Use of hydrological models for fen restoration - Biebrza middle basin case study

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Warsaw Agricultural University

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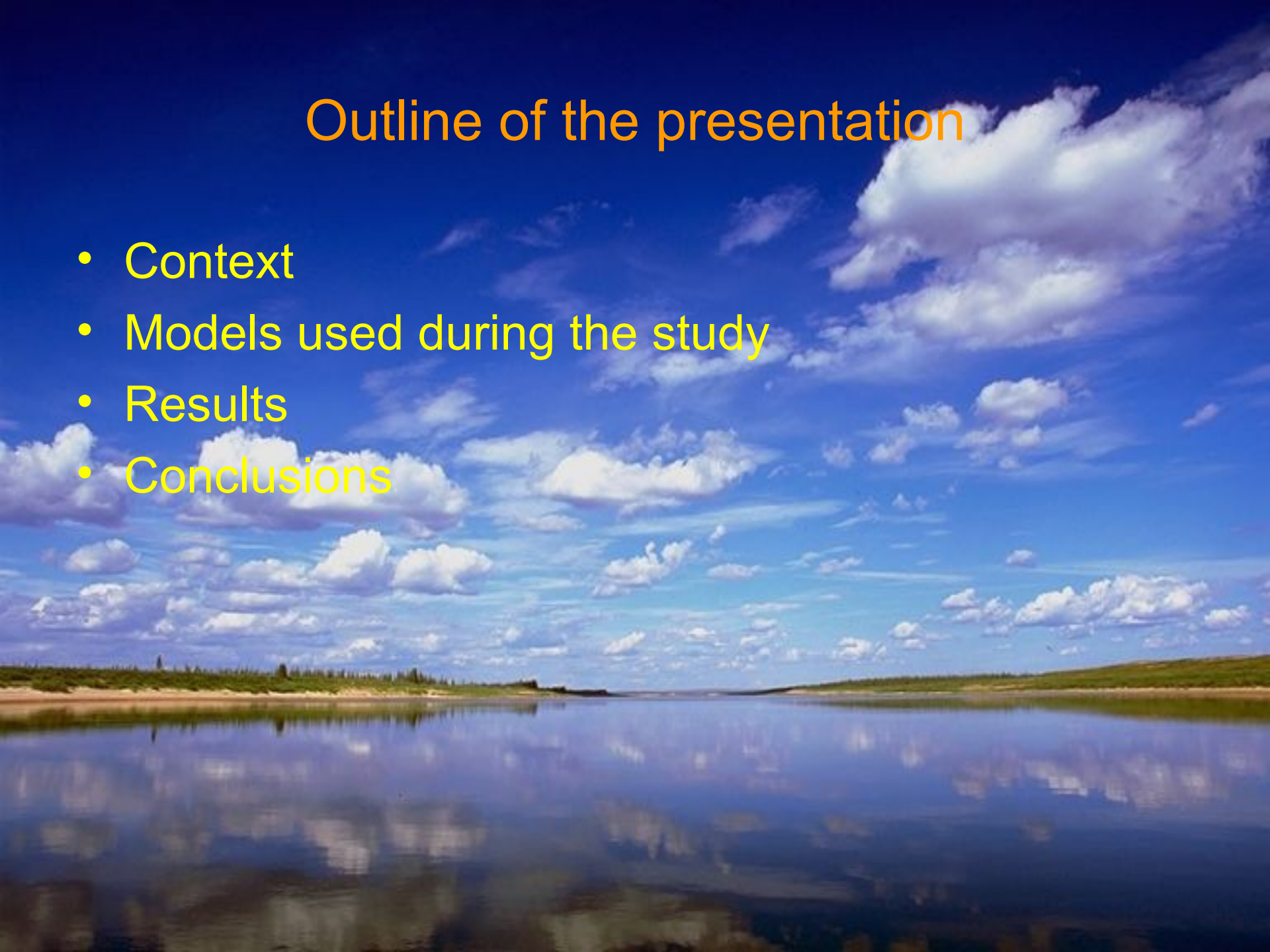
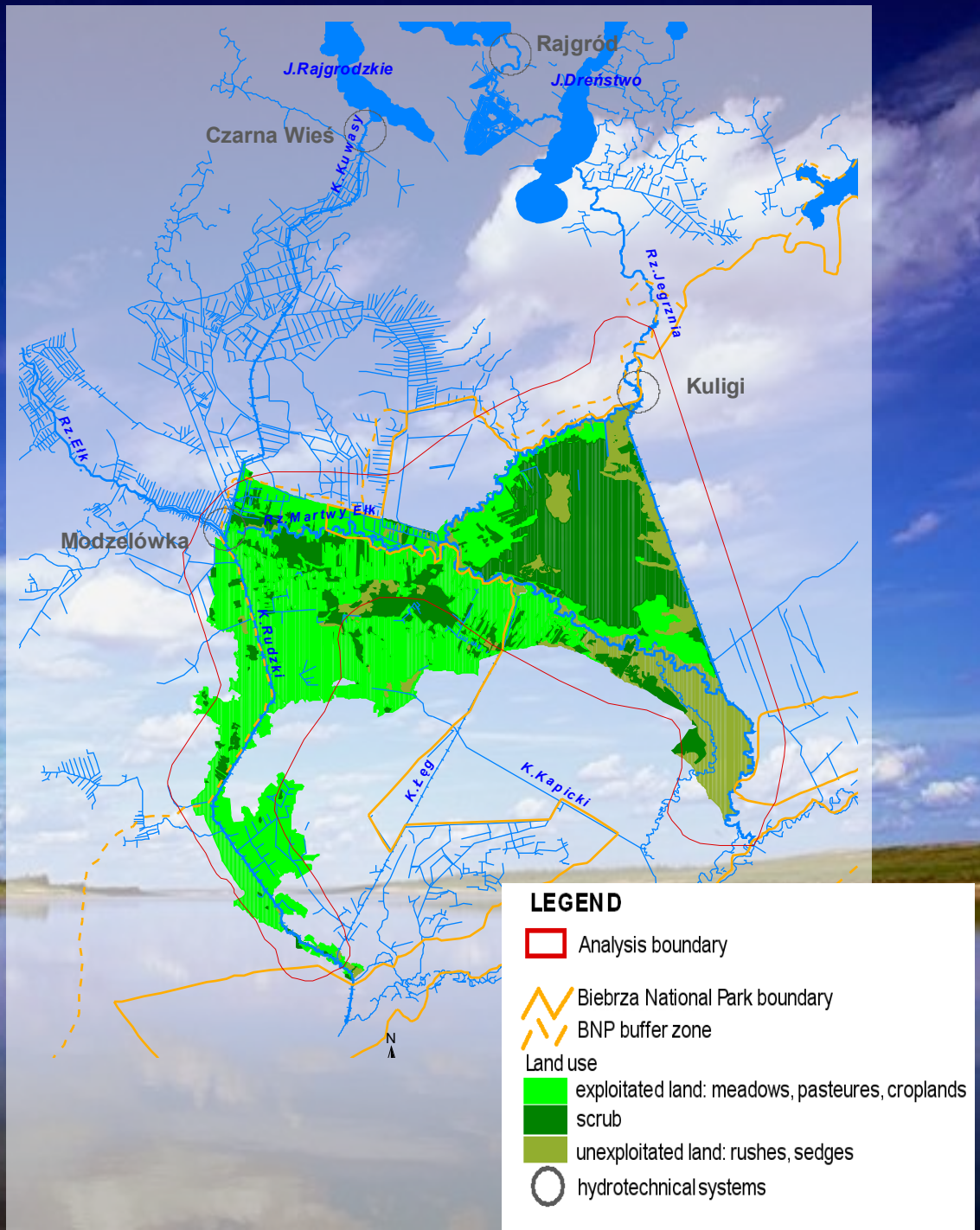
Outline of the presentation

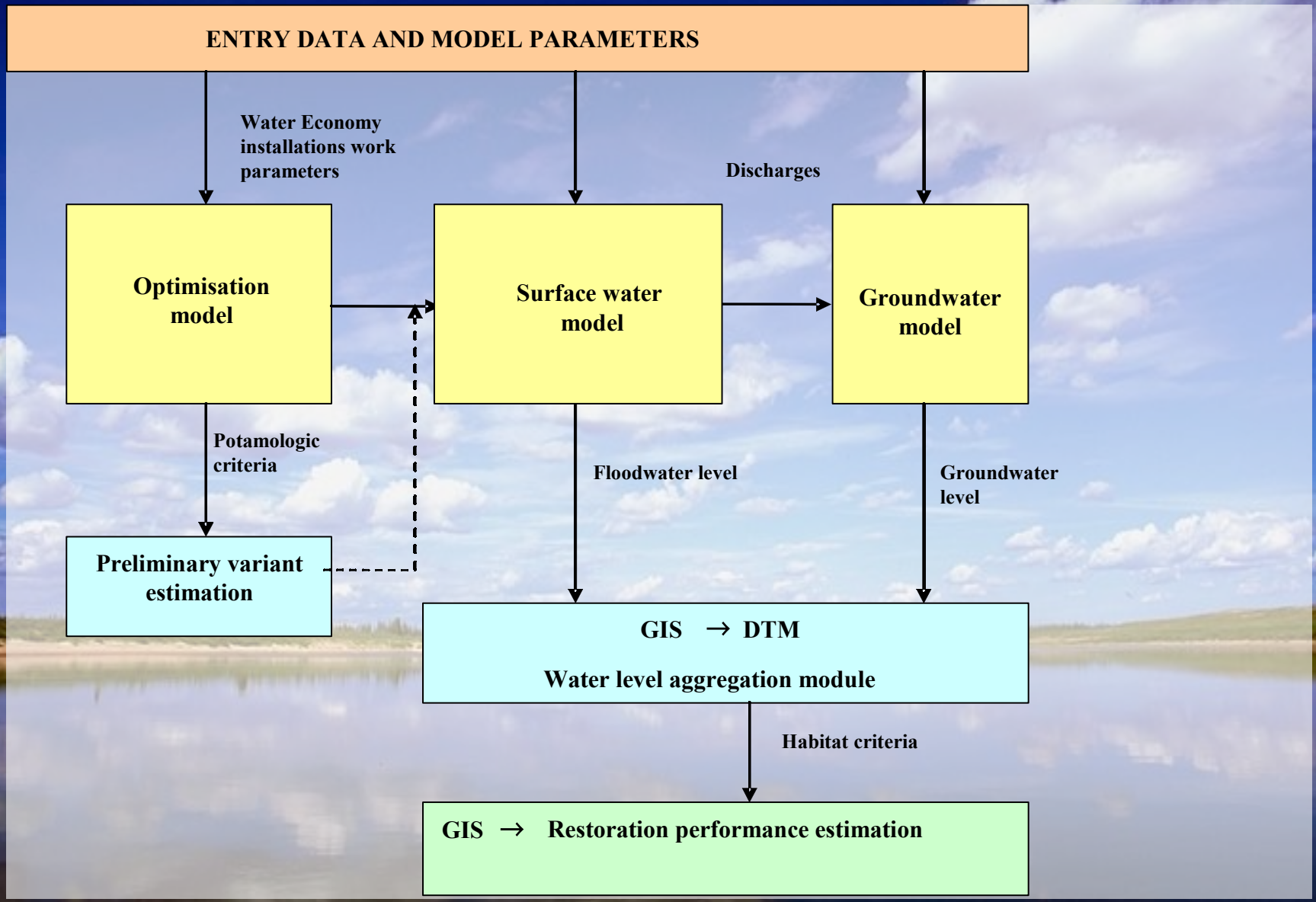
- Context
- Models used during the study
- Results
- Conclusions



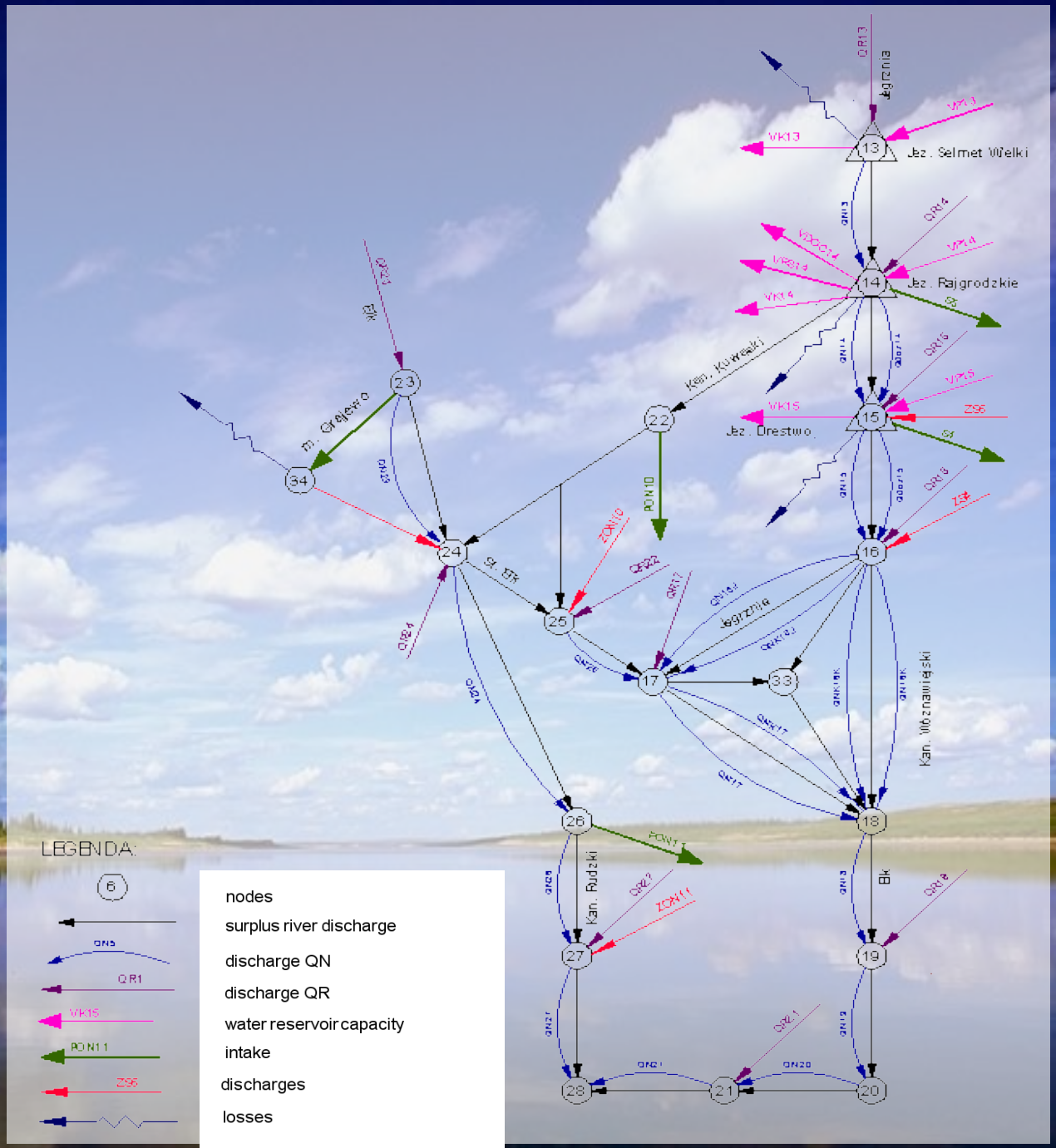
Study area


Rajgród
J.Rajgrodzkie
J.Dreństwo
Czarna Wieś
K.Kuwasy
Rz.Jegrznia
Kuligi
Rz.Elk
Rz.Martwy Elk
Modzelówka
K.Rudzki
K.Łęg
K.Kapicki
N
LEGEND
Analysis boundary
Biebrza National Park boundary
BNP buffer zone
Land use
exploitated land: meadows, pasteures, croplands
scrub
unexploitated land: rushes, sedges
hydrotechnical systems

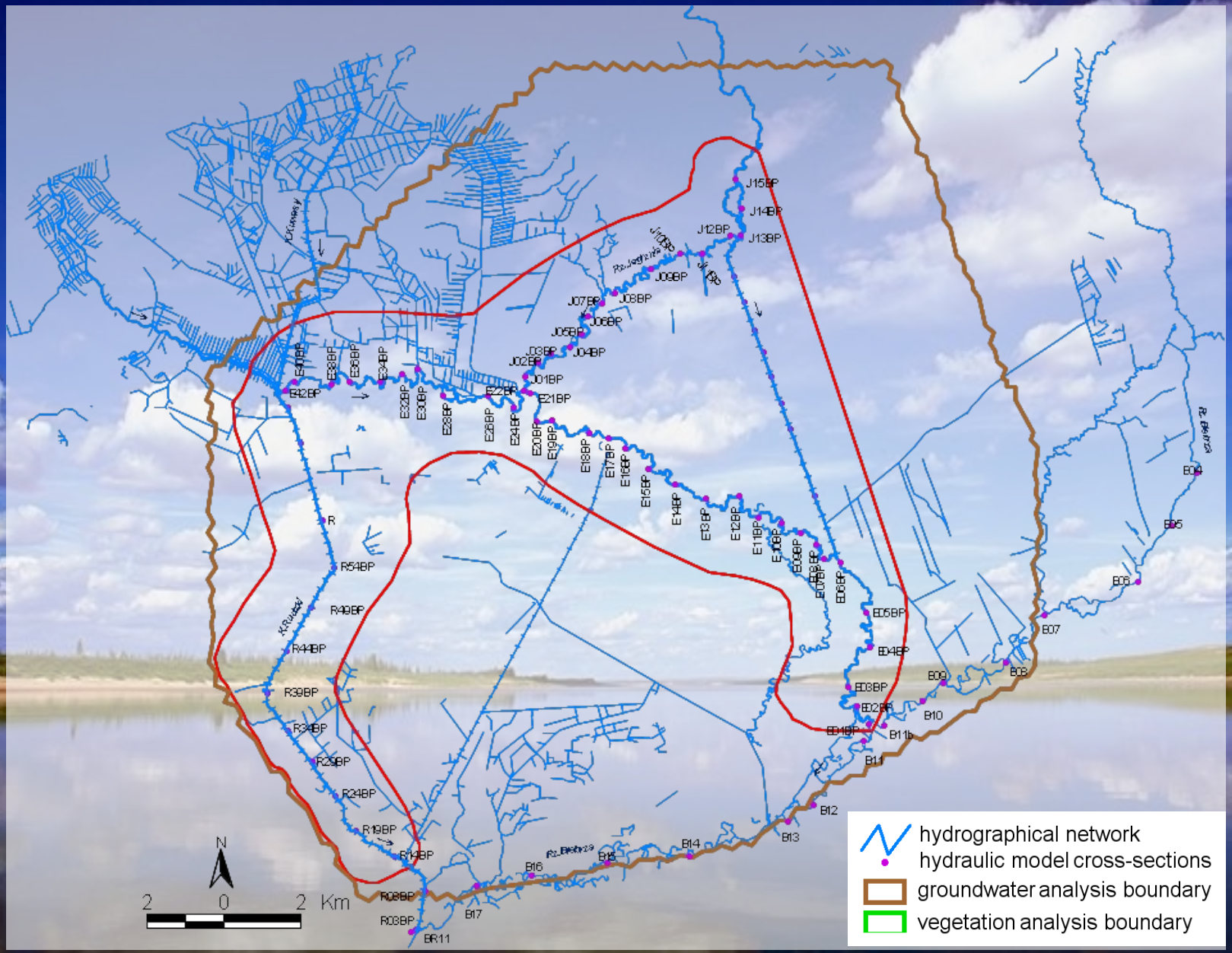
Models used during the study



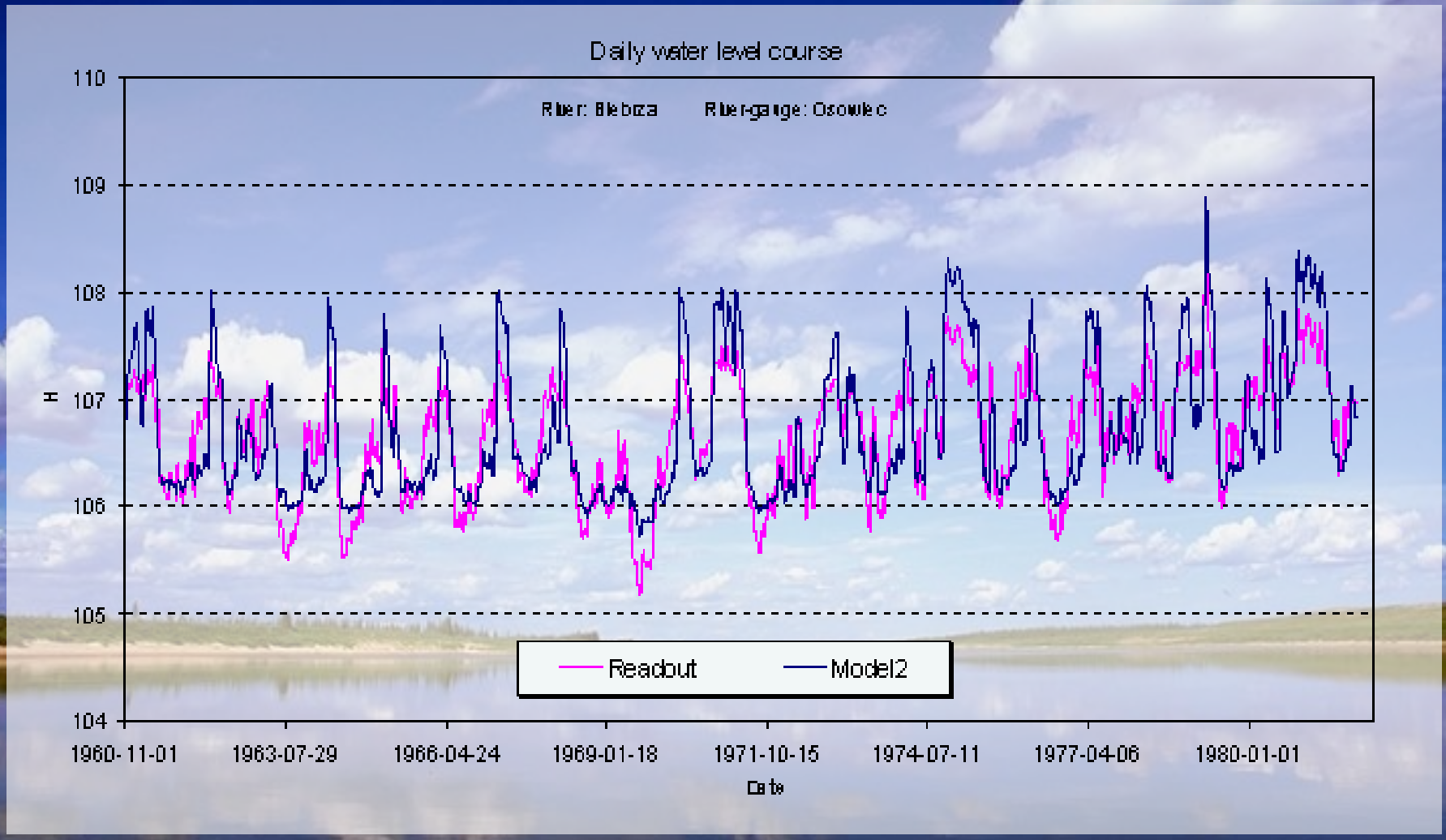
Optimisation model



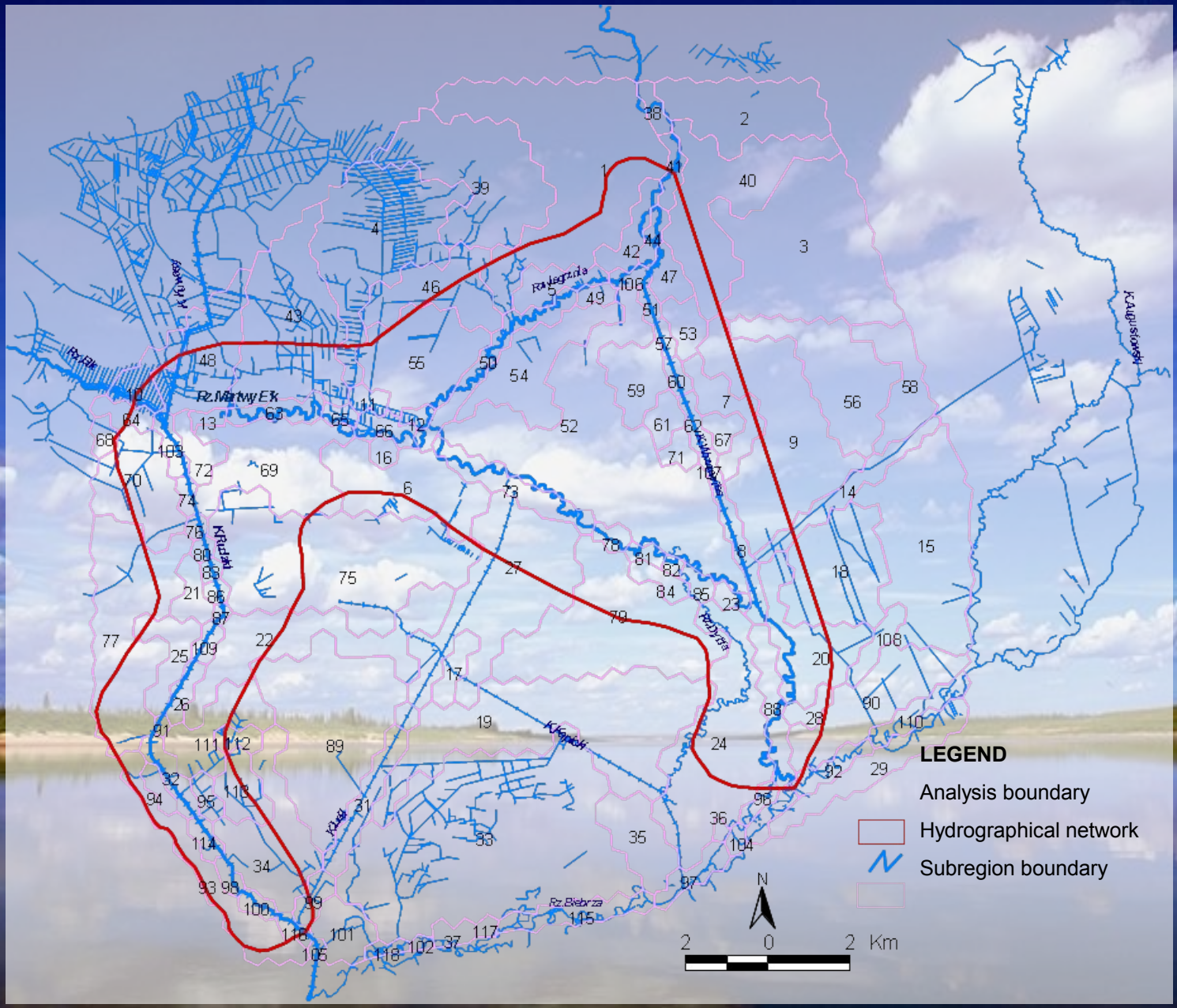
Simulation hydrodynamic surface water model



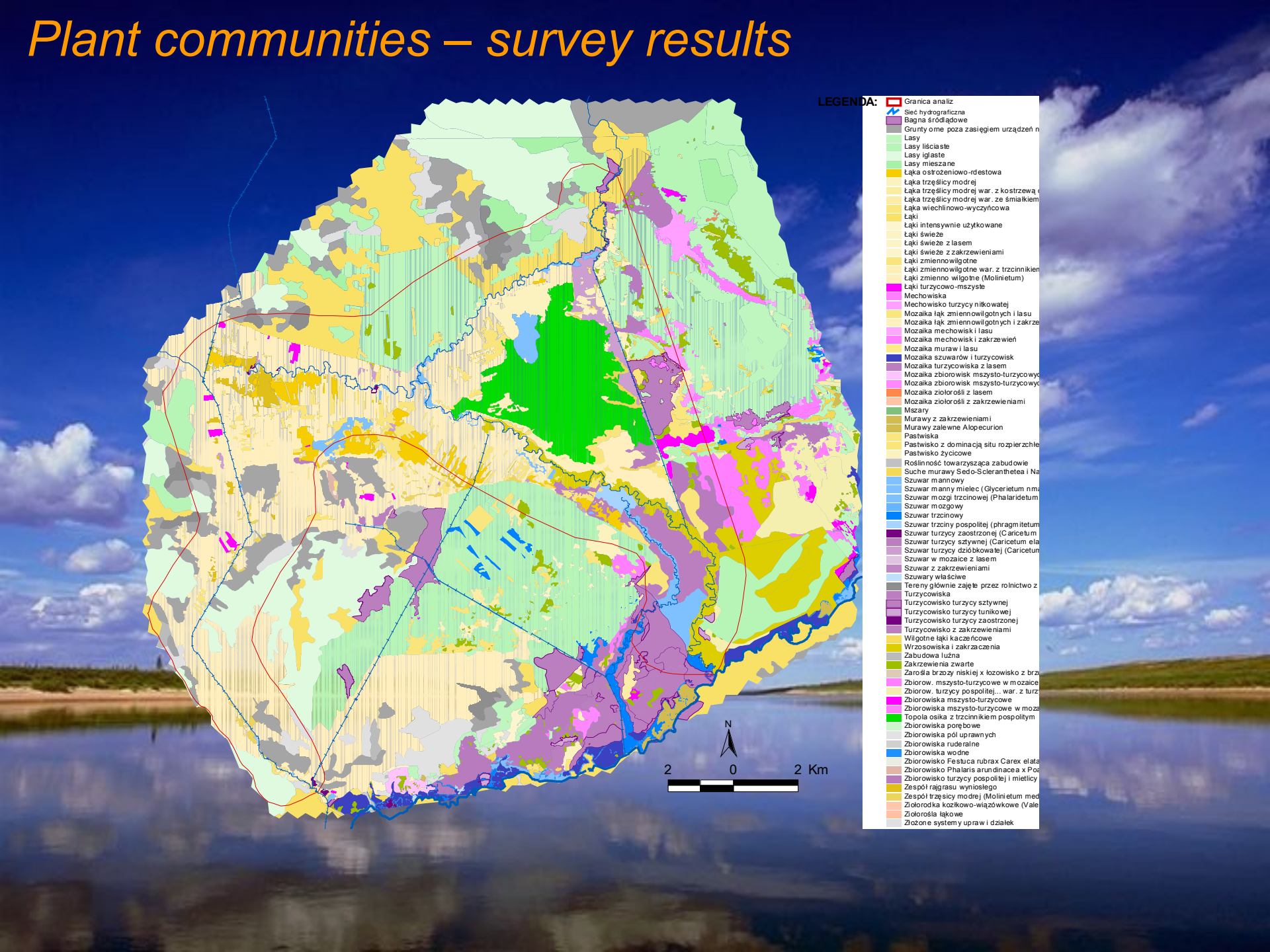
Verification results



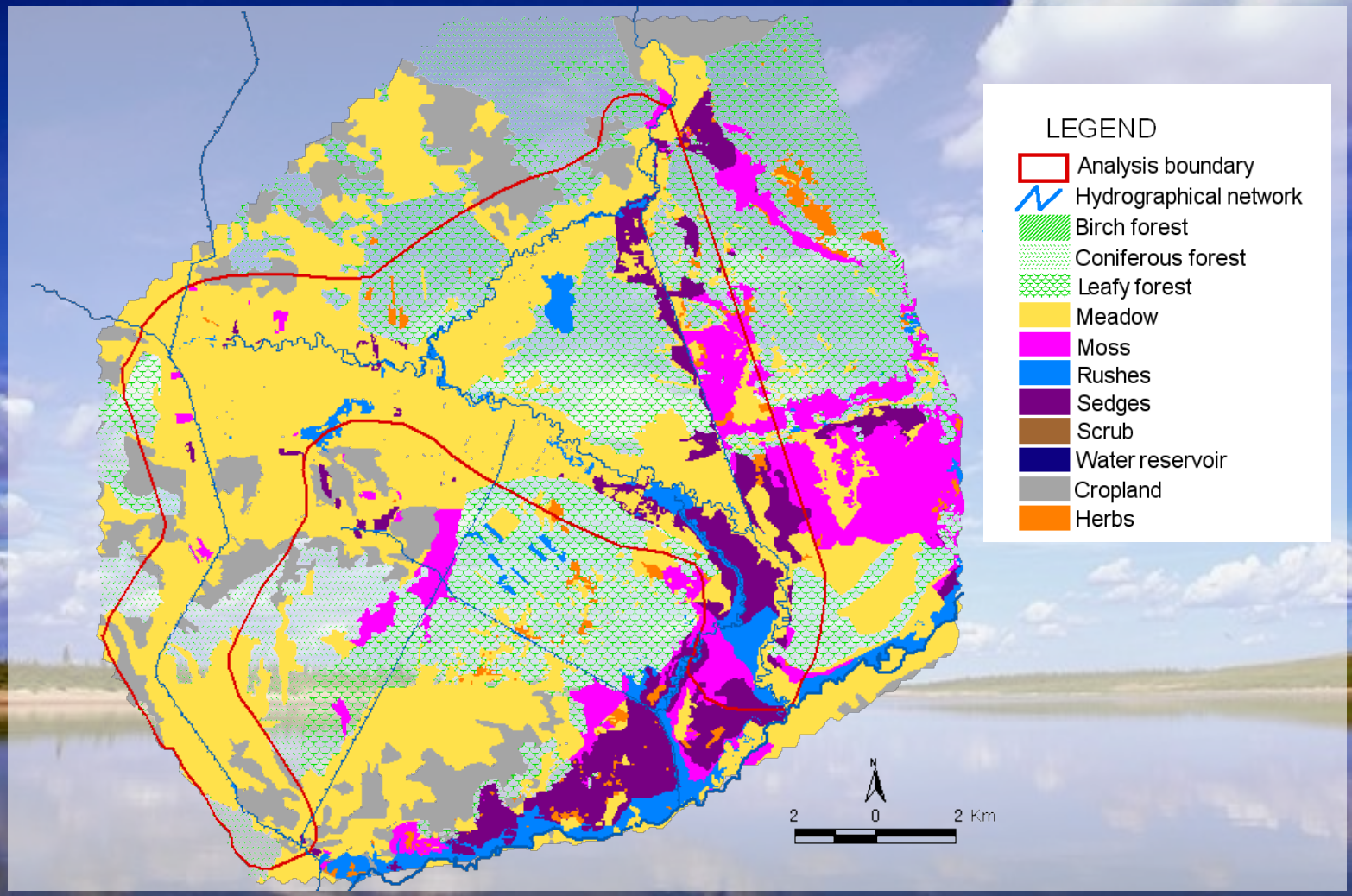
Simulation groundwater model - SIMGRO



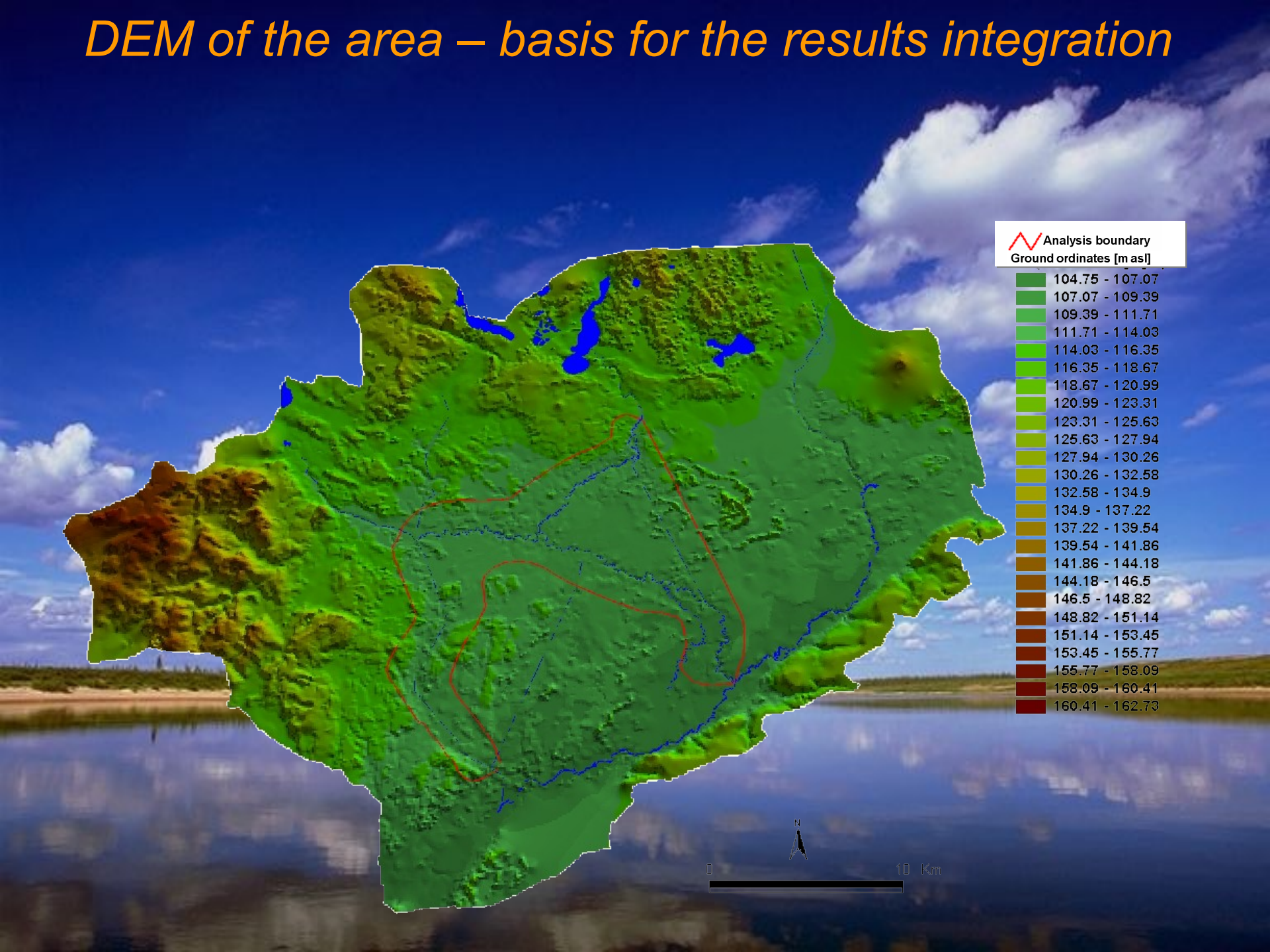
Plant communities – survey results



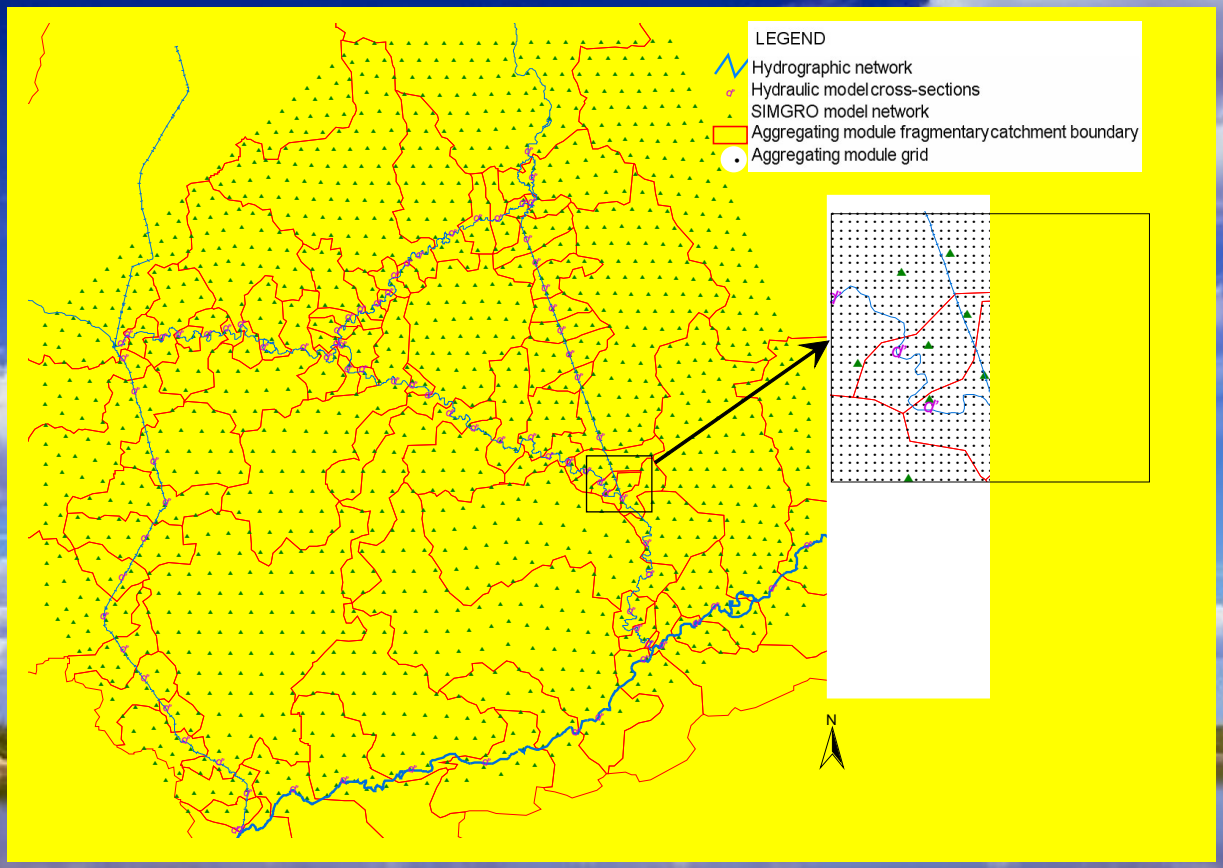
Plant communities – model input



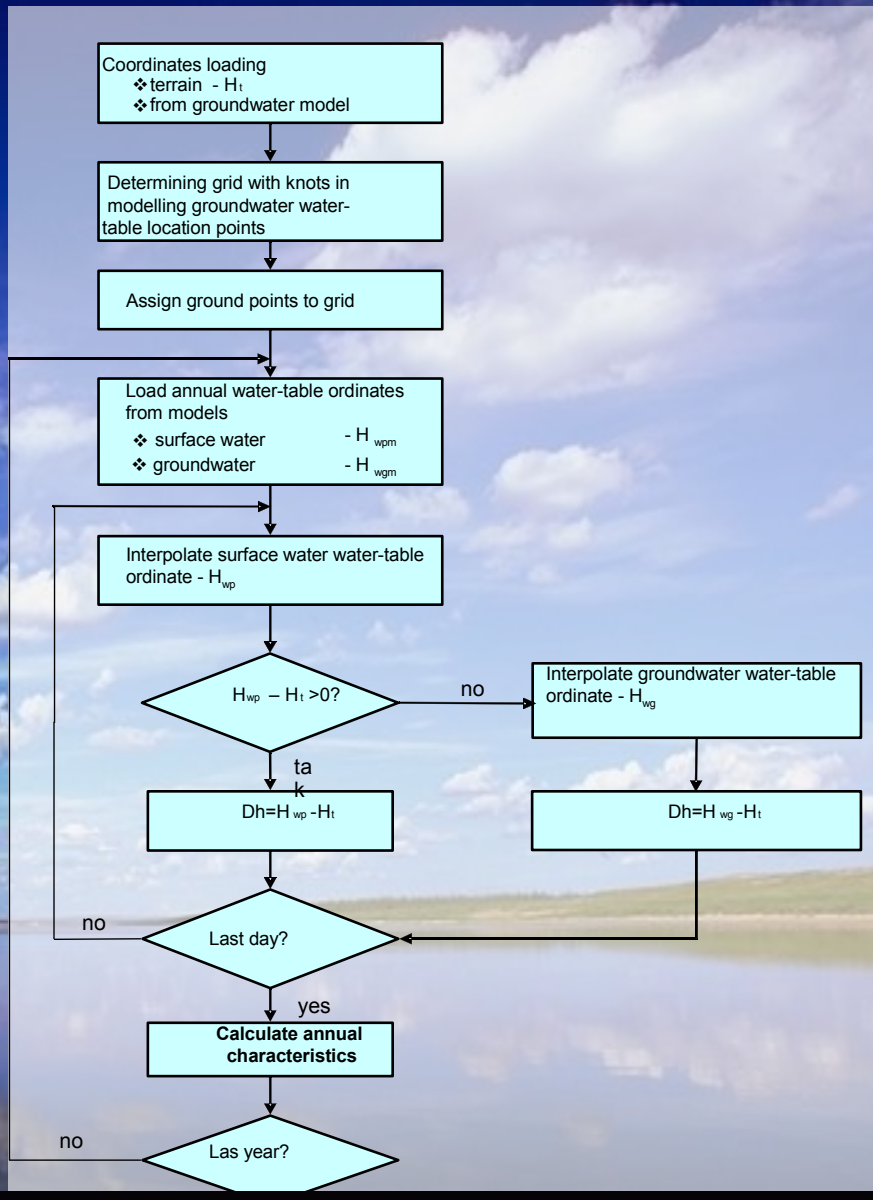
DEM of the area – basis for the results integration



Groundwater results vs. Surface water results

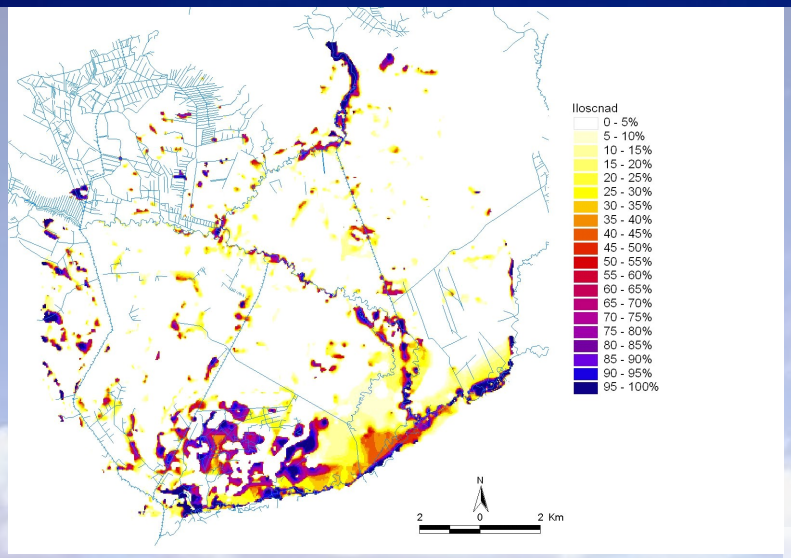


Integration of the reults and calculation of hydrological characteristics

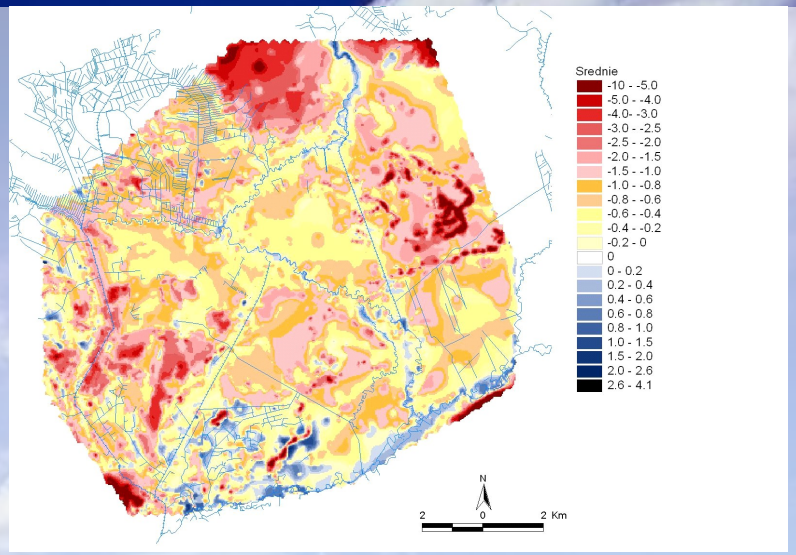


Hydrological characterisitics

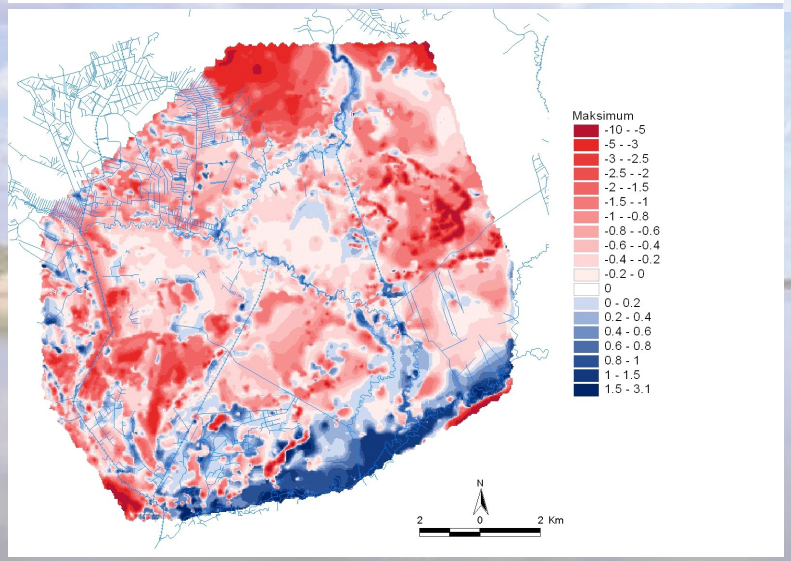
Flood incidence



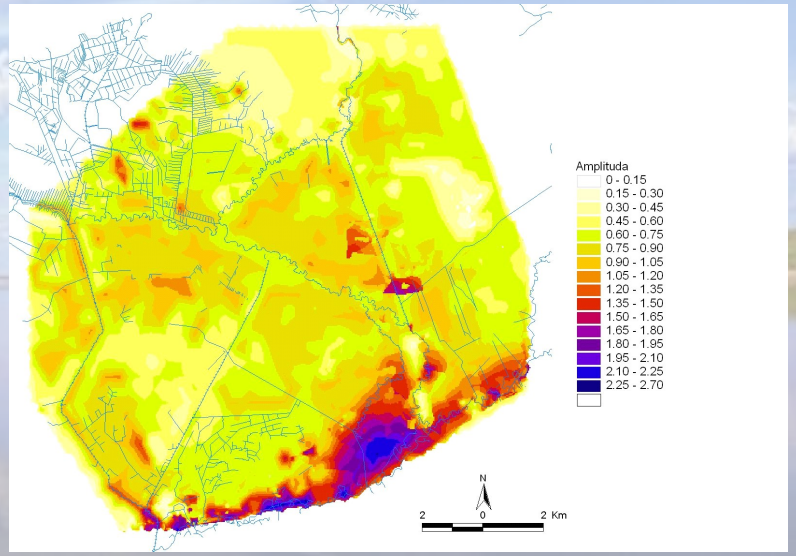
Low-flow period average



High-flow period average



Average amplitude



Eight optimizations variants

	Variants						
Denotation	R1	R2	R3	R4	R5	R6	R7
Size of fish ponds	existing	existing	existing	max	max	max	max
OMIPod -Size drainage systems. Irrigated	existing	existing	existing	max	max	max	max
OMIROd - Size drainage systems. Drain	existing	existing	existing	max	max	max	max
K - Crop coefficient [-]	extensive	extensive	extensive	intensive	intensive	intensive	intensive
VU14 useful capacity of the Rajgordzkie Lake [mln m^3]	15,0	20,0	15,0	20,0	20,0	20,0	15,0
VD14 Intended capacity of Rajgordzkiego Lake [mln m^3]	5,00	0,00	5,00	0,00	5,00	0,00	5,00
VRS14 Flood reserve capacity Rajgordzkiego Lake [mln m^3]	5,00	0,00	0,00	0,00	0,00	0,00	0,00
Bank flow P16K [m^3/s]	10,0/8,00*	10,0/8,00*	10,0/8,00*	10,0/8,00*	10,0/8,00*	10,0/8,00*	10,0/8,00*
Bank flow P17 [m^3/s]	4,00/3,00*	4,00/3,00*	4,00/3,00*	7,00/5,00*	7,00/5,00*	7,00/5,00*	7,00/5,00*
Flood forming flow ((16J+16K) [m^3/s]	-	-	18,0	18,0	18,0	18,0	18,0
Flood formihg flow (P17) [m^3/s]	5,00/4,00*	5,00/4,00*	5,00/4,00*	8,00/7,00*	8,00/7,00*	8,00/7,00*	8,00/7,00*
Freshet impulse	not	not	yes	not	yes	not	not
K.Kuwaski - facility channel	not	yes	yes	yes	yes	yes	yes
Hydrotechnical system Modzelówka Rudzki C./ Old Ełk [%]	100/0	100/0	100/0	70/30	70/30	70/30	70/30
Hydrotechnical system Kuligi Woźnawiejski C./Jegrznia [%]	70/30	70/30	70/30	70/30	70/30	30/70	30/70

*** Period of overgrowing**

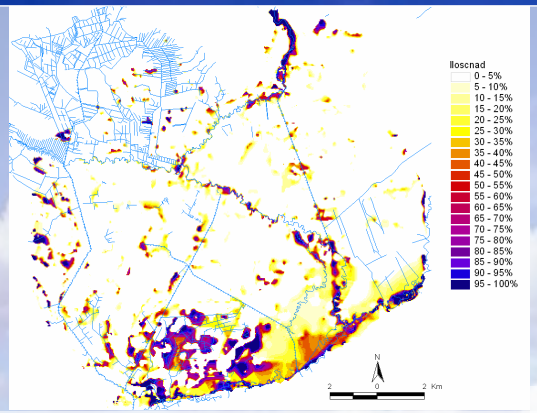
Results of optimization

			Variant R1			Variant R2			Variant R3		
No	Users	Pmax	Gt	Gt_{lato}	Gv	Gt	Gt_{lato}	Gv	Gt	Gt_{lato}	Gv
1.	Hydrobiologycal flow 14 (belown Rajgrodu)	1,01	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
2.	Hydrobiologycal flow 15 (belown Drętwo Lake)	1,53	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
3.	Hydrobiologycal flow 16J (Jegrznia)	0,48	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
4.	Hydrobiologycal flow 16K (Woźnawiejski C.)	1,13	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
5.	Hydrobiologycal flow 18 (Ełk)	1,86	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
6.	Hydrobiologycal flow 24 (Rudzki C.)	1,87	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
		Pmax	Gt_{OM}	DN	MN_{Sr}	Gt_{OM}	DN	MN_{Sr}	Gt_{OM}	DN	MN_{Sr}
7.	Drainage object ONP10	2,52	0,980	207	207	0,996	219	-	0,996	219	219
8.	Drainage object ONP11	-	-	-	-	-	-	-	-	-	-
9.	Fish ponds St4	0,20	1,000	-	-	1,00	-	-	-	-	-
10.	Fish ponds St5	1,00	1,000	-	-	1,00	-	-	-	-	-
		Pmax	Gt_{WB}	MN_{zal}	Gt_{opt}	Gt_{WB}	MN_{zal}	Gt_{opt}	Gt_{WB}	MN_{zal}	Gt_{opt}
11.	Environmental flow 16J	5,70	-	0,12	-	-	0,08	-	-	0,76	-
12.	Environmental flow 16K	12	0,044	0,16	-	0,044	0,12	-	0,046	0,76	-
13.	Environmental flow 17	5	0,083	0,08	-	0,083	0,08	-	0,083	0,08	-
14.	Environmental flow 28	-	-	-	0,651	-	-	0,651	-	-	0,651
		Qdoz	DQmax	MN	-	DQmax	MN	-	DQmax	MN	-
15.	Belown Rajgrodzkie Lake P14	5,50	12,2	0,840	-	6,8	0,920	-	6,8	0,920	-
16.	Belown Dręstwo Lake P15	6,00	13,5	0,800	-	6,1	0,840	-	6,1	0,840	-

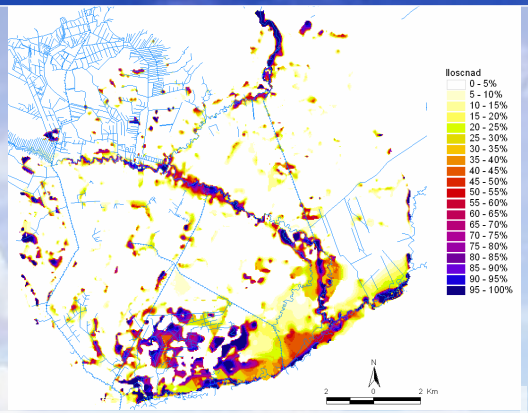
Six simulation variants

Variant	Distribution of the flow in node Modzelówka C. Rudzki/Old Ełk	Distribution of the flow in node Kuligi Woźnawiejski C./ Jegrznia	The flood pulse from Rajgrodzki lake	Parameters of the work of remaining hydraulic structures
RS 0	100/0	70/30	Not	R2
RS 1	70/30	70/30	Not	R4
RS 2	70/30	30/70	Not	R7
RS 3	100/0	70/30	Yes	R3
RS 4	70/30	70/30	Yes	R5
RS 5	0/100	0/100	Not	R2

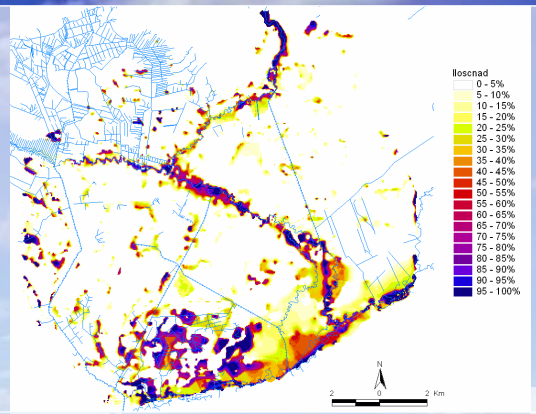
Simulation results – frequency of flooding



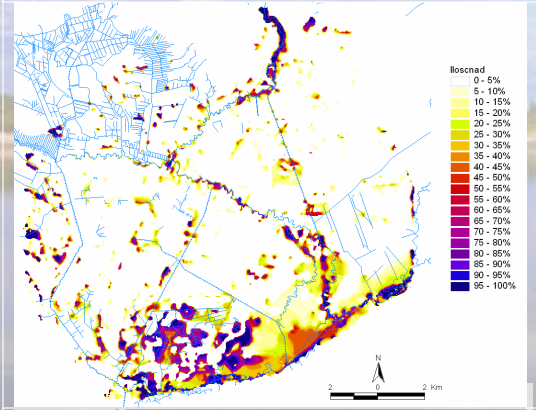
Variant 0



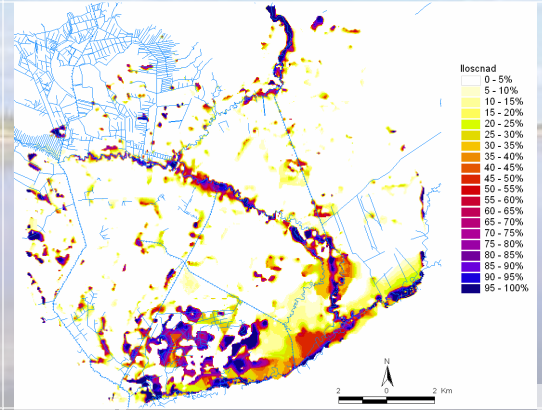
Variant 1



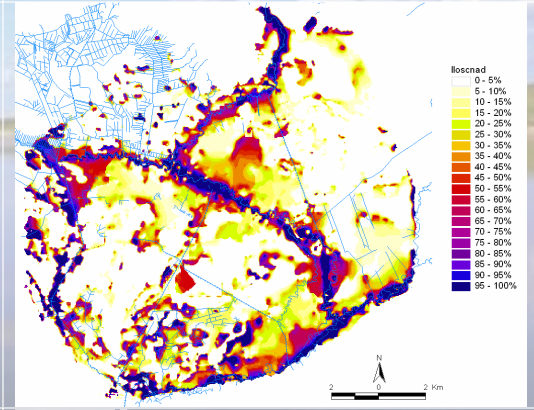
Variant 2



Variant 3

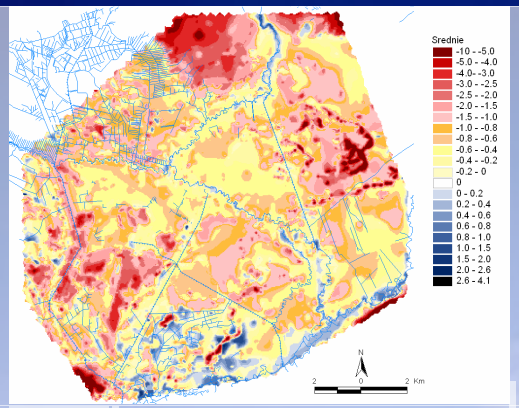


Variant 4

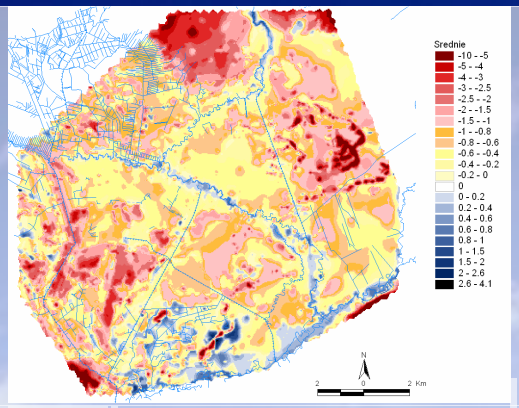


Variant 5

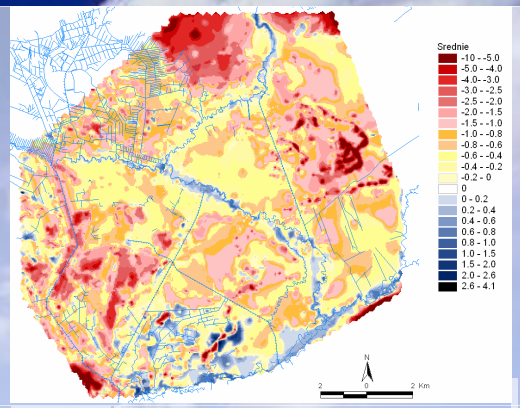
Simulation results – average amplitude



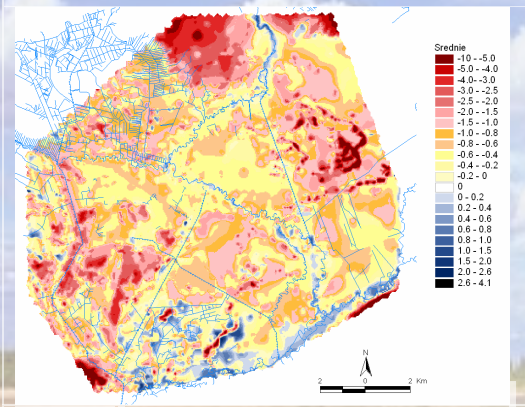
Variant 0



Variant 1



Variant 2



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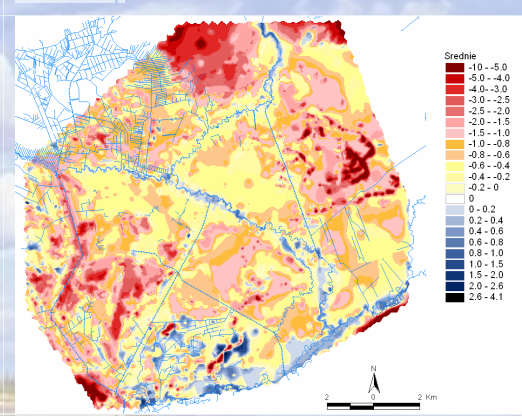
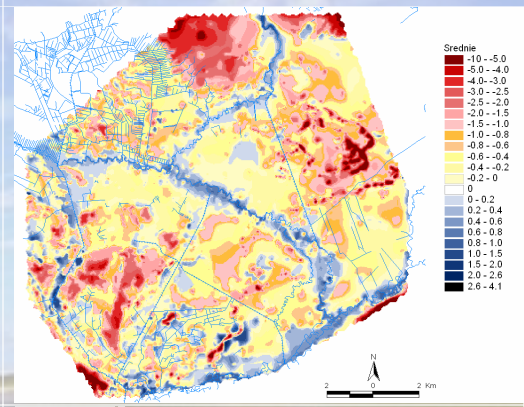
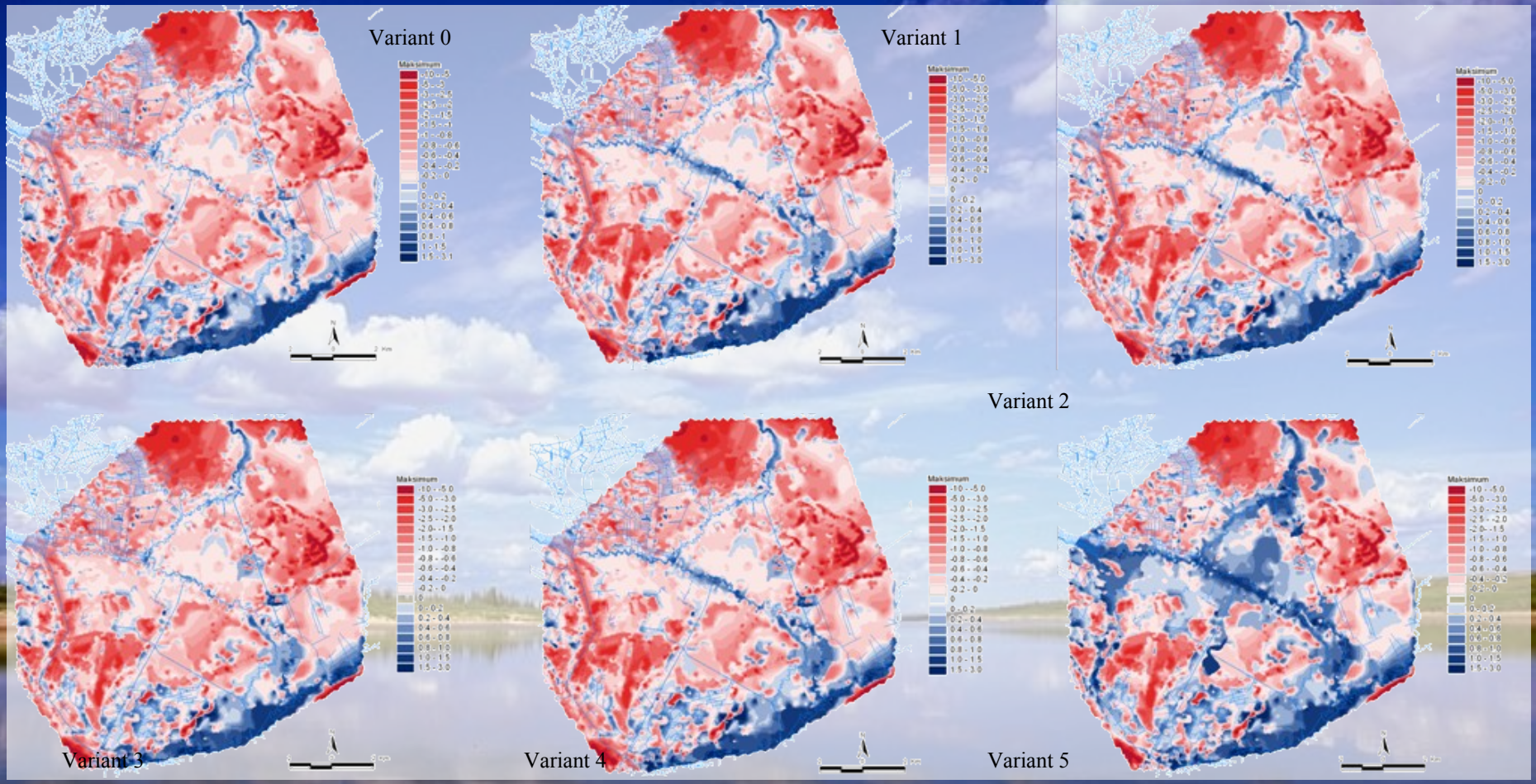


Variant 4

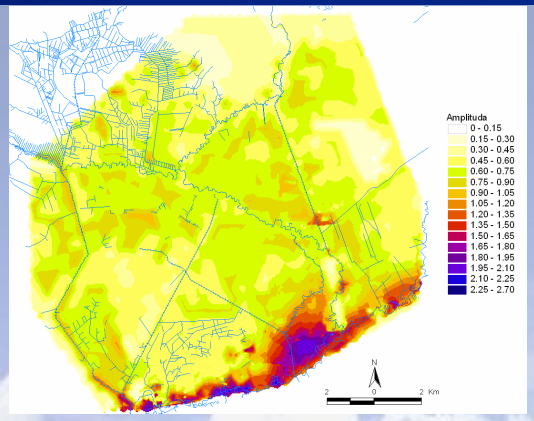


Variant 5

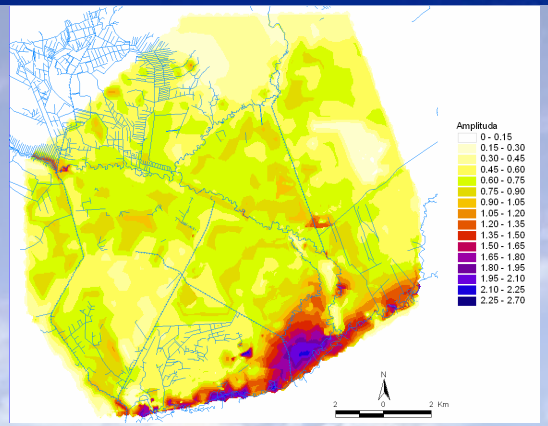
Simulation results – average maximum inudation



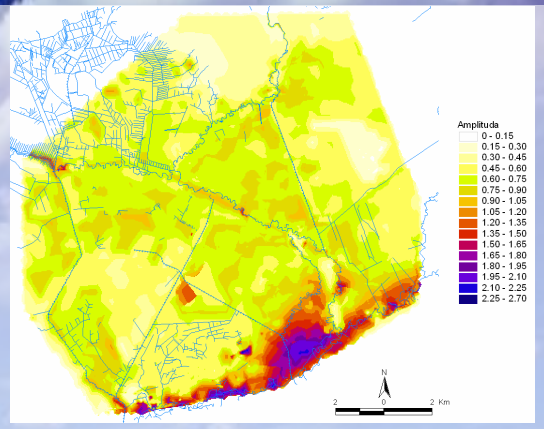
Simulation results – average water depth



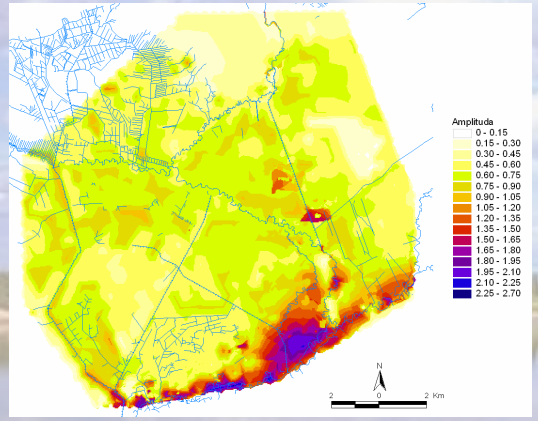
Variant 0



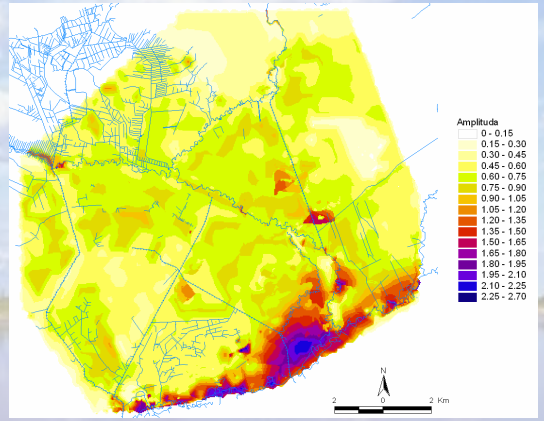
Variant 1



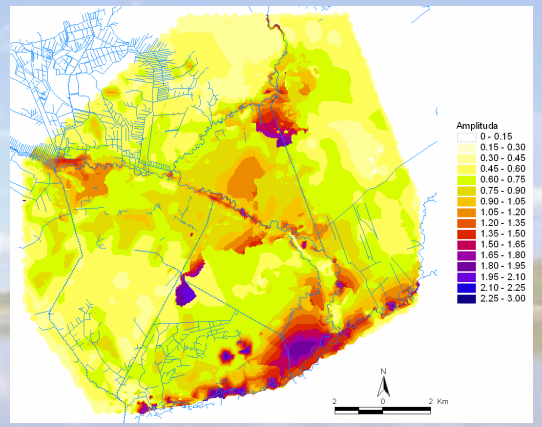
Variant 2



Variant 3



Variant 4



Variant 6

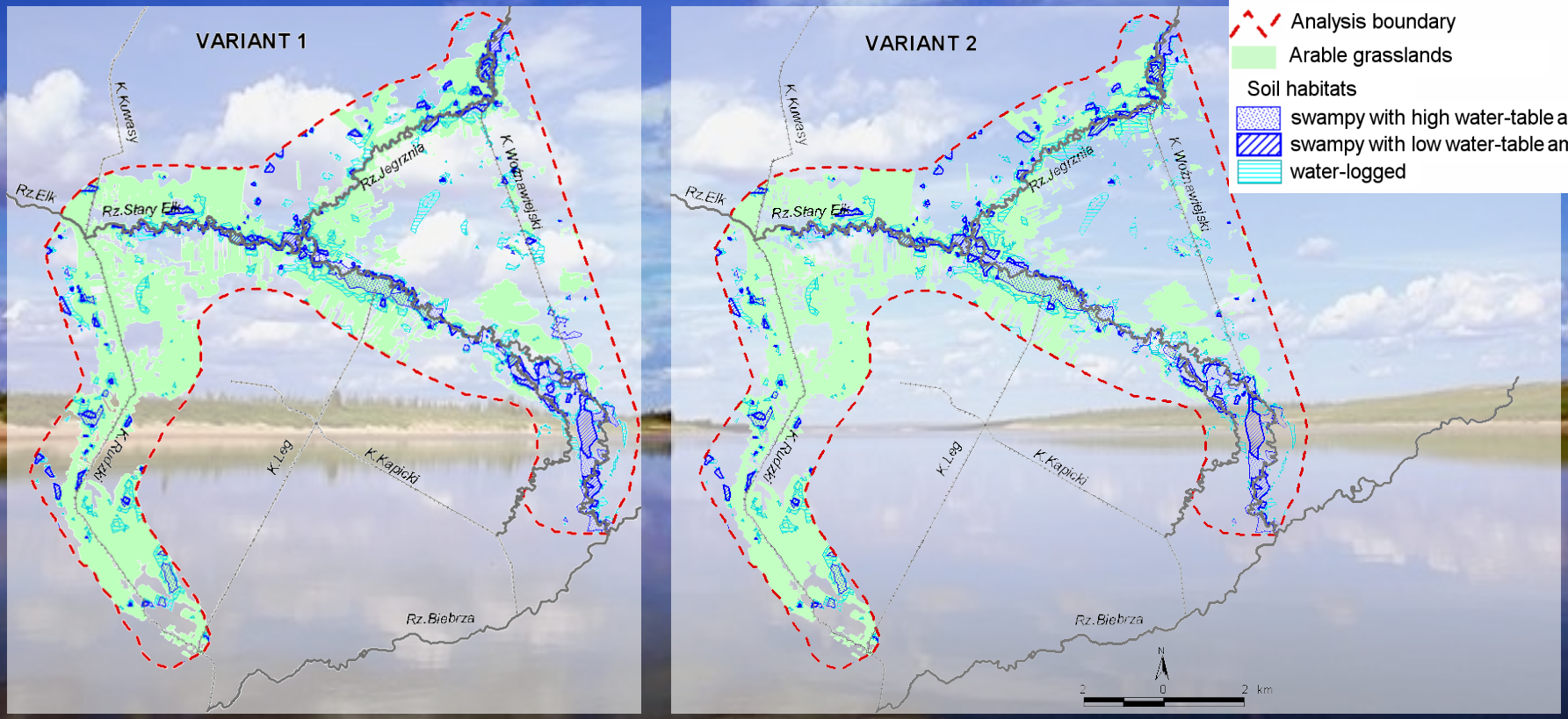
Proposal for the thresholds: swamp, wet, moist

	SSH [cm]	f_{ZL} [%]	SΔH [cm]	SNH [cm]
Swamp habitat - small amplitude	>0	>30	<70	> - 60
Swamp habitat - large amplitude			>70	
Wet habitat	<0;-30>	<10;30>	-	-
Moist habitat	<-30;-60>	<10	-	-

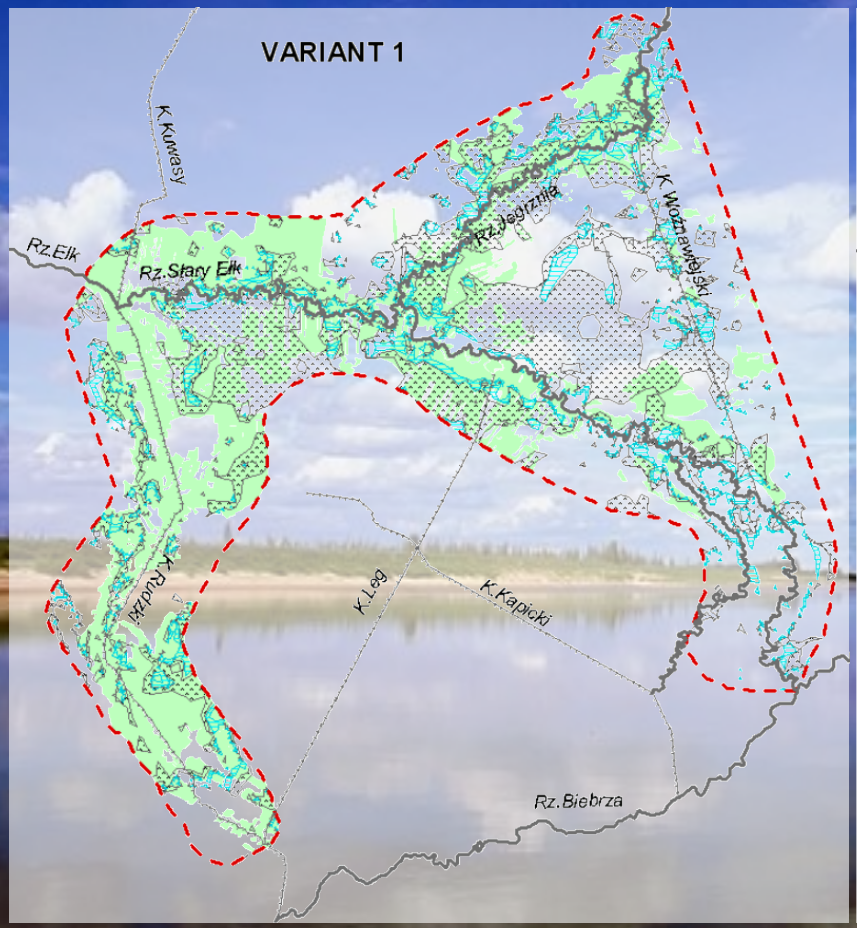
Simulation results – size of areas of different status

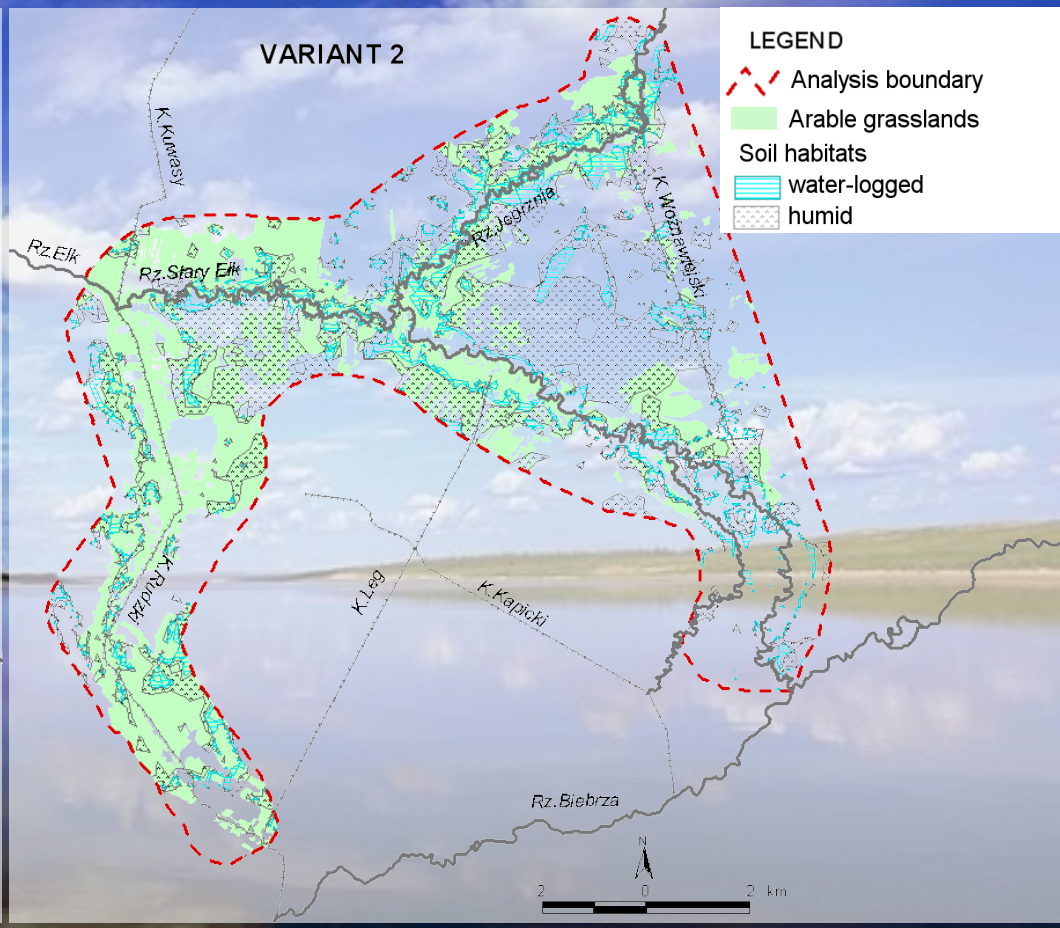
	Swamp habitat:		Wet habitat	Moist habitat
Variant:	Large amplitude water level	Small amplitude water level		
RS0	226	358	795	3809
RS1	452	492	821	3791
RS2	537	505	915	3676
RS3	281	322	801	3715
RS4	516	441	822	3687
RS5	3145	1371	1429	1384
Total area =		14449 ha		

Simulation results – maps of areas of different status vs. current land use (1)



Simulation results – maps of areas of different status vs. current land use (2)





Conclusions

- Model combination as a way of by-passing the lack of wetlands dedicated models;
- Key issues: DEM quality, distributed model output verification;
- Ecological interpretation of the results – biota respond.