Mitigation of Pluvial Flooding by Nature-Based Solutions

A study in urbanisation of Tervuren, Belgium

Hello!

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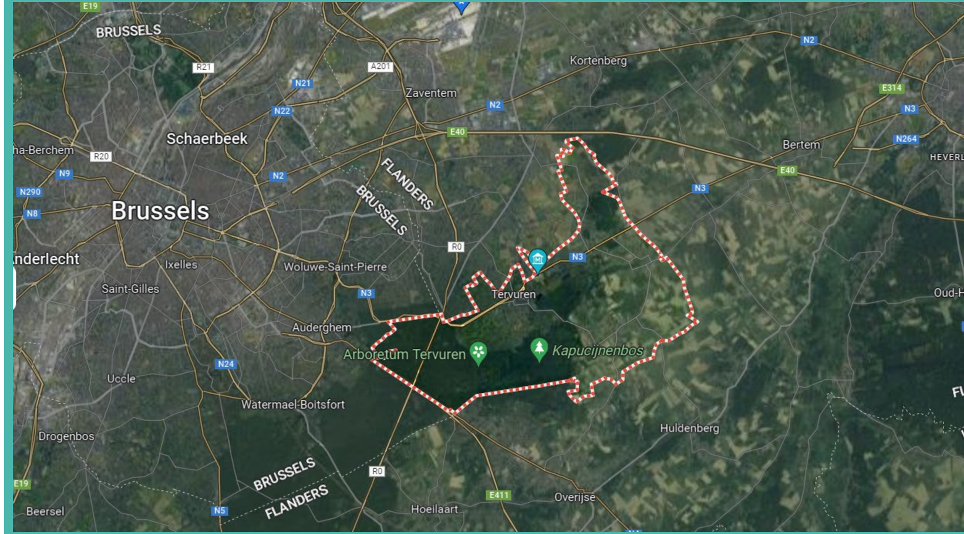
Tervuren

- Flemish Brabant, Flanders, Belgium
- Somewhat cold climate, high precipitation
- Combination of green spaces and heavily urbanised areas
- Suffers due to pluvial flooding



What are nature-based solutions?

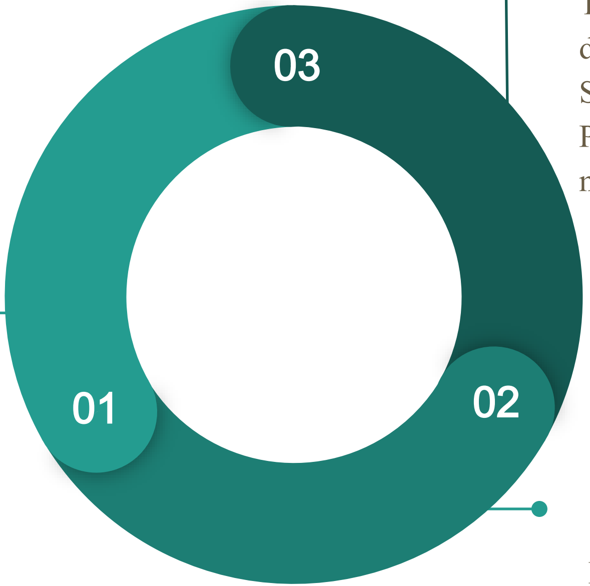
Figure 1. Example of a nature-based solution (Soil Science)

Natural solutions for engineering problems that have minimal impact on surrounding ecosystems and human health

- Minimising structural projects; maximising risk-free solutions
- Often neglected in policy-making due to uncertainties
- Examples: raingardens, floodplains, porous or permeable pavement

The Goal:

Determine if implementing porous pavement has a significant effect on reducing flooding in the urban regions of Tervuren, Belgium.



The Teams:

The teams have been split up focusing on different aspects of the solution. The Q-GIS, SWMM (Conceptualisation and Parameterisation) Teams, and a project manager to oversee and direct the team.

Solution:

Develop a method of selection for areas where it would be most beneficial to install porous pavement in the given region, and evaluate different methods of modelling to estimate the effect.

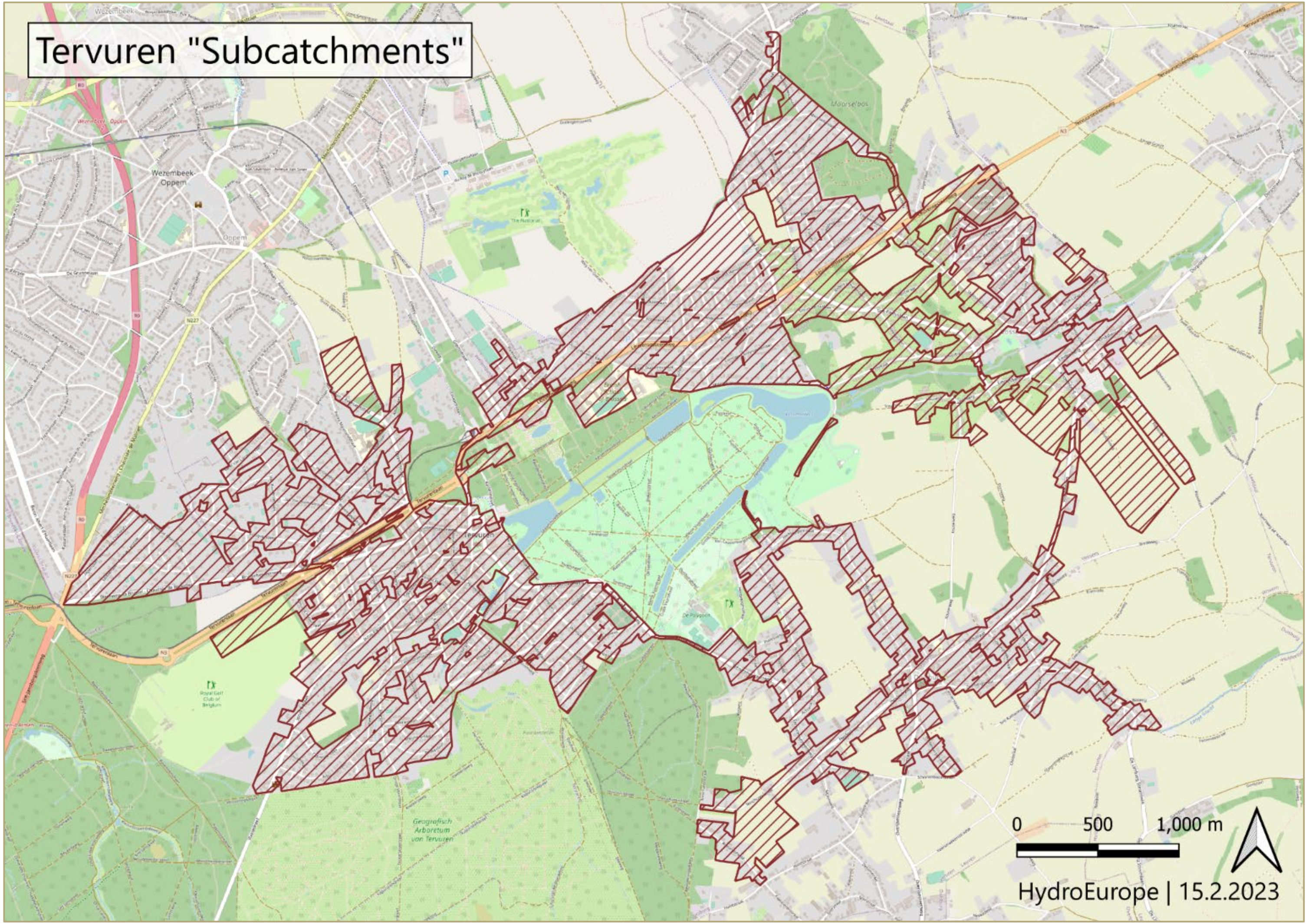


Figure 2. Delineation of subcatchments for municipality
using OSMStandard

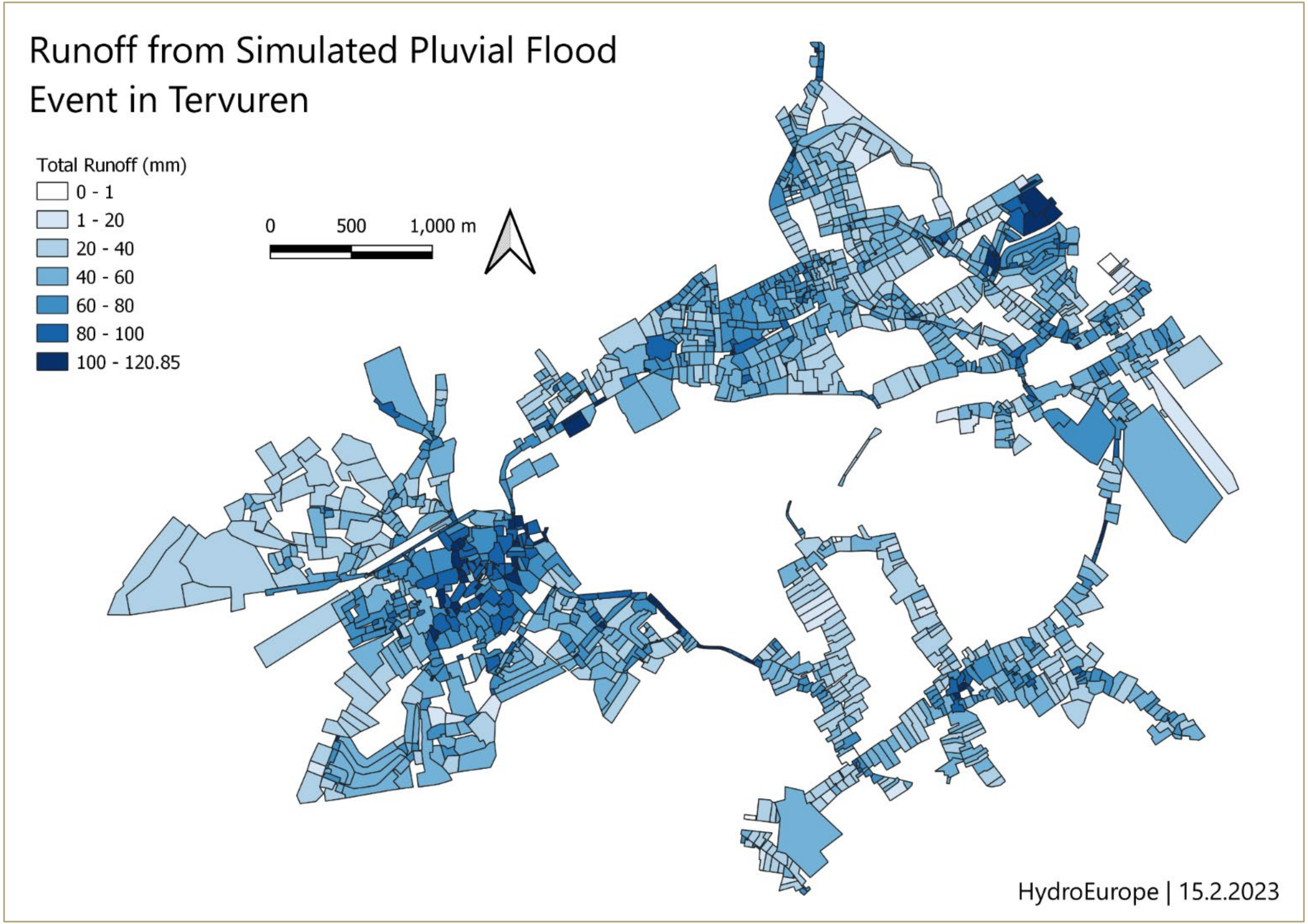
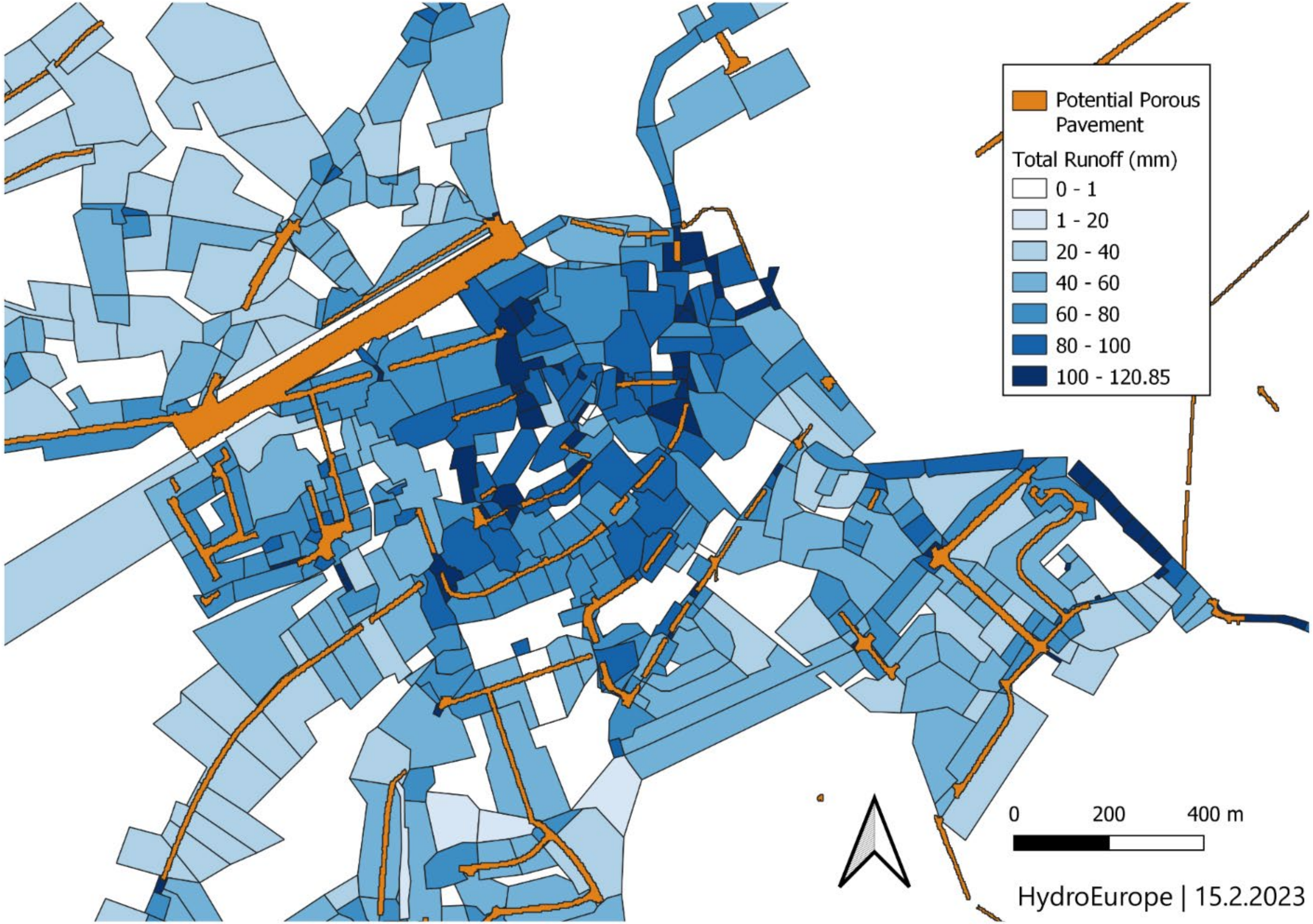


Figure 3. Total runoff results from initial SWMM run with in imperviousness, visualised using QGIS

Figure 4. Example of available area for installation of po
pavement, visualised using QGIS



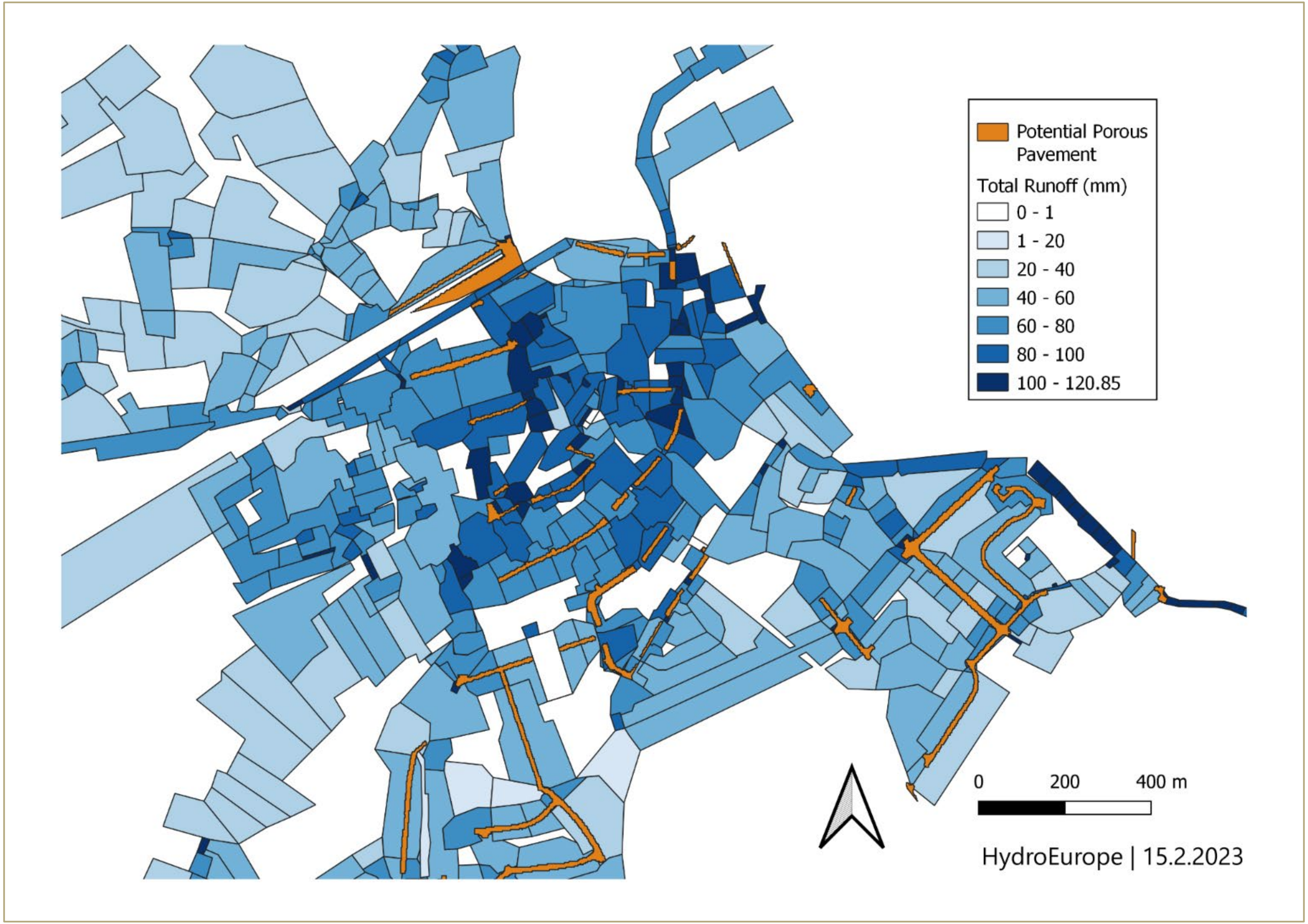


Figure 5. Area for installation of porous pavement as sel
conceptualisation team, visualised using QGIS

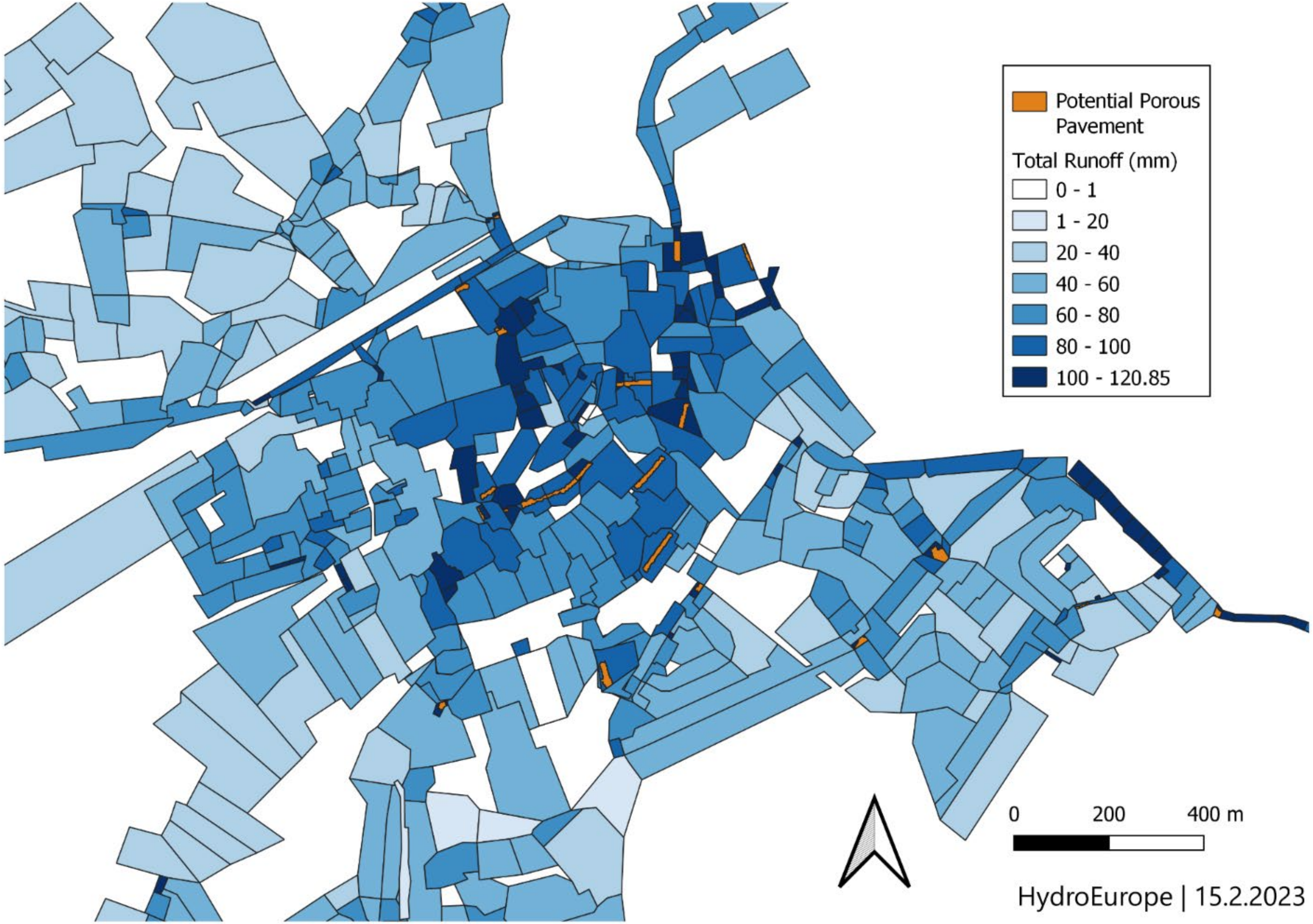
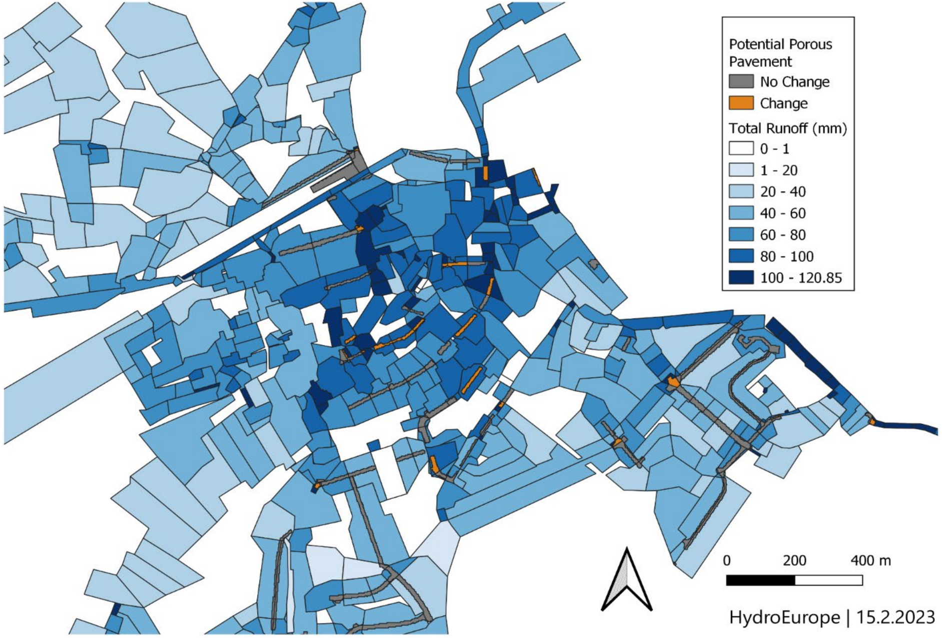


Figure 6. Area for installation of porous pavement based impact subcatchment selection, visualised using QGIS

Uncertainties

Figure 7. Comparison of pavement area selections, visualised using QGIS



- Difficult to view the sewer overflow in QGIS
- Limited selection of the sub-catchments
- 31 of 1990 sub-catchments selected which represents 10 000 m^2 of the 510 000 m^2 that could be used for the porous pavement.

Parameterisation

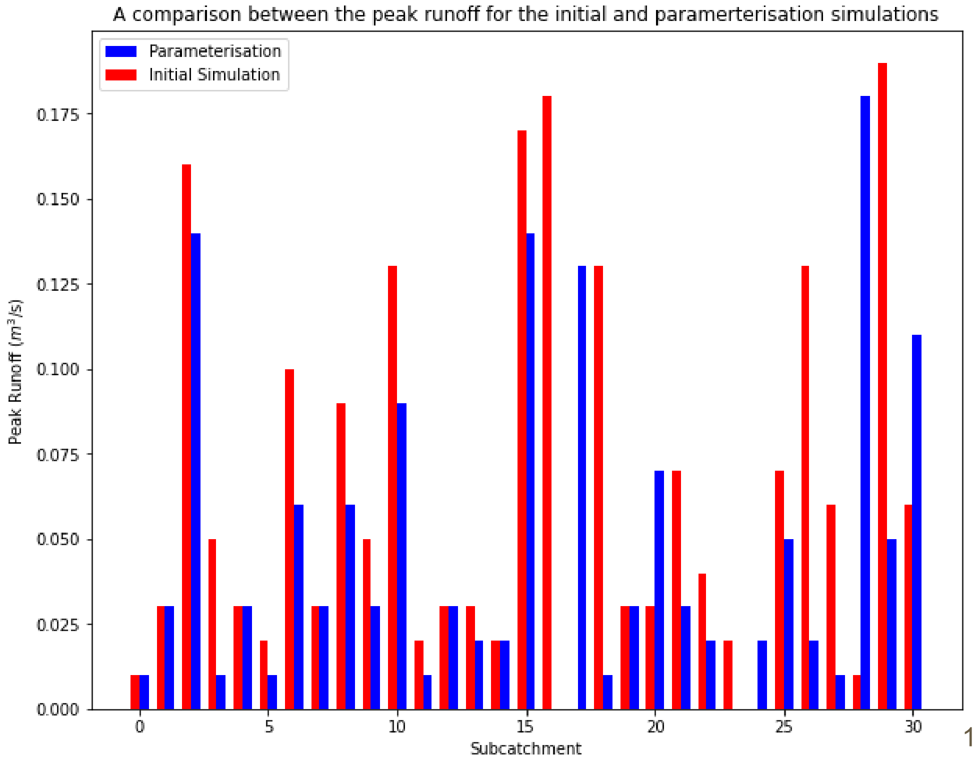
Solution Objective	Inputs	Outputs
Specific characterisation of of permeable pavements	Soil	Analysis of runoff for entire catchment area
Apply inputs to the 31 catchments	Storage	Analysis of runoff for sub-catchments
Determine the effect on reducing flooding through implementation of permeable pavements.	Surface	
	Pavement	

Parameterisation Results

-7% Peak Runoff (m^3/s)

-5% Runoff Coefficient

Advantages	Disadvantages
Specific characterisation	Localised changes
Efficiency	Increased complexity
Flexibility	Spatial Variability



Conceptualisation

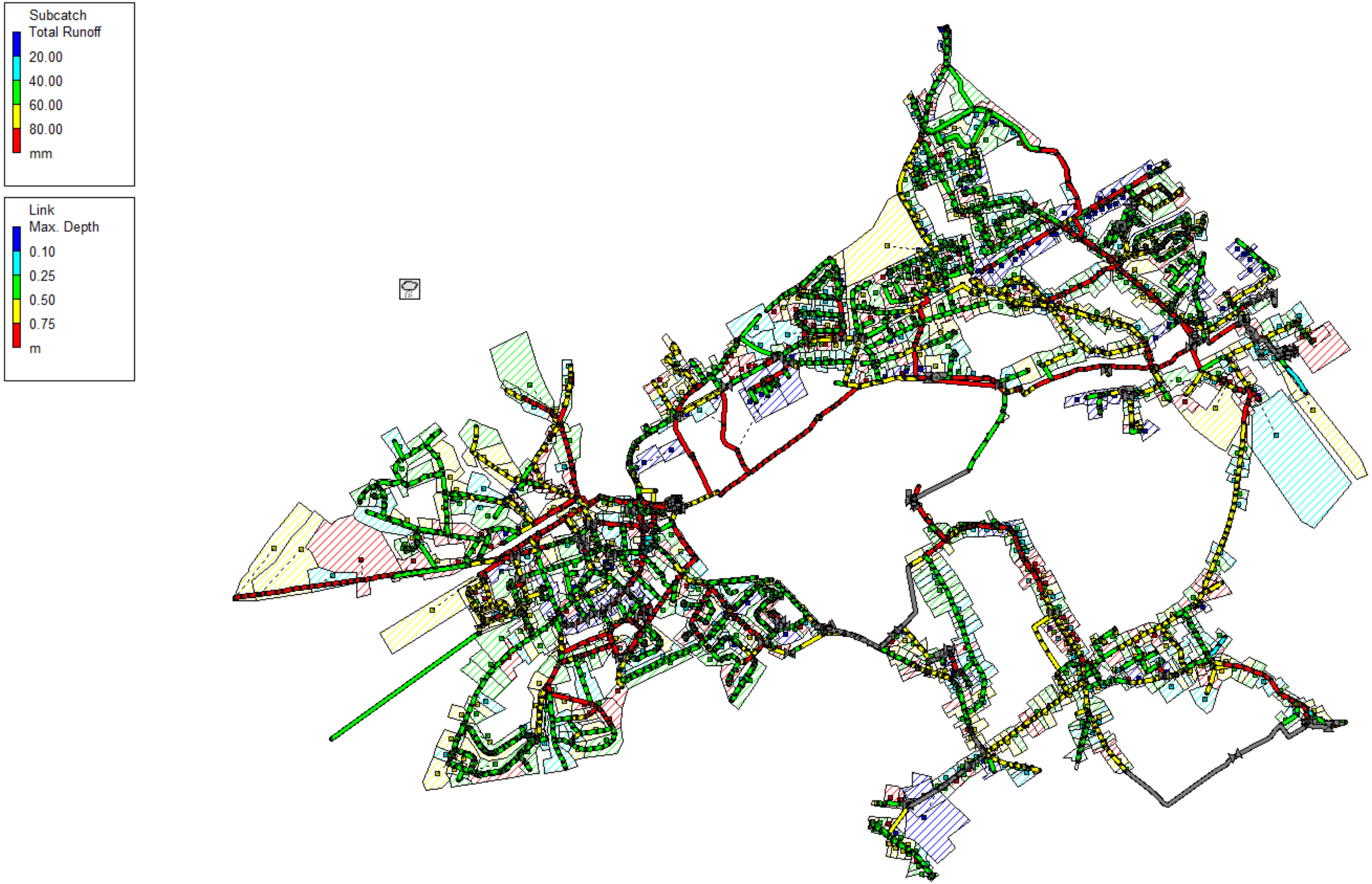
Strategy 1: Flooding area method

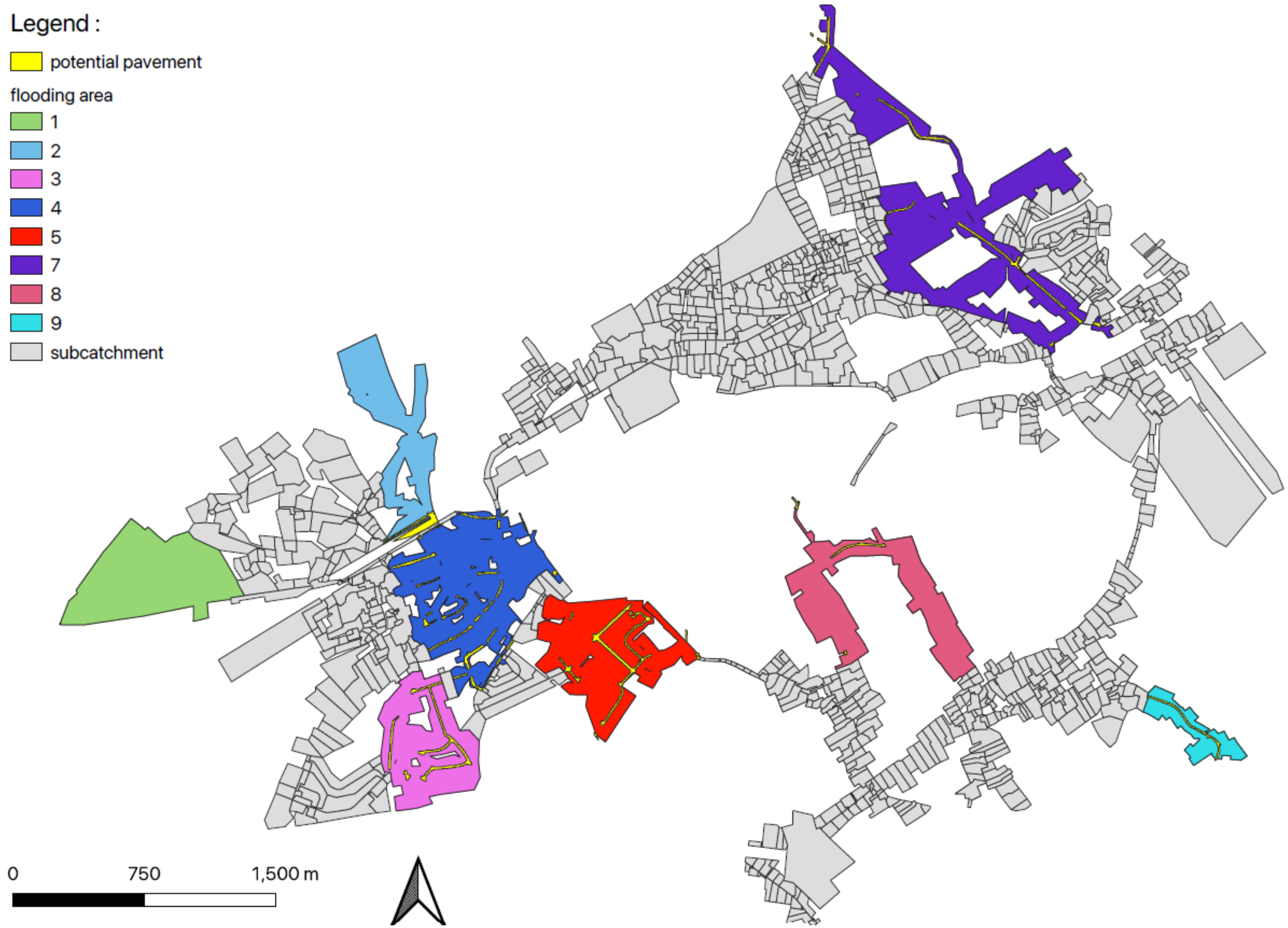
- Run the initial SWMM model
- Define flooding area
- Compare with potentiel porous pavement area for every flooding area
- Reduce % of impervious for every groups of subcatchment

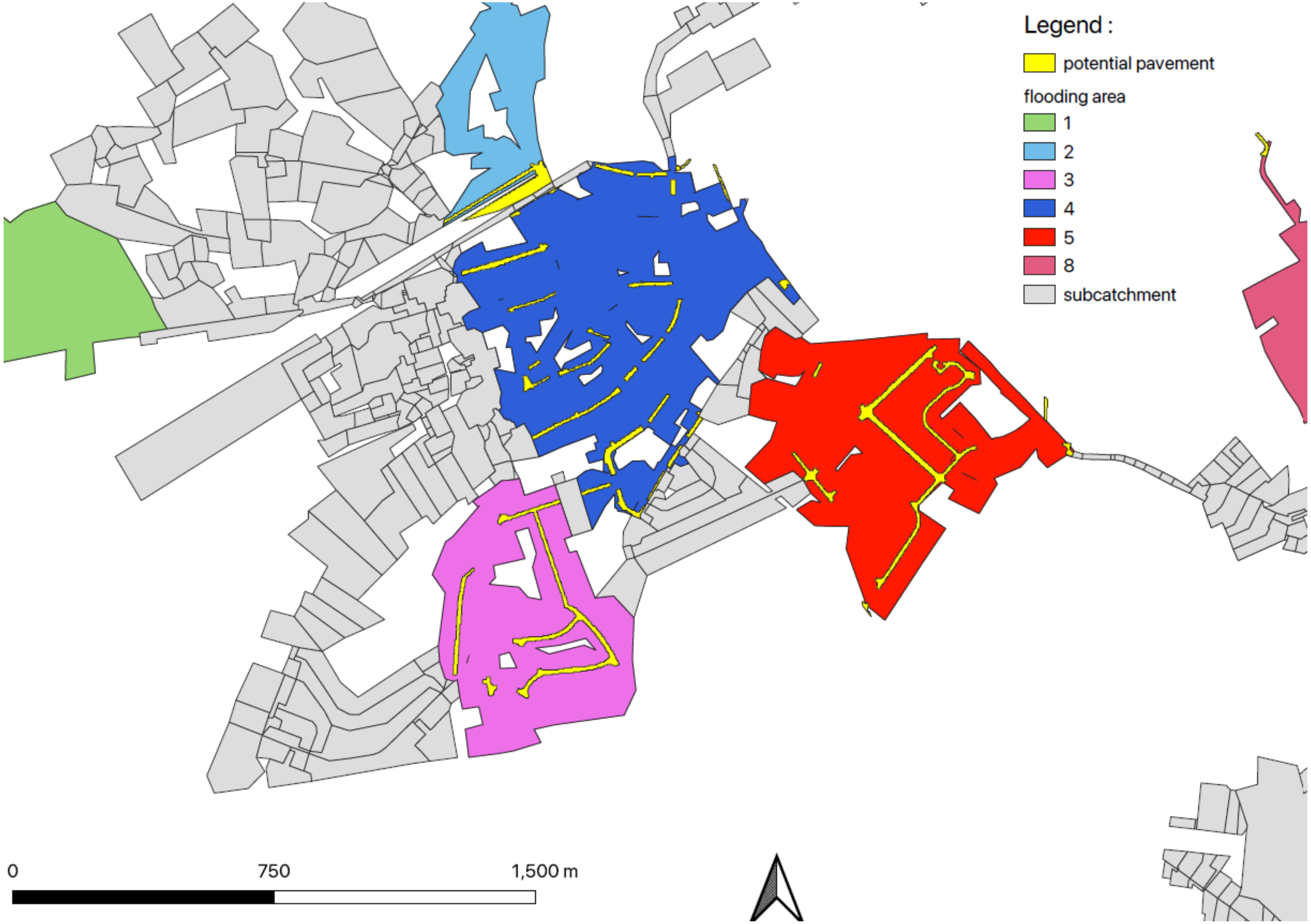
Strategy 2: Improvements by subcatchment

- After running the model, select the subcatchments with bigger total runoff and area with potential implementation of pavement.
- Reduce % of impervious for certain catchments (31 in total, same ones as the parametrisation model)

- SWMM result for initial model




Legend :
potential pavement
flooding area
1
2
3
4
5
7
8
9
subcatchment
0
750
1,500 m


Legend :
potential pavement
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1
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subcatchment
0
750
1,500 m

- Changing parameter = Reduce % of impervious for every groups of subcatchment

Flooding area	Area of subcathment (m^2)	Pavement surface (m^2)	Percent of impervious replacing for each sub-catchment
1	292899	40	0.01%
2	383617	11438	2.98%
3	321456	19721	6.13%
4	262009	28885	11.02%
5	373024	25632	6.87%
7	516970	25865	5.00%
8	83677	4662	5.57%
9	689253	6175	0.90%

We modify 1.16% of the total sub catchment area

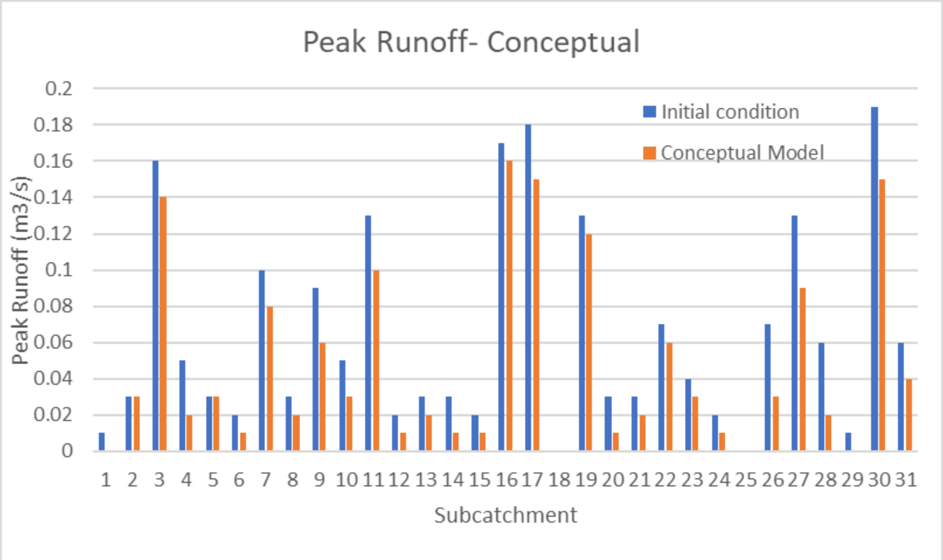
- Result

Strategy 1: Flooding area method

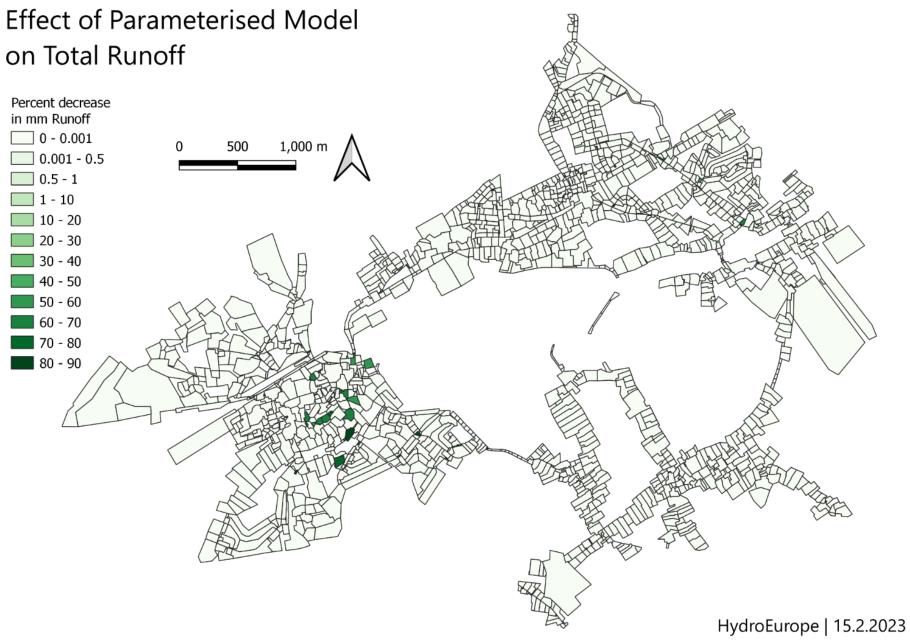
Initial Flooding losses *10^6 ltr	Flooding losses conceptualization method *10^6 ltr	% of flooding reduce
0.355	0.307	13.5%

The method makes it possible to reduce flooding in the municipality as much as possible, but this is not the only necessary solution

Strategy 2: Improvements by subcatchment



*Improvements for the total area are almost neglectable.
* Only local changes (subcatchment level) can be appreciated: Reduction of 27% of peak runoff and 18 % of runoff coefficient for the total of the 31 subcatchments



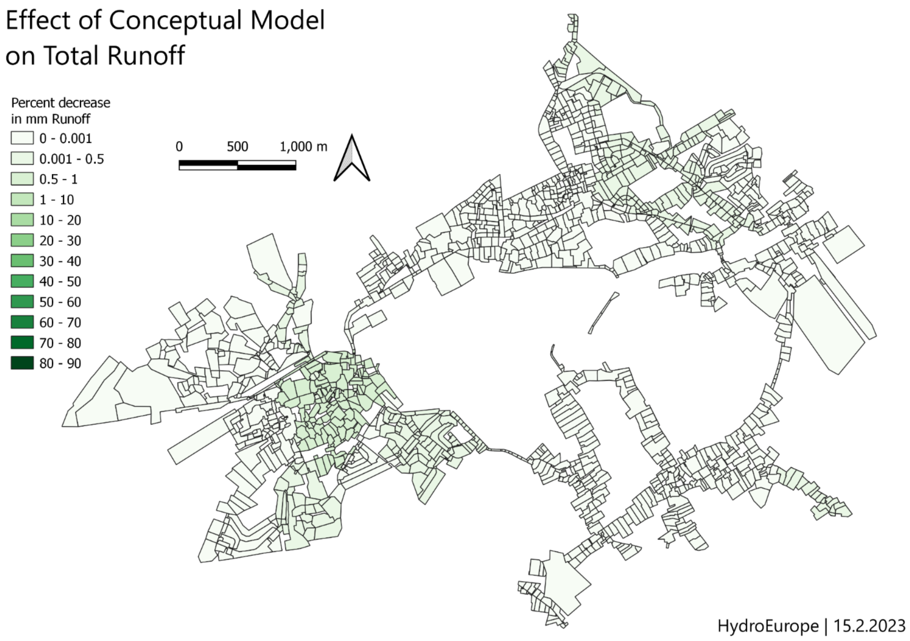
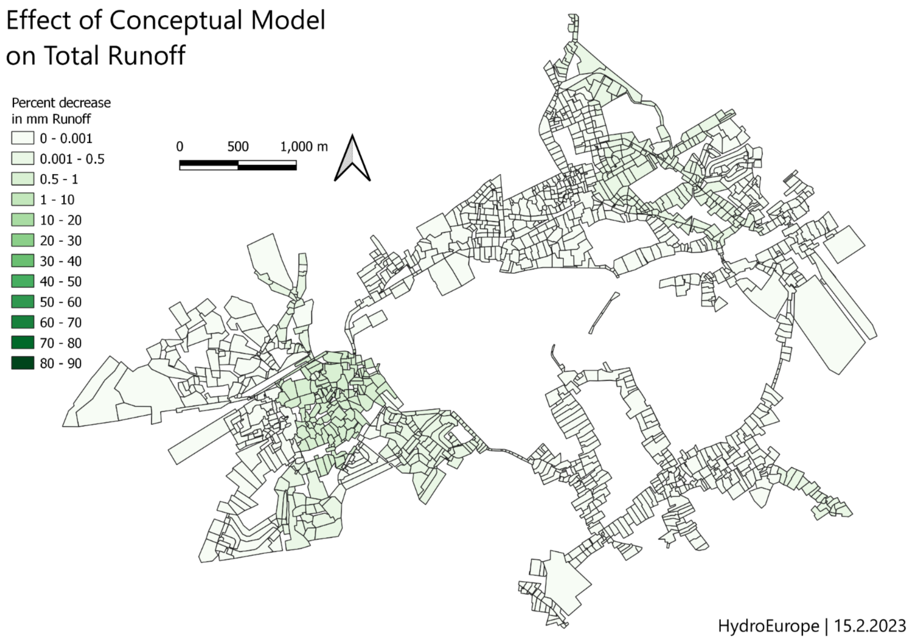


Figure 13. Comparison of results for parameterised model and conceptual model, visualised in QG



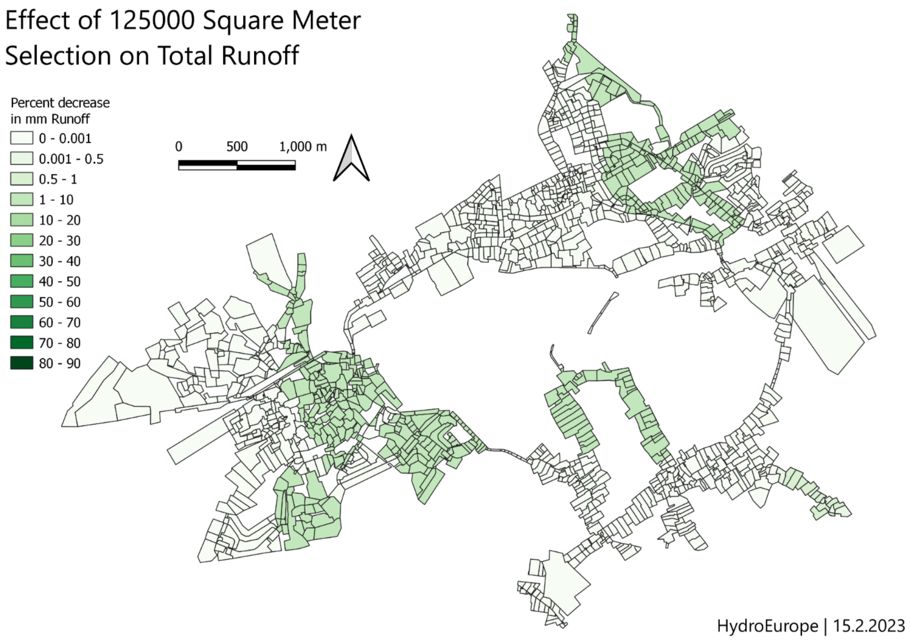


Figure 14. Comparison of results for conceptual model with limited selection and larger selection,

Conclusion

- Conceptualisation preferred over parameterisation
- Conceptualisation approach is optimistic
- Permeable pavements alone do not have a significant effect on the entire catchment
- Take a combined approach of green infrastructures (rain-gardens, retention pond, swales)

TOTAL COST	
Cost 1 (10,000m2)	1 758 943 €
Cost 2 (125,00 m2)	21 986 784 €

Any

Question