



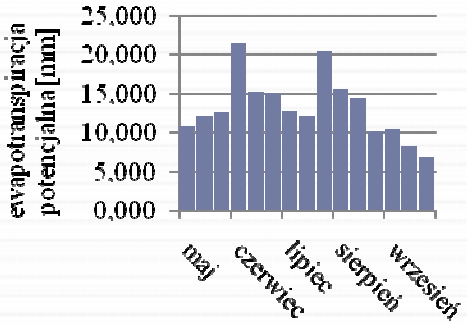
BIRCH



GRASSLANDS

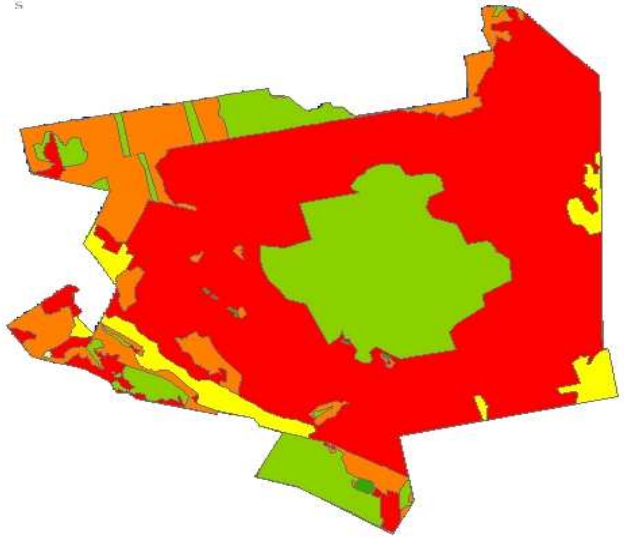


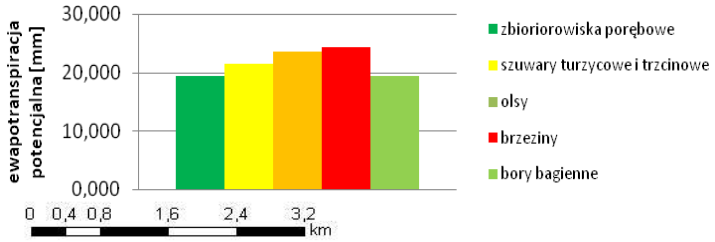
SEDGES



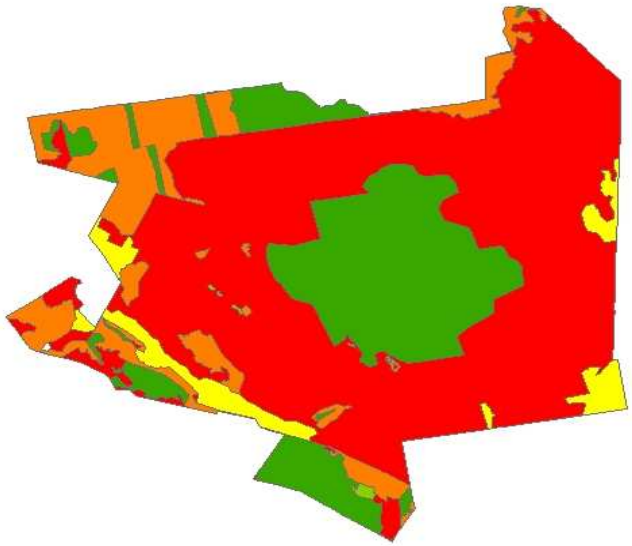
ET map summer period June and September

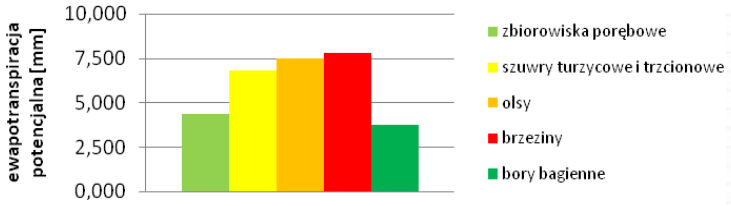
1ST 10DAYS OF JUNE

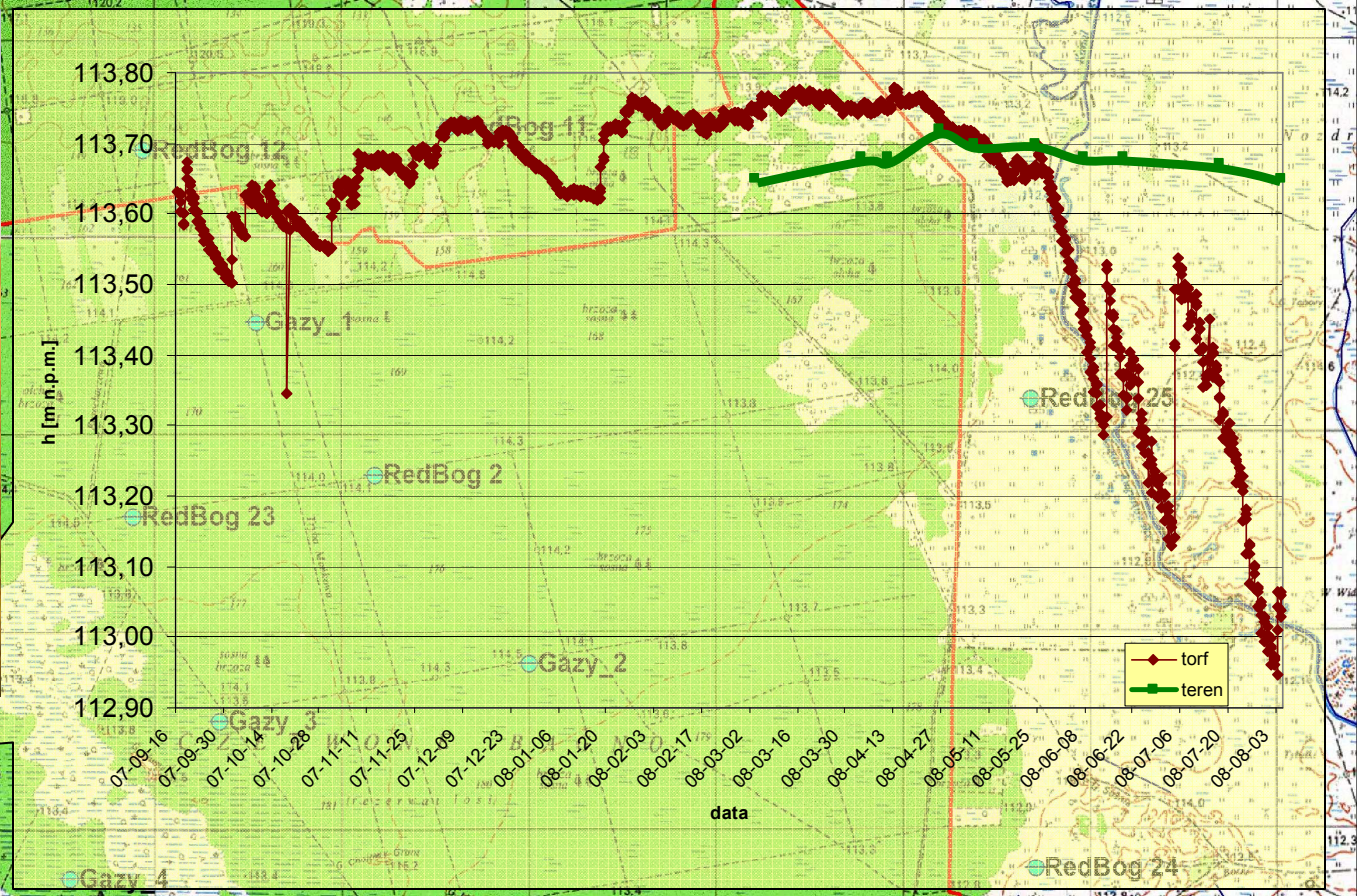




3RD 10 DAYS OF SEPTEMBER







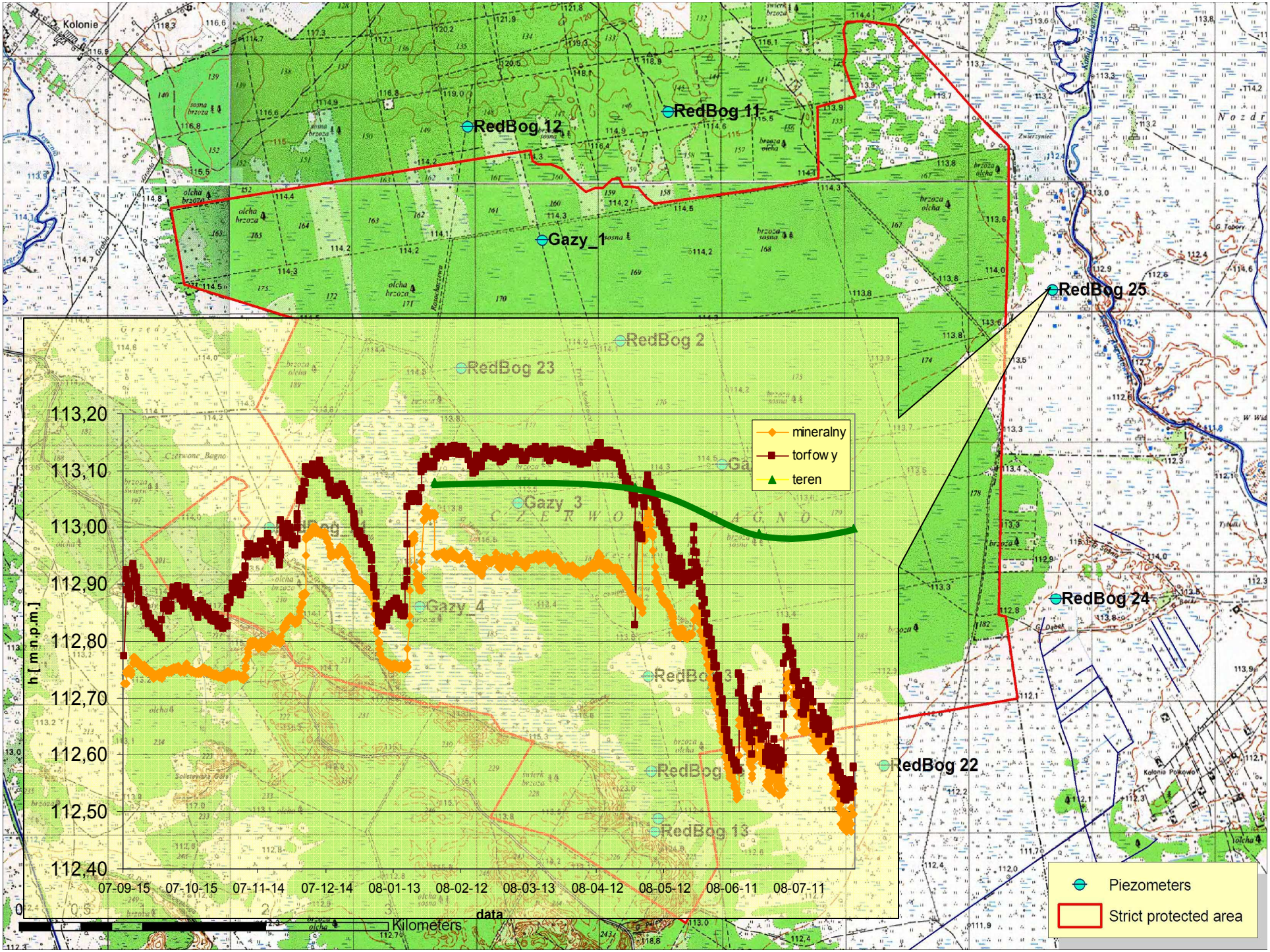
RB21 – Sedge vegetation

RedBog_21
RedBog 15
RedBog 13
RedBog 22
RedBog 24
RedBog 3
RedBog 2
RedBog 23
Gazy_1
Gazy_2
Gazy_3
Gazy_4
RedBog 11
RedBog 12
RedBog 25

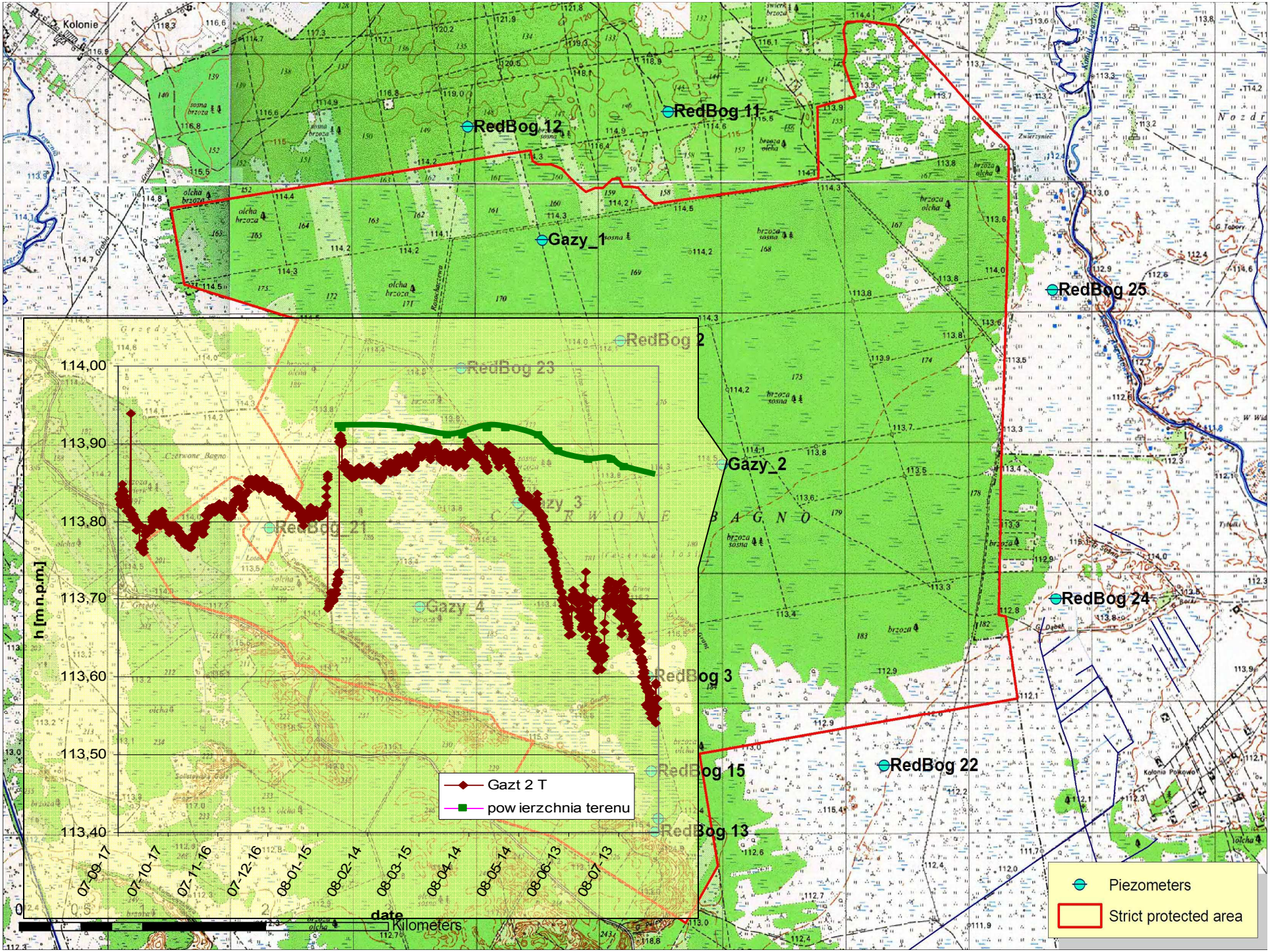
0 0.5 2 3 Kilometers

Piezometers
Strict protected area


RB25 – Sedge vegetation and birch encroachment

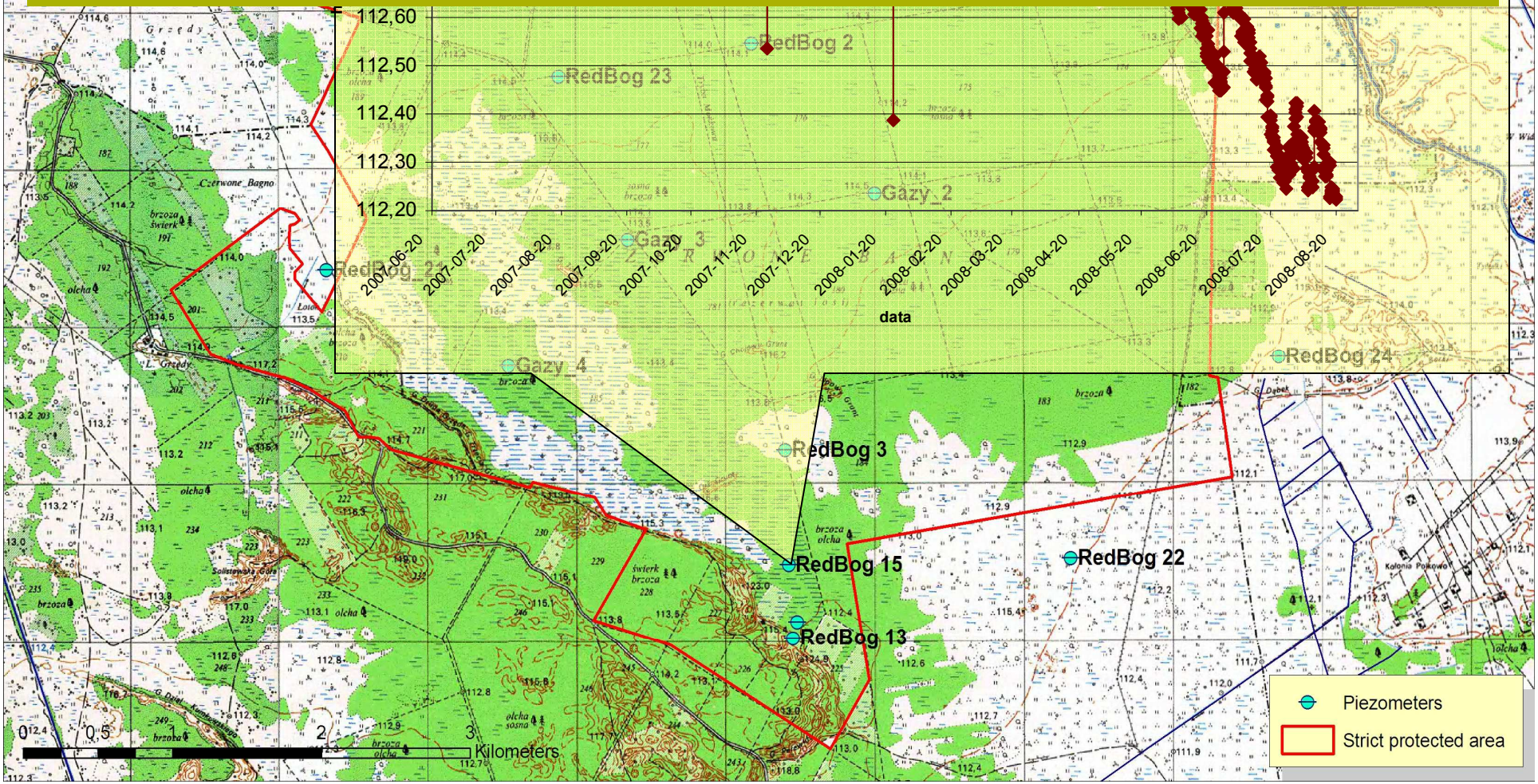

RedBog 12
RedBog 11
Gazy_1
RedBog 25
RedBog 24
RedBog 22
RedBog 2
RedBog 23
Gazy_3
Gazy_4
RedBog 3
RedBog 13
mineralny
torfowy
teren
113,20
113,10
113,00
112,90
112,80
112,70
112,60
112,50
112,40
h [m n.p.m.]
07-09-15
07-10-15
07-11-14
07-12-14
08-01-13
08-02-12
08-03-13
08-04-12
08-05-12
08-06-11
08-07-11
data
Kilometers
Piezometers
Strict protected area


Gazy 2 – Pine forest on the bog

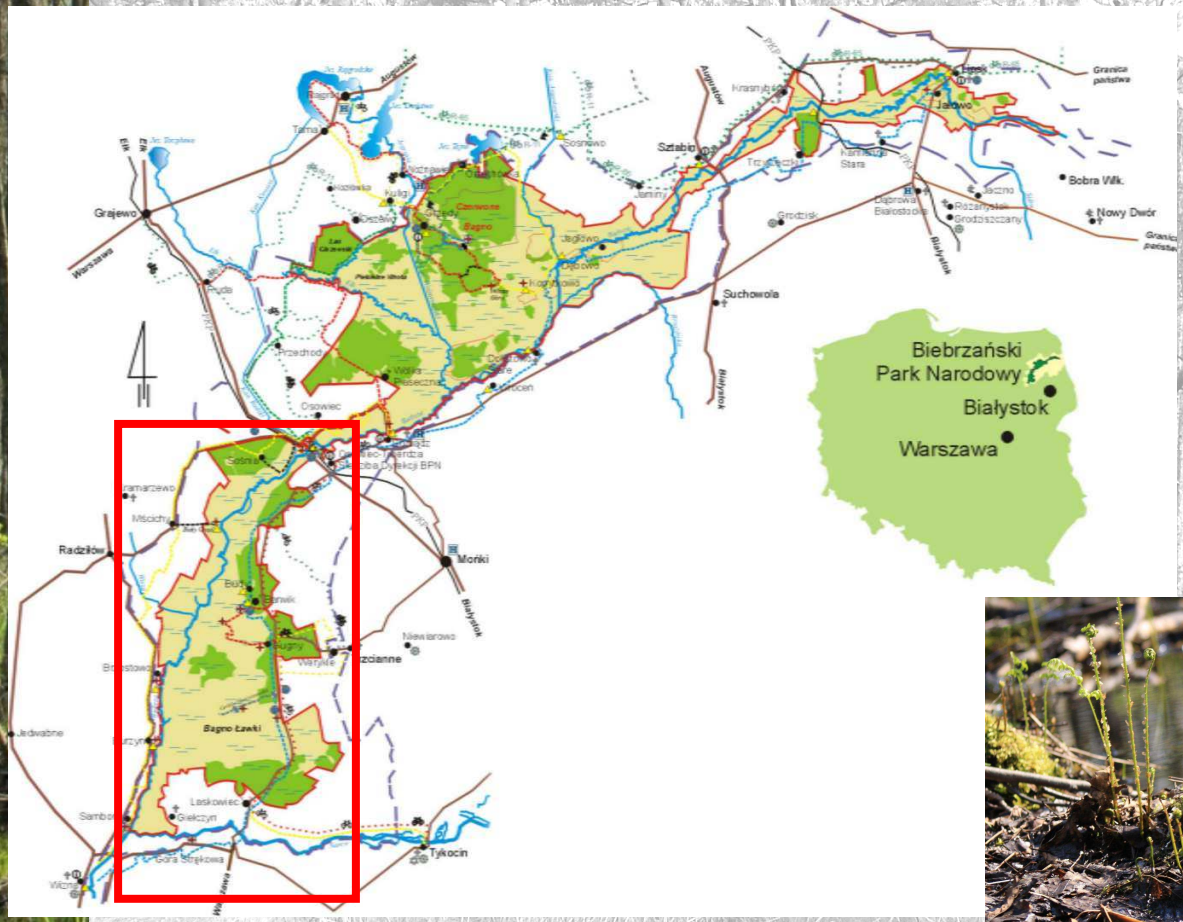

RedBog 12
RedBog 11
Gazy_1
RedBog 25
RedBog 2
RedBog 23
Gazy_2
RedBog 21
Gazy_3
Gazy_4
RedBog 24
RedBog 3
RedBog 22
RedBog 15
RedBog 13
114,00
113,90
113,80
113,70
113,60
113,50
113,40
h [m n.p.m.]
07-09-17
07-10-17
07-11-16
07-12-16
08-01-15
08-02-14
08-03-15
08-04-14
08-05-14
08-06-13
08-07-13
date
Gazt 2 T
powierzchnia terenu
Kilometers
Piezometers
Strict protected area

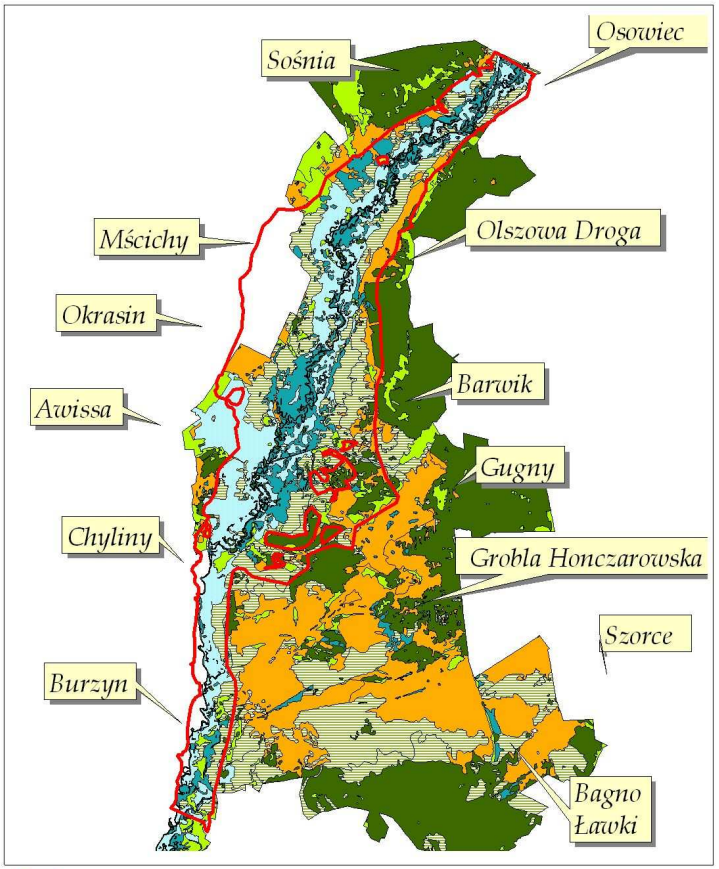

RB15 – Alder forest

- In the drained mire we observe the bigger decline of water under the birch stands
- In the natural mire, despite the significant changes in ET we do observe a little changes in the ground water regime



Biebrza River lower basin

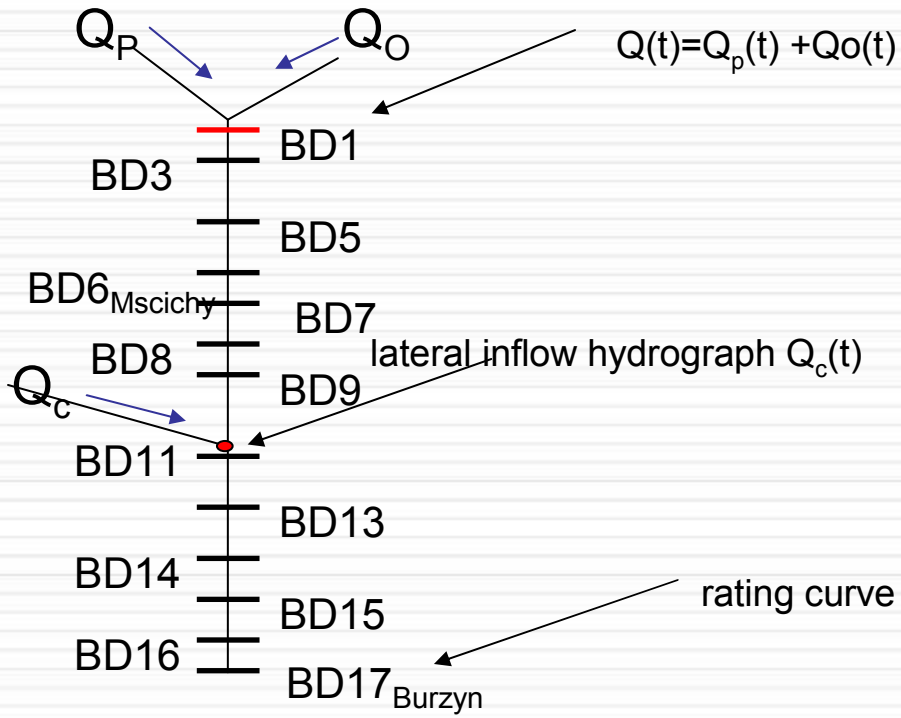



Osowiec
Sośnia
Mścichy
Olszowa Droga
Okrasin
Barwik
Awissa
Gugny
Chyliny
Grobla Honczarowska
Szorce
Burzyn
Bagno Ławki
River floodwater zone obtained by hydro-chemical method
Generalised vegetation comunities
Reeds, manna grass
Tall sedge
Sedge
Sedge-moss
Meadows
Forest
2 0 2 4 Kilometers
N
W
E
S

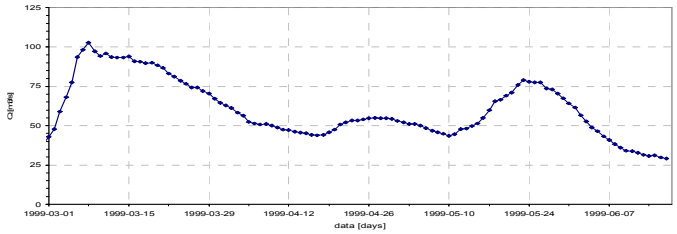
Hydraulic model topological scheme

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

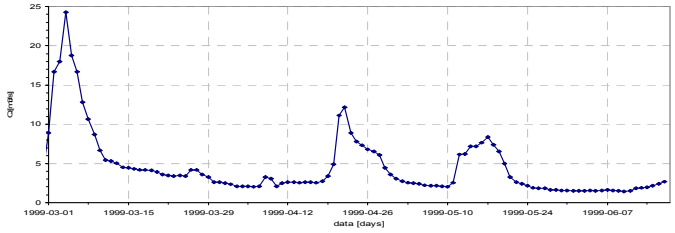
Boundary conditions



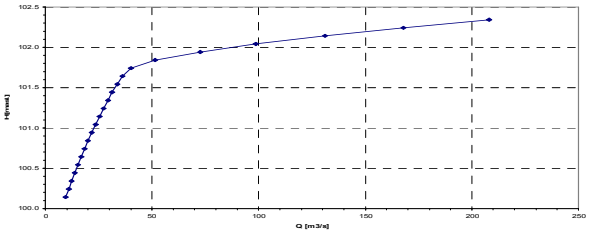
$Q(t)=Q_p(t)+Qo(t)$



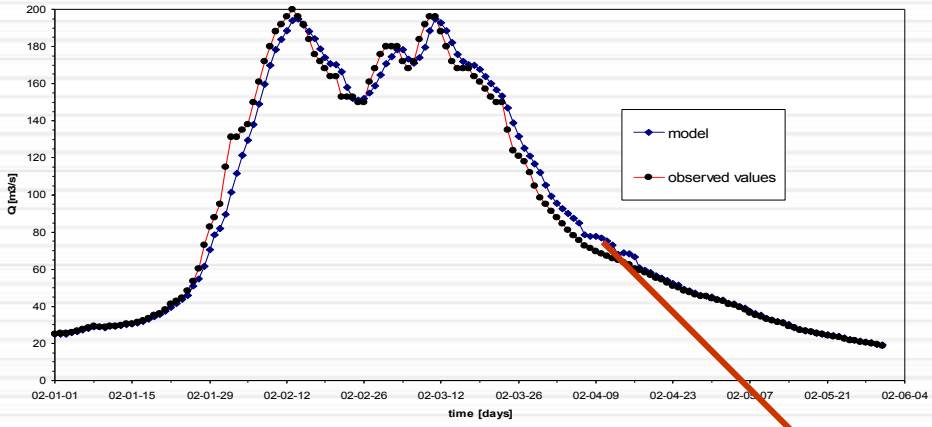
lateral inflow hydrograph $Q_c(t)$



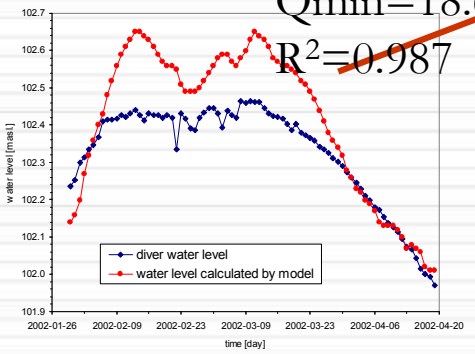
rating curve



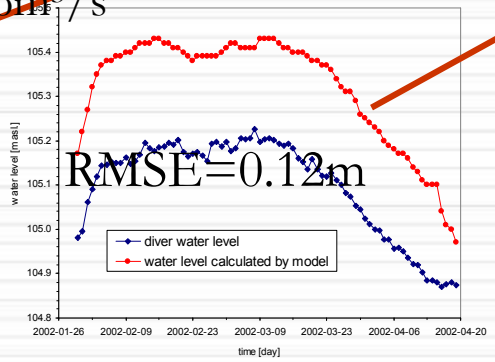
Results of hydraulic model



RMSE=6.89m^3/s
Qmax=200m^3/s
Qmin=18.6m^3/s
R^2=0.987

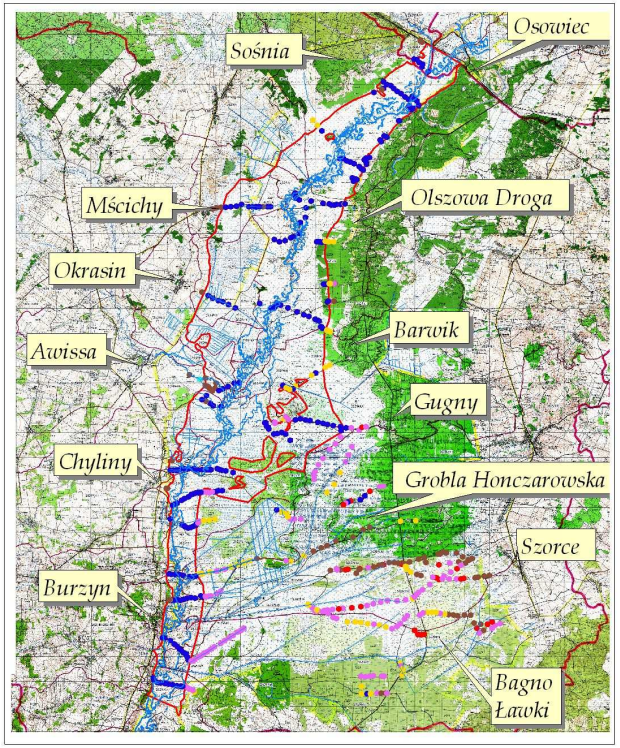


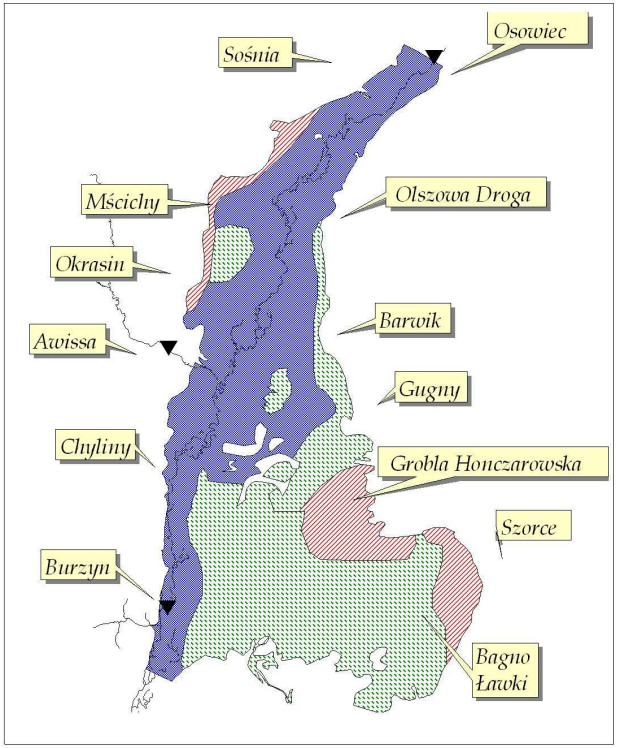
RMSE=0.12m

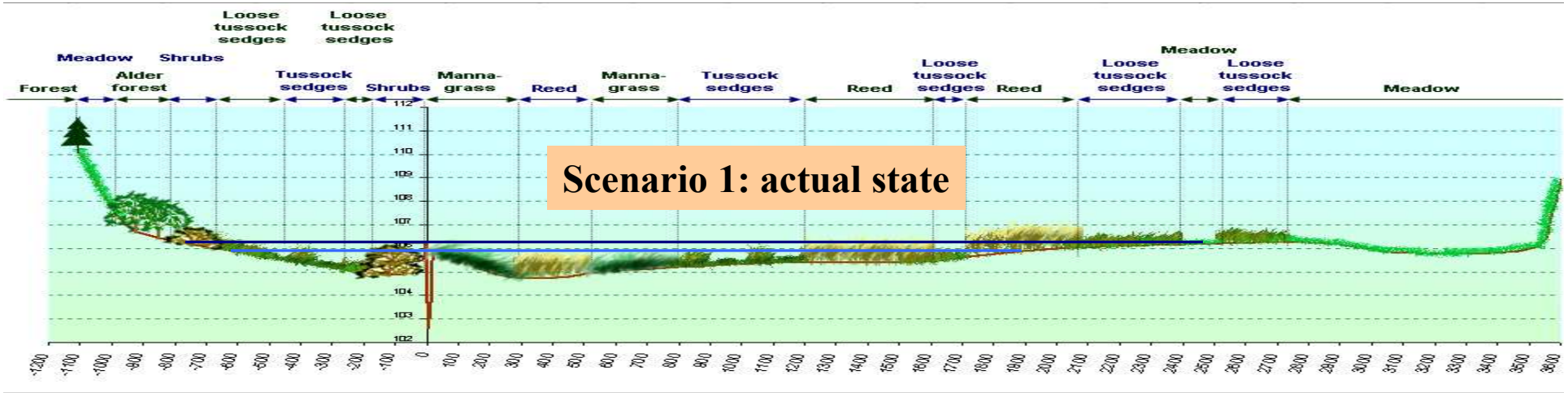


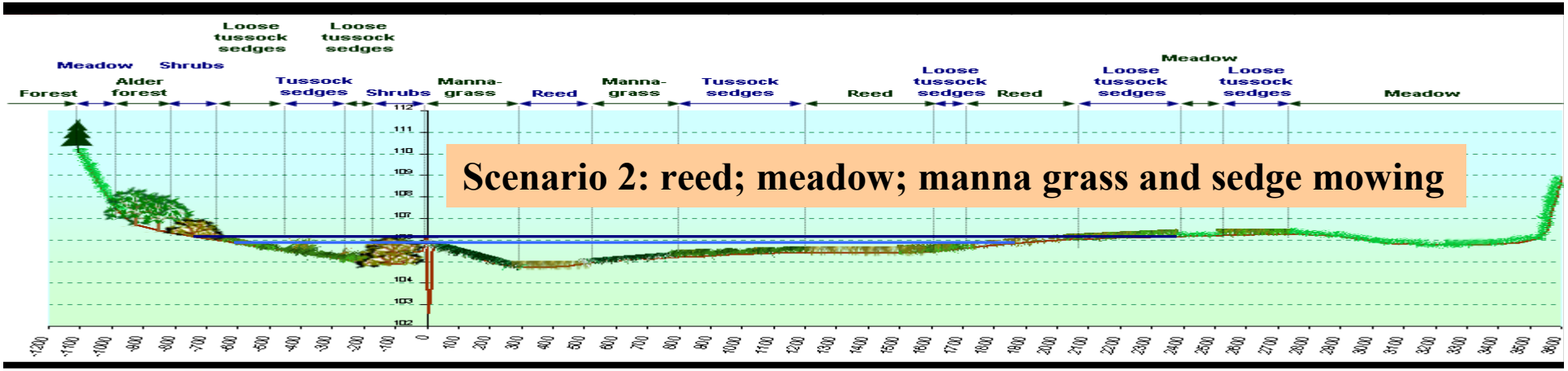
RMSE=0.22m

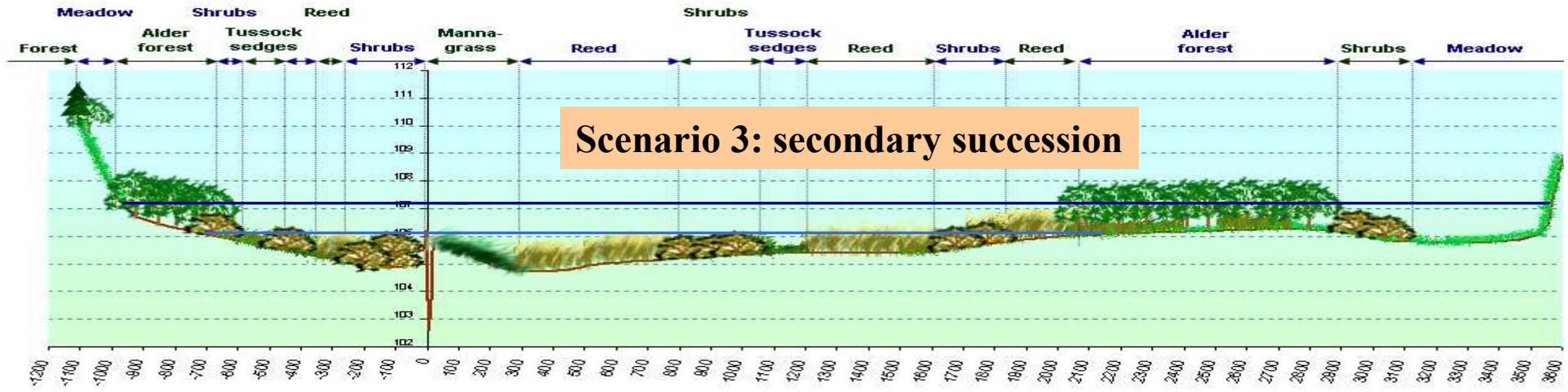
Results of chemical analysis



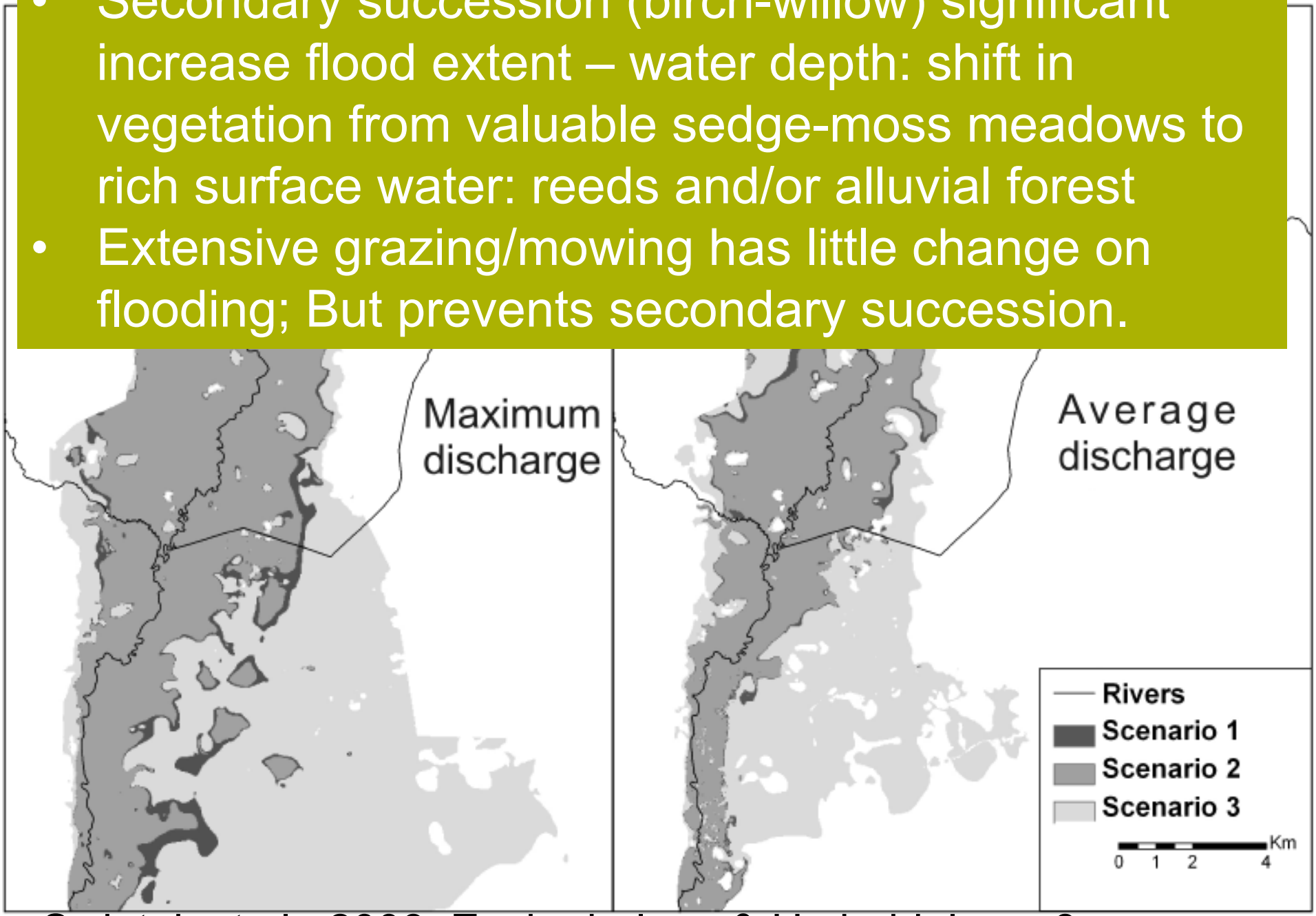



Meadow
Forest
Alder forest
Shrubs
Loose tussock sedges
Loose tussock sedges
Tussock sedges
Shrubs
Manna-grass
Reed
Manna-grass
Tussock sedges
Reed
Loose tussock sedges
Reed
Loose tussock sedges
Meadow
Loose tussock sedges
Meadow
Scenario 1: actual state


Meadow
Forest
Alder forest
Shrubs
Loose tussock sedges
Loose tussock sedges
Tussock sedges
Shrubs
Manna-grass
Reed
Manna-grass
Tussock sedges
Reed
Loose tussock sedges
Reed
Loose tussock sedges
Meadow
Loose tussock sedges
Meadow
Scenario 2: reed; meadow; manna grass and sedge mowing


Meadow
Forest
Alder forest
Shrubs
Tussock sedges
Reed
Shrubs
Manna-grass
Reed
Shrubs
Tussock sedges
Reed
Shrubs
Reed
Alder forest
Shrubs
Meadow
Scenario 3: secondary succession

- Secondary succession (birch-willow) significant increase flood extent – water depth: shift in vegetation from valuable sedge-moss meadows to rich surface water: reeds and/or alluvial forest
- Extensive grazing/mowing has little change on flooding; But prevents secondary succession.



Swiatek et al., 2008, Ecohydrology & Hydrobiology, 8.

Conclusions

- The role of forest in the water regime of wetlands strongly depends on hydrological supply of the site – bogs and fens with the slow groundwater flow can be modified as a result of secondary succession
- The increase of the forest cover on the floodplain is not important from the water balance point of view but can significantly change the flood regime (and probably further the course of succession)
- In our research we should recognized that biota can also (re)shape the a biotic condition of the site, up to the threshold point


Fot. Wiktor Rotkow