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SUSTAINABLE WATERS WaterMan

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EXTREME WEATHER LAYER AS A TOOL FOR NBS IMPLEMENTATION FOR CLIMAT CITY ADAPTATION

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Workshop & on-site visit
Schweinfurt / DE, 5-6 June 2023

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Extreme Weather Layer

NOAH

One of main outputs of the NOAH Project

What is it?

A combination of hydraulic modelling and municipality's spatial planning GIS database.

How does it do?

Connects the results of a rainfall-runoff model and hydraulic model of urban stormwater system with the cadastral maps to visualize the plots of the urban areas under flood hazard.

Why?

These plots should be used for planning and future development of the urban areas in order to avoid increase in the flood hazard. Different climate scenarios are incorporated to EWL allowing to analyze the mitigative effects of stormwater management solution.

Extreme Weather Layer

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To whom it refers?

Urban planners can utilize it to gain information about flood hazard areas in the present and future and to develop climate-resilient cities.

When?

Based on the observed latest intensed natural hazards, there is a strong need for incorporating climatic scenaris into the spatial planing in cities and adaptation.

In the BSR NOAH project, the EWL has been piloted in eight pilot sites in the Baltic Sea region. With the information acquired by testing the tool in a flood hazard area, the selected areas have been equipped with suitable water management and/or measurement technologies. By enhancing the water management conditions in an urban area, spillages of wastewater in flood events can be decreased – which helps to reduce overflows of nutrients and harmful substances into receiving water bodies, especially the Baltic Sea.

Main steps in the implementation of EWL

- Preparation of inputs
- Development of hydrologic and hydraulic model
- Definition of climate scenarios
- Identification of flood-prone locations
- Definition of flood hazard classes based on acceptable flood rates, volumes or durations

The next steps enabled by the EWL are:

- (1) Adjustments in the spatial planning – inclusion of measures minimizing the flood hazard
- (2) Testing of the adaptation scenarios with the use of numerical model
- (3) Identification of flood-prone locations (if still exist)
- Back to (1) …

Implementation of EWL – The Słupsk case study

- Preparation of inputs

➢ Definition of the spatial extent

➢ Definition of the desired spatial resolution of outputs

➢ Preparation of GIS layers characterizing the sewer system

➢ Delineation and parameterization of catchments

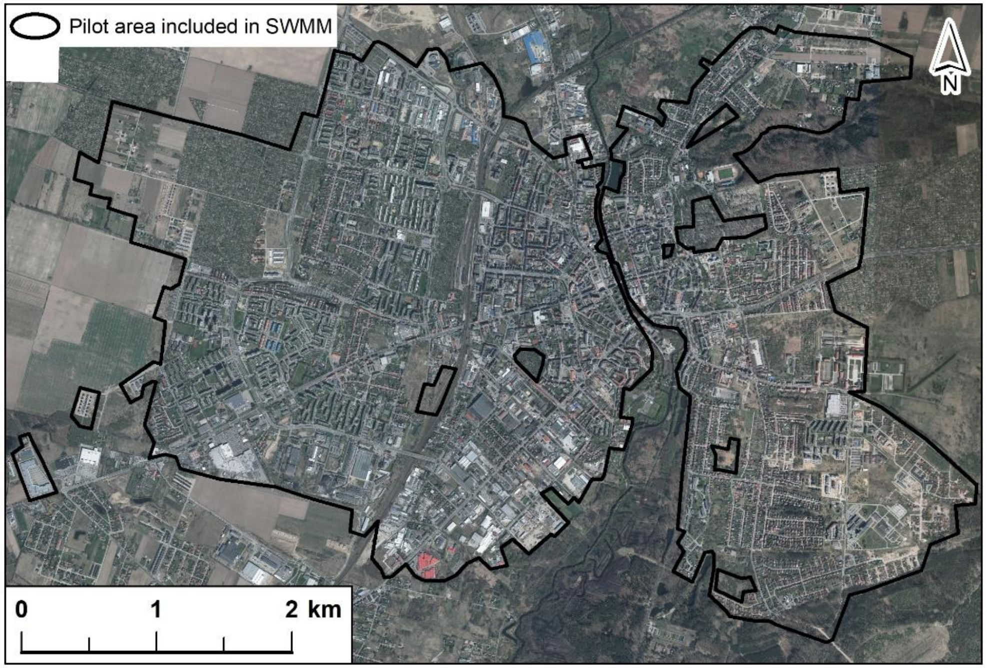
➢ Acquisition of data regarding the precipitation (and other inflows)

Is it the entire city or a part of it?

In Słupsk:

~ 22 km^2

~ 170 km of sewer pipes



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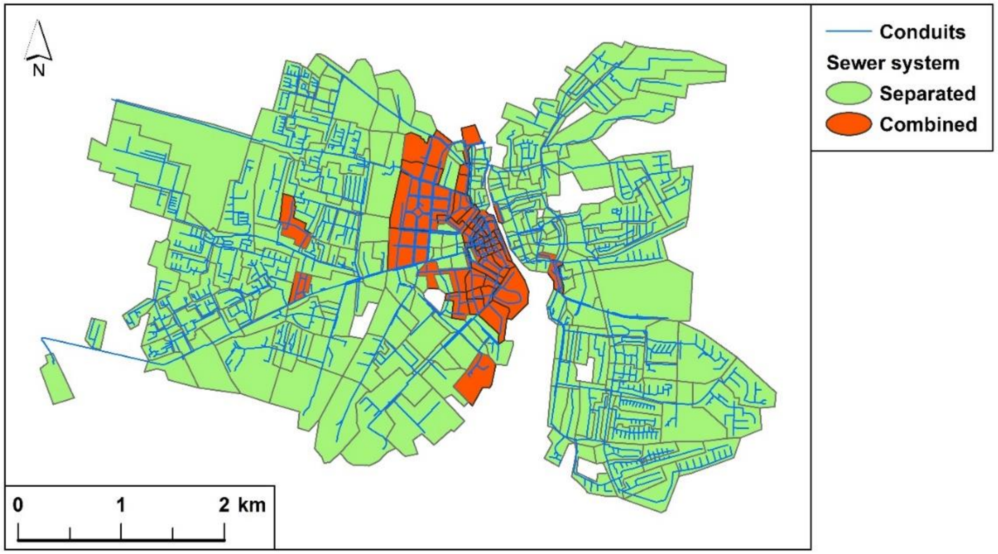
How much detailed should be the model?

- Scalled down to each manhole or only the main collectors?
- All system or selected part?

Outputs should include:

- flood rates, volumes and durations
- Spatial extent and depth of flooded area



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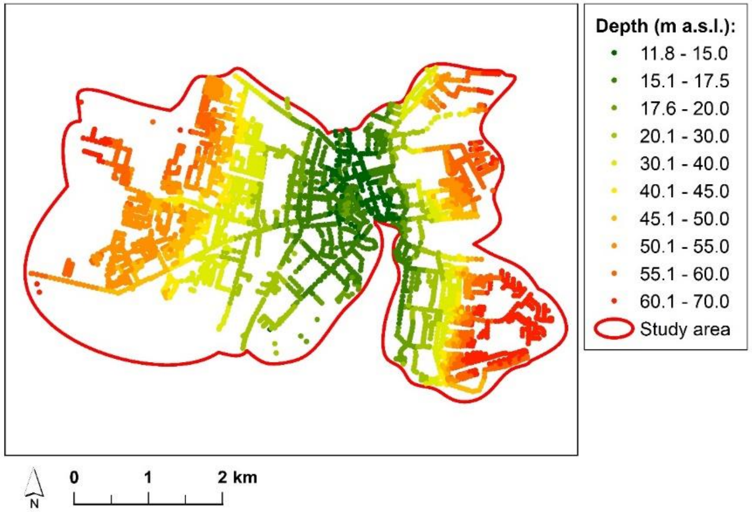
May include:

- Surface elevation
- <u>Depths of manholes and conduits</u>
- Cross-section geometry
- Materials, age and other parameters affecting the flow / friction / infiltration
- Tanks, pumping stations, overflows, flow regulation devices (gates, weirs)



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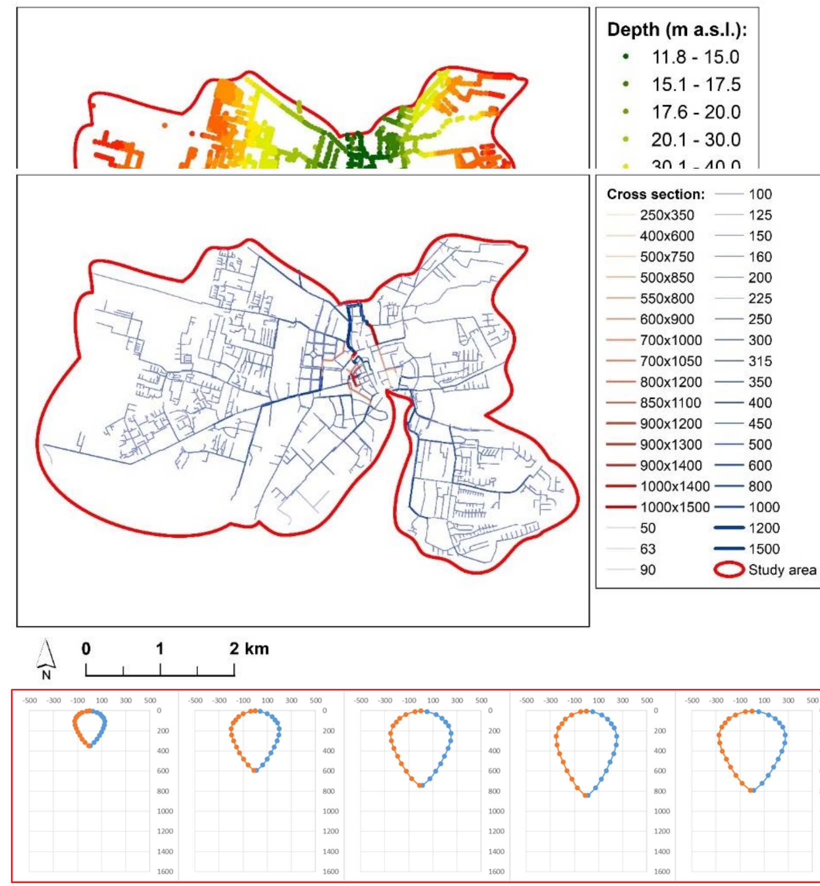

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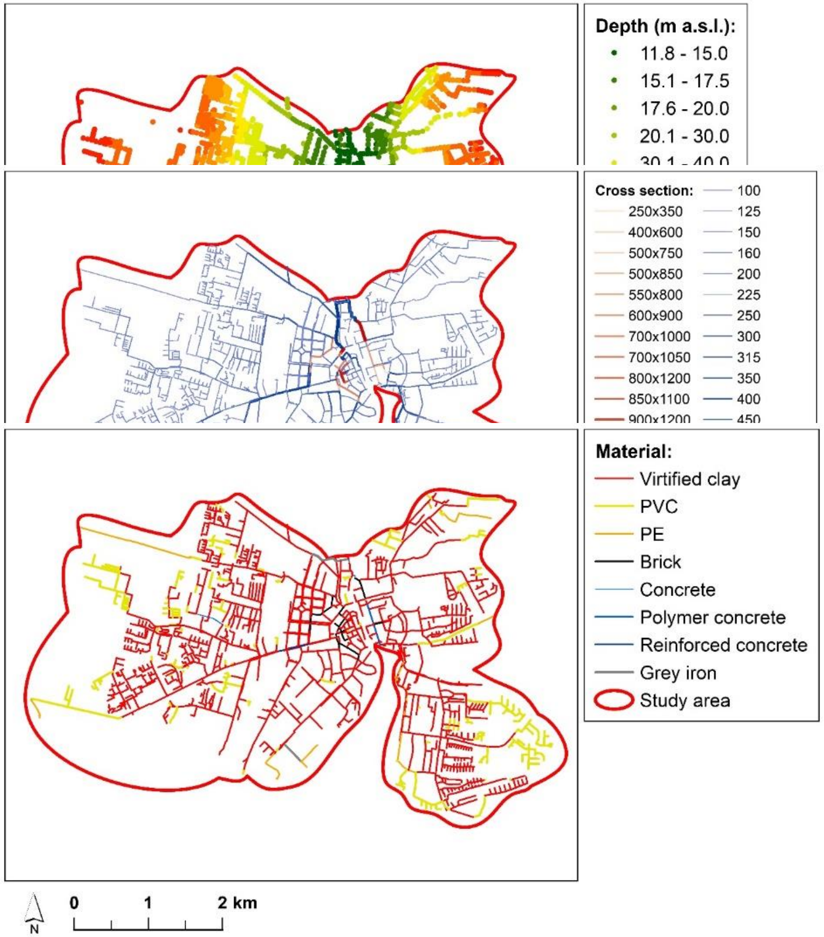

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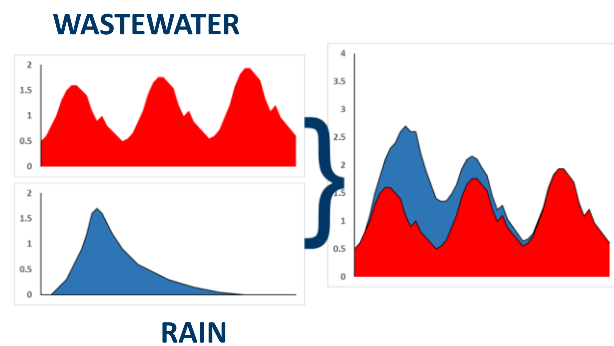
May include:

- Roughness coefficients
- Existing retention potential (e.g. BGI)
- Sources of pollution
- **Type of inflows**
- Slopes
- % of impervious areas



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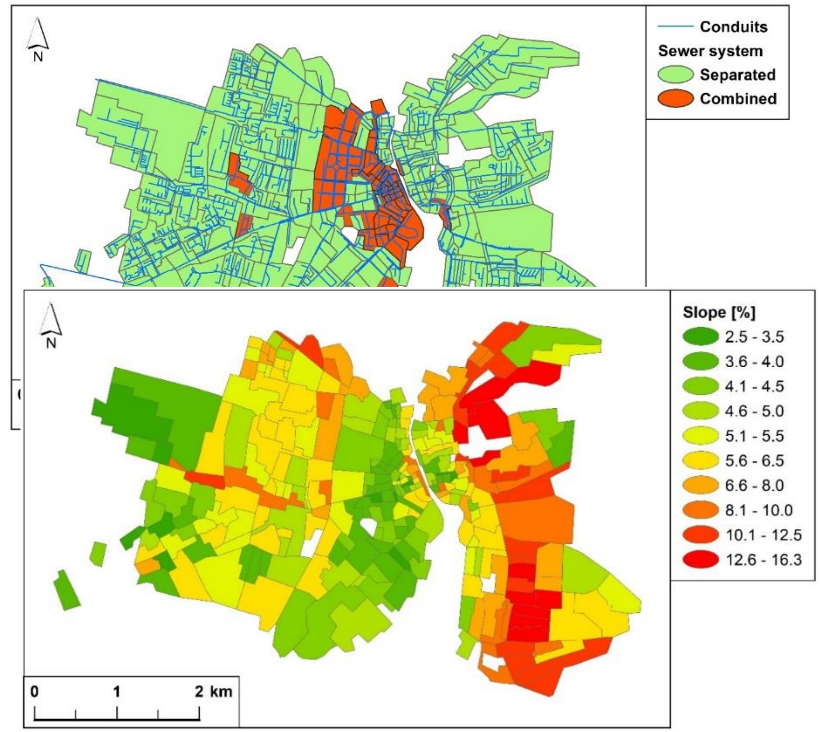

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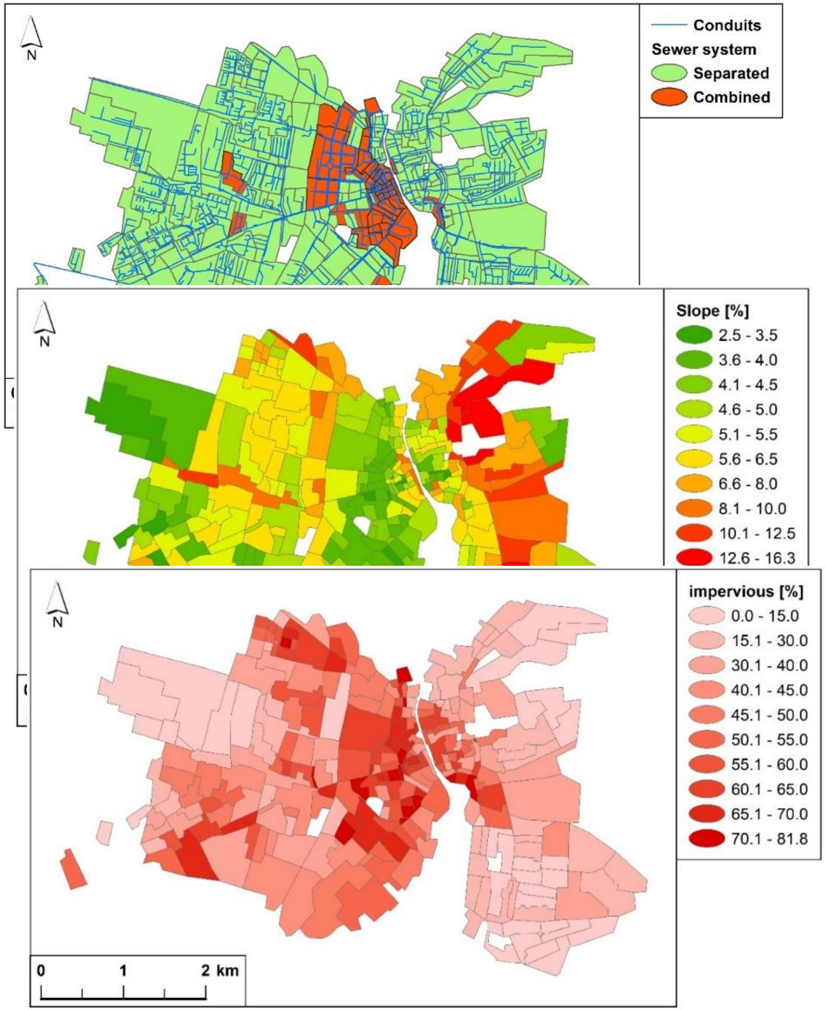

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Precipitation:

- Characteristic rain events to be analyzed (duration & probability)
- Time series for long periods if required by the city

Other inflows

- Infiltration
- Production of wastewater (in case of combined sewer systems)
  - Preferably including spatial and temporal variations
  - May require information about water consumption and inflows to the WWTP in dry seasons

t[min]	t [h]	Precipitation [**mm/event**] - probability of occurrence:										
		0.1%	**0.2%**	**0.5%**	**1%**	**2%**	**3%**	**5%**	**10%**	**20%**	**50%**	**100%**
5		18.99	18.00	16.61	15.50	14.31	13.57	12.59	11.14	9.49	6.74	2.42
10		26.96	25.52	23.52	21.91	20.20	19.14	17.72	15.63	13.25	9.28	3.04
15		31.93	30.23	27.85	25.93	23.89	22.63	20.94	18.45	15.63	10.90	3.47
30		40.84	38.66	35.61	33.15	30.53	28.91	26.76	23.57	19.94	13.89	4.36
60	1	61.19	57.86	53.20	49.45	45.45	42.98	39.68	34.81	29.28	20.03	5.48
120	2	72.61	68.68	63.18	58.76	54.04	51.12	47.24	41.49	34.96	24.05	6.89
180	3	76.50	72.39	66.65	62.03	57.11	54.06	50.00	44.00	37.19	25.80	7.88
360	6	83.27	78.87	72.74	67.80	62.54	59.28	54.94	48.53	41.24	29.06	9.91
420	7	84.84	80.38	74.16	69.15	63.81	60.51	56.11	49.60	42.21	29.86	10.42
480	8	86.23	81.71	75.41	70.34	64.94	61.59	57.14	50.55	43.07	30.56	10.89
540	9	87.47	82.91	76.54	71.41	65.95	62.57	58.07	51.41	43.84	31.21	11.32
600	10	88.59	83.99	77.56	72.38	66.87	63.46	58.91	52.19	44.55	31.80	11.72
660	11	89.62	84.98	78.49	73.27	67.71	64.27	59.69	52.91	45.21	32.34	12.10
720	12	90.57	85.89	79.36	74.10	68.50	65.03	60.41	53.58	45.81	32.85	12.45
780	13	93.34	88.52	81.78	76.36	70.58	67.00	62.24	55.19	47.19	33.82	12.78
840	14	95.82	90.87	83.95	78.38	72.45	68.78	63.89	56.65	48.43	34.70	13.10
900	15	98.14	93.07	85.98	80.28	74.20	70.44	65.43	58.01	49.60	35.53	13.40
960	16	#####	95.13	87.89	82.05	75.84	72.00	66.87	59.30	50.69	36.31	13.69
1020	17	#####	97.08	89.68	83.73	77.39	73.47	68.24	60.51	51.72	37.05	13.97
1080	18	#####	98.91	91.38	85.32	78.86	74.86	69.53	61.65	52.70	37.76	14.23
1140	19	#####	#####	92.99	86.82	80.25	76.18	70.76	62.74	53.64	38.42	14.49
1200	20	#####	#####	94.53	88.25	81.57	77.44	71.93	63.78	54.52	39.06	14.74
1260	21	#####	#####	95.99	89.62	82.84	78.64	73.04	64.77	55.37	39.68	14.98
1320	22	#####	#####	97.39	90.92	84.04	79.78	74.11	65.72	56.19	40.26	15.21
1440	24	#####	#####	#####	93.38	86.31	81.94	76.12	67.50	57.72	41.37	15.65

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Implementation of EWL – The Słupsk case study

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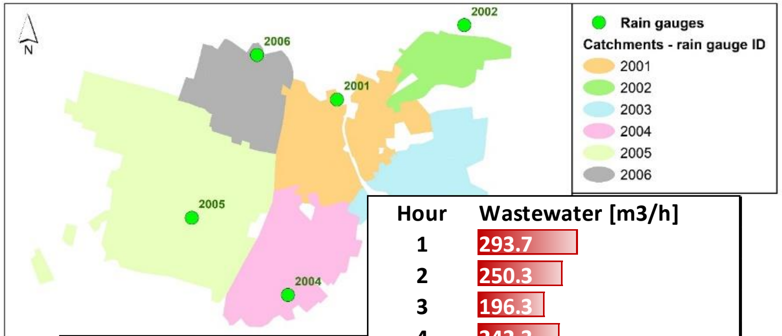

Month	Infiltration [m3/h]
1	244.3
2	259.9
3	290.7
4	209.9
5	176.3
6	96.8
7	95.3
8	131.1
9	173.8
10	231.3
11	222.0
12	212.6

Hour	Wastewater [m3/h]
1	293.7
2	250.3
3	196.3
4	242.3
5	283.0
6	377.0
7	561.6
8	679.0
9	755.9
10	760.7
11	709.2
12	691.3
13	657.8
14	656.7
15	651.1
16	633.4
17	615.1
18	656.1
19	690.2
20	737.3
21	769.5
22	739.4
23	591.3
24	428.0

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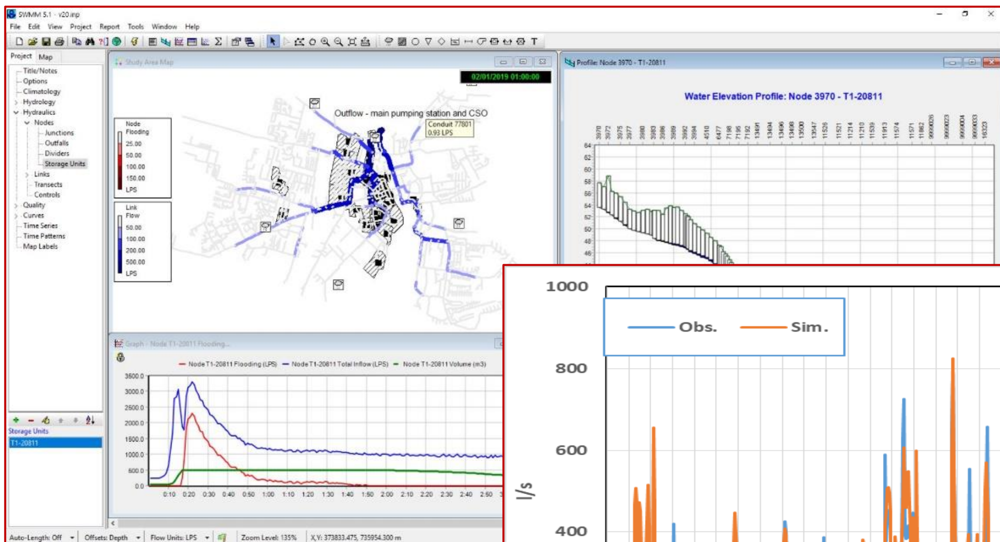
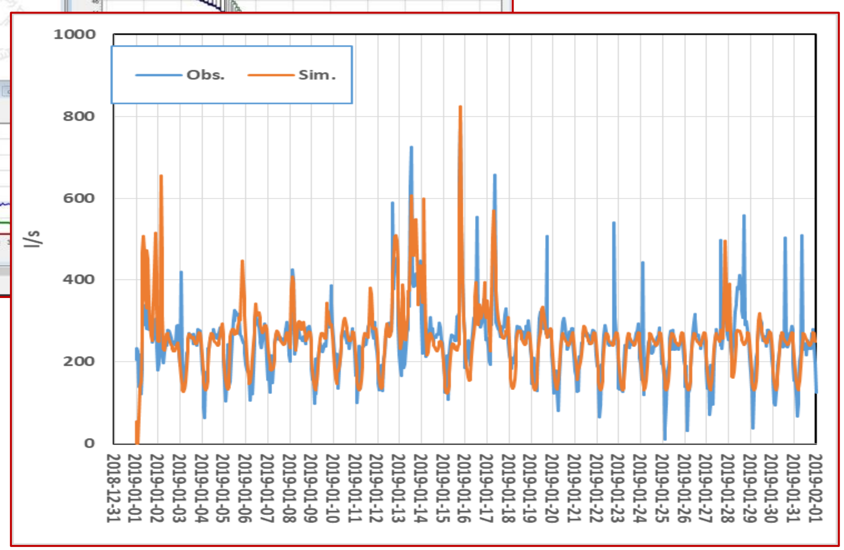
Implementation of EWL – The Słupsk case study

- Development of hydraulic model

Storm Water Management Model (SWMM) used in the EWL





Model validated with the use of hourly flow rates for a month:

dry period

- R=0.74
- NSE=0.55

Wet period

- R=0.83
- NSE=0.63

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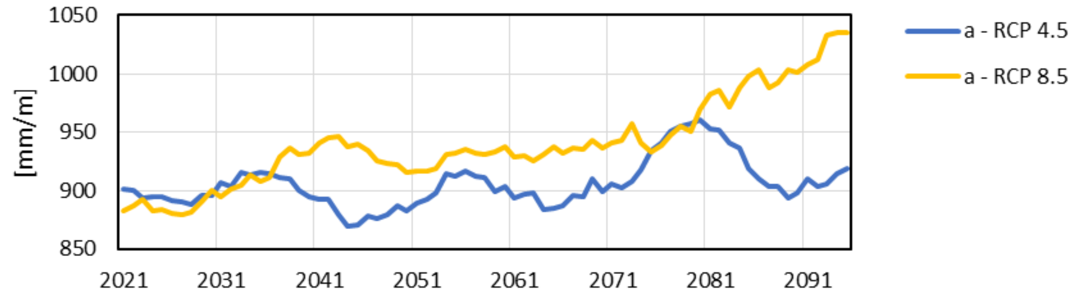
Implementation of EWL – The Słupsk case study

- Definition of climate scenarios

Climate scenarios analyzed in Słupsk

- RCP 4.5 & RCP 8.5
- Two horizons: 2051-2060 and 2091-2100



Rainfall events were analyzed:

- Duration: 20-minute
- Return period: 2 and 20 years (p = 50% and p = 5%)

Probability	Scenario	Precipitation [mm]
50%	Current	12.11
	RCP 4.5 2051-2060	12.58
	RCP 4.5 2091-2100	13.75
	RCP 8.5 2051-2060	14.39
	RCP 8.5 2091-2100	16.38
5%	Current	23.31
	RCP 4.5 2051-2060	24.58
	RCP 4.5 2091-2100	25.79
	RCP 8.5 2051-2060	27.55
	RCP 8.5 2091-2100	29.09

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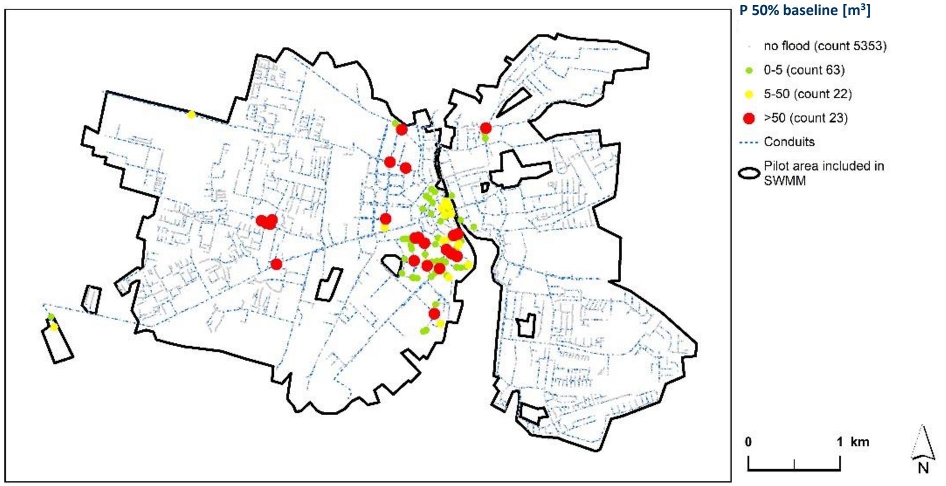
Implementation of EWL – The Słupsk case study

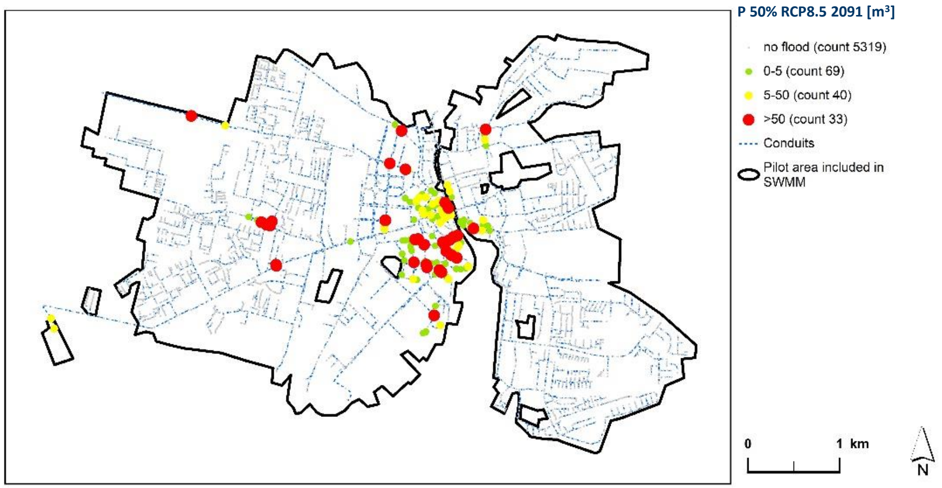
- Identification of flood-prone locations
- Definition of flood hazardclasses

EWL enables various types of flood hazard visualization

➢ An example of manholes and flood hazard classes based of the flooding flow rate

Probability	Scenario	Classes - total flooding [m3]		
		0-1	1-10	>10
50%	**Current**	63	22	24
	RCP 4.5 2051-2060	60	26	26
	RCP 4.5 2091-2100	68	27	29
	RCP 8.5 2051-2060	70	32	30
	RCP 8.5 2091-2100	69	40	34
5%	Current	89	46	51
	RCP 4.5 2051-2060	91	47	53
	RCP 4.5 2091-2100	94	45	55
	RCP 8.5 2051-2060	103	43	60
	RCP 8.5 2091-2100	102	42	64





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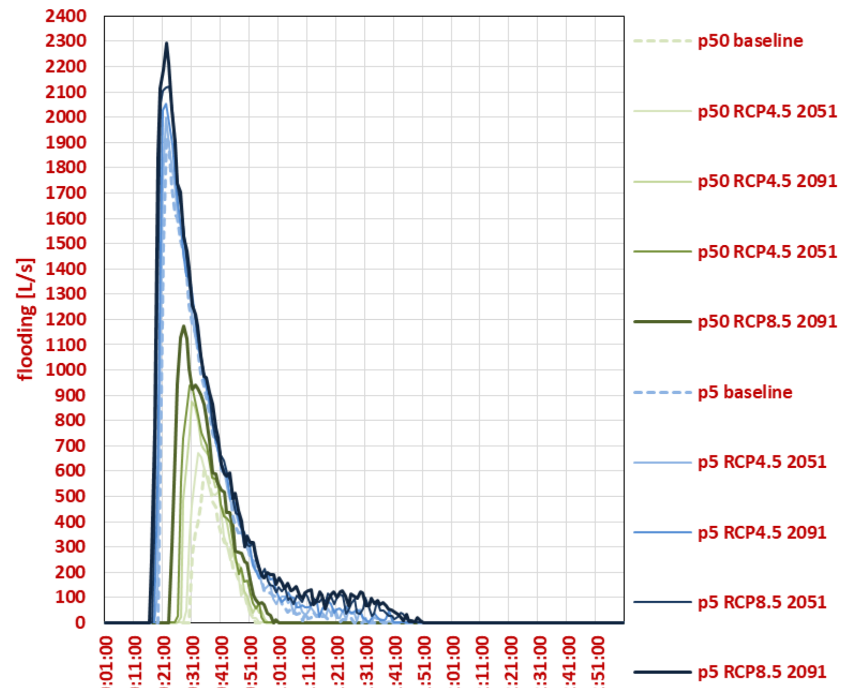
➢ An example of manholes and flood hazard classes based of the flooding flow rate

➢ Overflow to the Słupia river



CONCLUSONS

EXTREME WEATHER LAYER

- Is important tool that can be used to analyze the urban areas' resilience using different climate and future development scenarios.
- Moreover, this tool can be used by a municipality and/or water utility to pre-design adaptive measures like blue-green infrastructure or smart storm water systems .
- Specific technical requirements and descriptions can be derived from analyses of EWL results

Thank you

The investigation was carried out with in the NOAH project - INTERREG BSR no # R093 "Protecting Baltic Sea from untreated wastewater spillages during flood events in urban area"