Evaluating stormwater management scenarios in Bucharest, Romania

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CENTRUL DE CERCETARE INGINERIA APELOR SUBTERANE ccias 2011 BUCUREȘTI - ROMÂNIA

UTCB Universitatea Tehnică de Construcții București

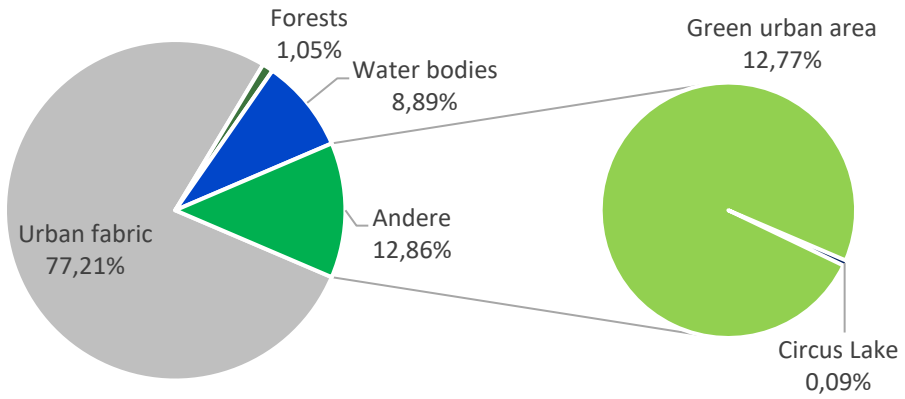
WaterWise Hub

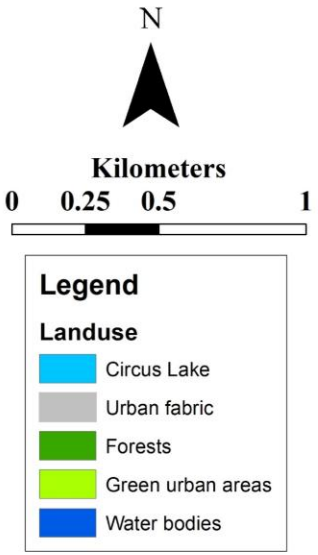
Study area

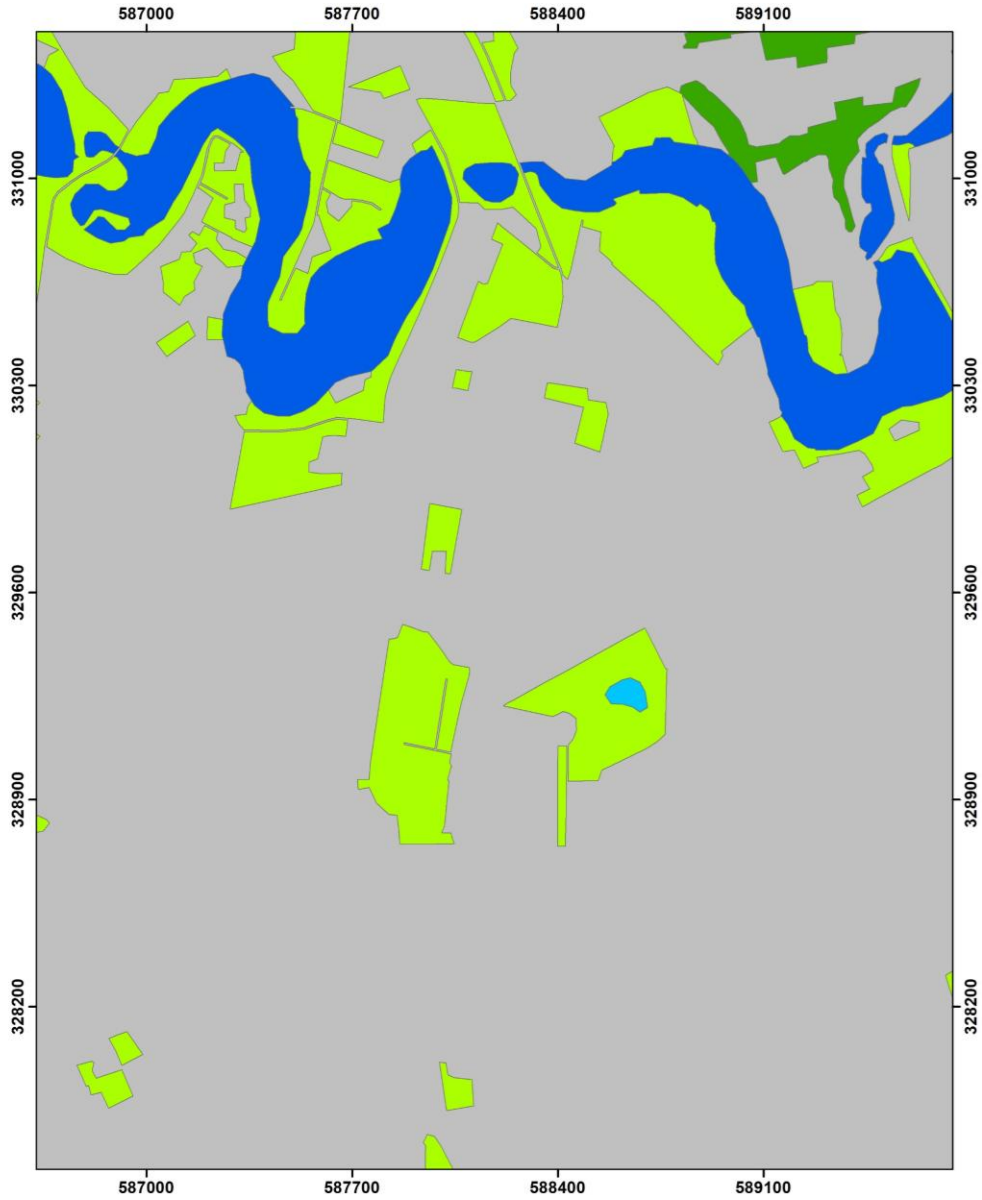
- **Total area = 12 km²**

(Green space area = 1.5 km², urban fabric = 9 km², water bodies 1.5 km²)

- Precipitation = 657.36 mm for 2018 (according to the https://en.tutiempo.net/climate/romania/2018.html)
- The average precipitation in rainfall days is 4.12 mm/day according to the 2825 days in 19 years (2001-2019)

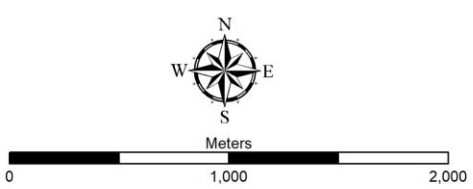


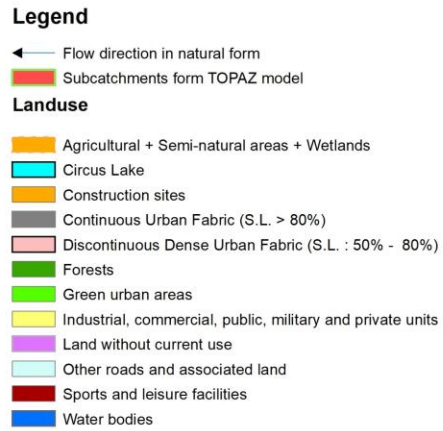


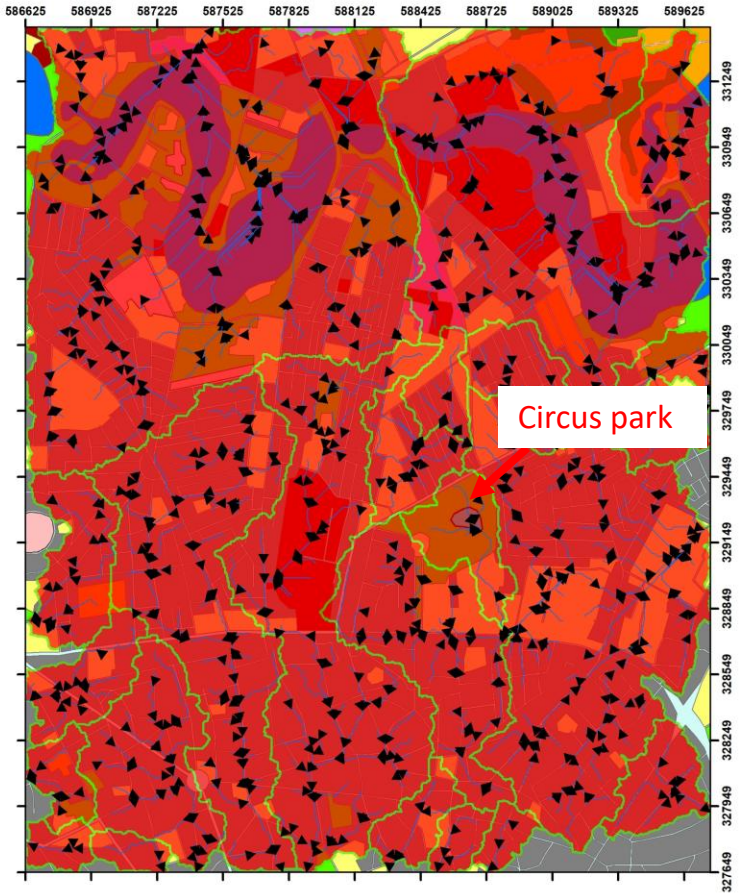


Flow direction and delineating Subbasins

- The modelling process started running the TOpographic PArameteriZation (TOPAZ) model as part of Watershed Modelling System (WMS by Aquaevo) to calculate runoff flow direction, then delineating subbasins.

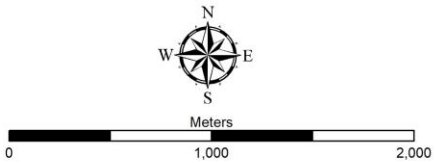


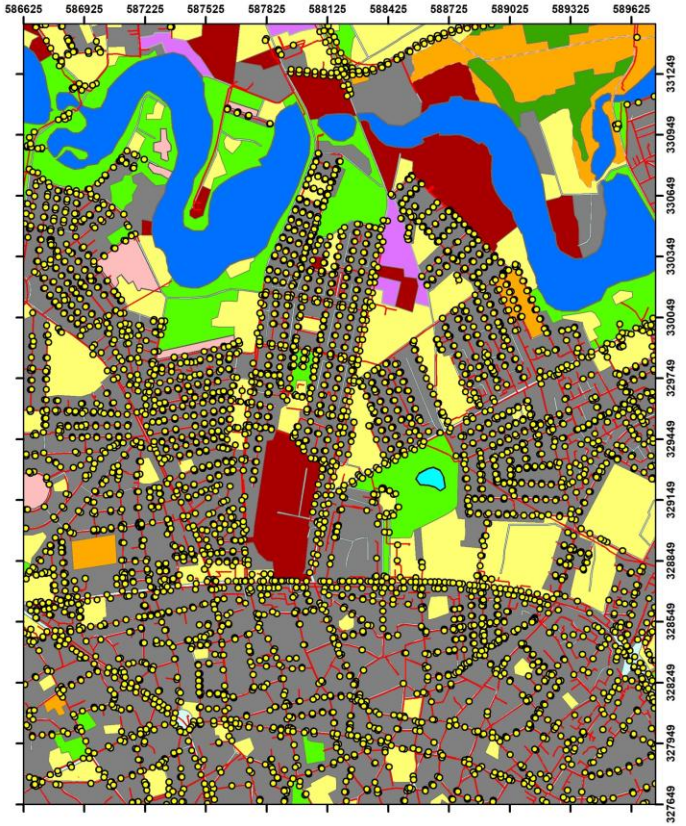


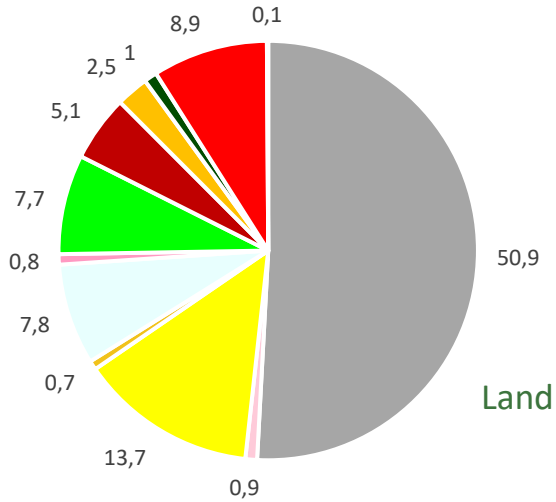


Running Storm Water Management Model (SWMM) for the entire study area

- In the urban area, the subcatcments delineation done according to the landuse file as the runoff is not following the natural flow direction. Each landuse demonstrates a subcatchment.
- The model simulated surface runoff and runoff in the sewer system (11 types landuse)
- 4097 inlets, 604 subbasins according to the landuse
- Infiltration method Green-Ampt (K=4.97 cm/h, effective porosity 0.12)







Land use percentage of entire area (12 km^2)

- Continuous Urban Fabric (S.L. > 80%)
- Discontinuous Dense Urban Fabric (S.L. : 50% - 80%)
- Industrial, commercial, public, military and private units
- Construction sites
- Other roads and associated land
- Land without current use
- Green urban areas
- Sports and leisure facilities
- Agricultural + Semi-natural areas + Wetlands
- Forests
- Water bodies
- Circus Lake

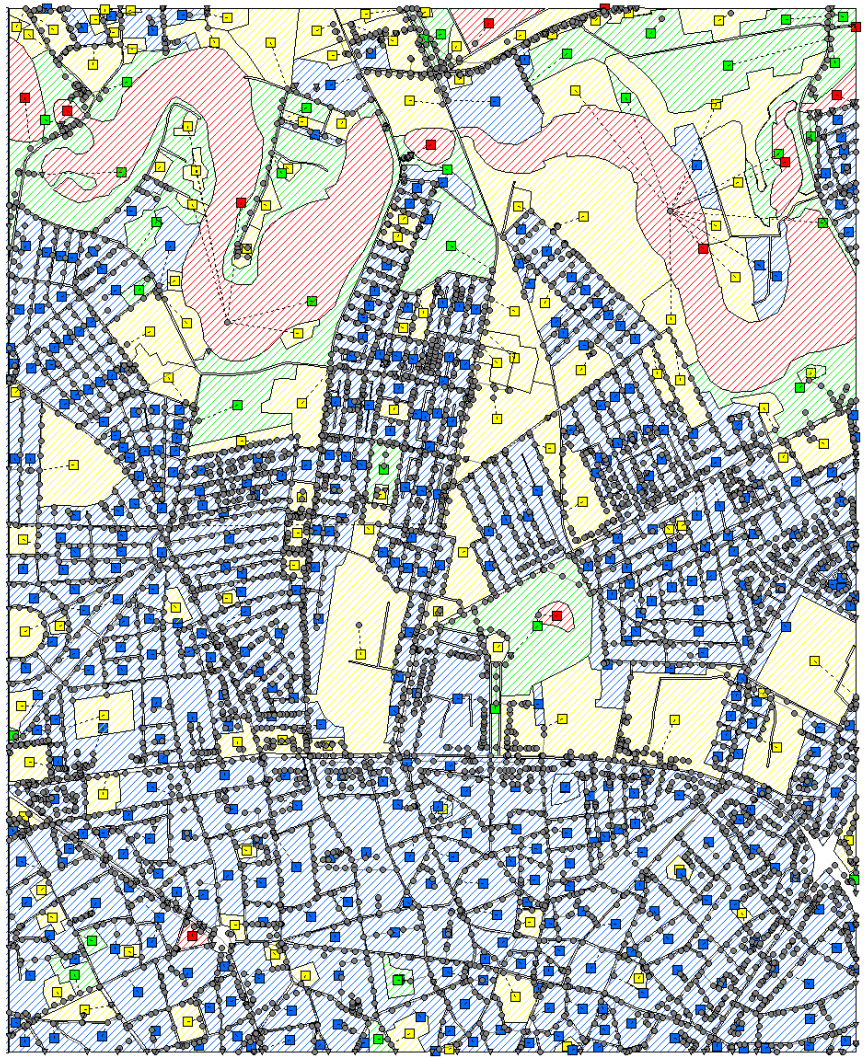
Scenarios

- **SC1: Doing nothing (Business As Usual)**
- **SC2. Decreasing imperviousness in industrial areas from 77.8 to 69% by converting them to leisure areas**
- **SC3. Implementation of NbSs in the green spaces and water catchment areas supplying the NbSs**

❖ The imperviousness is based on the SCS curve number by EPA.

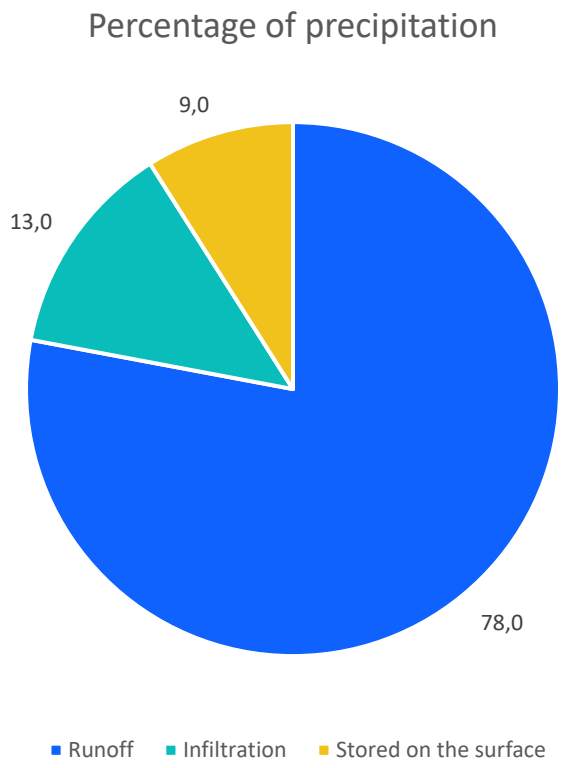
Land use map according to imperviousness

- Green areas (25% imperviousness)
- Industrial area (69 – 77.8 % imperviousness)
- Water bodies
- Residential area (98.3 % imperviousness)



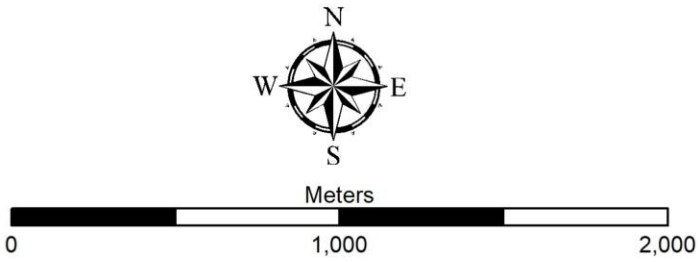
The results of Scenario 1

- As mentioned before, this is the current situation without any change in land use.
- The table provides the detailed numerical values for each parameter for 2018.
- The pie chart demonstrates infiltration, runoff, and stored water in the surface.
- The difference between the runoff volume entering and exiting the sewer network is due to surcharging at the inlets.

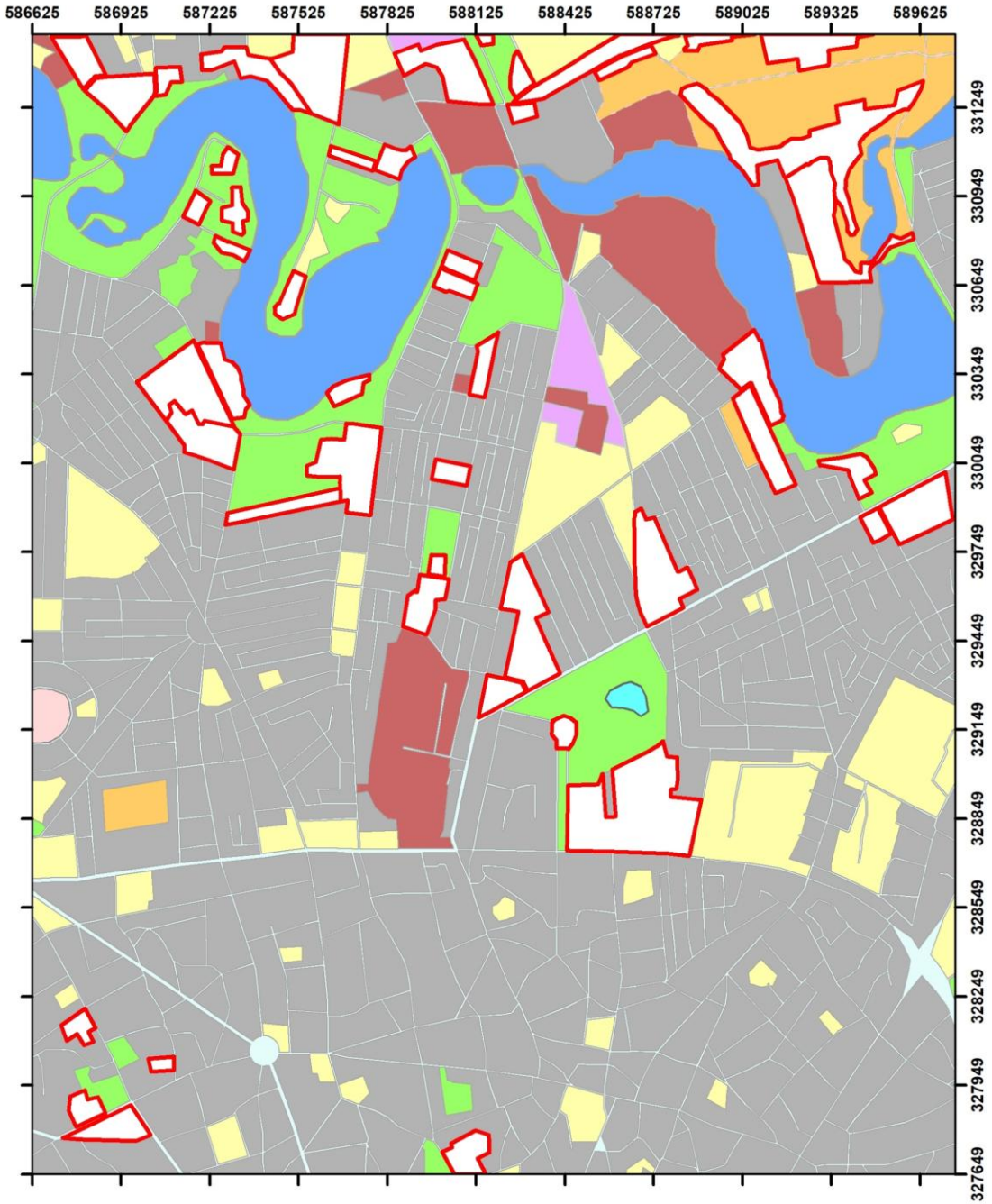


Unit	Precipitation	Infiltration	Surface Runoff	Runoff enters sewer system	Runoff exits from system
Cubic meter/year	7 923 910	1 034 040	6 177 150	6 176 640	5 066 970
l/s	251.3	32.8	195.9	195.9	160.7

Scenario 2

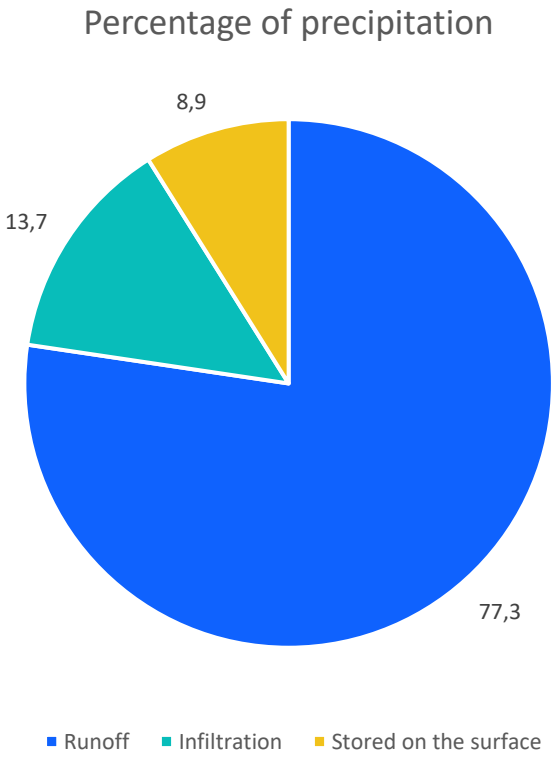


1.04 km^2 of the industrial area (1.64 km^2) is converted to leisure areas **(about 69 % of the industrial area)**.



The results of Scenario 2

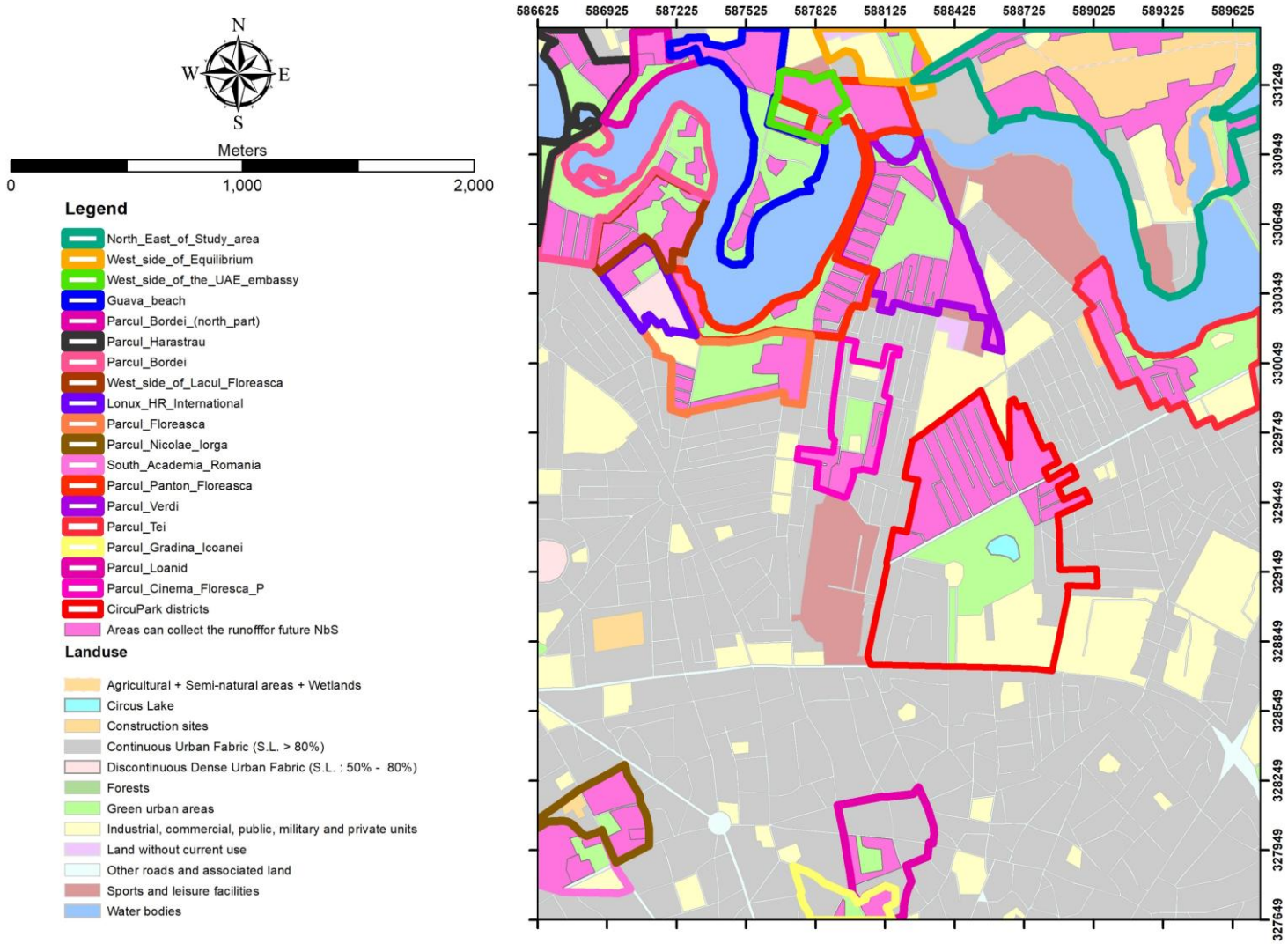
- The industrial areas around the green spaces turn into a leisure area (69 percent of the industrial area)
- The table provides the detailed numerical values for each parameter for 2018.
- The pie chart demonstrates infiltration, runoff, and stored water in the surface.
- The difference between the runoff volume entering and exiting the sewer network is due to surcharging at the inlets.



Unit	Precipitation	Infiltration	Surface Runoff	Runoff enters sewer system	Runoff exits from system
Cubic meter/year	7 923 910	1 088 900	6 128 850	6 128 310	5 029 840
l/s	251.3	34.5	194.3	194.3	159.5

Scenario 3. Implementation of NbSs in the green spaces and water catchment areas supplying the NbSs

- The 19 green spaces have been chosen.
- The concept assumes that flow follows gravity, By overlapping this map with flow direction, eliminating the need for pumping; therefore, the the hypothetical areas (totally 3.68 km^2) that total amount of rainfall that could be collected could be suitable to implement NbSs are from these areas-filled in pink color, was considered (the areas are bordered by calculated (**1.65 km^2**). colored polygons).



The results of Scenario 3

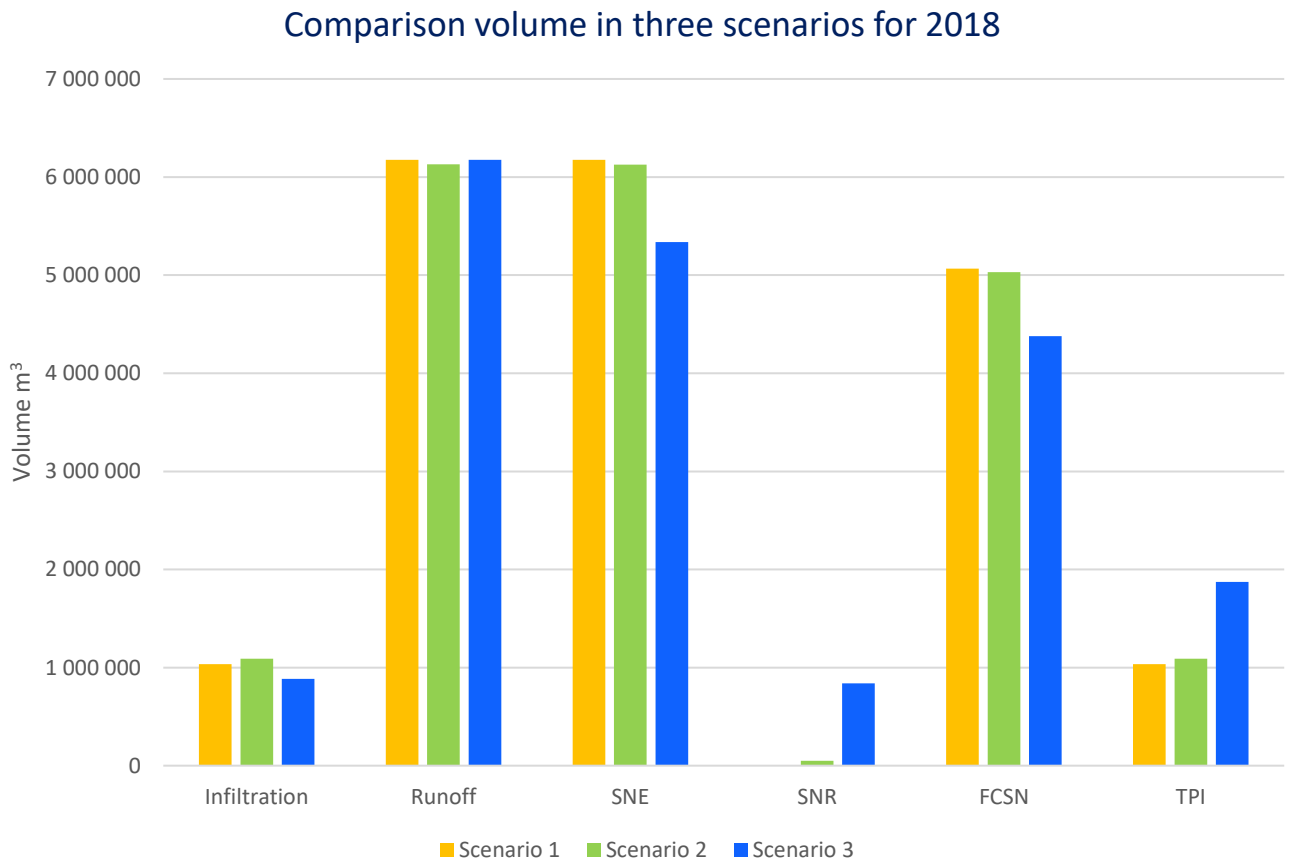
- The neighborhood areas near green spaces can collect 839,760 m ^{3} of runoff via gravity, leading to a reduction in the total runoff entering the sewer network.
- The total infiltration from these areas is 148,947 m³, which, in Scenario 3, could be collected for future NbSs.
- The total area of locations that can be considered as supplying runoff to NbSs is 1.65 km², including 0.85 km² of residential area and 0.79 km² of industrial area.
- The difference between the runoff volume entering and exiting the sewer network is due to surcharging at the inlets.

Unit	Precipitation volume	Infiltration volume	Surface Runoff	Runoff enters sewer system	Runoff Exits sewer System
Cubic meter/year	7,923,910	885,093	6,177,150	5,337,390	4,376,790
l/s	251.3	28	195.9	169.2	138.8

Comparison

Parameter		Scenario 1	Scenario 2	Scenario 3
Infiltration in the urban area	m^3/year	1 034 040	1 088 900	885 093 / 1 034 040
	l/s	32.8	34.5	28/ 32.8
Runoff	m^3/year	6 177 150	6 128 850	6 177 150
	l/s	195.9	194.3	195.9
SNE	m^3/year	6 176 640	6 128 310	5 337 390
	l/s	195.9	194.3	169.2
SNR	m^3/year	0	48,330	839,760
	l/s	0	1.6	26.6
FCSN	m^3/year	5 066 970	5 029 840	4 376 790
	l/s	160.7	159.5	138.8
Total Infiltration	m^3/year	1 034 040	1 088 900	1 724 853/ 1 873 800
	l/s	32.8	34.5	54.6 / 59.4

SNE-sewage network entrance
SNR-sewage network relief
FCSN-finally collected by the sewage network



SNE- Sewage Network Entrance
SNR- Sewage Network Relief
FCSN- Finally Collected by the Sewage Network
TPI – Total Potential Infiltration

Conclusion

- **Scenario 2 (conversion of industrial areas into leisure areas):**
  - Infiltration increases by ~5%
  - Surface runoff and flows entering the sewer system decrease by <1%
- **Scenario 3 (Implementing NbS):**
  - Total infiltration increases significantly by ~67–81%
  - Water entering and stressing the sewer network decreases by ~13–14%, reducing system load
  - Flow conditions improve, with better distribution and less pressure during peak events