



Urban water management scenarios ranked

Deliverable 5.5



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EXECUTIVE SUMMARY

This deliverable focuses on the work done to rank the urban stormwater management scenarios generated by the Planning Platform, in terms of costs and co-benefits. The modular tools of the Planning Platform can be used individually to produce specific outputs or can be used within extended workflows to generate urban stormwater management scenarios.

Section 1 – Scenario workflow presents the two workflows applied to the MULTISOURCE municipalities. The Hydraulic data approach was applied to the Ecully catchment in the Greater Lyon area. This workflow uses the Hydraulic Disconnection Module (HDM) output from INSA (WP5) to generate and evaluate urban stormwater management scenarios with centralised/decentralised and NBS/grey solutions. For the other MULTISOURCE municipalities, a data-reduced workflow was set up based only on open data since the HDM model requires monitored data of the Combined Sewer Overflow (CSO), which is not always performed or publicly available. Thus, the data-reduced approach with only open data was applied to Girona, Oslo and the Metropolitan City of Milano (CMM).

Section 2 - Scenario evaluation focuses on the methodologies developed for the ranking of urban stormwater management scenarios in the Ecully catchment, Greater Lyon. The analysis for the cost module was carried out using detailed cost data for NBS projects from IRIDRA (WP1). Co-benefit values such as biodiversity, social benefits and circularity were obtained from the Nat4Wat tool developed by ICRA (WP4). The life cycle cost assessment of the scenarios was conducted by INRAE (WP4).

Section 3 - Planning platform application to other municipalities, presents the results of the data-reduced workflow applied to the other MULTISOURCE municipalities: Girona, Oslo and two municipalities for CMM. The evaluation and ranking of scenarios regarding costs and co-benefits is illustrated for each city. The section afterwards reports on the workshops with the international partners from Vientam (HCMUT) and Brasil (UFSC), with whom the potential of the Planning Platform application for their context was discussed in connection with business models (WP3).

Finally, the Planning Platform's long-term impact and how the modules' further development in GitLab will contribute to future projects are illustrated.

1 SCENARIO WORKFLOW

This paragraph presents the structure of the Planning Platform and the workflows applied to evaluate the scenarios for urban stormwater management conducted together with individual municipalities and metropolitan cities.

1.1 Stormwater Management Planning

The Planning Platform can assist municipalities, water companies, or practitioners implementing nature-based solutions in cities. The environmental constraints are evaluated based on the urban area features, while total project costs are considered in relation to the space available for implementation and the size required to handle design storms. Following traditional stormwater practice, the corresponding grey alternative is developed as an additional scenario and confronted with the scenario utilising Nature Based Solutions (NBS) for water storage and reuse. Assessing co-benefits and impacts, such as life-cycle assessment (LCA), the NAT4WAT tool supports informed decision-making by offering a broader, integrated perspective, which is essential for modern planning, extending beyond a pure monetary comparison. The Planning Platform brings together all these modules in a comprehensive framework, allowing them to be combined and tailored to specific applications and case studies, depending on data availability. This concept is further detailed below.

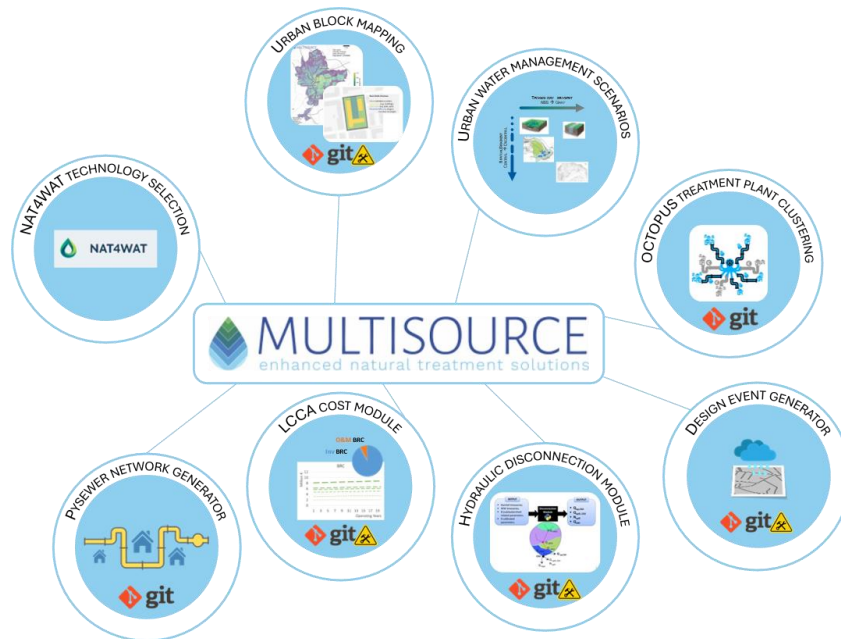


Figure 1.1: Planning Platform tools

The modules of the Planning Platform can be used individually or in a defined workflow. Primarily to facilitate NBS implementation in urban areas, two main workflows are explained in the following paragraphs. The choice of one workflow over the other mainly depends upon the intended strategy and data availability. The workflow for decentralised planning follows a data-reduced approach, which can be conducted through open data. The workflow, including centralised planning at the outlet of the urban catchment, requires a hydraulic modelling approach with additional data for calibration. An exemplary scheme of the two workflows is reported below.

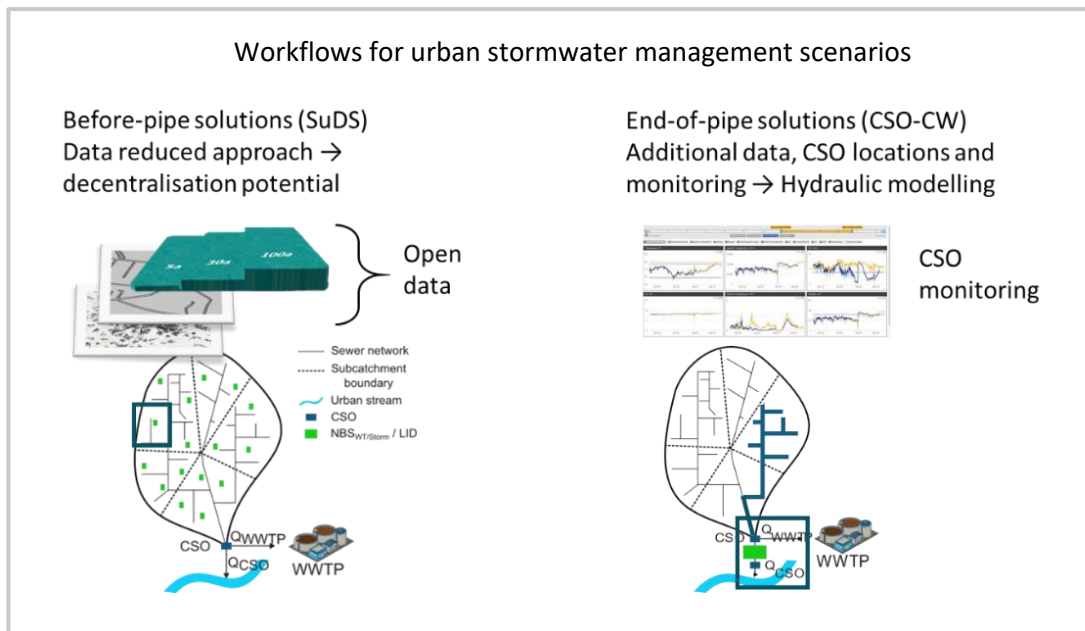


Figure 2.2: Scheme showing the two workflows for urban stormwater management scenarios, dependent on the detail of data availability.

1.2 Data-reduced approach – Decentralised Planning

The data-reduced approach can be automatically applied to cities, as it requires the use of only open data. This workflow uses the **Design-event generator** (Fig. 1.1) and the **Block-mapping tool** (Fig. 1.1) to derive the urban blocks and compute metrics for implementing potential NBS based on the available open area and street network. Also, given the high level of urban sealing, Sentinel-2 data on urban greenery from the Copernicus Services (Zha et al., 2003) have been integrated to improve the identification of connected green areas. The primary outputs of these two tools are automated routines for sizing NBS based on runoff generated from impervious surfaces and the available green area. Additionally, for each urban block, they assess the potential for decentralisation (see Section 2.2), offering a ranking of locations. The decentralisation potential indicates the percentage of water retention that each block contributes within the broader urban catchment, helping to identify the most impactful areas for intervention. This workflow can be applied to cities interested in assessing whether there is enough space to implement decentralised NBS. **The Urban Water Management Scenario** (Fig. 1.1) compares the decentralised NBS technology, e.g. bio-retention cell, and the corresponding grey alternative, e.g. infiltration shafts. Both decentralised scenarios exclude pollution from road runoff since they assume local retention and reuse/infiltration of impervious runoff within urban blocks. These scenarios are compared with the objective of retaining a design storm with a 100-year return period (**Design-event generator**, Fig. 1.1). This data-reduced approach is applied to the municipalities of Girona and Oslo, as well as the suburban area of the metropolitan city of Milan.

1.3 Hydraulic Data approach – Centralised Planning

The workflow for centralised planning involves estimates of the spill volumes at the combined sewer overflow, which requires a hydraulic sewer system model. This workflow is used for the Ecully catchment in the metropolitan area of Lyon, which employs the results in output from the **Hydraulic Disconnection Model (HDM)** (Fig. 1.1) from INSA. The HDM model requires time series of combined sewer overflow (CSO) observations to calibrate the parameters of the hydraulic sewer system model. The monitoring of

CSO, although always more demanded by regulation for pollutant controls in water bodies, is not always set, or hasn't been done in a long time, making this dataset difficult to integrate into the analysis. Although the developed **pySewer Network Generator** (Fig. 1.1) assists in determining where sewer lines could be located within the urban environment, and it can be coupled with pySWMM (McDonnell et al., 2020) to simulate CSO, these hydraulic models also require calibration for parameters that cannot be estimated by open data (e.g. diameter of pipes). The hydraulic models are necessary to estimate the resilience of the sewer system following an extreme design storm, e.g. with 100 years return period, identify overflows when the capacity of the sewer is exceeded, and determine the sizing of centralised NBS to retain spill volumes directly at the outflow of the sewer system. With the simulated CSO spill, the **Urban Water Management Scenario** (Fig. 1.1) computes the centralised scenario with a CSO-Constructed Wetland for the NBS scenario and a retention treatment basin (RTB), also known as a CSO tank for the grey corresponding alternative. The results of this workflow for Ecully, Lyon, are reported in *D5.3 Urban Water Management Scenarios*.

2 SCENARIO EVALUATION

This paragraph presents the detailed analysis to derive the ranking of the urban stormwater management scenarios for the Ecully catchment, according to project total costs and further benefits such as environmental impacts and ecosystem benefits.

2.1 Ecully, Lyon metropolitan area

Four urban stormwater management scenarios were evaluated for the Ecully catchment in the Lyon metropolitan area: NBS/grey and decentralised/centralised. A greater detail of each scenario, namely the sized technologies for several design storms and spatial distribution, are reported in *D5.3 Urban Water Management Scenarios*.

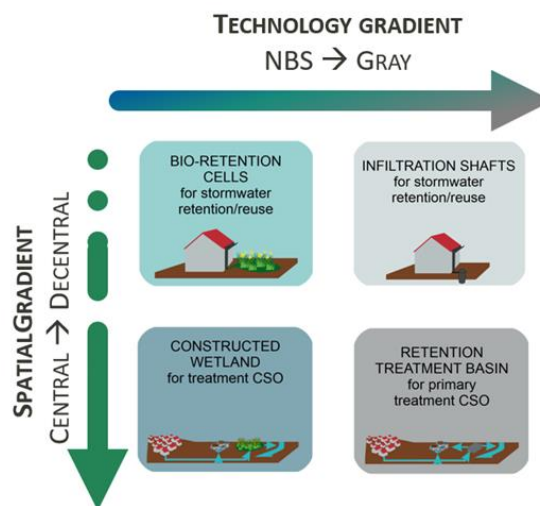


Figure 2.1: The four scenarios for urban stormwater management along the spatial and technological gradient.

The results of each scenario, in the form of tables, will not be reported again here. Within this deliverable will be illustrated the metrics to evaluate the decentralisation potential of the urban catchment, which is also applied to the other municipalities with the data-reduced approach, and the association of total project costs, life cycle assessment (LCA) and co-benefits scores from the Nat4Wat tool.

2.2 Decentralisation Potential

The decentralisation potential is an indicator to express which % of the impervious runoff can be retained within the urban catchment. First, a retention potential (%) has been developed to express the percentage of impervious runoff from A_{seal} that can be retained within the A_{nbs} potential area (m^2) for reuse or infiltration within the single block (Lipperera et al., 2024).

$$R_p(\%) = \frac{A_{nbs} (h_{techn} - h_{rain})}{A_{seal} h_{rain}} 100$$

The technology has a water retention capacity equivalent to 0.516 m of accumulated rainfall during high-intensity storms, based on the infrastructure's design for the bio-retention cell (D5.3 Urban Water Management Scenarios). The retention percentage ($R_p\%$) indicates whether the system can capture all or only part of the runoff from the impervious surfaces within the block (Fig. 2.2).

- If the total runoff from impervious surfaces is less than the system's capacity within the designated NBS area, it will store 100% of the impervious runoff, with additional unused storage remaining ($> 100\%$);
- If the system's capacity is lower than the generated runoff, only a portion (e.g., 75%) will be retained, while the excess (e.g., 25%) will overflow into the sewer system.

Thus, the indicator tells us whether the available NBS area is sufficient to retain local runoff, given the extreme events and the design parameters of the technology.

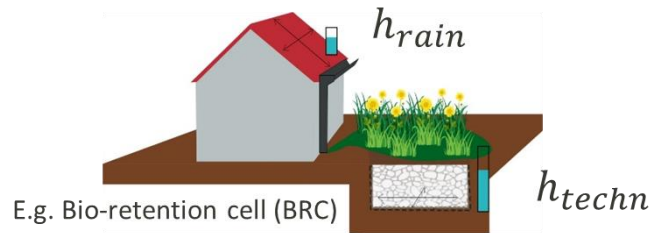


Figure 2.2: Illustration of the parameters determining each block's Retention Potential R_p (%).

This indicator is computed automatically for each block. To know how much effect the retention potential of the single block has on the overall urban catchment, another indicator called Decentralisation Potential (%) has been developed to identify which block would contribute most to retaining the impervious runoff of the whole catchment, roads excluded (Lipperera et al., 2024).

$$D_p(\%) = \frac{\min\left(A_{seal,n}, A_{nbs,n} \frac{h_{techn} - h_{rain}}{h_{rain}}\right)}{\sum_n A_{seal,n}} 100$$

With $A_{seal,n}$ and $A_{nbs,n}$ representing the relative areas of the block n in the urban catchment, this indicator identifies priority blocks for decentralised NBS interventions in urban catchments.

For example, the block in the northern part of the Ecully catchment has high sealed area, and this makes the block retaining up to 10% of the total impervious runoff of the urban catchment excluding roads up to 35 mm of rainfall, corresponding to a design storm with return period of 5 years (Fig. 2.3). As rainfall depth increases (>35 mm), the decentralised bio-retention cell would reach its maximum capacity, given the limited extension of A_{nbs} , and the contribution of the block in retaining the 10% of the total urban catchment runoff would decline (Fig. 2.3).

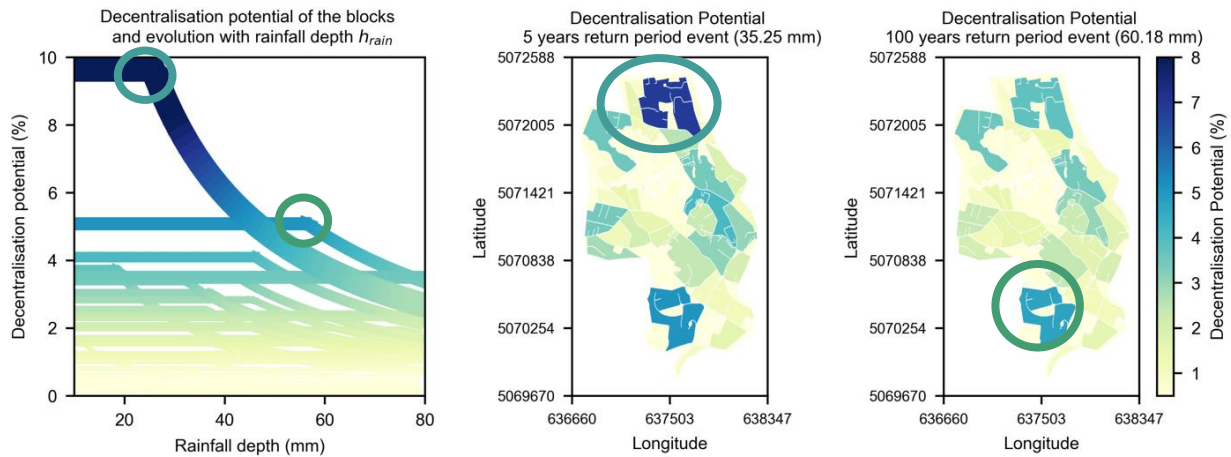


Figure 2.3: Decentralisation potential D_p (%) of the blocks in the Ecully catchment. Each line represents a block with the width of the line proportional to the sealed area. On the right side are reported the maps, showing the D_p (%) of the blocks for the rainfalls depths of 35 mm and 60 mm. The circles show which blocks has the highest D_p (%) for the moderate-high and extreme rain event (Lipperera et al., 2025).

With higher mm depth of rainfall, other blocks with larger NBS potential areas are more stable in retaining a portion of the total urban catchment impervious runoff. The southern block, for a 60 mm rainfall, corresponding to a design storm with a return period of 100 years for the Ecully catchment, can still retain around 5% of the impervious runoff of the urban catchment. Therefore, NBS intervention priority depends not only on the environmental constraints of the urban catchment but also on the selected design storm and rainfall depth. These findings are reported for a constant water accumulation depth (h_{techn}) per block, assuming the implementation of the same bio-retention cell, although different technologies with different depths of the storage layers could enhance retention at specific locations. By summing the single D_p (%), the total decentralisation potential reflects the total impervious runoff (excluding roads) that can be retained within the urban catchment through NBS decentralised interventions, reducing sewer overflow and flood risks.

2.3 Life Cycle Cost Assessment (LCCA)

Life Cycle Cost Analysis (LCCA) is an economic assessment tool used in the planning, design, construction, operation and maintenance of infrastructure projects. It helps decision-makers evaluate the total cost of a project over its entire lifetime, all discounted at present value, rather than focusing solely on the initial capital cost. The calculations are based on the assumption that the reference point for all discounted infrastructure project costs is the beginning of the first year of operations, referred to as year zero. The analysis does not account for future real price changes. Still, it is consistent with the recommended practice of conducting a comparative analysis first without incorporating price increases for running costs or reinvestment (DWA, 2011).

A database was gathered from IRIDRA for the initial investment costs and the following running costs of NBS, comparable to the construction, operation and maintenance (O&M) costs. The database contains a detailed list of project cost items, design parameters for the realised constructed wetlands specific to CSO, and project cost items for the interventions with bio-retention cells. Costs associated with land acquisition were excluded from this evaluation, as well as costs for monitoring equipment. Since the projects from IRIDRA spanned from 7 interventions for constructed wetland for CSO designed from 2015 to 2023, and 8 bio-retention cells interventions designed from 2018 to 2024, the historical cost data were normalised to the reference year 2023, using the method of the consumer price index (CPI) (Lipperera et al., 2025). Costs have been converted using the Italian harmonised consumer price index (HICPs)

(<https://data.ecb.europa.eu/data/datasets/ICP/ICP.M.IT.N.000000.4.INX>). After the cost correction to align prices to the same reference year, cost functions were fitted for the total construction and O&M costs based on the volume capacity the NBS infrastructure could retain (m^3). Finally, new estimated construction and O&M costs were derived for the sized infrastructure of the scenarios for the Ecully catchment (Lipperera et al., 2025). For the O&M of the bio-retention cells, a parametric cost was considered, as advised by IRIDRA.

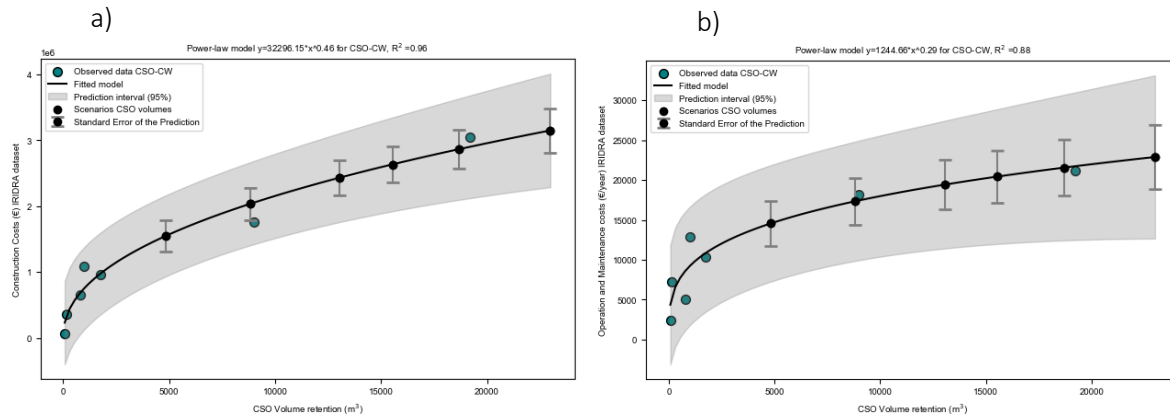


Figure 2.4: Costs functions for construction costs (a) and operation and maintenance costs (b) of constructed wetlands for CSO (CSO-CW) retention and pre-treatment, fitted from observation data from the IRIDRA dataset (Lipperera et al., 2025).

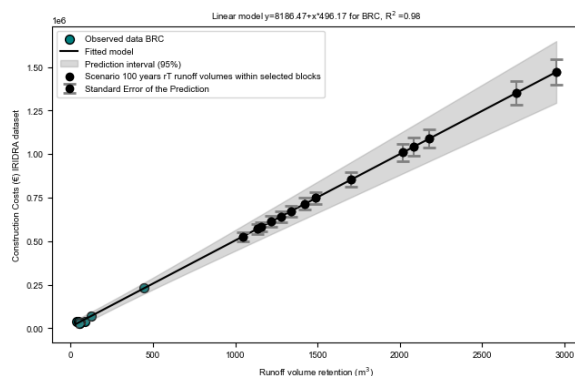


Figure 2.5: Costs function for construction costs of bio-retention cells (BRC) for the retention of stormwater runoff, fitted from observation data from the IRIDRA dataset (Lipperera et al., 2025).

After evaluating the total construction costs and O&M costs for the constructed wetland for CSO (CSO-CW) and bio-retention cells (BRC) having different sizing to contain large volumes of stormwater runoff and CSO spill for the different design storms, the total project costs at present value (PCPV) are calculated for each technological scenario and corresponding sizing for the design storm.

The total present value of future O&M costs is evaluated through a discounting factor for a uniform series of annual expenses. This factor, known as DFACS (Discounting Factor for a Uniform Series), allows the stream of equal yearly O&M costs for the 20-year lifespan to be converted into a single present value equivalent, given the interest rate. The PCPV have all the investment costs occurring at point 0, and all future costs for O&M are discounted to their present value at the start of the project. The formulations for the cost module are explained in Khurelbaatar et al. (2021).

Below are reported the Project costs at present values for the scenarios with the constructed wetland for CSO and for the bio-retention cells BRC, sized to handle the volumes of CSO and stormwater runoff (m^3) for the different design storms from 5 to 100-year return period. The error bar associated with each infrastructure's total costs, derived from fitting the cost function, is well visible in the graphs.

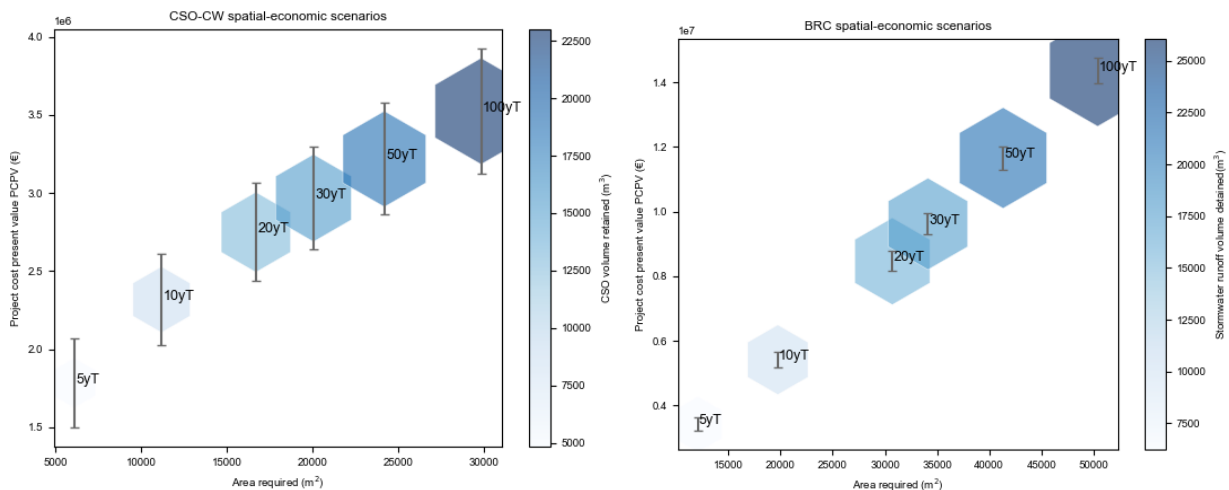


Figure 2.6: Project costs at present values PCPV (€) estimated for constructed wetlands for CSO retention and pre-treatment, and for the bio-retention cells for stormwater runoff retention (b) in the Ecully Catchment. The infrastructures are sized based on the design storm from 5 to 100-year return period, for which the target volume to retain (m^3) is reported in the graph. The error bar refers to the error associated with the total costs (Lipperera et al., 2025).

For the grey technologies, after talking with experts in the construction sector, it was concluded that parametric costs should be used. For the infiltration shafts in concrete, a parametric cost of 800 €/m³ from the Regional Regulation for Hydraulic Invariance (2019) was considered, assuming 1% of the investment cost for each year of operation and maintenance (O&M). For the retention treatment basin (RTB), the parametric cost equal to 2500 €/m³ for a CSO tank >20 m³/ha was taken from Quaranta et al. (2022). A summary of the total project costs at present value (PCPV) for each scenarios technology is reported in Fig. 2.7.

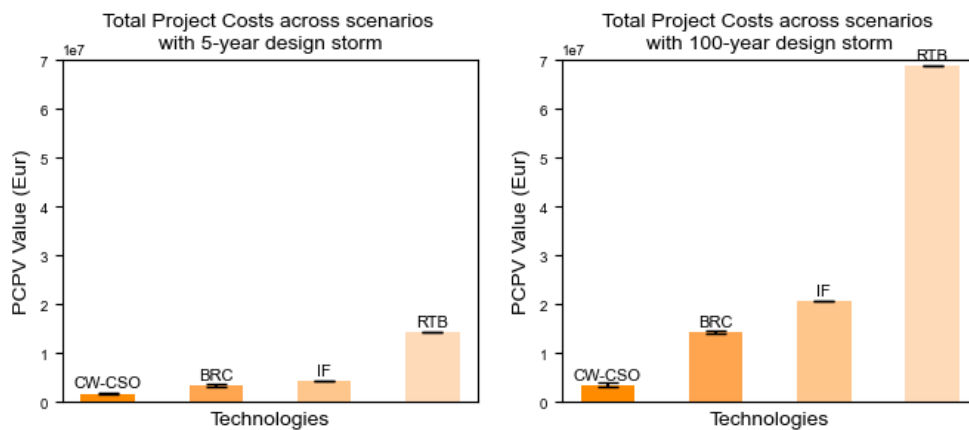


Figure 2.7: Project costs at present values PCPV (€) for the scenarios technologies sized for a 5-year and 100-year design storm for Ecully catchment, Lyon.

2.4 Nat4Wat scores – Co-benefits

The Nat4Wat scores have been linked to the scenarios for the Ecully catchment. By querying the Nat4Wat tool with the available space and the amount of rainfall, it is possible to get the suggested technologies from the tool with the relative scores. Also, for the centralised solution, given the available space and the CSO volume for the design storms, it is possible to get the recommended centralised technologies with

relative scores. Giving as input the parameters of the block with the highest decentralisation potential in the Ecully catchment, the cumulated rainfall of 35.25 mm for the 5-year return period and querying the Nat4Wat to find the NBS technology to implement within the largest connected area of the block, the selected NBS from the Nat4Wat tool with the relative co-benefits are the following (Table 1.1).

Table 1.1 Selected NBS for rainfall retention from Nat4Wat tool for a single block with BS_BS=Bioretention swale (or trench), DB_DB=detention basin, IS_IBa=infiltration_basin, PO_PO=pond, PO_PR=pond retrofits, BS_RG=rain garden and BS_RP= raised planter.

Technology id	Enough area	Surface avg (m ²)	Estimated capex mean	Biodiversity score	SocialBenefits score	Circularity score
BS_BS	TRUE	21119.27	2761344.12	0.67	0.67	0.11
DB_DB	TRUE	2430.87	184746.17	1.00	1.00	0.22
IS_IBa	TRUE	3068.20	199433.28	0.67	0.67	0.00
PO_PO	TRUE	3329.96	227103.26	1.00	1.00	0.22
PO_PR	TRUE	3329.96	374354.09	1.00	1.00	0.33
BS_RG	TRUE	23633.47	2434246.91	0.56	0.67	0.11
BS_RP	FALSE	33086.85	327228.96	0.67	0.83	0.56

It should be noted that the greater surface required from the Nat4Wat tool is due to the depth of the technologies, for example, 0.25 m for rain gardens (BS_RG). In comparison, the bio-retention cells implemented in the **Planning Platform's Urban Water Management Scenario** have a depth of 1.5 m.

In the case of the centralised scenario, for the design storm with a 5-year return period, the total spill volume of the event is 4832 m³. The parameter of the Nat4Wat requires 'spilledVolume' as the total CSO spill volume in one year, and the sizing of the constructed wetland is done by satisfying the hydraulic loading rate of HLR = 45 – 60 m³/m²/year. Given the different criteria in sizing, only the co-benefits scores are shown.

Table 1.1 Selected NBS for CSO spill treatment from Nat4Wat tool for single block, with A_FWS=Aerated + free water surface wetland, CSO_ATW=Aerated treatment wetland for CSO and CSO_CW=Treatment Wetland for CSO.

Technology id	Biodiversity score	SocialBenefits score	Circularity score	Removal performance
A_FWS	0.56	0.28	0.56	0.78
CSO_ATW	0.33	0.11	0.58	0.78
CSO_CW	0.33	0.11	0.57	0.61

The user should remember that the Urban Water Management Scenario technologies might have different parameters (which could be further specified by the user) compared to the design parameters of the technologies implemented within the Nat4WAT tool for the specific technologies. Also, in the **LCCA Cost Module** of the Planning Platform, cost functions are used to account for the scaling effects of the technologies. Project costs are estimated over the project's lifetime, accounting for operation and maintenance, re-occurring costs and interest rates. The Nat4Wat instead returns the estimated mean CAPEX from WP3 for the selected technologies.

Comparing the co-benefits scores from the NAT4Wat tool for the scenarios developed for the Ecully Catchment shows that decentralised NBS such as BS_RG have higher biodiversity and social benefits. In contrast, the CSO-CW has higher circularity.

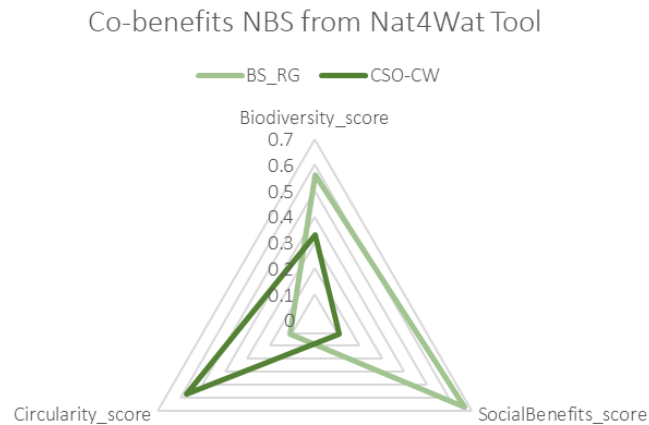


Figure 2.4: Radar graph with the co-benefits from the Nat4Wat tool for the technologies implemented in the Planning Platform.

For the infiltration shafts in the following Section 3, the biodiversity score has been considered equal to zero. The social benefit has been considered at 0.29, given the maximum performance in flood mitigation and the indirect contribution in temperature regulation in the urban environment through the water infiltration into the ground, which might keep the soil moister.

The circularity score for the infiltration shaft is 0.10, similar to the rain garden since pathogens can be found in harvested roof water, but a part is removed with the fine sediments filtrated within the gravel layer of the shaft, while no BOD is present in the influent water.

2.5 Life Cycle Assessment

In order for INRAE to run the Life Cycle Assessment (LCA) of the urban stormwater management scenarios developed for the Ecully catchment, hypotheses were made on the NBS and grey technologies used in the scenarios (see Appendix). INRAE used the Environmental Footprint (EF) 3.1 characterisation method. For the green-centralised scenario, the modelling hypothesis was based on the French Vertical Flow Wetland from Dufossé et al. (2025). However, the surrounding infrastructures (inferring and deferring canals, technical building, etc.) and surrounding weddings were not accounted for since there was no information on the surrounding infrastructure from the scenario. Also, all the emissions to the air, water, and soil linked to the operation of the filters and the spreading of sludge were not accounted for since detailed information was not available. Only technology construction, maintenance and dismantlement were considered for the green decentralised scenario with bio-retention cells (BRC), infiltration shafts (IF) and retention treatment basin (RTB). Considering these computed scenarios for decision-making in a pre-feasibility phase and not having appointed the construction site and related company to undertake the works, the same hypothesis for the sites in Ecully was assumed as the French VF wetland for the material distances and origins, the material end-of-life, and the building team and engines.

The modelling hypothesis and results of technologies were adapted to the sized infrastructures in the scenarios for the design storm with a 5-year return period and a 100-year return period. No assumptions were made about the water quality and the biological activities that could happen in the different structures. All Life Cycle Assessment (LCA) results are expressed in percentage (%) for each impact category as shown in Fig. 2.5 and 2.6. These values are derived from a contribution analysis according to the impacts across different life cycle stages, from the construction to the end-of-life and the operation and maintenance stages. All results are expressed per functional unit (FU), providing a common basis for comparison. The percentages represent the relative impact within each category. For each category, the technology with the highest absolute impact is set to 100%. The impacts of the other technologies are

then expressed as a percentage of this maximum value. This method normalises the data, making comparing technologies across different impact categories easier.

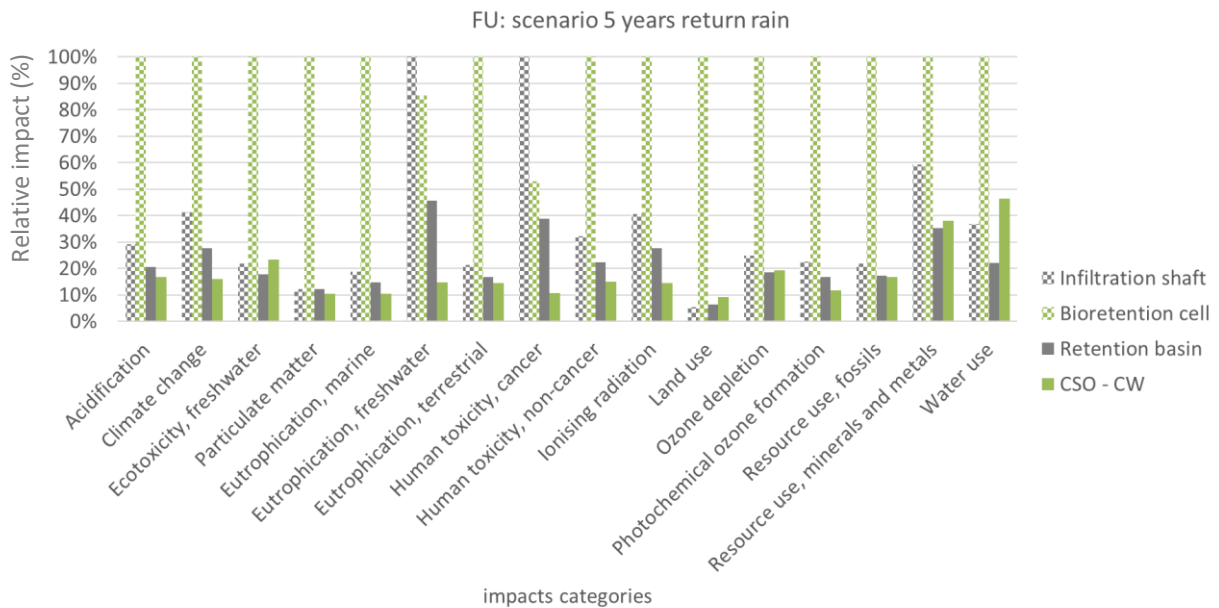


Figure 2.5: Functional units and impact categories for the four technological scenarios sized for a design storm with 5-year return period.

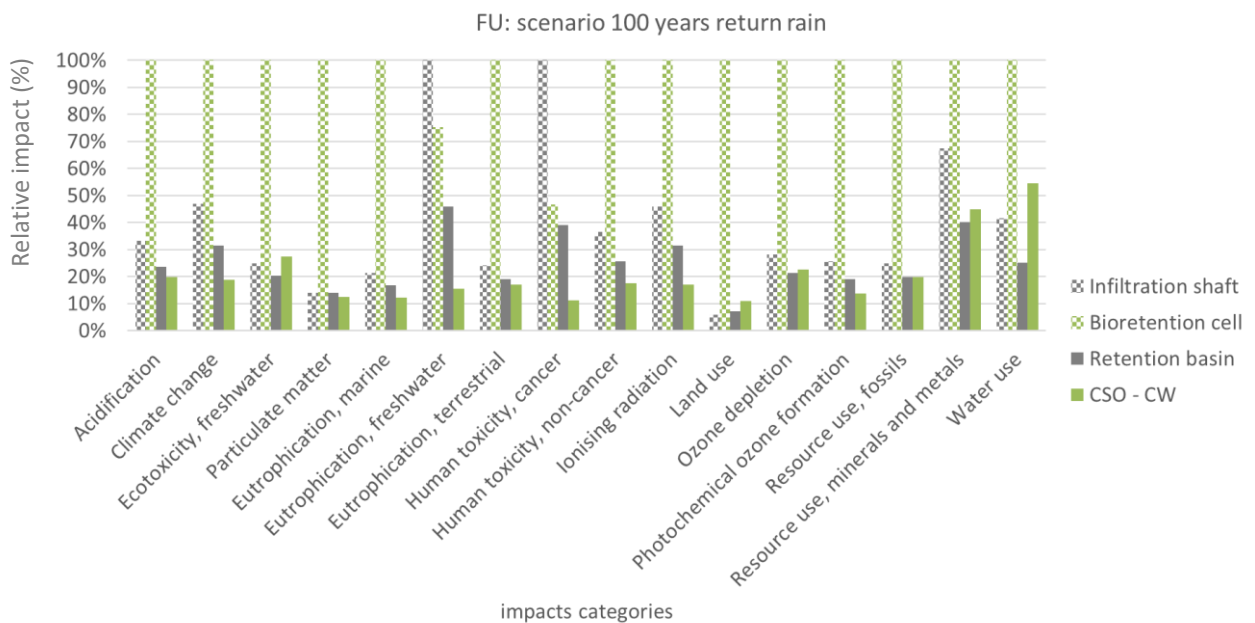


Figure 2.6: Functional units and impact categories for the four technological scenarios sized for a design storm with a 100-year return period.

For Bioretention Cells (BRCs), the main contributors to environmental impacts across all categories are the materials used for construction and maintenance, primarily the gravels that fill the storage layer. In the case of infiltration shafts, the key impact drivers are the concrete walls and the galvanised steel used for the grid. The relative graphs of the single contribution in the impact categories for each technology are reported in the Appendix. When comparing the technologies under both 5-year and 100-year return period design storms, the trends remain consistent: centralised solutions outperform decentralised ones, requiring less surface area to achieve the same functionality.

Among the centralised options, the green infrastructure solution (CSO-CW) performs significantly better in 10 out of 16 impact categories. In contrast, the grey infrastructure solution shows lower environmental impacts in 3 categories. Overall, in the scenarios, bioretention cells emerge as the least favourable option from an environmental impact perspective due to the extended area required and the use of gravel for construction and refurbishment. It should be considered, however, that in the developed scenarios, the bio-retention cells have one meter depth storage filled with gravel. It is not excluded that bio-retention cells with a less impactful design could be used in future scenarios. It is important to remember that no emissions to air and soil due to biological activity within the filters were considered in the LCA, nor were the quality of the water released into nature. These conclusions should be complemented with more in-depth studies considering input water quality, biological activity, and physicochemical transformations within the technology to estimate emissions from air, sludge composition, and water quality released in nature. The modelling hypothesis (see Appendix) should be validated for all technologies' construction, maintenance, and end-of-life use. Additionally, the proposed LCA assumes a 50-year lifespan, with substrate refurbishment after 15 years. In contrast, the economic analysis in Section 2.3 uses a 20-year time frame and excludes the dismantling phase in its life cycle cost assessment. For a more accurate comparison, both analyses should align in terms of time horizon and life cycle stages considered.

3 PLANNING PLATFORM APPLICATION TO OTHER MUNICIPALITIES

This paragraph presents the feedback we gathered from municipal and metropolitan city partners as part of our WP5 objective to test and evaluate the Planning Platform tools in exploring strategies for NBS implementation. The results were obtained from the data-reduced approach described in Section 1.2. In support of this, the following paragraph presents the results for each municipality, namely a block-level map indicating the potential for NBS allocation, along with statistics on decentralisation potential and the percentage of stormwater that can be retained locally. We did not receive a specific target in stormwater retention from municipalities, since this requires specific computations from experts, thus, we set-up a common target to retain the impervious runoff from existing settlements for a design storm of 100-year return period. This was the basis for discussion and receiving feedback from the MULTISOURCE municipalities on the Planning Platform.

The scenarios developed with the Planning Platform for the MULTISOURCE municipalities are the following:

1) **Bio-retention cells (BRC)** for runoff retention



2) **Bio-retention cells and Infiltration Shafts (BRC+IF)**



3) Only **Infiltration Shafts (IF)** for runoff retention



The project cost data in the scenario ranking are shown as normalised values in reference to the maximum project costs of having only infiltration shafts (IF). Since applying a linear transformation to the single project cost items would be necessary to extend the analysis to other countries, the relationship between the two project costs should remain similar. For this reason, as normalised values, we show how much project costs are expected to vary for the BRC+IF scenario compared to IF.

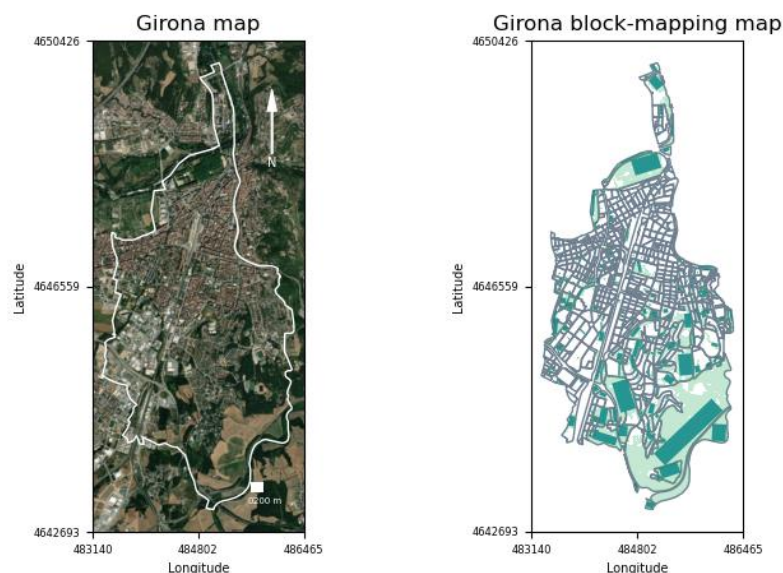
3.1 Girona Municipality

For the municipality of Girona, the administrative area was considered as the boundary, while the northeast forested part was excluded. Meeting with the Municipality of Girona staff, they confirmed that there is one unique treatment plant for the city in the north of Girona, and only 20% of the sewer system is separated. At the same time, there are numerous CSO locations along the river. Due to network collapse and leaves in drains, the city presents criticalities in flooded points all over the city of Girona. The municipality reported that flooding often happens when a rain episode surpasses 70 mm in an hour, especially when part of this quantity, around 40 mm, falls in 20 to 30 minutes. The causes of flooding are mainly:

- Obstruction of the drain due to the drag of materials during the rain episode.
- Network collapse
- Bad design of the network, with impediments to the water flow and hydraulic obstructions.

The city's northern area, which is located downstream, has more flooding spots due to the sum of these three causes and the direction of the runoff that follows the natural topography of the city, so the runoff is concentrated in the north of Girona. However, the hill neighbourhood of Montjuïc is particularly critical because it has a different urban catchment area and a different urban layout, where the rivers used to be before the urbanisation of the late 1970s. Although it is within the administrative boundaries of Girona, this area was excluded from the analysis. Also, the Plaça de Catalunya, which is close to the river, is a spot of interest, along with other low spots in the urban area. The municipality of Girona reported that they are interested in sustainable urban drainage solutions (SUDs) such as bio-retention cells, infiltration trenches, constructed wetlands, and storm tanks as last options. The technician from the municipality of Girona also expressed their intention to use the available public space in the southern area of the city, located uphill, to retain water in infrastructures with a high capacity, such as retention basins to protect the downstream areas from the runoff where the sewerage gets collapsed during periods of heavy rains and cloudbursts.

The block-mapping results for the administrative boundaries of Girona are reported below, as well as the relative statistics and decentralisation potential.



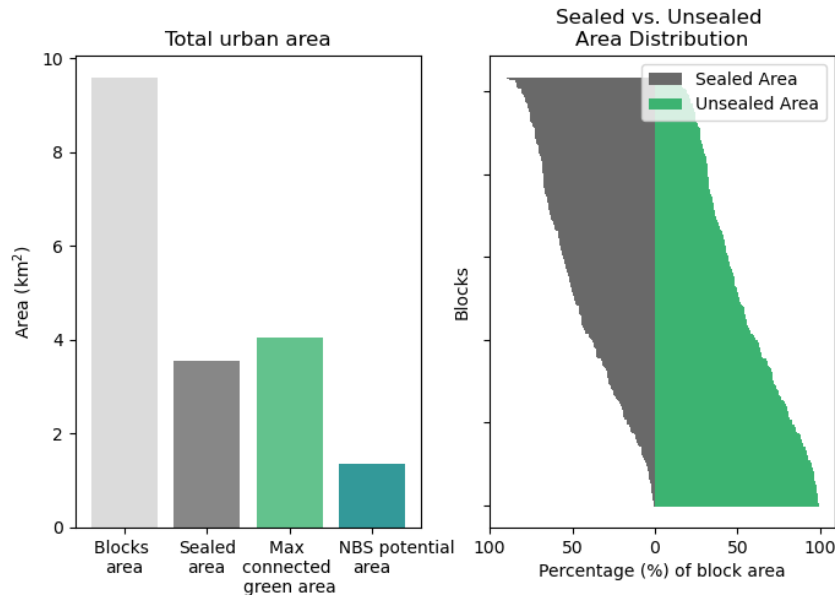


Figure 3.1.1: ESRI WorldImagery map of Girona with administrative boundary considered for this analysis. Block mapping of the urban environment and relative statistics on the blocks.

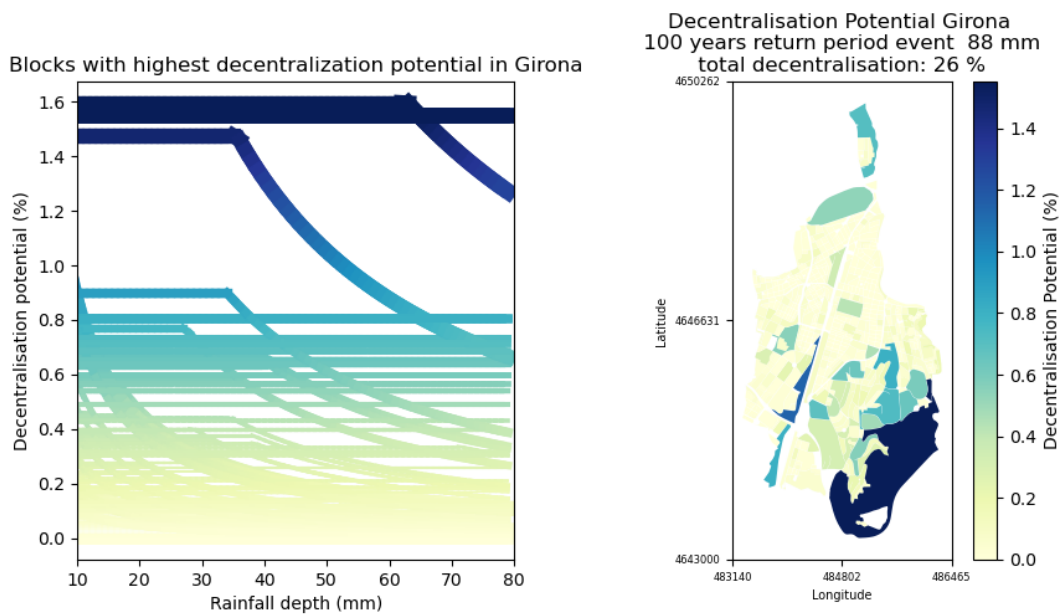


Figure 3.1.2: Decentralisation Potential (%) for implementing Bio-retention cells in Girona, and evolution in each block contribution in retaining stormwater with increasing rainfall depth (mm). The width of each line is proportional to the sealed area of the block. On the right is the screenshot with the decentralisation potential for 100-year return period, corresponding to 88 mm of rainfall.

The results for the three scenarios for urban stormwater management, introduced at the start of this Section, are reported below.

Girona Map retained target = 28%



Volume retained vs Runoff generated for 100 yT event

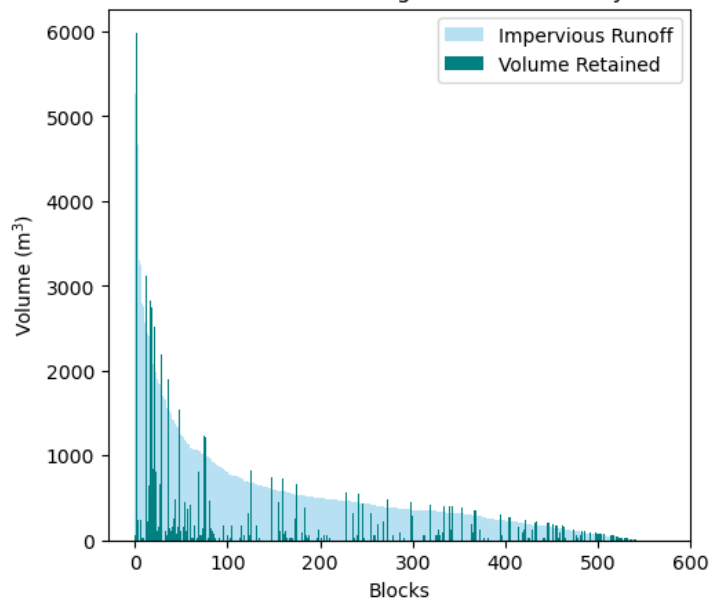


Figure 3.1.3: Scenario with only Bio-retention cells implemented.

Girona Map retained target = 100%



Volume retained vs Runoff generated for 100 yT event

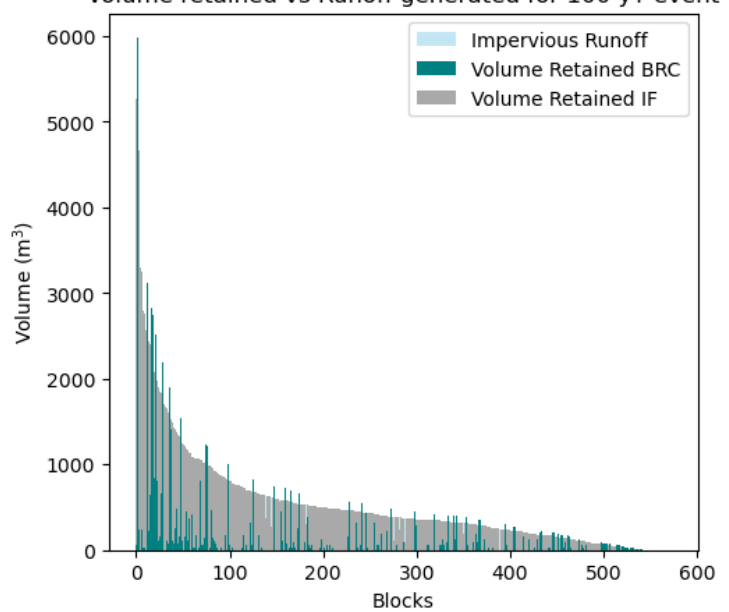


Figure 3.1.4: Scenario with Bio-retention cells and infiltration shafts implemented.

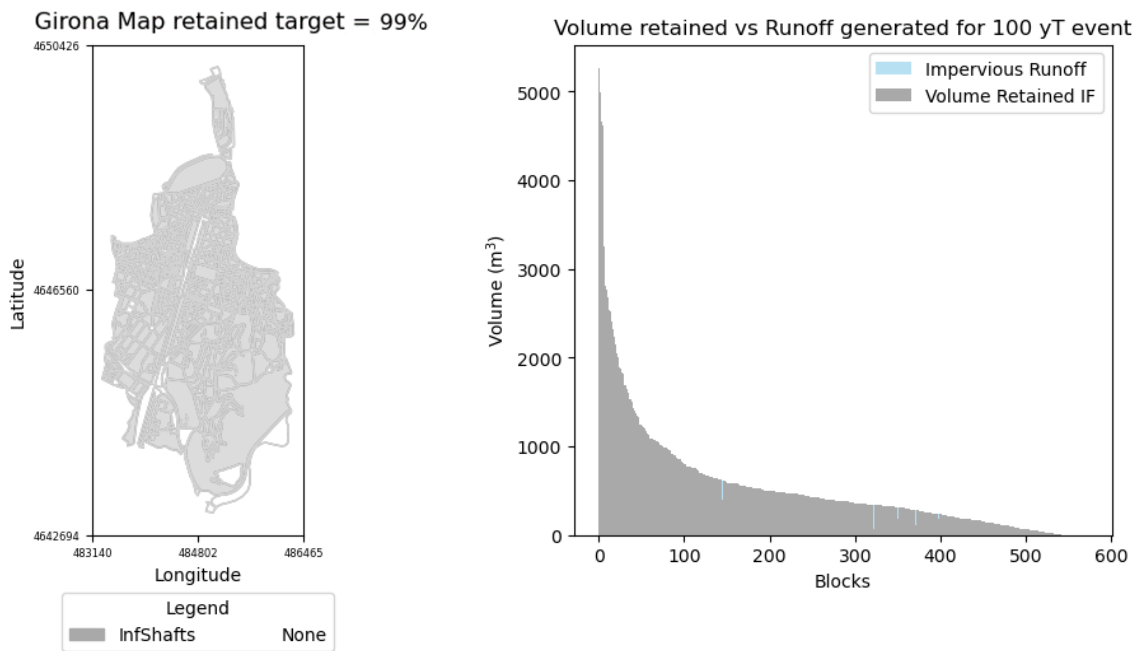


Figure 3.1.5: Scenario with only infiltration shafts implemented.

From the results of Girona, it appears that the city's central part is highly sealed, making it very difficult to plan interventions to retain runoff from surrounding settlements. Indeed, the city would manage to retain only 28% of the whole runoff from settlements with the implementation of only BRC (Fig. 3.1.3).

Differently from the Ecully catchment, it is not possible to have one centralised scenario for the constructed wetland since there are multiple CSO spills along the city. Thus, it is impossible to convey the combined sewer flow to one location with the current sewer system. Also, within the central part of the city, the only unsealed area would be the river plain, which would not be an available space during flooding because of the higher river levels.

Moreover, our intensity-frequency analysis agreed with the 20-30 min situation with 40 mm for which there starts to be urban flooding, as reported by the technician, for which it seems that the sewer system's capacity does not cope with extreme events > 10-year return period. The central part of the city would have in some blocks a few unsealed areas, for which 99% of the volume could be retained by infiltration shafts (Fig. 3.1.5). Indeed, in our Planning Platform tool it is set for the infiltration shafts to be implemented in unsealed areas to not account for de-sealing. In the BRC+IF scenario, the total retained volume is 100% of the target because extra runoff is retained from the NBS area itself during the storm (Fig. 3.1.4). For this reason, the total retained volume is slightly higher than that one with only infiltration shafts.

The decentralisation potential (Fig. 3.1.2), confirms that the southern part of the city, located uphill, could be a good location for decentralised intervention. However, the sized BRC for the actual impervious runoff of the block is smaller than the potential area (Fig. 3.1.1), which indicates that the settlements are few in that area. Thus, it should be further investigated whether the runoff from the surrounding agricultural/forested area would be relevant for the sizing of a retention basin or whether water transfer from other blocks with extended sealing areas would be possible.

Besides the positive feedback, the municipality of Girona commented that separating the public and private areas would be useful since acting in the private area is more difficult. This is a remark we also had from the personnel of the metropolitan city of Milano, although there is no open data set for private and public areas. Also, the municipality of Girona suggested that suburban basins, topographic and drainage ones, should already be integrated at this analysis stage. Within our workflows, topographic data from digital elevation models are entered within the hydraulic data approach when modelling the

sewer system. However, topographic data could already be included at an earlier stage within the workflow of the data-reduced approach for specific investigations.

In Table 3.1 is reported a summary of the decentralised scenarios for Girona.

Table 3.1 Summary of the Scenarios for Girona

Title	Bio-retention cell area (m ²)	Infiltration Shafts area (m ²)	Volume Retained (m ³)
Scenario only Bio-retention cells Girona, Design Storm 100 yT, retained target = 28%	214139	-	86799
Scenario mixed Girona, Design Storm 100 yT, retained target = 100%	214139	120947	312970
Scenario only Infiltration Shafts Girona, Design Storm 100 yT, retained target = 99%	-	165814	310073

To evaluate and rank the proposed water management scenarios for Girona, total project costs were estimated using the LCCA cost module described in Section 2.3. The cost estimations are always based on cost functions calibrated with data provided by IRIDRA. In order to normalise costs for comparison, the grey infrastructure strategy with the implementation of infiltration shafts was used as the baseline reference. The mixed solution, which combines Bioretention Cells (BRC) and Infiltration Facilities (IF), showed slightly lower costs when normalised against this baseline due to the limited implementation of bio-retention cells in the central part of the city. Over 20 years, the mixed solution with BRC would require 92% of project life cycle costs at present value compared to implementing only infiltration shafts. It is important to note that these cost estimates would benefit from further refinement using construction and operation & maintenance (O&M) data specific to Girona, improving the accuracy and local relevance of the LCCA.

In addition to economic costs, the scenario ranking also includes co-benefits, such as environmental and social benefits, derived from the Nat4Wat tool. The co-benefits are weighted according to the relative area occupied by the BRC in the mixed scenario. Specifically, BRC would cover 64% of the total area used for the combination of BRC and infiltration shafts. This allowed for a comparative evaluation of co-benefits between the mixed scenario by weighting the area occupied by the bio-retention cell and infiltration shaft technology and the scenario relying solely on infiltration shafts.

It is also important to notice that the scenario with only bio-retention cells cannot be compared in the ranking, since the targeted runoff volume retained from such intervention would be only 28% in comparison to the mixed or only infiltration shafts scenario, thus, the total implemented units and areas would not be sufficient for covering the target runoff generated from a design storm with 100-year return period.

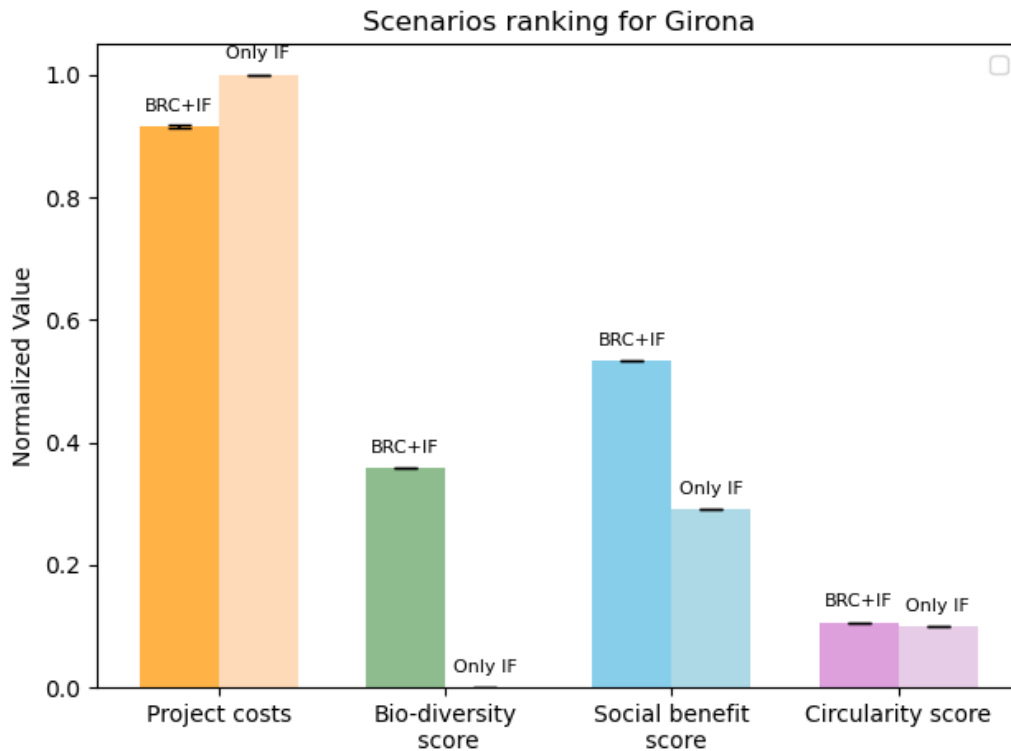


Figure 3.1.6: Scenario ranking for the urban stormwater management scenario for 100-year design storm in the city of Girona.

3.2 Oslo Municipality

The Municipality of Oslo has established clear regulations and guidelines that require the use of Nature-Based Solutions (NBS) as a standard component in all development projects in the city. As a result, NBS are widely implemented throughout Oslo. However, the main focus is on areas where development is planned. The municipality is particularly interested in exploring scenarios in locations where there are fewer incentives for implementation but where the need for stormwater management is critical.

Although Oslo's suburbs are green, with abundant vegetation and natural water retention capacity, the most significant stormwater challenges are found in the dense urban core. Neighbourhoods such as Grønland, Tøyen, Grünerløkka, Jernbanetorget and Kvadraturen often experience flooding problems. These areas are characterised by narrow streets and limited space that must accommodate a wide range of functions including pedestrians, cyclists, public transport and accessibility needs for blind and wheelchair users. As a result, implementing NBS in these areas requires innovative and space-efficient solutions.

Oslo's combined sewer system carries wastewater to the west and south of the city, where it is treated in a large treatment plant. There are several combined sewer overflow (CSO) locations along this route. In addition, separate storm sewer systems in other areas carry runoff directly to nearby rivers and fjords.

Oslo does not have a city-wide intervention strategy such as Milano, although they do have strategies and planning frameworks in place. Specifically, Oslo adopted a municipal stormwater strategy in 2014, supported by a municipal master plan and thematic action plans, e.g. a climate adaptation strategy and a blue-green structure plan. These documents emphasise nature-based stormwater management. The implementation of NBS largely occur through individual infrastructure or development projects, such as roads upgrades or local park restorations, rather than through a coordinated city-wide deployment of stormwater measures. For example, when a new cycle lane is designed, rainwater bioretention cells are

also required. However, the municipality acknowledges that these small, dispersed interventions can lead to challenges, particularly in terms of maintenance, which tends to be more costly when infrastructure is fragmented.

The block-mapping results for the selected administrative boundaries of Oslo are reported below, as well as the relative statistics and decentralisation potential.

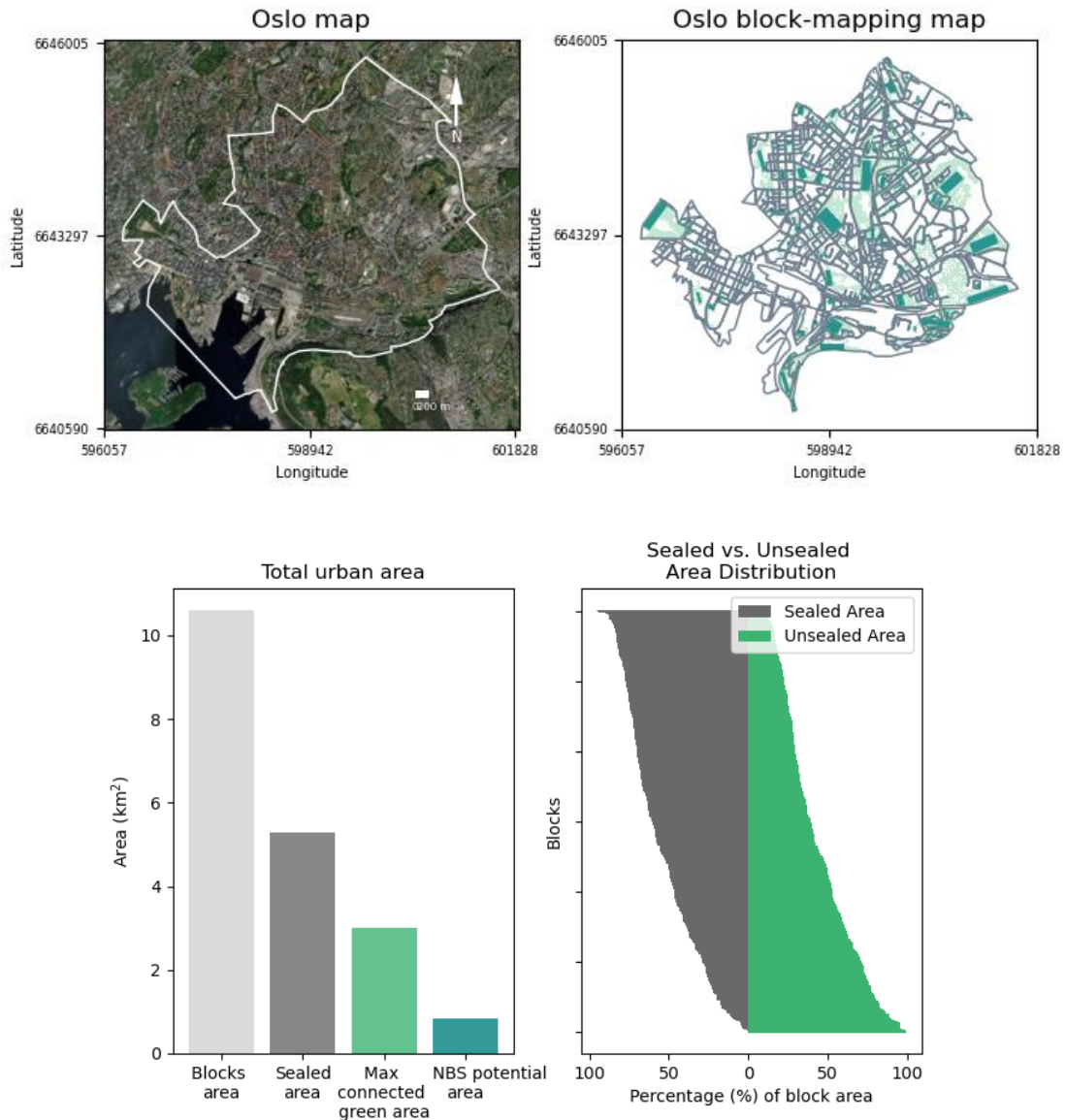


Figure 3.2.1: Esri WorldImagery map of Oslo with administrative boundary considered for this analysis. Block mapping of the urban environment and relative statistics on the blocks.

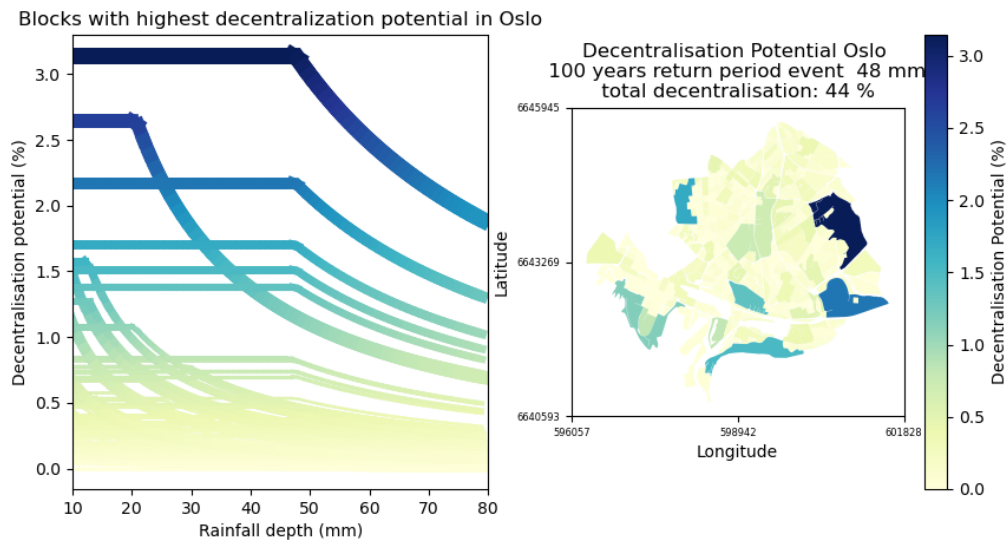


Figure 3.2.2: Decentralisation Potential (%) for implementing Bio-retention cells in the selected districts of Oslo, and evolution for each block contribution in retaining stormwater with increasing rainfall depth (mm). The width of each line is proportional to the sealed area of the block. On the right is the screenshot with the decentralisation potential for 100-year return period, corresponding to 48 mm of rainfall.

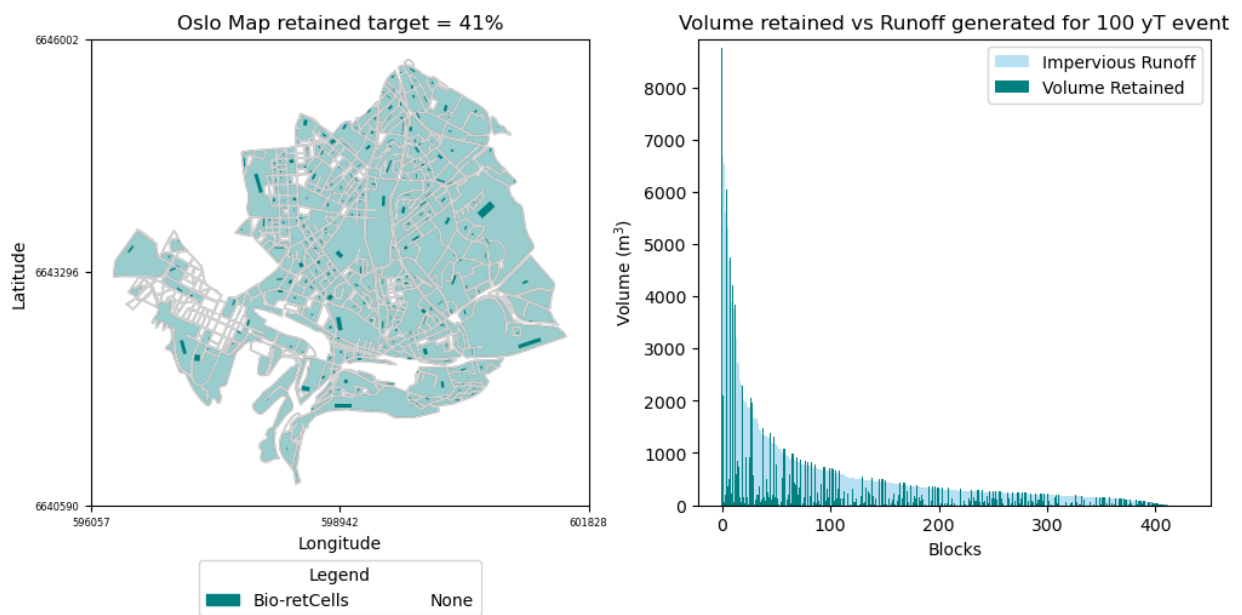


Figure 3.2.3: Scenario with only Bio-retention cells implemented.

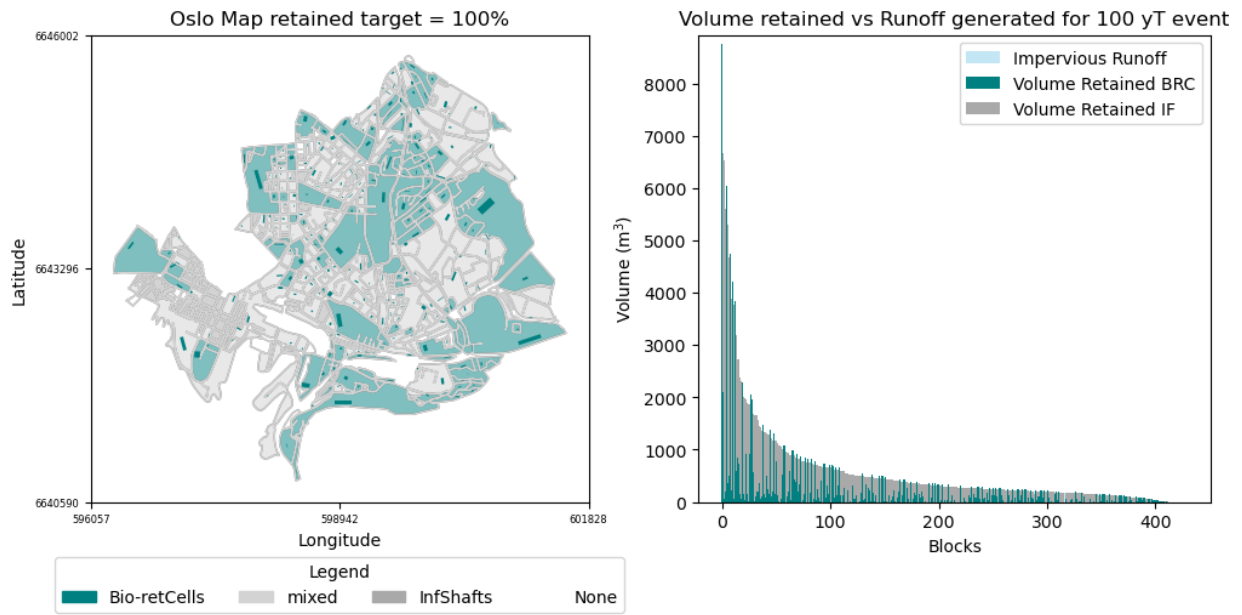


Figure 3.2.4: Scenario with a mix of bio-retention cells and infiltration shafts implemented.

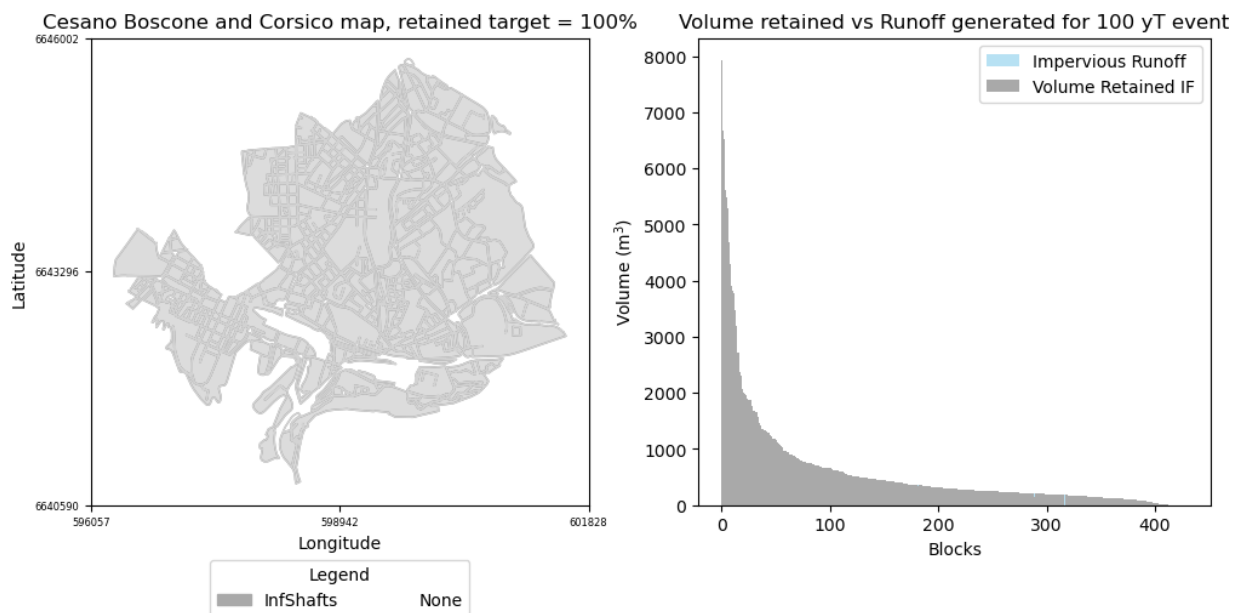


Figure 3.2.5: Scenario with only Infiltration shafts implemented.

Our Planning Platform can assist in identifying where targeted intervention can be addressed to relieve the sewer system from stormwater and reduce operation and maintenance costs, as demonstrated for the Ecully Catchment (Lippera et al., 2024). The white central spots for which no solution is implemented (Fig. 3.2.3) are the space occupied by the railway and dedicated area (from urban Atlas, Copernicus). As guessed by the staff of the Oslo Municipality, Kvadraturen, on the west-centre side of the city, has no space to implement NBS. And similarly, the central part in Grønland and Jernbanetorget. Still, part of this area is unsealed, so infiltration shafts or other underground facilities for stormwater management could be implemented to retain the runoff from the surrounding sealed area. On the east side of the catchment (Hovin and Hetterstad), these locations have a higher potential to retain high runoff from the numerous settlements being connected to the park spaces (Fig. 3.2.2).

Table 3.2 Summary of the Scenarios for the analysed sub-urbs in Oslo

Title	Bio-retention cell area (m ²)	Infiltration Shafts area (m ²)	Volume Retained (m ³)
Scenario only Bio-retention cell Oslo, Design Storm 100 yT, retained target = 41%	238715	-	104420
Scenario mixed Oslo, Design Storm 100 yT, retained target = 100%	238715	79141	252416
Scenario only Infiltration Shafts Oslo, Design Storm 100 yT, retained target = 100%	-	134777	252032

To evaluate and rank the proposed water management scenarios for Oslo, total project costs were estimated using the LCCA cost module as described in Section 2.3. In the comparison, the grey infrastructure strategy, specifically, the implementation of infiltration shafts only, was used as the baseline reference for normalisation of costs. The mixed solution, which combines Bioretention Cells (BRCs) and Infiltration Facilities (IF), showed significantly lower costs when normalised against this baseline. Over a 20-year period, the mixed solution would require 86% of project life cycle costs compared to implementing only infiltration shafts (Fig. 3.2.6). It is important to note that these cost estimates would benefit from further refinement using construction and operation & maintenance (O&M) data specific to Oslo, which would improve the accuracy and local relevance of the LCCA.

In addition to economic costs, the analysis also considered co-benefits, such as environmental and social benefits, derived from the Nat4Wat tool. These co-benefits were weighted according to the relative area occupied by BRCs in the mixed scenario. Specifically, BRCs covered 75% of the total area used for the combination of BRCs and infiltration shafts. This allowed for a comparative evaluation of co-benefits between the mixed scenario, by weighting the area occupied by the bio-retention cell and infiltration shaft technology, and the scenario relying solely on infiltration shafts.

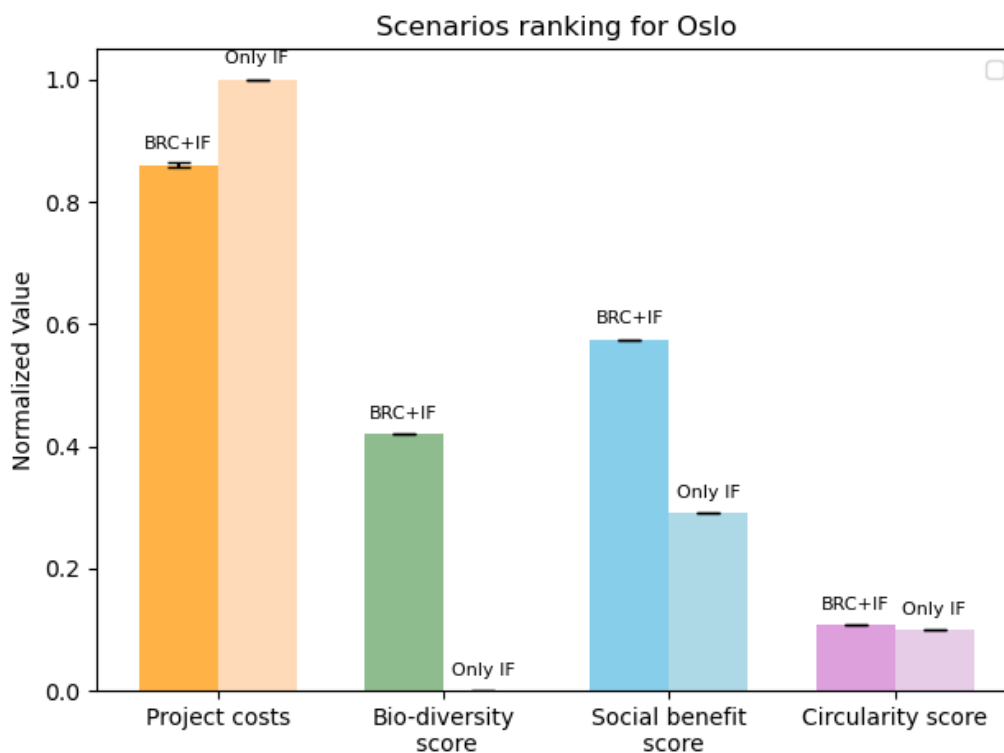


Figure 3.2.6: Scenario ranking for the urban stormwater management scenario in the selected area for the city of Oslo.

3.3 Corsico, Cesano Boscone e Opera (Metropolitan City of Milano)

The Metropolitan City of Milan (CMM) launched the Sponge programme in 2022, which aims to implement NBS interventions to retain and store rainwater locally rather than channelling and draining it into the sewerage system. The city aims to coordinate all available tools to reduce the vulnerability of natural and socio-economic systems and increase the territory's resilience, particularly in areas with high levels of surface sealing and dense urban development. A total of 90 interventions have been identified in 32 municipalities, focusing on publicly owned areas, such as car parks, squares, roads and green spaces, to increase the sustainable management of stormwater runoff. Priority has been given to local retention and where possible infiltration. As of April 2025, it is reported on the CMM's website that half of the construction sites have been completed, while the remaining half are still ongoing (<https://www.cittametropolitana.mi.it/PNRR/Piani-Urbani-Integrati/Spugna/>).

The CMM spans 1,575 km² and includes 133 municipalities, and it is served by multiple combined sewer systems, meaning it encompasses multiple urban catchments and several wastewater treatment plants. Since running results with the Planning Platform tools for the entire CMM would have been demanding, and results would not have been detailed in the deliverable, we asked for an urban area of interest. The CMM provided us with two focus areas to test the results of the Planning Platform, located in the municipalities of Cesano Boscone and Corsico and Opera. For the intensity-duration-frequency curves, due to the incompleteness of historical rainfall time series from download series from meteorological stations, the parametrisation of the intensity-duration-frequency curves was taken directly from the Regional Agency for Environmental Protection (ARPA Lombardia) at the website: <http://idro.arpalombardia.it>.

The results are shown below for the two focus areas requested by the CMM staff, one at the border between Cesano Boscone and Corsico and one in Opera. It is important to remember that the urban block-mapping tool is not ideal for detailed planning, for which cadastral data should be integrated. Still, through the use of open data, the tool can identify strategic locations for rainwater retention and reduce pressure on the sewer networks within a large urban area. The focus area suggested by the CMM is reported in orange in the maps below. First, the results for Cesano Boscone and Corsico, with the block-mapping and decentralisation potential, are shown to identify where there is potential for NBS implementation.

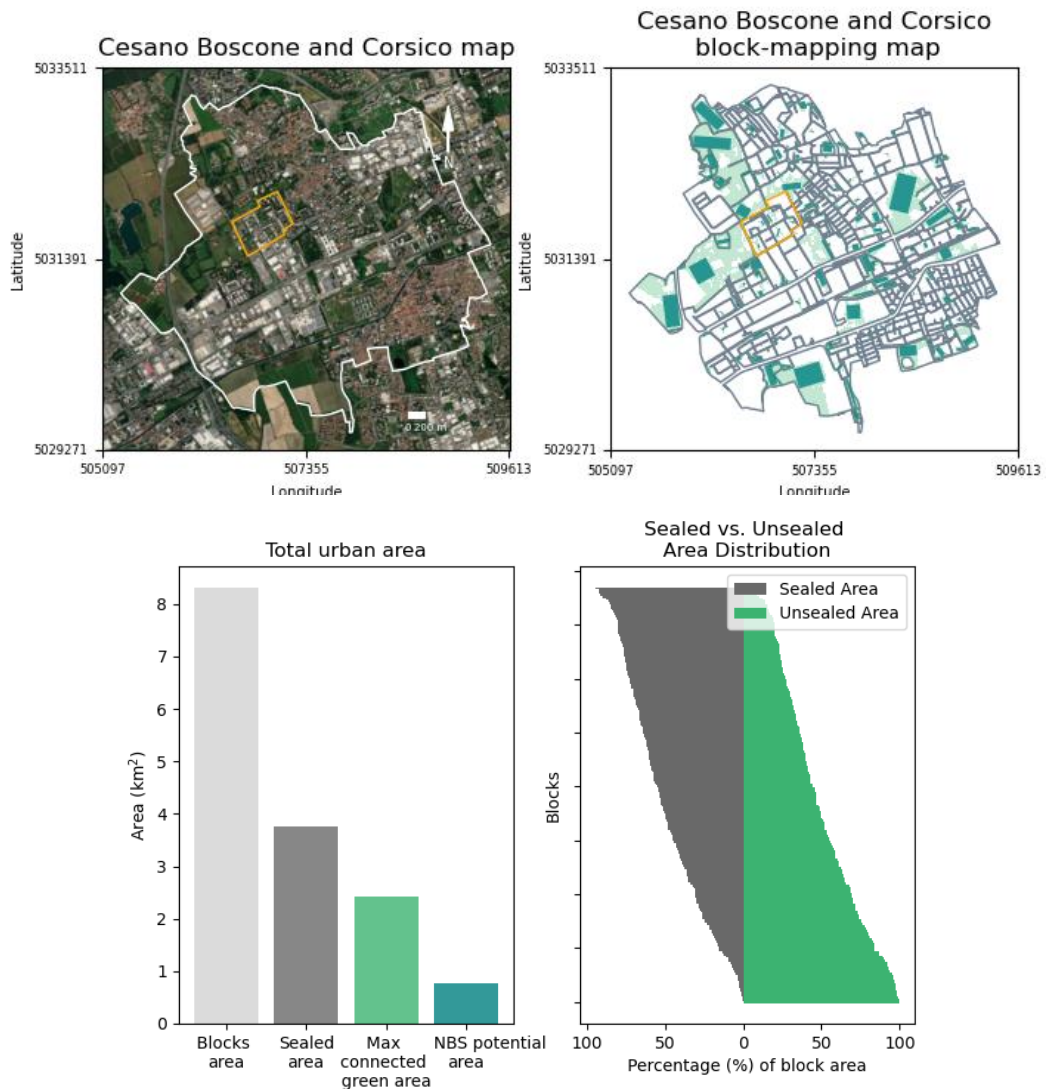


Figure 3.3.1: Esri WorldImagery map of the administrative area of Cesano Boscone and Corsico with the administrative boundary considered for this analysis. Block mapping of the urban environment and relative statistics on the blocks.

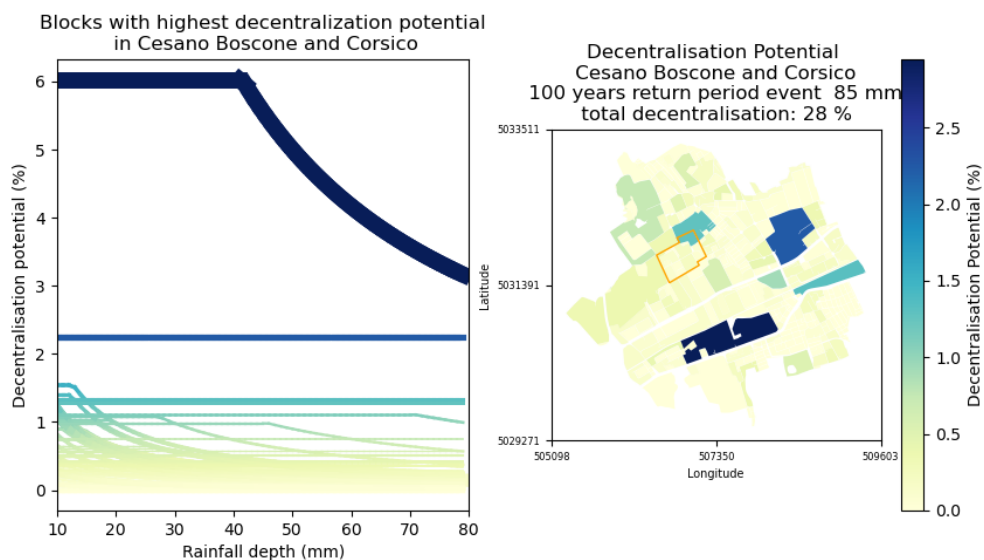


Figure 3.3.2: Decentralisation Potential (%) for implementing Bio-retention cells in Cesano Boscone and Corsico, and evolution in each block contribution in retaining stormwater with increasing rainfall depth (mm). The width of each line is proportional to the sealed area of the block. On the right is the screenshot with the decentralisation potential for 100-year return period, corresponding to 85 mm of rainfall.

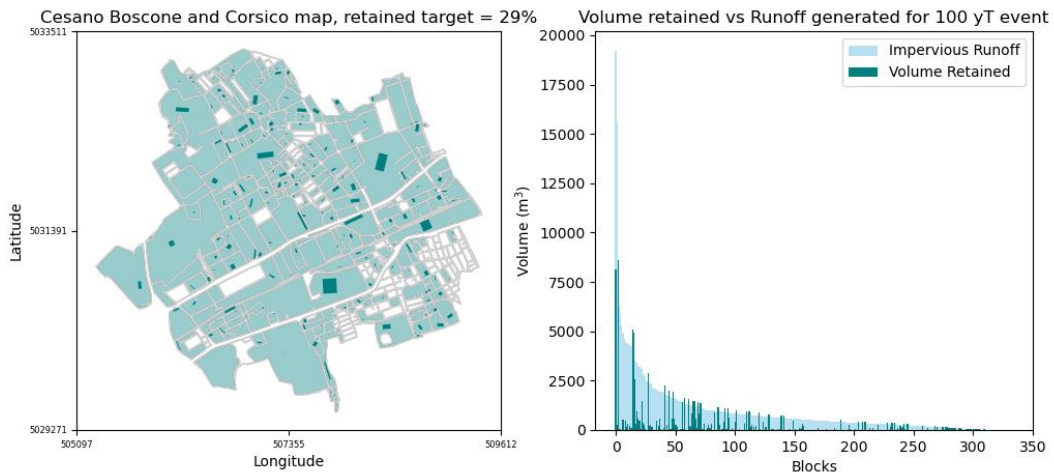


Figure 3.3.3: Scenario with only Bio-retention cells implemented.

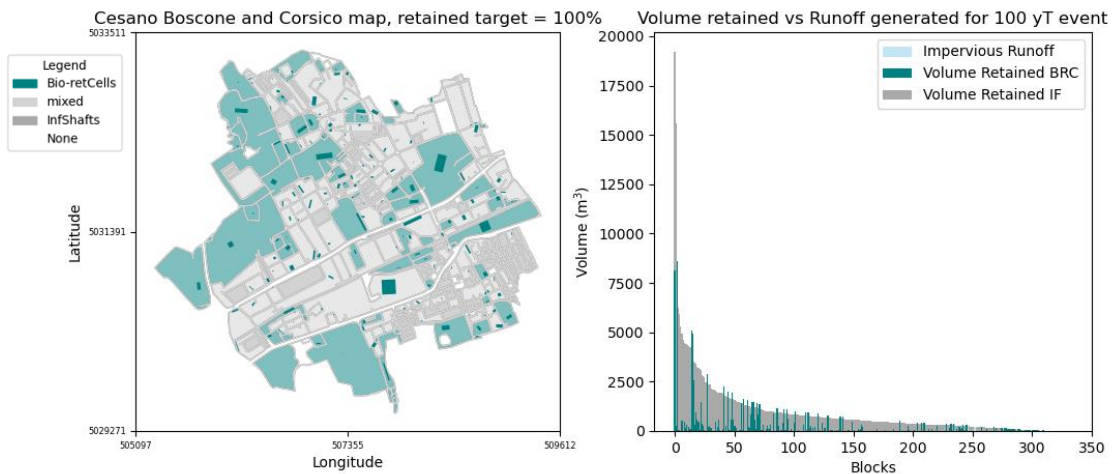


Figure 3.3.4: Scenario with mix Bio-retention cells and Infiltration Shafts implemented.

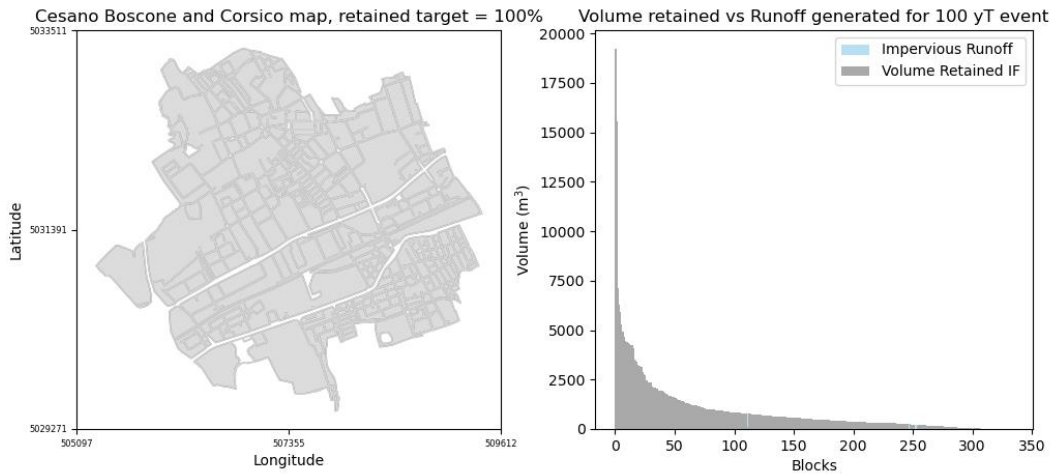
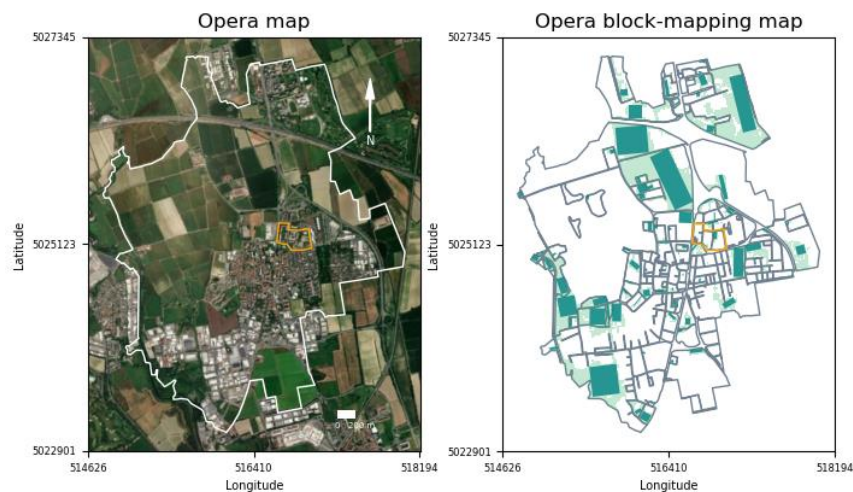


Figure 3.3.5: Scenario with only infiltration shafts implemented.

As shown in Fig. 3.3.3, there are distributed blocks within Cesano Boscone and Corsico that would be suitable for implementing NBS to retain extreme design storms. However, within the two municipalities, the total retained impervious runoff for a 100-year design storm, would only be 29% of the total runoff generated from the human settlement. The block that could implement a bio-retention cell holding 6% of the impervious runoff of all the blocks' impervious runoff (Fig. 3.3.2), might be an overestimation since one road crossing the block is not reported in the urban atlas. Thus, the impervious area connected to this block might be overestimated, and further investigation should be done. The urban green distributed within the urban texture could still lead to potential water transfer among contiguous blocks.

The results for Opera are shown below, with the second focus area chosen by the CMM always represented in orange.



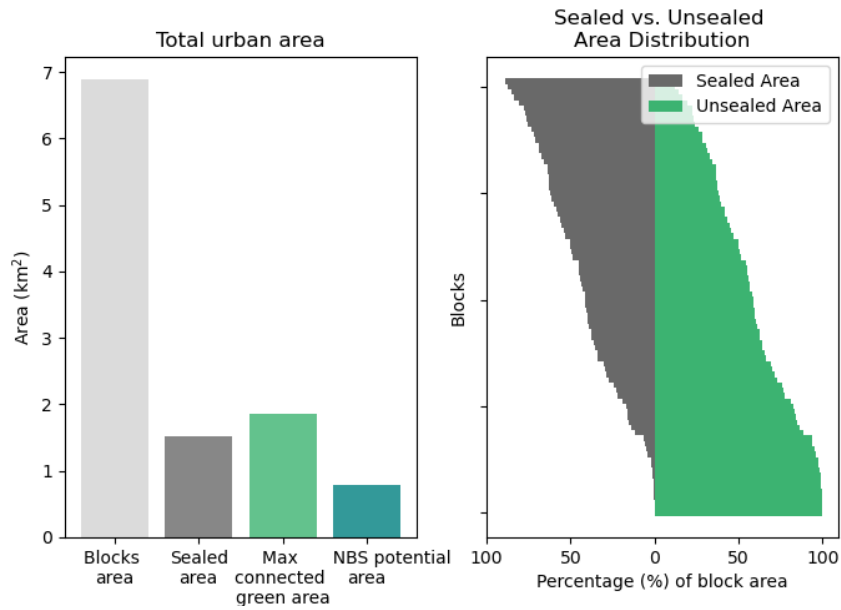


Figure 3.3.6: Esri WorldImagery map of the administrative area of Opera with administrative boundary considered for this analysis. Block mapping of the urban environment and relative statistics on the blocks.

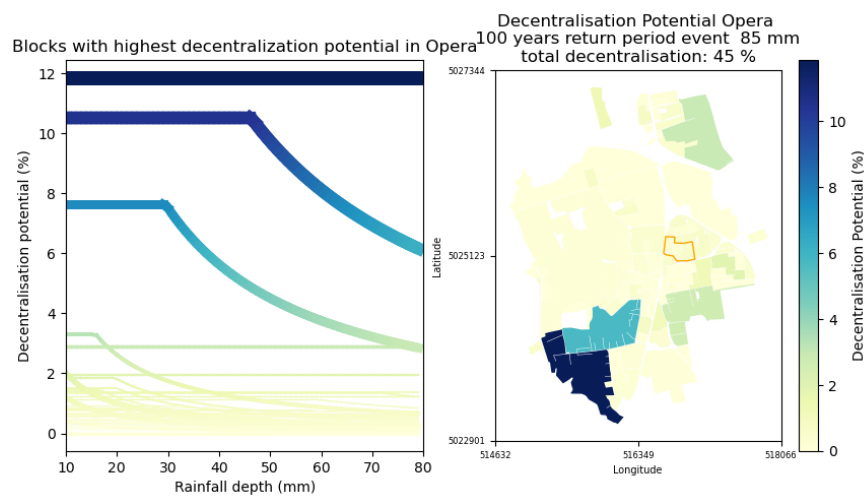


Figure 3.3.7: Decentralisation Potential (%) for implementing Bio-retention cells in Opera, and evolution in each block contribution in retaining stormwater with increasing rainfall depth (mm). The width of each line is proportional to the sealed area of the block. On the right is the screenshot with the decentralisation potential for 100-year return period, corresponding to 85 mm of rainfall.

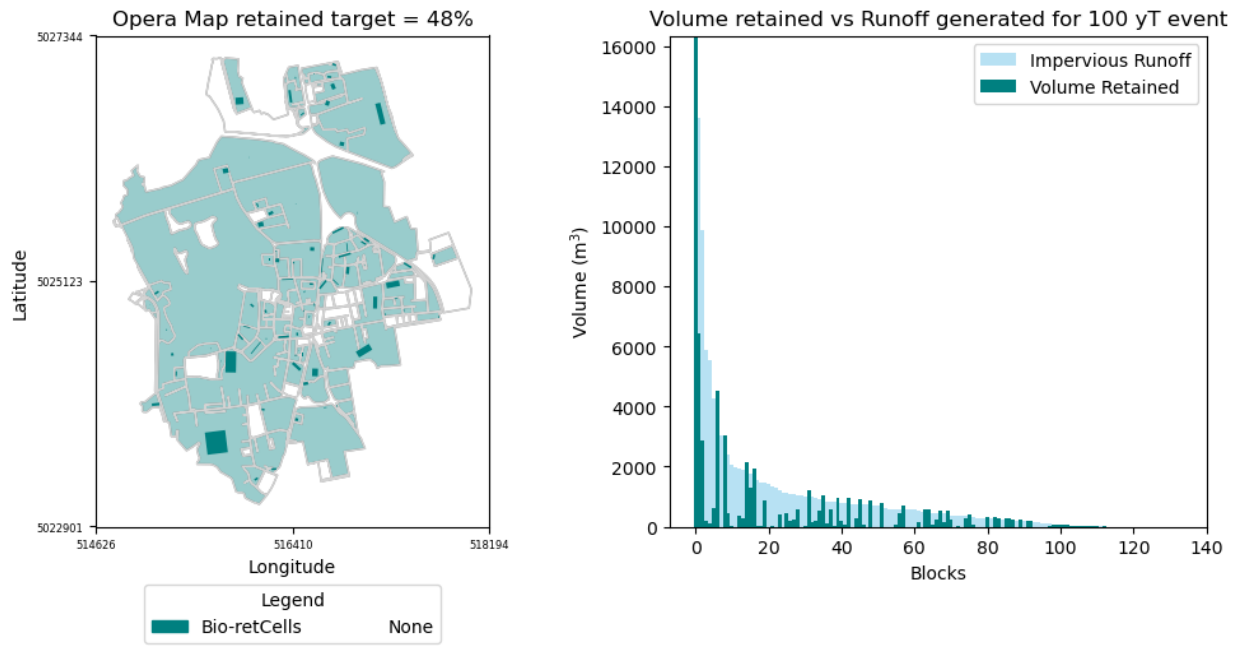


Figure 3.3.8: Scenario with only Bio-retention cells implemented.

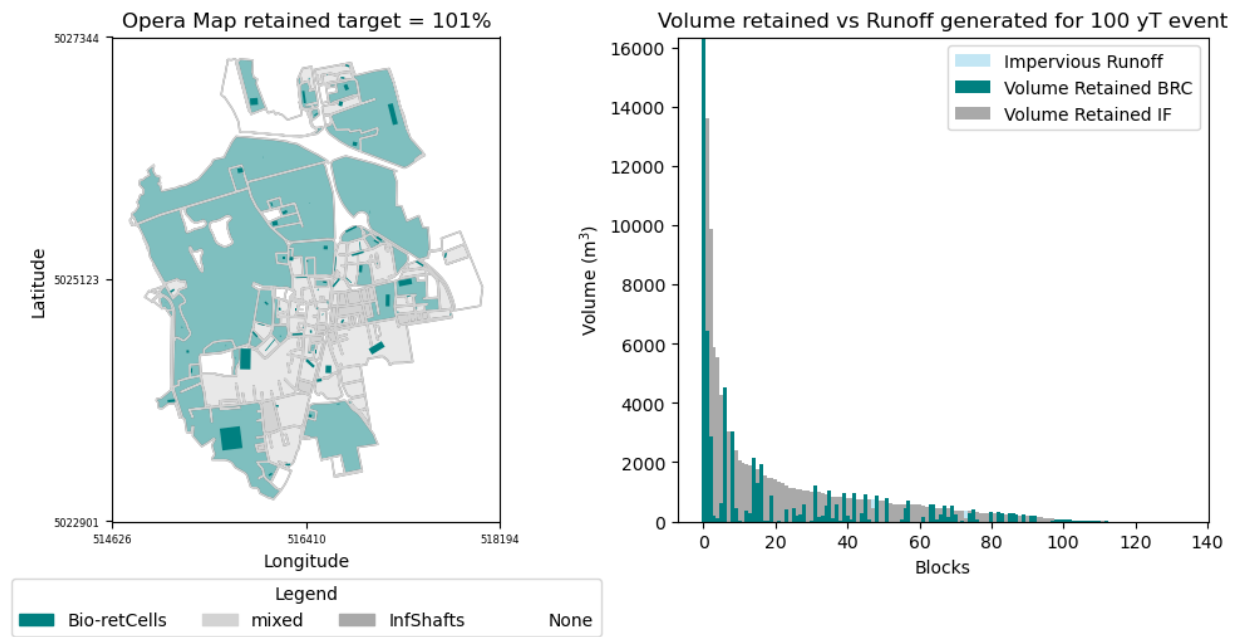


Figure 3.3.9: Scenario with mix Bio-retention cells and Infiltration Shafts implemented.

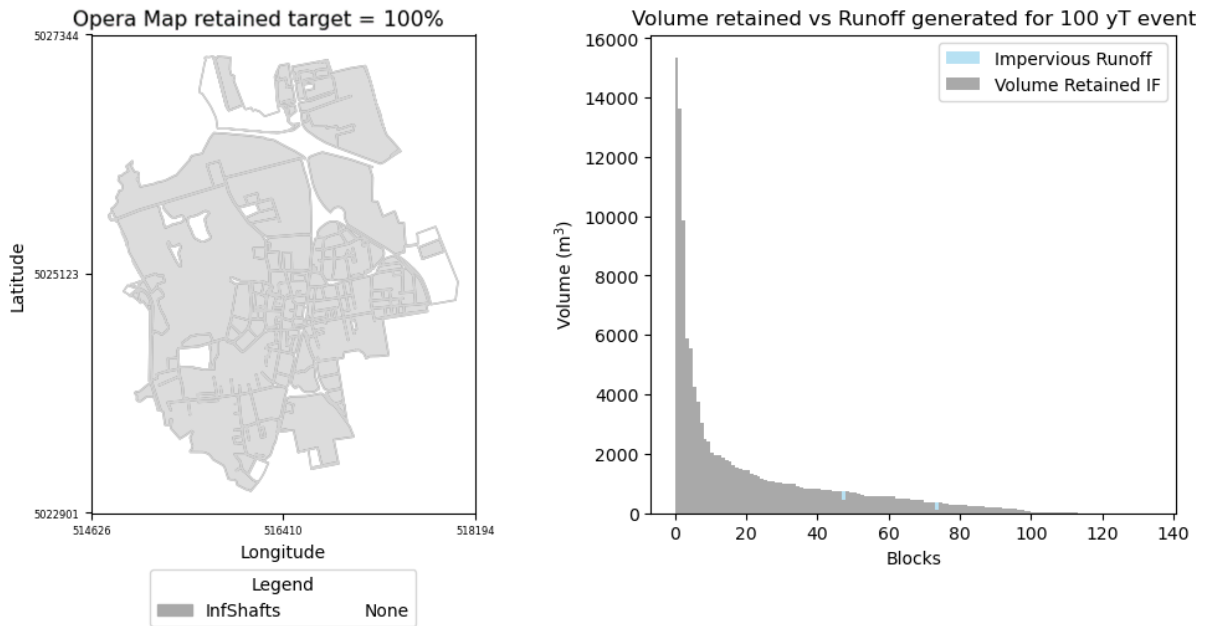


Figure 3.3.10: Scenario with only infiltration shafts implemented.

The urban area of Opera has a higher capacity for retaining impervious runoff within the blocks compared to Cesano Boscone and Corsico, with a total decentralisation potential of 48% for bio-retention cell implementation (Fig. 3.3.8). However, the two blocks most suitable for NBS implementation are located in the south, where there are settlements connected to extended green urban areas. In contrast, where the most settlements are, in the municipality's centre, there is not enough green area for BRC implementation. Infiltration shafts might be more suitable for collecting roofs' runoff in the city centre (Fig. 3.3.9). Indeed, most interventions in the CMM municipality use permeable pavement solutions for urban sustainable drainage. The surrounding agricultural area around Opera might have a marginal potential for urban runoff mitigation unless dedicated strategies are implemented.

The staff of the Metropolitan City of Milan (CMM) confirmed that, at the time they were using digital data to identify intervention sites, our tool would have been highly useful in assessing the potential for decentralised NBS across the metropolitan area. The technical director of the engineering firm involved also emphasised that the tool could be particularly valuable during the master planning phase, as it enables coordinated planning of interventions across a large territory. The identification of public spaces could be further helpful in targeting interventions.

Below are reported the tables with the summary of the analysed areas within the CMM administrative boundaries selected.

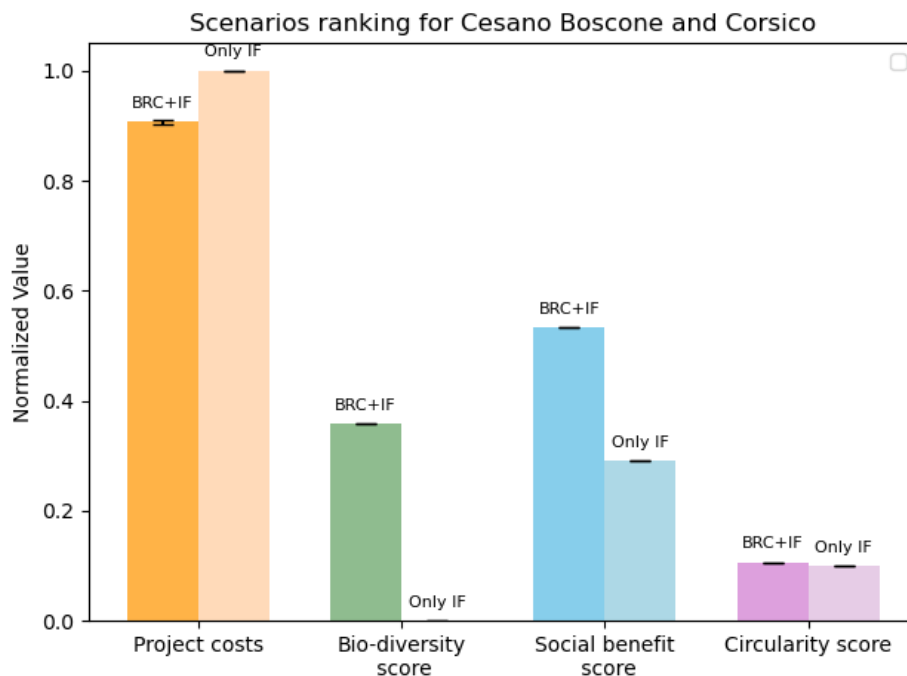
Table 3.3 Summary of the Scenarios for the analysed sub-urbs in CMM

Scenario for Cesano Boscone and Corsico	Bio-retention cell area (m ²)	Infiltration Shafts area (m ²)	Volume Retained (m ³)
Only Bio-retention, Design Storm 100 yT, retained target = 29%	217250	-	91144
Mixed, Design Storm 100 yT, retained target = 100%	217250	121964	319216
Scenario only Infiltration Shafts, Design Storm 100 yT, retained target = 100%	-	169781	317491

Scenario for Opera	Bio-retention cell area (m ²)	Infiltration Shafts area (m ²)	Volume Retained (m ³)
Only Bio-retention, Design Storm 100 yT, retained target = 48%	142707	-	62162
Mixed, Design Storm 100 yT, retained target = 101%	142707	36991	131336
Scenario only Infiltration Shafts, Design Storm 100 yT, retained target = 100%	-	68990	129013

The ranking of the scenarios for the cities is reported below. Total project costs were estimated using the LCCA cost module described in Section 2.3. The cost estimations are based on cost functions calibrated with data provided by IRIDRA. In order to normalise costs for comparison, the grey infrastructure strategy with the implementation of infiltration shafts was used as the baseline reference. The mixed solution, which combines Bioretention Cells (BRC) and Infiltration Facilities (IF), showed slightly lower costs when normalised against this baseline. Over 20 years, the mixed solution with BRC would require 91% of project life cycle costs in Cesano Boscone- Corsico and 84.7% in Opera compared to implementing only infiltration shafts.

In addition to economic costs, the scenario ranking also includes co-benefits, such as environmental and social benefits, derived from the Nat4Wat tool. The co-benefits are weighted according to the relative area occupied by the BRC in the mixed scenario. Specifically, BRC covered 64% in Cesano Boscone- Corsico and 79% in Opera of the total area used for the combination of BRC and infiltration shafts. This allowed for a comparative evaluation of co-benefits between the mixed scenario by weighting the area occupied by the bio-retention cell and infiltration shaft technology and the scenario relying solely on infiltration shafts.



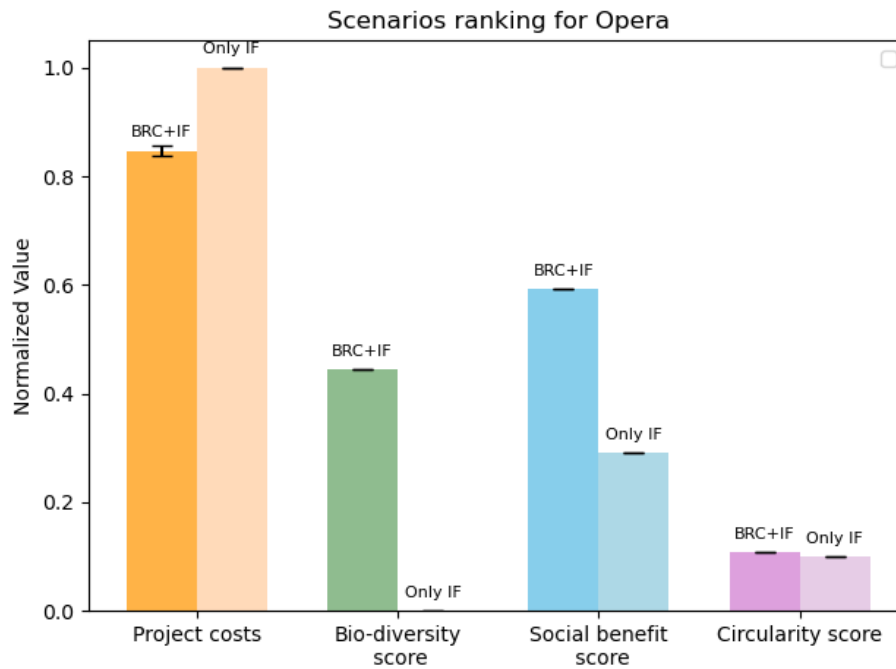


Figure 3.3.11: Scenario ranking for the urban stormwater management scenario in the areas selected for CMM.

4 INTERNATIONAL PARTNERS

This paragraph presents the workshops held with the international partners to solicit discussion on the application of Planning Platform tools and how they can assist in reaching urban stormwater challenges in their respective urban contexts.

4.1 Workshop results from Vietnam

The workshop focused on identifying scenarios to improve urban stormwater management in Ho Chi Minh city, based on NBS technologies and spatial information from the block mapping, such as sealing degree, settlement area and population (Fig. 4.1.1. and Fig. 4.1.2). Ho Chi Minh City faces numerous flooding challenges driven by a combination of high tides, extreme storm events, and land subsidence. Both groups recognised the severity of these issues and proposed NBS infrastructure tailored to the city's diverse urban environment and block map information.

One group highlighted key constraints such as limited space for large-scale interventions, the need for canal renovation, and the potential displacement of residents. Despite these challenges, they proposed targeted NBS strategies. Near the airport, a retention basin was suggested, while in areas with green spaces, water transfer to parks could help manage excess stormwater. Given the prevalence of narrow houses and small courtyards, green roofs were considered an effective and space-efficient option. Solutions such as swales, buffer infiltration zones, rain gardens, and constructed wetlands could be implemented where more space is available. They also recommended integrating septic tanks with constructed wetlands to enable wastewater reuse. Infiltration-based strategies, including managed aquifer recharge, were also included in the debate to improve groundwater conditions.

Another group of stakeholders emphasised the variability in soil conditions and urban infrastructure across the city. It was highlighted during the discussion that areas with good soil infiltration are ideal for implementing decentralised NBS, while compacted soils along canal areas require alternative approaches. With its combined sewer system, the city centre was deemed suitable for decentralised

solutions, while newly developed areas with separated systems were more appropriate for centralised stormwater collection. In rural or suburban zones, which lack formal sewer networks, a hybrid of network extension and decentralised treatment could be effective. Technologies proposed by the stakeholders group included retention basins and sluice gates on canals to prevent tidal water intrusion, constructed wetlands for decentralised wastewater treatment, and a variety of green infrastructure solutions such as green roofs, bank filtration, buffer strips, rain gardens, and bioretention cells. A particular concern was the widespread use of septic tanks that discharge directly into canals; to address this, constructed wetlands were recommended to treat effluent before it reaches the waterways.

In summary, the discussion sparked by the scenario identification based on the block map information proved fruitful in addressing the city's flooding challenges, and both groups advocated for a tailored, site-specific mix of NBS technologies that reflect the specific spatial, infrastructural and environmental constraints of Ho Chi Minh City.

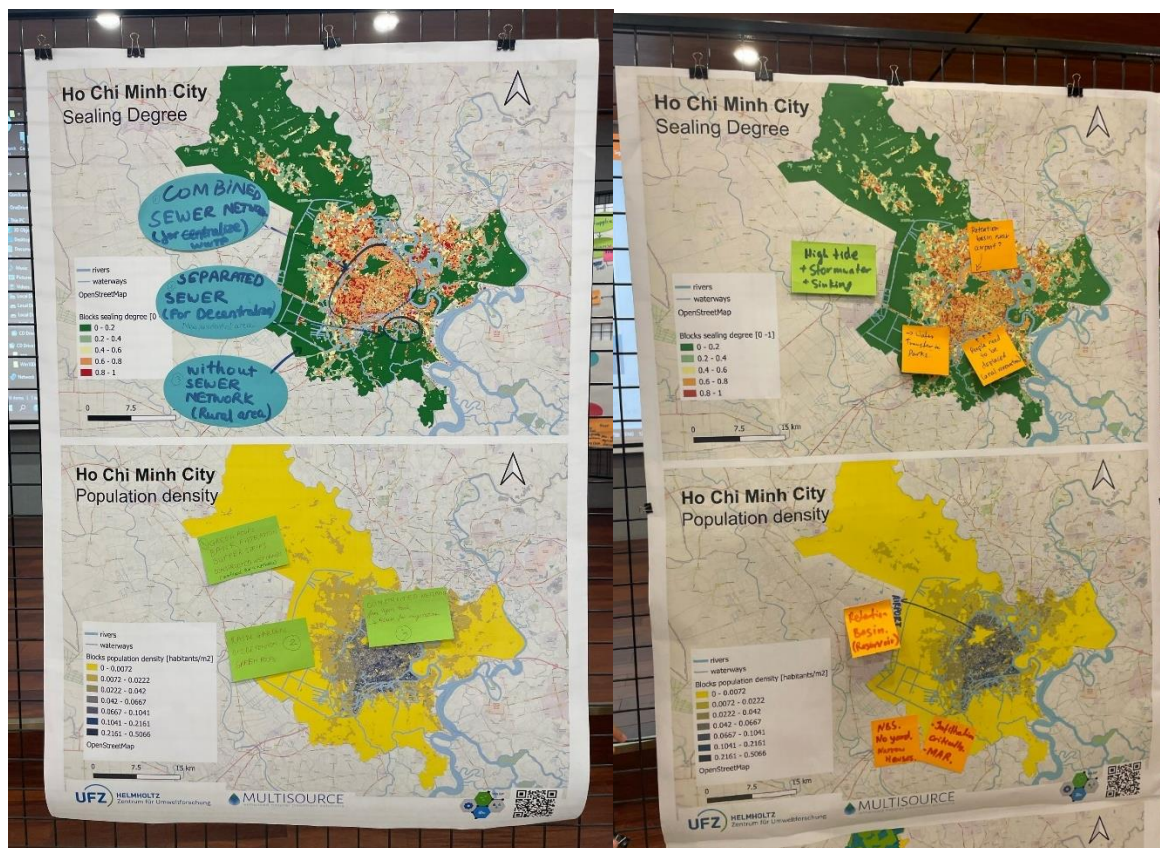


Figure 4.1.1: Block maps with sealing degree and population data used during the workshop in Ho Chi Minh city.

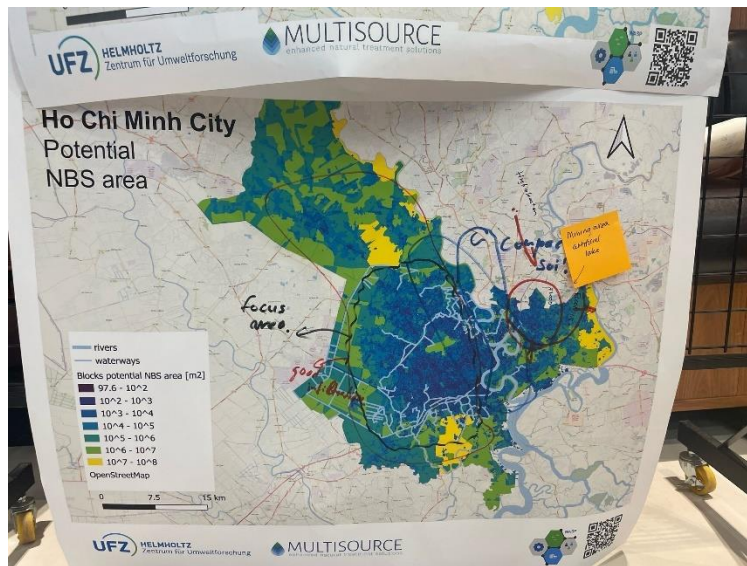


Figure 4.1.2: Block maps with Potential NBS area used during the workshop in Ho Chi Minh city.

4.2 Workshop results from Brasil

In Brazil, a dedicated workshop (Fig. 4.2.1) was held on the topic "MULTISOURCE tools for Sbn dissemination – decision-making for technology."



Figure 4.2.1: Workshop participants in Brazil

The two platforms developed under the MULTISOURCE project, OCTOPUS (by UFZ) and Nat4Wat (by ICRA), were showcased during the session. The main goal was to introduce these tools and raise awareness about their potential to support decision-making processes and enhance planning around selecting and placing nature-based solutions (NBS) for water treatment and management.



Figure 4.2.1: Water management locations and issues discussed during the workshop in Florianópolis (Brasil).

The session aimed to promote the wider adoption of these tools among professionals, researchers, and stakeholders in the water sector. Both platforms received enthusiastic feedback, underscoring their relevance and potential impact. To highlight the local water management issues and priorities Maria Magri (USFC) developed a map (Fig 4.2.2) where participants could interactively show locations and issues for which the tools can be applied. Notably, Nat4Wat attracted significant attention, with more than 40 new users registering during the event, an indication of the growing need for user-friendly, accessible tools in the field of sustainable water management.

5 LONG TERM IMPACTS

This deliverable presented the main results of the urban stormwater management scenarios for the Ecully catchment, Lyon, and their evaluation in terms of project costs, impacts and co-benefits. The potential for application in other cities, even where limited information is available, and feedback from the municipalities of Girona, Oslo and the Metropolitan City of Milano was also integrated. The data-reduced approach, although not practical for detailed planning, can provide a useful assessment for master plans when coordinating targeted interventions within an urban catchment. Where CSO data are available, hydraulic models for the sewer network systems can be coupled using PySewer, from the Planning Platform, interactively with PySwmm. These projects require more data for calibration and validation, and for this reason, we at the UFZ welcome projects to work on and develop the tools further. This is also the reason why the Planning Platform consists of a set of modules in Gitlab. The aim is that the developed tools can be constantly updated and tailored to specific case studies through their open source code (<https://doi.org/10.21105/joss.06430>, <https://doi.org/10.1016/j.oneear.2023.08.005>). This way, the open data that feeds the tools can also be updated when data with better resolution becomes available.

Beyond the end of MULTISOURCE, other projects within the department will work on further refining the tools, such as the WATERUN and UT-UBGI projects, which will continue the work of facilitating the implementation of NBS and LIDs for sustainable urban drainage. In addition to supporting municipalities and water companies unfamiliar with Gitlab and programming, the UFZ has set up a City Office to advise municipalities and support the use of the tool.

The modelled results for this deliverable are available in Zenodo with the DOI: 10.5281/zenodo.15425128.

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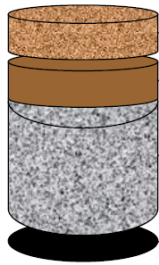
ANNEX: Modelling Hypothesis of the LCA for the Ecully catchment scenarios

Green decentralised scenario – Bioretention cell

Modeling hypothesis

Same hypothesis as the French VF wetland for :

- Material distances and origins
- Material end-of-life
- Building team and engines



- 1,55 m depth – 1 m diameter
- Volume : 1,22 m³ – Excavated volume = 4,87 m³
 - Excavation team work (110m³/h same as CW) = **0,04h**
- Surface layer (wood chips): h = 0,25 m (ρ≈400 kg/m³)
 - V = 0,196m³ -> **M_{chips} = 78,5 kg**
- Soil layer (soil) : h = 0,3m (locally reused)
 - V= 0,236m³ -> **no mass included as it is locally provided**
- Storage layer (gravels) : h = 1 m at the bottom
 - V= 0,785m³ -> **M_{gravels} = 251,2 kg**
- Geotextile S = 0,785m² with 800g/m² (same as CW)
 - **M_{geotextile} = 0,628 kg**
- Lifespan = **25 years** with a full substrat refurbish after 15 years
- Land use : «*Occupation, urban, discontinuously built up*»

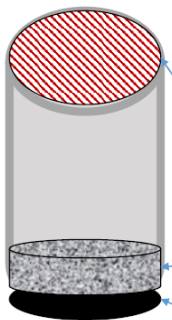
Only technology construction, maintenance and dismantlement were considered

Grey decentralised scenario - Infiltration shaft

Modeling hypothesis

Same hypothesis as the French VF wetland for :

- Material distances and origins
- Material end-of-life
- Building team and engines

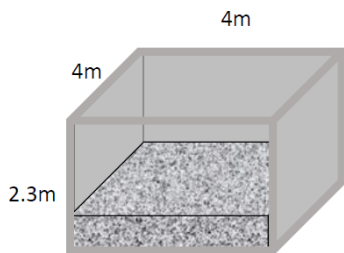


- 2m depth – 1 m diameter
- Volume : 1,57m³ – Excavated volume = 6,28m³
 - Excavation team work (110m³/h) = **0,06h**
- Wall thickness = 0,1 m
 - V_{concrete} = 0,565m³ -> **M_{concrete} = 1 356kg**
- Grid : 0,95 m diameter
 - **40 kg of galvanized steel**
- Gravels : h = 0,2m at the bottom
 - **M_{gravels} = 251,2 kg**
- Geotextile S = 0,785m² with 800g/m² (same as CW)
 - **M_{geotextile} = 0,628 kg**
- Lifespan = 50 years, with no maintenance at all
- Land use : «*Occupation, urban, discontinuously built up*»

Only technology construction, maintenance and dismantlement were considered

Grey centralised scenario – Retention basin

Modeling hypothesis



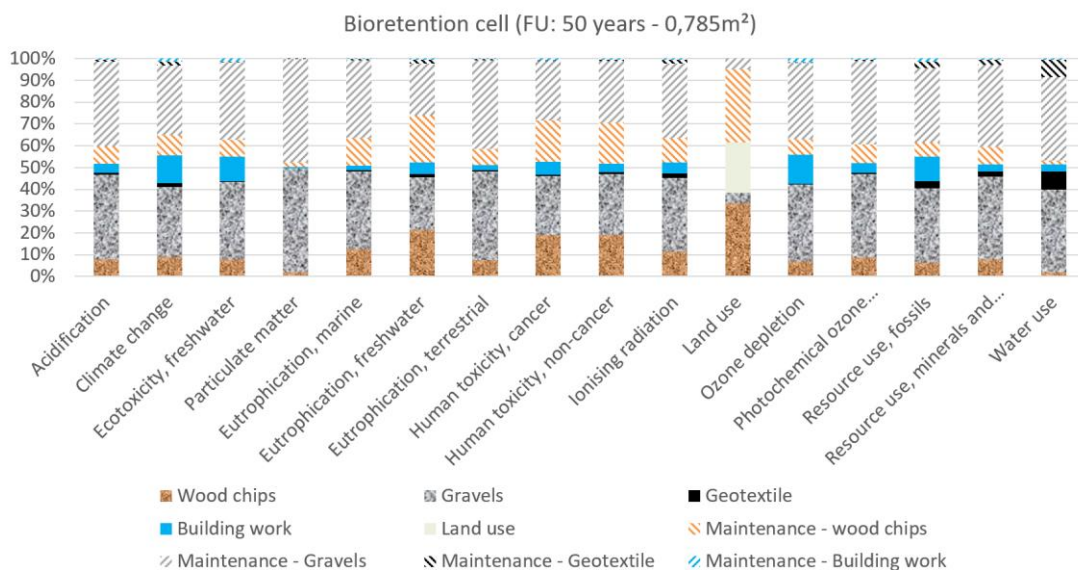
- Area = 4*4m², depth = 2,3m depth
- Volume : 36,8 m³ – Excavated volume = 147,2 m³
 - Excavation team work (110m³/h) = **1,34 h**
- Wall thickness = 0,15 m (sides and bottom)
 - Vconcrete = 7,92 m³ -> **M_{concrete} = 19 008 kg**
- Gravels : h = 0,3 m at the bottom
 - Vgravels = 4,8 m³ -> **M_{gravels} = 7 200 kg**
- Lifespan = **50 years**
 - With a gravel replacement every 15 years (4 times in the lifespan) (including excavation work for the gravel volume)
 - A regular inspection and preventive maintenance
- Land use : « *Occupation, urban, continuously built up* »

Same hypothesis as the French VF wetland for :

- Material distances and origins
- Material end-of-life
- Building team and engines

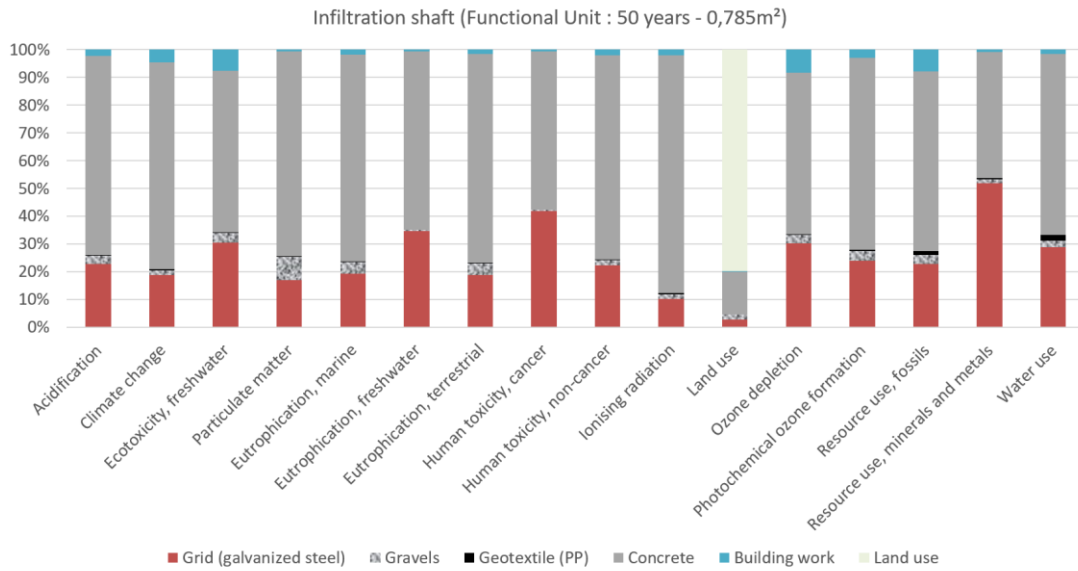
Only technology construction, maintenance and dismantlement were considered

Single contributions for each technology to the impact categories



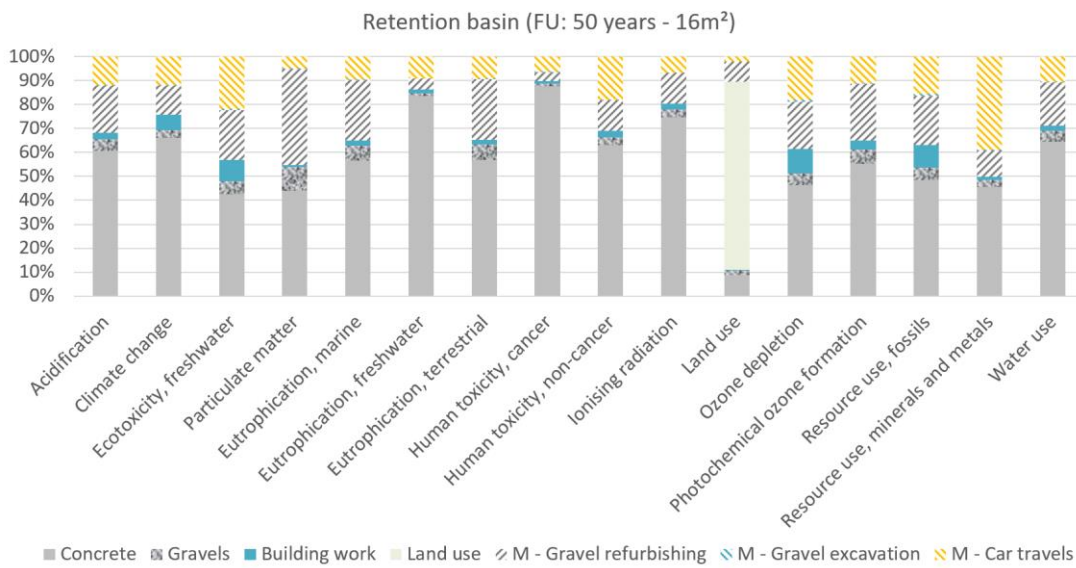
Main materials for construction and maintenance (gravels first then wood chips) are the main contributors to all impact categories.

Software : SimaPro 9.5.0.2
Database : Ecoinvent 3
Characterisation Method : EF3.1



Main impact contributors : concrete (walls) and galvanized steel (grid).

Software : SimaPro 9.5.0.2
 Database : Ecoinvent 3
 Characterisation Method : EF3.1



Main impact contributors : concrete (walls) and gravel for maintenance.

Software : SimaPro 9.5.0.2
 Database : Ecoinvent 3
 Characterisation Method : EF3.1

The overall goal of MULTISOURCE is to, together with local, national, and international stakeholders, demonstrate a variety of about Enhanced Natural Treatment Solutions (ENTS) treating a wide range of urban waters and to develop innovative tools, methods, and business models that support citywide planning and long-term operations and maintenance of nature-based solutions for water treatment, storage, and reuse in urban areas worldwide. The project includes seven pilots treating a wide range of urban waters. Two individual municipalities (Girona, Spain; Oslo, Norway), two metropolitan municipalities (Lyon, France; Milan, Italy), and international partners in Brazil, Vietnam, and the USA will contribute to each of the main project activities: ENTS pilots, risk assessment, business models, technology selection, and the MULTISOURCE Planning Platform. The use of urban archetypes in the Planning Platform will enable users to quickly classify regions (in both developed or developing countries) suitable for the application of nature-based solutions for water treatment (NBSWT) and compare scenarios both with and without NBSWT.



MULTISOURCE
enhanced natural treatment solutions



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