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Department of Hydraulic Engineering and Geotechnics,

Dominant hydraulic conditions in the 2-D model – Vistula River from Zawichost to Słupia Nadbrzeżna

Jacek Florek, Maciej Wyrębek, Agnieszka Woś

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The background: Risk Management in Nature - 2000 sites under the condition of flooding illustrated with the Example of the Vistula River Gorge in Lesser Poland

Time: 2014-2017,

Joined founding:

85% EEA Financial Mechanism 2009-2014 (Norwegian Financial Mechanism, European Economic Area, National Fund for Environmental Protection and Water Management, PL02) „Biological Diversity Protection"

15% University of Agriculture in Krakow, Environmental Engineering and Land Surveying,

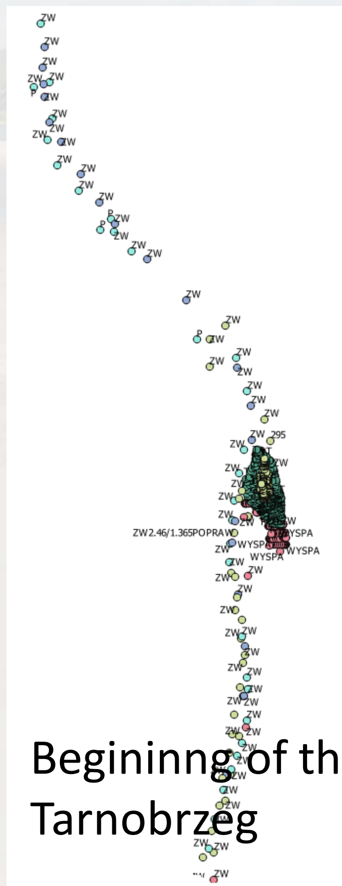
Team:

University of Agriculture in Kraków
Polish Academy of Sciences

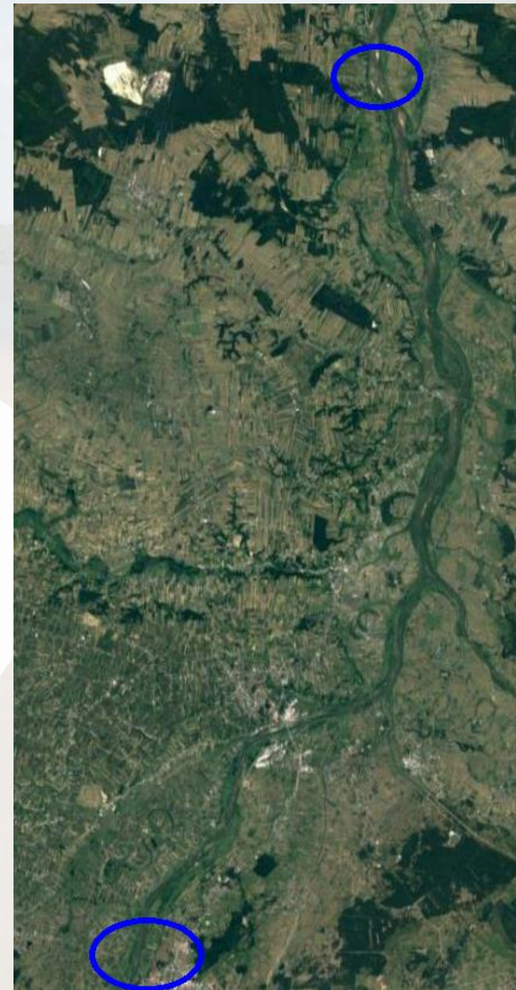
Location:

Field measurement: Hydromorphology

End of the stretch – Słupia Nadbrzeżna



Begininng of the stretch - Tarnobrzeg



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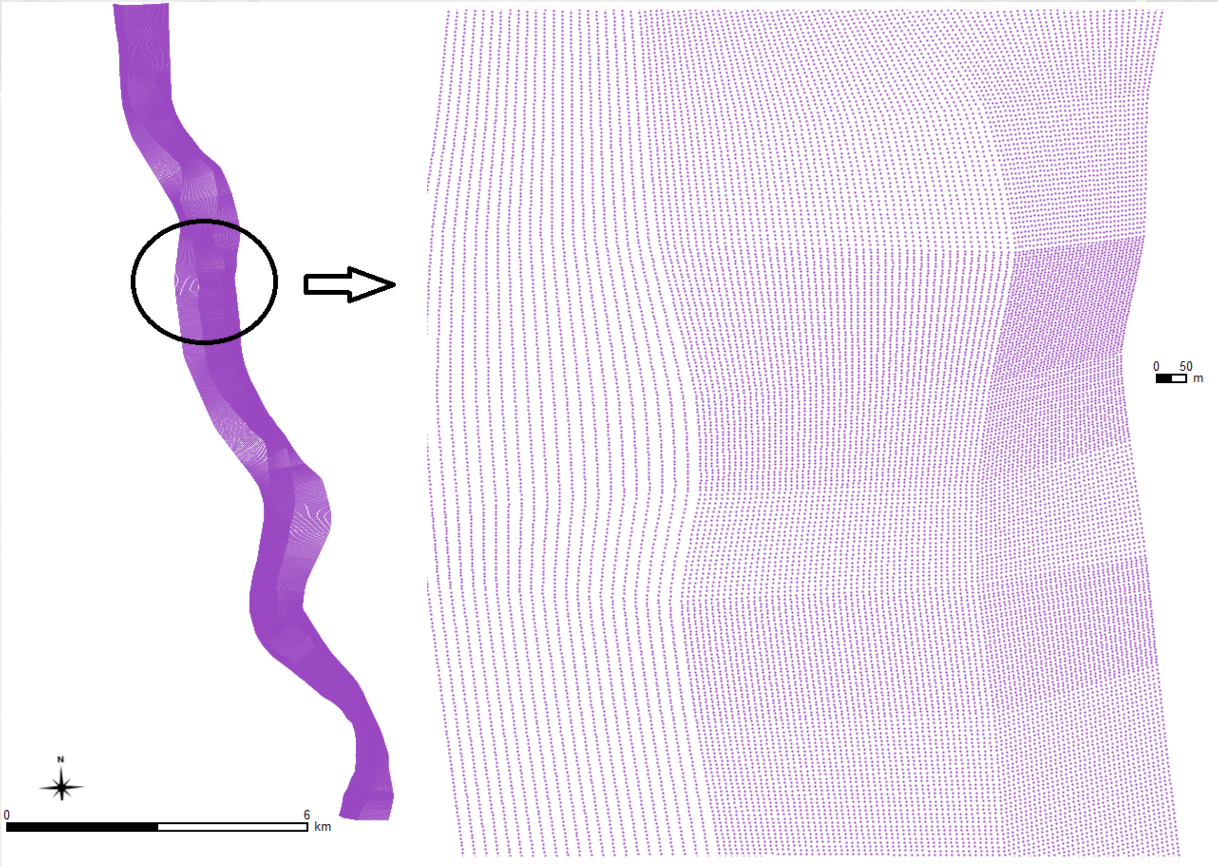
Basic geometric parameters of the 2-D hydraulic model, a data obtained from 3 sources: measurement in 2017 (ADCP, GPS RTK) and raster of the DTM

	Width of block [m]		Distance between nodes [m]		Number of nodes
	min	max	min	max	
Right bank	107.7	617	4.7	26.8	65642
Channel	211.6	786.3	4.2	15.7	142700
Left bank	81.5	806.3	2.3	22.4	102744



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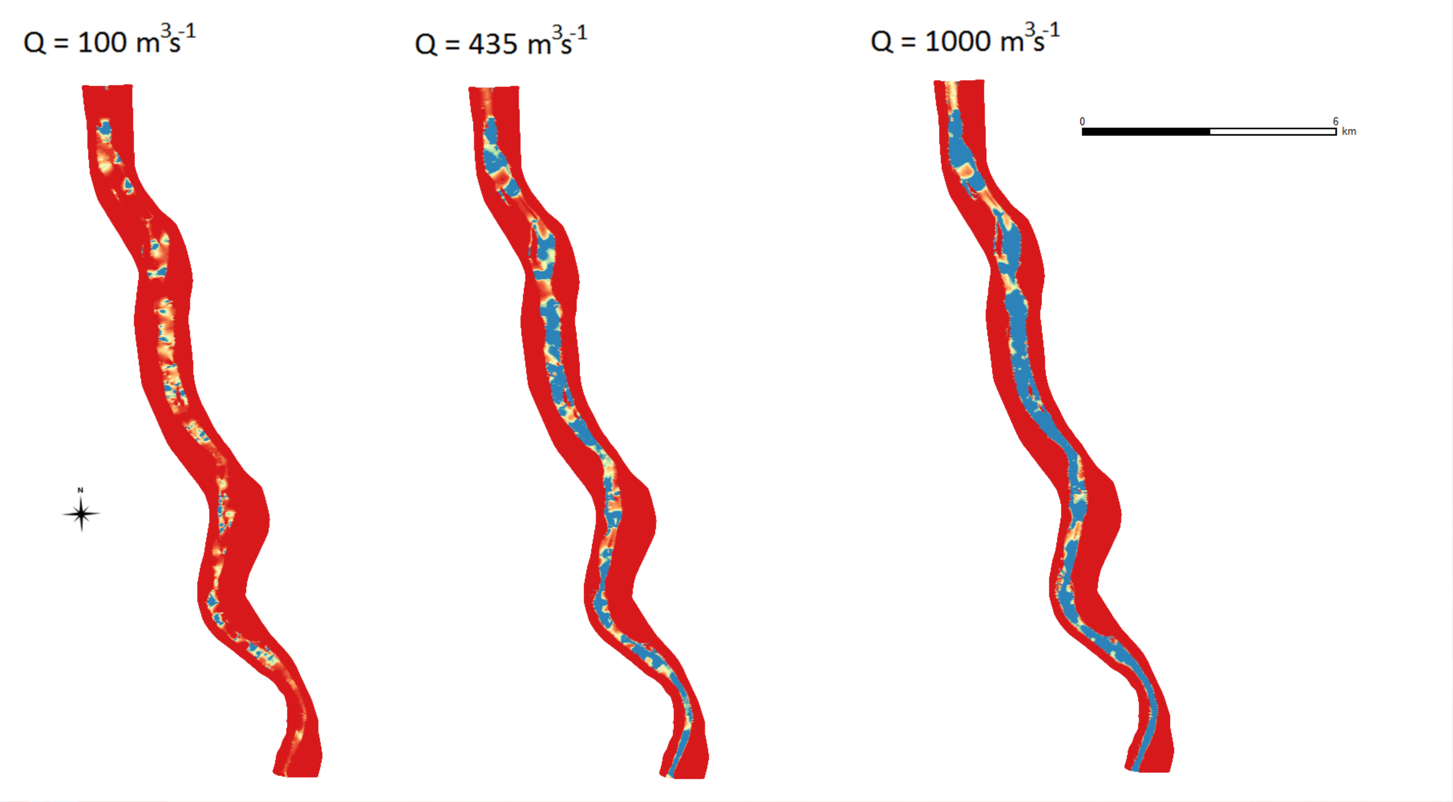
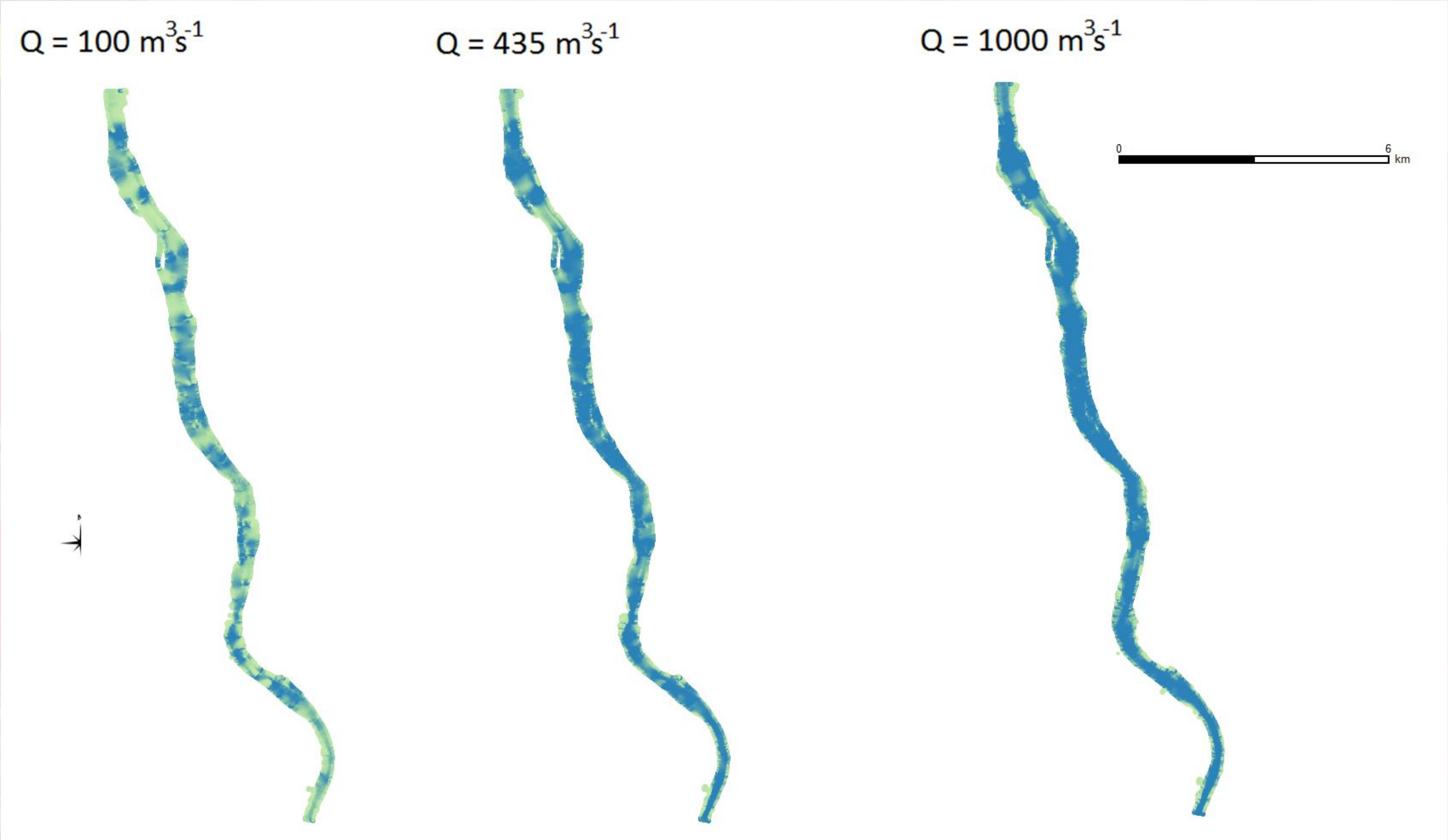
Results: Linear scale



Results: Quantiles (the scale is proportional to the number of grid's nodes)



Not much more to see – this all is just a picture, details will not be perceived …

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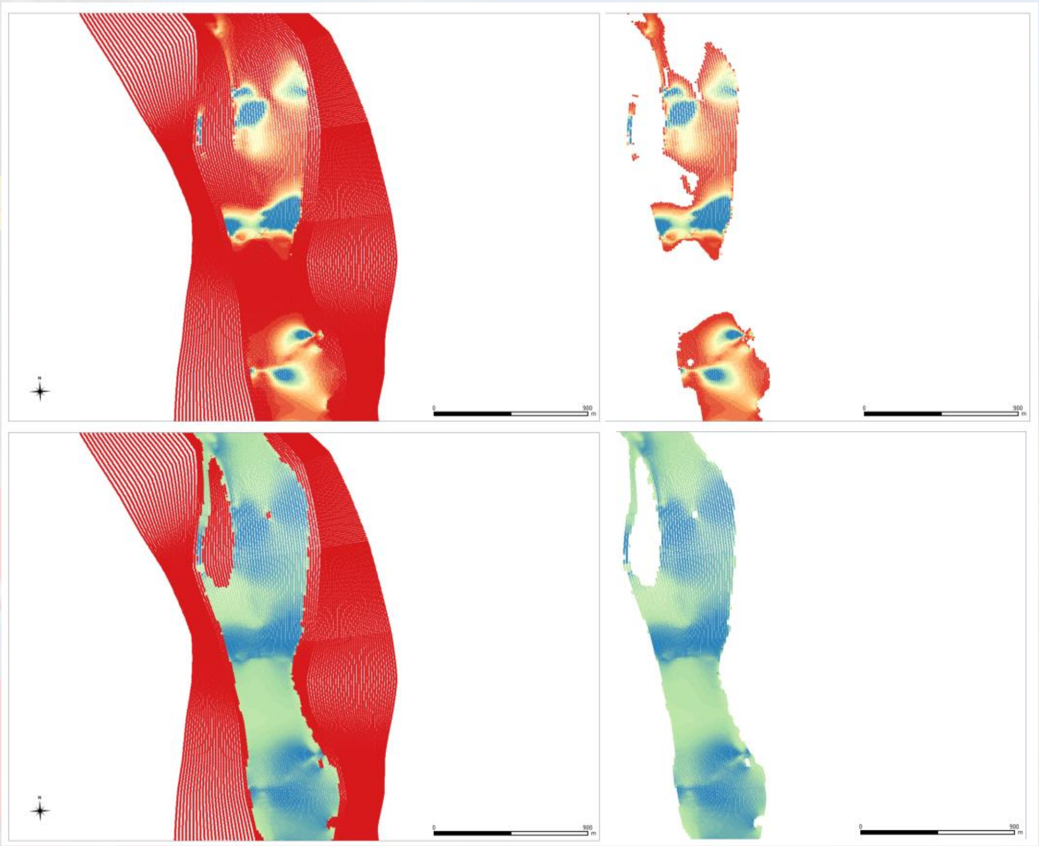

Linear scale

Scale based on Quantiles

And another problems appear – joined points from the parts of grid where the water is present and moves with other from “outside”

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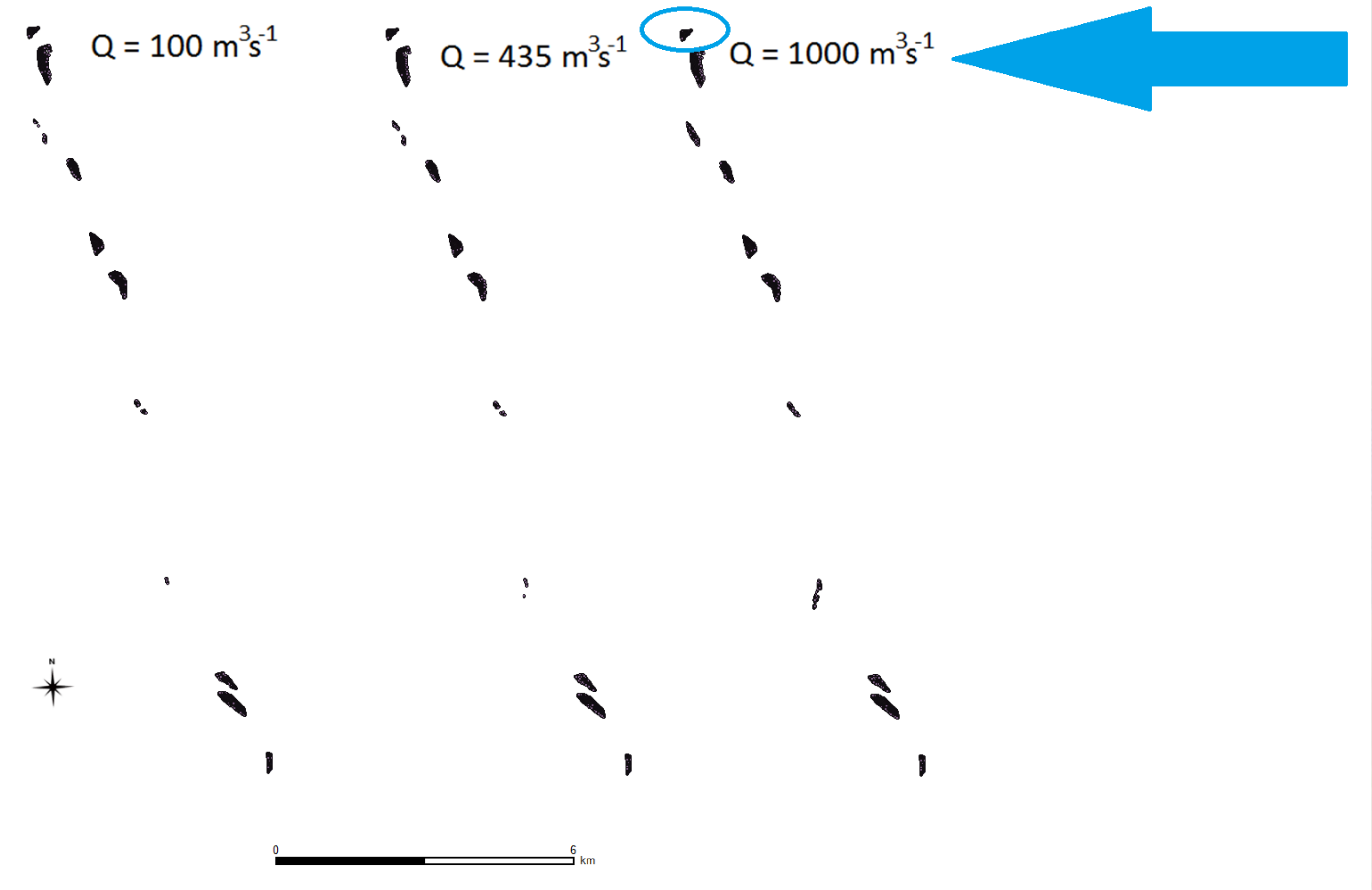
Depth, sand banks – intersections



Let’s say we are obtaining information about sand banks and how they change with the changing flow Q and on top of it only the depth is considered – sand banks x flows x depth (Spatial Intersection), 13 groups of nods, *only one is not changed !*

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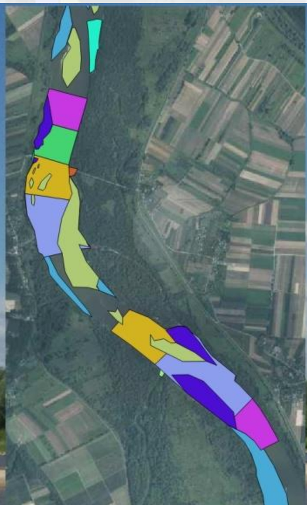
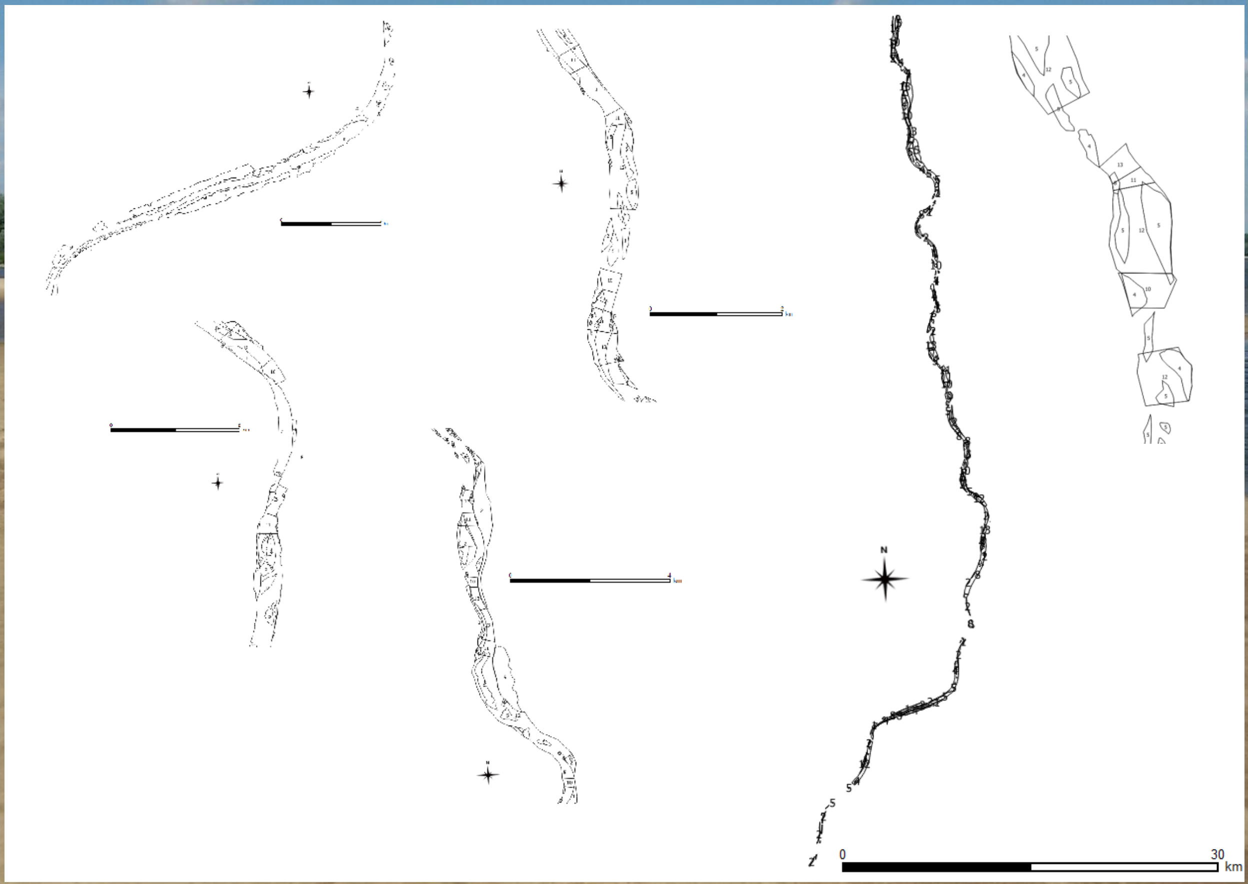
Difference – what's changed by the: flow, place, parts of the channel (morphological elements), where is that? is there anything else in this place? similarities, differences.. 316 found





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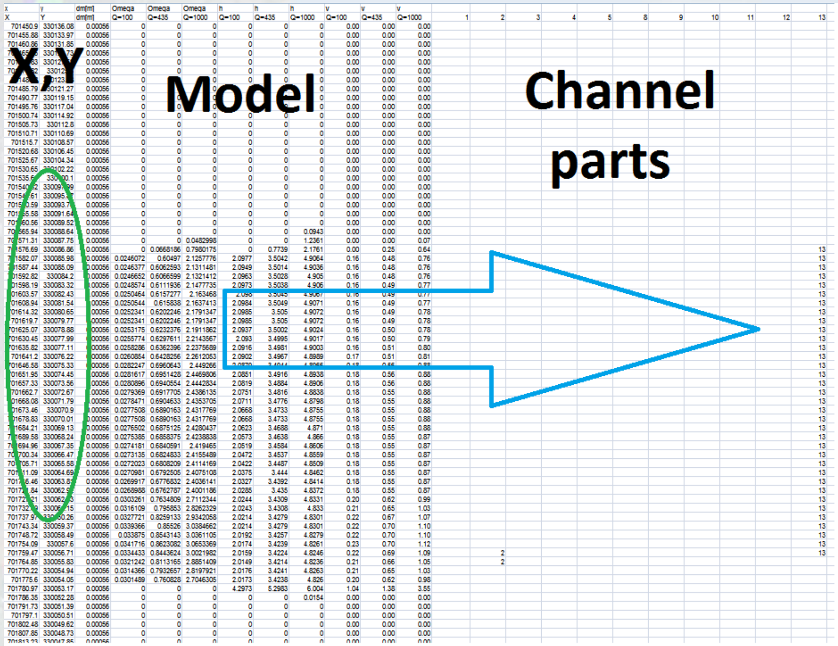

305379	698042	346323	0.00075	0	0	0	0	0	0	0.00	0.00	0.00
305380	698052	346323	0.00075	0	0	0	0	0	0	0.00	0.00	0.00
305381												
305382												

305380

Mid channel bars and islands

4742	698896.8	342356.8	0.8004
4743	698836	342389.1	0.8003
4744	698911.3	342326.1	0.8003
4745	700137.7	335425.1	0.8002
4746	698909.2	342188.3	0.8002
4747	700406.3	336495.7	0.8001
4748	697913.2	344038	0.8001
4749	697628.4	344294.6	0.8001
4750	698908.3	342155.9	0.8
4751	698851.3	342383.2	0.8
4752	697616.1	344262.1	0.8
4753			

4752

Q = 100 m^3s^{-1}

Sandbanks

7431	699139	340956	0.00075	0	0	1.24841	
7432	699079	341252	0.00075	0	0	0.3838	
7433	698096	343334	0.00075	2.9E-07	0	4.1E-08	1.
7434	699138	341160	0.00075	0	0	0.0439	
7435	697558	345595	0.00075	0	0	0	
7436	697575	345529	0.00075	0	0	5.6E-06	
7437	699415	338660	0.00046	0	0	0.00512	
7438							
7439							

7437

Q = 435 m^3s^{-1}

Wide channel

19614	697747	344732	0.00075	1.79459	5.80383	12.0749	1.0237	2.0069
19615	697759	344733	0.00075	2.5235	6.68285	10.9321	1.0481	2.0371
19616	697771	344733	0.00075	2.07662	5.4251	6.89905	1.0477	2.0367
19617	697783	344734	0.00075	0.46022	0.31254	2.13043	1.0164	2.0093
19618	697744	344738	0.00075	1.83649	6.24831	13.327	1.0606	2.0465
19619	697756	344739	0.00075	2.58042	7.16061	11.7955	1.0677	2.0538
19620	697768	344739	0.00075	2.17524	5.61374	7.11248	1.0438	2.0362
19621	697780	344740	0.00075	0.51416	0.33769	2.00453	1.0055	1.9959
19622								
19623								

19621 Q, h, v ? ..- Any conditions

Searching for relations

Since we know it's about the numbers of the nods in the grid, what and how the numbers can be distinguish ? .. parts of the channel and model parameters.. spatially related.

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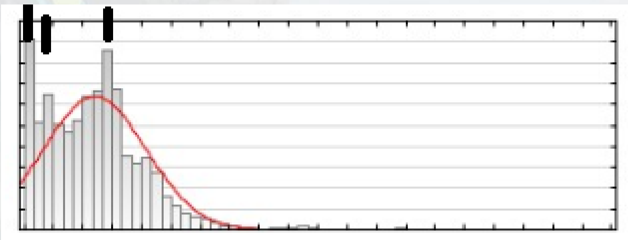
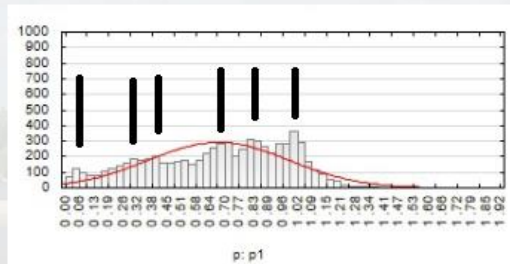
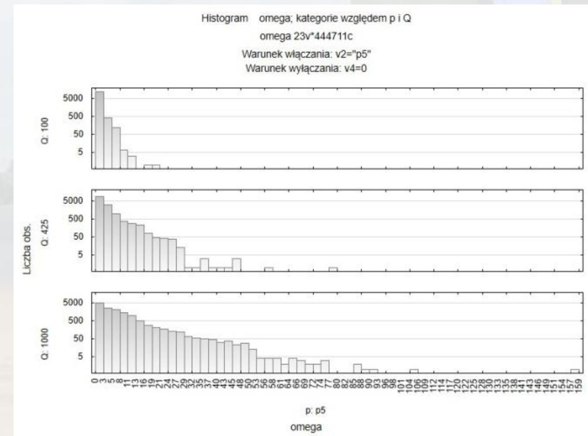
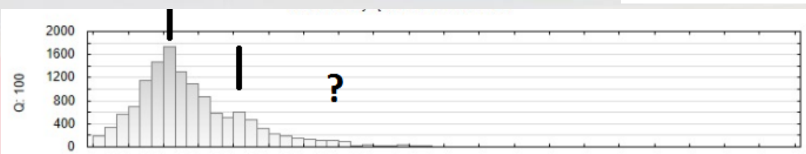


To much ?

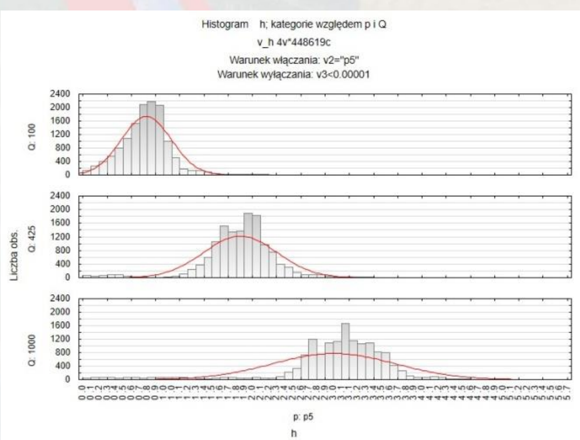


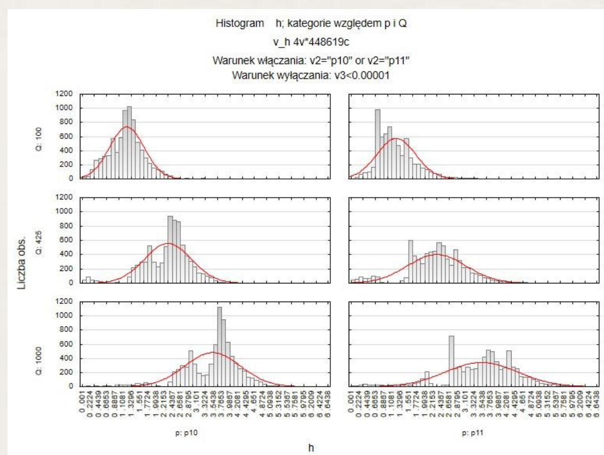


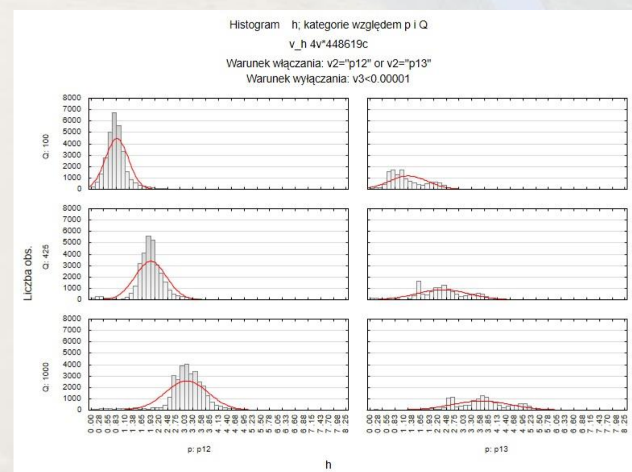
Insufficient ?



Spatial Intersections







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Spatial Intersections the data is gathered

unit	average value for the model	parameter	numerosity for the wh	average	dominant 1 numerosity	dominant 1 dominant value	dominant 2 numerosity	dominant 2 dominant value	dominant 3 numerosity	dominant 3 dominant value	avarage values
expanding	3.20	hQ1000	6419	3.64	2861	3.75	557	2.88			3.72
	2.11	hQ435	6025	2.43	2914	2.02	250	0.13			2.46
	1.04	hQ100	5962	1.29	3046	1.25					1.30
	0.84	vQ1000	6085	0.95	909	0.88	1103	1.38	229	0.06	0.97
	0.61	vQ435	5885	0.64	1306	0.56	436	0.07			0.64
	0.31	vQ100	5907	0.29	2304	0.31					0.29
narrowing	3.20	hQ1000	4832	3.58	781	3.88	1103	3.12	66	0.13	3.65
	2.11	hQ435	4746	2.33	889	2.38	190	0.13			2.37
	1.04	hQ100	4666	1.18	2260	1.01	263	0.13			1.17
	0.84	vQ1000	4781	0.91	854	0.94	166	0.06			0.93
	0.61	vQ435	4595	0.67	1811	0.63	347	0.06			0.67
	0.31	vQ100	4607	0.32	1418	0.31					0.32

average value, whole model, h [m], v [ms^{-1}]	parameter	discharge [m^{3}s^{-1}]	area for the whole grid [m^2]	average, h [m], v [ms^{-1}]	dominant 1 area [m^2]	dominant 1 value, h [m], v [ms^{-1}]	dominant 2 area [m^2]	dominant 2 value, h [m], v [ms^{-1}]	dominant 3 area [m^2]	dominant 3 value, h [m], v [ms^{-1}]	average value of the rest, h [m], v [ms^{-1}]
widening part of the channel											
3.2	h	1000	372835	3.64	166175	3.75	32352	2.88			3.72
2.11	h	435	349950	2.43	169254	2.02	14521	0.13			2.46
1.04	h	100	346291	1.29	176921	1.25					1.3
0.84	v	1000	353435	0.95	64066	1.38	52797	0.88	13301	0.06	0.97
0.61	v	435	341818	0.64	75856	0.56	25324	0.07			0.64
0.31	v	100	343096	0.29	133823	0.31					0.29
narrowing part of the channel											
3.2	h	1000	280657	3.58	64066	3.12	45363	3.88	3833	0.13	3.65
2.11	h	435	275662	2.33	51636	2.38	11036	0.13			2.37
1.04	h	100	271015	1.18	131268	1.01	15276	0.13			1.17
0.84	v	1000	277695	0.91	49603	0.94	9642	0.06			0.93
0.61	v	435	266891	0.67	105188	0.63	20155	0.06			0.67
0.31	v	100	267588	0.32	82362	0.31					0.32
wide part of the channel											
3.2	h	1000	1126926	3.18	247898	3.13	15160	0.13			3.25
2.11	h	435	1107759	1.98	340134	1.88	45711	0.13			2.03
1.04	h	100	1084526	0.89	695254	0.74	263058	0.44			0.89
0.84	v	1000	1111767	0.77	167395	0.94	162516	0.56	47628	0.06	0.79
0.61	v	435	1072212	0.56	350705	0.38	180115	0.81			0.57
0.31	v	100	1062280	0.32	277927	0.19					0.32
narrow part of the channel											
3.2	h	1000	696299	3.61	114830	2.63	107744	3.63	50765	4.88	3.68
2.11	h	435	683695	2.4	116805	1.63	115237	2.38	37289	0.13	2.43
1.04	h	100	676725	1.26	147299	0.63	56515	2.38	36244	0.13	1.25
0.84	v	1000	688226	1.12	187202	1.31	56108	0.63			1.15
0.61	v	435	665108	0.77	313300	0.88	75508	0.06			0.78

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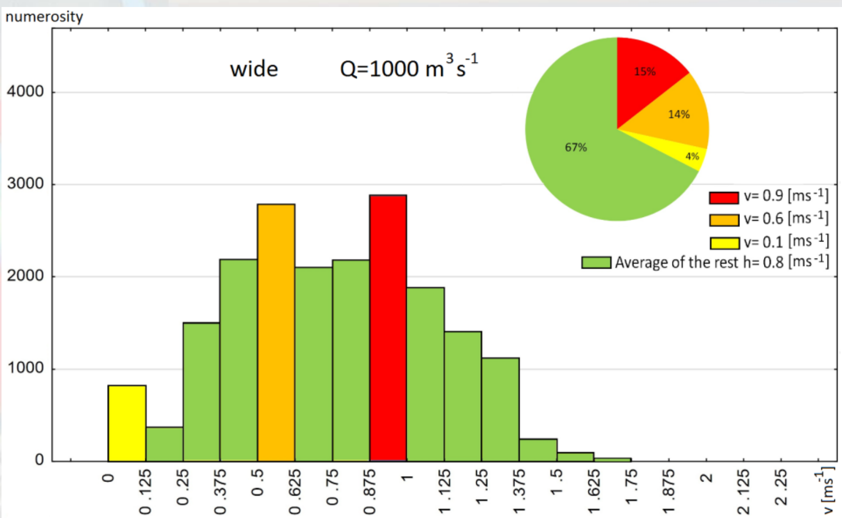
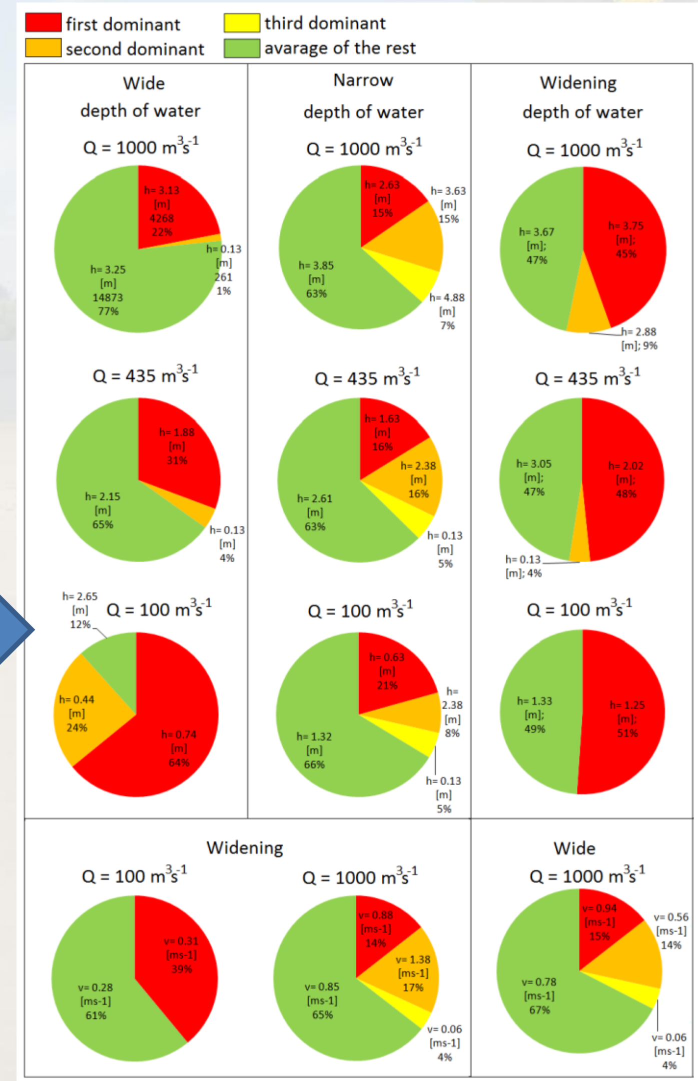
Differences among dominating (calculated) values in the parts of the channel (along the whole model)





The method of determining the dominating surfaces of the velocity on the example of the wide channel part, discharge 1000 m^3s^{-1}

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Conclusions

There are no mid channel bars or islands on the narrow channel while on a wide part a quarter of the area is occupied in this way,

- the majority of the channel areas with a dominant depth occur in the widening in narrowing and wide channel parts only during low stages,

- as for the water velocities dominating parts can be found at the low stage in a narrow channel, regulation works play major role,

- 200m of width (in some places) is not enough for the river of this size - this section of the river was modified many times in the past and it reached width well below which mid channel forms do not appear anymore,

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Conclusions

Negative:
-the preparation of data is labor-intensive,
-building of the hydraulic model,
-verifying large group of a variable relations in order to find relevant results,
-relatively large and uncomfortable data resources,

Positive:
-access to any possible questions about hydraulic and spatial interrelationships,
-number of relations between computational flows, hydraulic parameters and river channel parts is large,
-results beyond visual perception can be maintained: disproportions between length and width, too much information at once from one picture, similar conditions appear in places separated by long distances, impact of discharge depending on location is unequal,

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Sollutions

Operation on much more *limited in number, measured data* will pose a challenge and the solution seems to be selective approach concentrated only on the most important relations.

The nature of the processes and the amount of obtained data make the perception of all results difficult.
Spatial and contextual analysis can be used as a tool to increase usability of hydraulic 2-D model in the field of scientific purposes.
… time…

The authors consider analysis of the modeling results as a potentially useful tool to utilize measured data of riverbed geometry, water stage and velocity gathered in years 2014-2018 (with the perspective of continuation).

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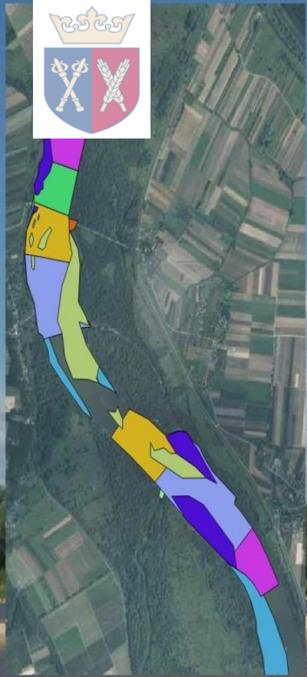

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