D.4.2 Final report on upscaling possibilities and cumulative effect of NBS in demo sites

Kinga Krauze, Kati Vierikko, Antti Rehunen, Pascal Breil, Renata Włodarczyk-Marciniak, Iwona Wagner

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1. Foreword

ATENAS project was, amongst the others, aimed at establishing a good foundation for small scale applications, that can be up scaled by a number of stakeholders. Each demonstration case took its own path to best support local communities in implementation of Nature-Based Solutions, what meant to indicate the problem, to find its critical aspects, to define how to deal with them, and how to enable NBS in urban scale as both top-down and bottom-up actions.
In Lyon the implementations must be well synchronized with actions of water and sewage syndicates and municipalities, as they close the water quality gap and supplement the conventional solutions. The NBS like constructed wetlands and porous ramps can hardly be implemented by local communities, associations or individuals without detailed research, planning and monitoring. Both types of NBS can however be adjusted and implemented in any part of the world as a strategy to improve state of freshwater bodies.
In Łódź the problem is rooted to post-industrial legacy of the city. Mitigation of drop of groundwater's table and violation of ecological flows in rivers is a very long-term and large scale process. It requires numerous NBS being implemented across the city, protection of ecosystem service hot-spots and importantly broad scale river restoration, at least to change the draining role of regulated channels into water regulation. While protection and restoration of water resources are tasks beyond capacity of individuals and civilians, all citizens can contribute to restoration of water cycle, through disconnecting own buildings and backyards from storm water system and support of infiltration of water, or at least installing rainwater retention facilities that decrease use of potable water for non-consumption purposes. For that reason, ATENAS served analysis of decision making networks to indicated both responsibilities of municipal bodies, but also entry points for citizens, checked legal paths applicable to NBS installation, surveyed general feelings and attitudes of people towards water (in all its forms) and NBS so that the applied solutions respond to society's value system, bypass the zone of concern and increase the knowledge of the audience, triggering many new initiatives.
In Helsinki area the leading role must be taken by the municipalities as managing water in densely populated areas may impose a risk. ATENAS demonstrated however how to open the process of city planning to variety of stakeholders and how to plan the city already for upscaling of in-site solutions towards one coherent system securing water and quality spaces to both humans and nature.

2. Case by case upscaling remarks

2.1 Lyon

Efficiency of the porous ramp

The data measured in the field confirm the efficiency of interception and biotransformation of the organic matter which arrives in the watercourse during stormy episodes and on low flows in the watercourse. The organization of the follow-up was carried out in various points of the watercourse equipped with the two porous ramps, as well as on the upstream and downstream of the watercourse in which it flowed (Fig. 1.1.1. Layout of the measuring points for the physico-chemical quality of surface waters (SW) and hyporheic waters (HW).
). It should be noted that it was complicated to interpret the point "X" downstream because a CSO comes to "pollute" the effect of the porous ramps on the quality of water.

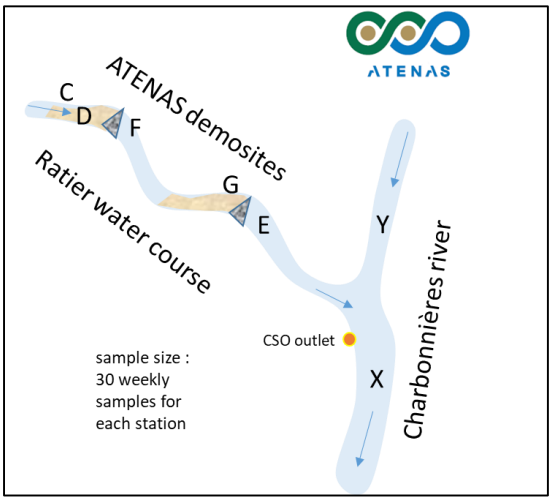


Fig. 1.1.1. Layout of the measuring points for the physico-chemical quality of surface waters (SW) and hyporheic waters (HW).

All results are presented in box-plot form (5%; 25%; 50%; 75%; 95%). Some plots are limited to the 80% quantiles to remove the effect of less frequent events.

The results on total organic carbon (TOC, Fig. 1.1.2) show that the concentration increases in hyporheic water flowing through the accumulated sand at the ramp, while it is lower in surface water. This demonstrates the trapping effect of particulate forms as dissolved organic carbon is little different (DOC, Fig. 26) in the points at stations C and D. There is, however, a drop in DOC downstream, potentially marking the creation of active bacterial biomass.

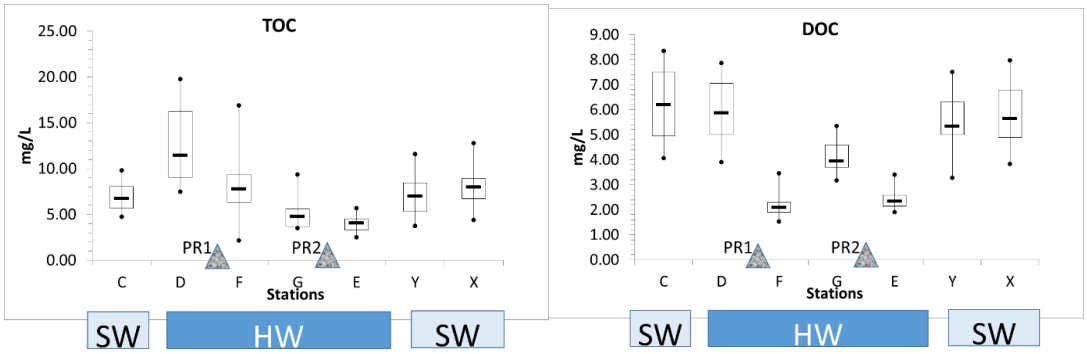


Fig. 1.1.2. The location of porous ramps (PR) 1 and 2 are indicated. Total organic carbon concentrations in surface water (SW) and hyporheic water (HW) (Left). Dissolved organic carbon concentrations in surface water (SW) and hyporheic water (HW) (Right).

The total nitrogen concentration shows an increase downstream of both porous ramps (Fig. 1.1.3).

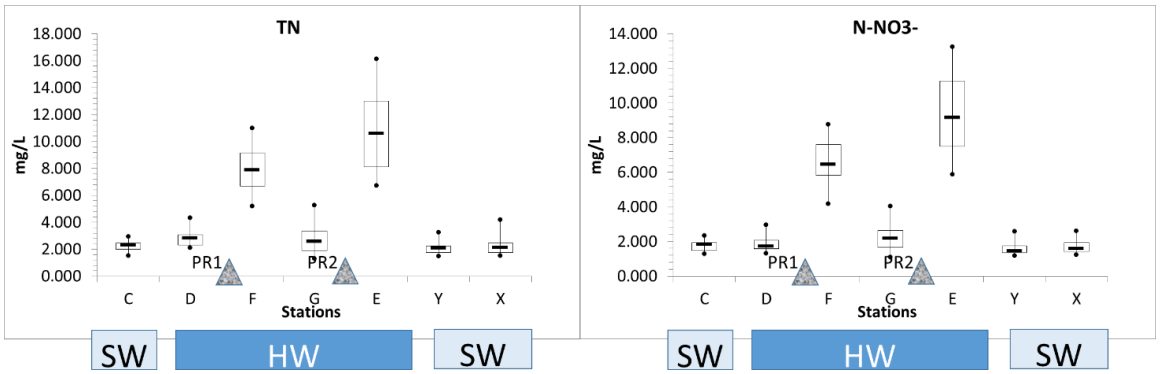


Fig. 1.1.3. Total Nitrogen concentrations in surface water (SW) and hyporheic water (HW)(left). N-Nitrate concentrations in surface water (SW) and hyporheic water (HW) (Right).

Fig. 1.1.3. allows to understand that the majority of the nitrogenous compounds evolve into nitrate ion. The high concentration in the hyporheic water (HW) downstream of the porous ramps can be explained by the accumulation process that occurs in the upstream part of the porous ramps over time. A funnel effect occurs at the base of the porous barriers, where low and medium flow hydraulic constraints limit the evacuation of hyporheic water flows towards the surface. This evacuation occurs mainly during the flooding of the river.

The ammonium ion (NH_4+) is an indicator of the pollution discharged by combined sewer systems. Its concentration is significant in the surface water before the first porous ramp (Figure 1.1.4). This concentration goes from 0.02 on average to 0.007, i.e. a decrease by a factor of 3. This low value in the hyporheic water (HW), which circulates in the sand, induces a significant decrease in the ammonium concentration downstream of the confluence (station X compared to station Y). The result is different if we include the highest concentration values (Figure 1.1.4). In this case, it is observed that they are located upstream and downstream of the porous ramp number 2. These high concentrations follow floods of the river with a delay of about 30 days.

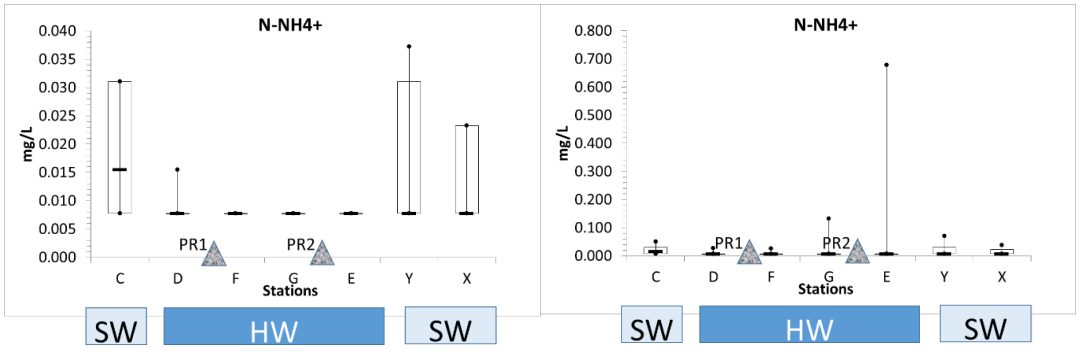


Figure 1.1.4. N-ammonium (NH_4+) distribution in the range 0-80% of ranked measured values (Left). N-ammonium distribution in the range 0-100% of ranked measured values (Right).

One hypothesis to explain this process is the transfer of organic matter stored in RP1 to RP2. This creates anoxic conditions (which have been verified by direct measurement) that are favourable for the production of inorganic NH_4 from Nitrate (NO_3) under the effect of specific metabolic pathways. Although this was not measured at this site (unlike the pilot site), there is probably also production of nitrogen gas N_2 here as a terminal form of biodegradation of nitrogen compounds.

The conclusions of the results for this demonstration site of a NBS in a watercourse are:

- the hydraulic processes combine with bacterial and physical processes (temperature, mechanical filtration, sand erosion-deposition in the upper 0.1m) and produce biodegradation reactions;

- the functions of trapping and transfer of the organic pollution in the porous medium constituted by the sand and the porous barrier are demonstrated by the measurement;
- the effectiveness of the NBS on the Charbonnières watercourses is however not sensitive. This is explained by a too small layout, which represents only 60% of the volume of sand calculated as necessary. Another problem is the presence of an active CSO outlet just upstream of thee station "X", which disrupts the effectiveness measurement of the device. This is therefore a notable limitation of this solution, which implies having a sufficient stream line with a not too steep slope (< 5 p 1000).

Multiplication of solutions in the case area

The demonstration principle used in the ATEANAS project for the solution based on porous ramps yielded positive results. The aim was to convince local managers of the practical and economic feasibility, as well as the performance, of the solution. The managers accepted the principle of a pedagogical board on the site. The idea of replicating the solution was raised at the outset of the project in the event of satisfactory results, with the possibility of disseminating the experience gained to river managers in the Auvergne-Rhône Alps region (https://www.arraa.org/). The principles of implementation and realization are available in the ATENAS project and will be adapted in French to support engineering offices.
Site selection criteria were proposed in the ATENAS project, and field surveys were carried out at the start of the ATENAS project for other eligible sites. The presentation of the results to managers serves as a trigger for upscaling.

ATENAS approach in strategic documents

The Yzeron river basin syndicate is currently analysing the management of storm water runoff on its territory, with the aim of conserving local water resources as effectively as possible and improving their quality. The analysis calls for innovative solutions. The porous ramp solution will be proposed in this land-use planning document, which is enforceable against third parties.

The stakeholders interested in NBS upscaling

The porous ramp solution complements storm water runoff management at source or on slopes. The peri-urban watersheds of major cities are suffering from rapid urbanization, which is leading to a deterioration in the quality of small watercourses, not only as a result of wet-weather urban discharges, but also due to changes in the drainage beds. The restoration of these sensitive water bodies is required by Europe's Water Framework Directive. Replicating the porous ramp solution is a practical and easy-to-implement form of compensation that stakeholders should appreciate.

However, the conditions required for the porous ramp solution are land ownership of the adjoining plots on the right and left banks, and the ability to bring in the porous barrier materials using a mechanical shovel. To be approved by the water authority, the system must not increase the risk of flooding. Consequently, the banks must be in flood-prone areas, with no exposed vulnerability, as the ramps can locally facilitate the overflow of the watercourse in the event of flooding. In France, non-national watercourses are the property of the riparian up to the middle of the watercourse. Owners may not, however, modify the bed of the watercourse, or divert all or part of the flow without authorization. Bed maintenance is the responsibility of riparian owners, who often have neither the skills, means nor inclination to fulfil this duty. This is why river syndicates are taking over the management of rivers not managed by the French state. The implementation of the porous ramp solution is therefore constrained by two conditions: accessibility for work and maintenance, and the absence of flood vulnerability in the vicinity.

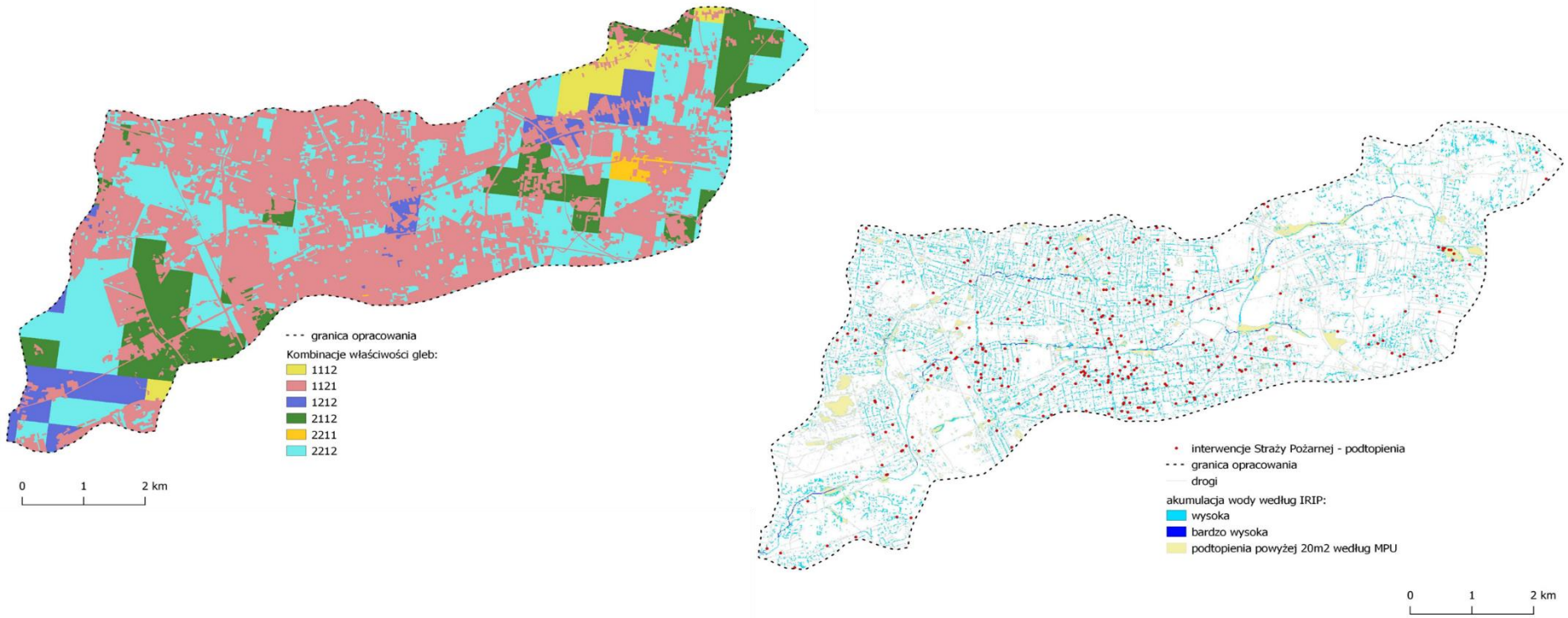
Foreseen cumulative effect of upscaling

The cumulative effect of porous ramps is already being sought between porous ramps. This is because the biofilter volume created by a single porous ramp is insufficient. It is therefore necessary, and if possible, to place the porous ramps in series in a watercourse. This effect is also compounded by solutions for managing runoff at source and on slopes, as the systems developed in urban environments are constrained by the space available. They are effective for normal rainfall, but not for heavy or intense rainfall. Networks are then mobilized, and urban discharges during rainy weather occur less frequently, but continue to exist.

2.2 Łódź

Indication of areas suitable for NBS

IRIP modelling indicated a number of unbuilt areas where currently runoff accumulates causing frequent problems with pluvial flooding (Fig. 1.2.1) and necessity for fire brigade interventions. Many of those areas are not only covered with greenery, but also corresponds with soils suitable for implementation of water detention NBS. Soils coded as 2212 most frequently coincide with flooded areas. It means that except directing water to river corridors instead of roads and streets (main accumulation areas), there is a great potential to re-direct the runoff to parks and green yards structured as well vegetated (to avoid erosion) retention basins. The low water conductivity of soils, but combined with high permeability, means that there is possibility of temporary water stagnation in land depressions after heavy rainfalls. That promises longer water release from the basins through evaporation and infiltration.



Soil code	Permeability	Vulnerability to erosion	Soil water retention capacity	Water conductivity
1112	Low	No	High	Low
1121	Low	No	Low	High
1212	Low	Yes	High	Low
2112	High	No	High	Low
2211	High	Yes	High	High
2212	High	Yes	High	Low

Fig. 1.2.1 IRIP map of water accumulation zones (dots- frequent intervention areas) and the soil properties map with code explanation below.

Decision making system

Considering how favourable the conditions for water regulation are in the Łódka River catchment, the scale of water problem – drying river and extensive pluvial flooding – is rather surprising. The more holistic and consequent actions should be taken to develop and implement the NBS-based water management strategy.

ATENAS allowed to work with small focus group of the city officer to understand what is a decision making process, how coordinated are the decisions and how much inter-sectorial collaboration they involve. Network analysis (NA) has been carried twice – in 2016 – for general environmental risk management and in 2022 for understanding the interaction between the most decisive bodies. The results have been compared and combined whenever necessary. The main bodies involved in NBS process are: Department of Urban Planning and Architecture, Department of Municipal Services (WGK), Divestiture and Property Management Division, Office of The City Engineer, Department of Ecology and Climate (WKŚ), City Greenery (of WKŚ), Road and Transport Authority (ZDiT), Polish Waters, Environmental Protection Department, Regional Board for Environmental Protection (RDOŚ), City Architect's Office, Voivodeship Conservator of Monuments, Marshal's Office, Waterworks company (ZWiK), City Investment Board (ZIM), City Planning Office (MPU), Revitalization Bureau, Voivodeship Fund. for Env. Protection (WFOŚ), City Activation Office and Residents. The tasks they are linked by are indicated in Fig. 1.2.2.

Focusing on two NA parameters eccentricity (*e*) and degree centrality (DC) (Tab. 1.2.1), one can conclude that:

1) As the eccentricity measures how far, at most, is each node from every other node, and in Łódź decision NBS making network we have 20 agents, its values indicate that there is no node truly connected with the others, the lowest eccentricity presents Department of Municipal Services (WGK), surprisingly much higher values got Department of Ecology and Climate (WKŚ) and City Planning Office (MPU). This is WKŚ which is responsible for the strategic planning and maintenance of green infrastructure of the city, WGK takes some of greenery maintenance's tasks and part of blue-infrastructure management, and MPU is key in spatial planning. The *e* values suggest high fragmentation of decisions related to NBS, and self-sufficiency of bodies being involved in NBS implementation, thus no real coordination of actions.

2) The DC index is the sum of edges attached to a node u, if the network is weighted, the DC score is the sum of weights of outbound edges from node u to all adjacent nodes. In the Łódź case it fortunately indicates that all main actors are indeed in the centre of decision making process. However, there are some agencies which competencies could empower the NBS multiplication e.g. the City Investment Board (ZIM) or Road and Transport Authority (ZDiT).

   ZIM is at the forefront of all major infrastructure investments in the city. Limiting its participation in the implementation of the NBS means that many investments are carried out conventionally. The same is true of the Road and Transport Authority (ZDiT), which is the main holder of funds for the reconstruction of traffic routes, i.e. the main holder of a major part of the city's investment budget. Given that most of the areas generating run-off and transferring it are roads, ZDiT's limited involvement in the transformation processes towards blue-green solutions means that most of the NBS upscaling opportunities are not exploited.

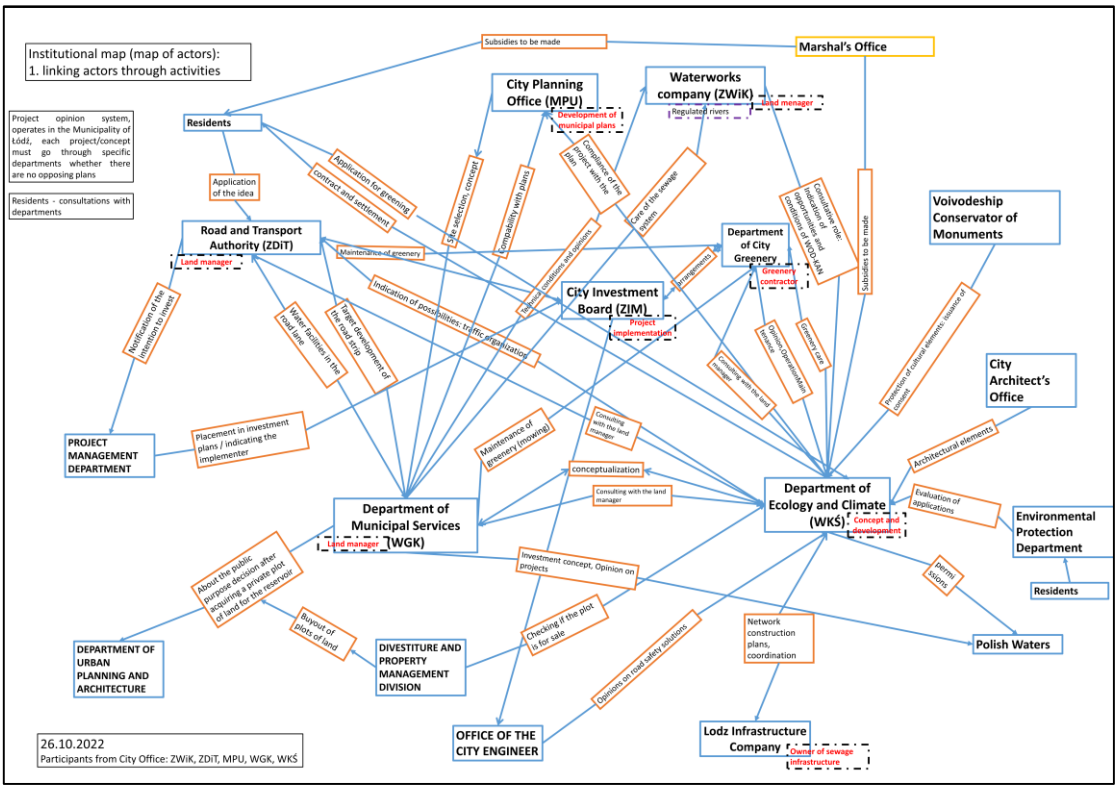


Fig. 1.2.2 NA of the NBS decision making system: Blue rectangle: City Office departments (WHO), Orange rectangle: tasks (HOW).

Tab. 1.2.1. NA analysis of the NBS decision making network.

	Eccentricity	***Centrality Degree (standardized)***
Department of Municipal Services (WGK)	4,76	0,169
Department of Ecology and Climate (WKŚ)	6,19	0,126
City Planning Office (MPU)	6,76	0,118
Regional Board for Env. Protection (RDOŚ)	6,42	0,073
City Activation Office	6,67	0,06
Polish Waters	6,01	0,051
Waterworks company (ZWiK)	5,75	0,051
City Architect's Office	7,26	0,042
City Greenery (of WKŚ)	7,44	0,042
Environmental Protection Department	7,85	0,042
Revitalization Bureau	7,26	0,039
Voivodeship Found. for Env. Protection (WFOŚ)	7,86	0,037
Marshal's Office	7,61	0,031
Residents	8,43	0,028
Divestiture and Property Management Division	8,33	0,025
City Investment Board (ZIM)	7,18	0,022
Department of Urban Planning and Architecture	6,19	0,022
Road and Transport Authority (ZDiT)	6,19	0,014
Voivodeship Conservator of Monuments	8,69	0,006
The City Engineer Office	15	0,003

e = 1 *when the node is connected to all others (star node),* ***e > 1*** *when the node is not directly connected to all others, Larger eccentricity means the actor is farther from others,* ***e = ∞*** *there is no path from that node to one or more other nodes*

Fuzzy Cognitive Mapping and scenarios for NBS upscaling

Implementing Mental Modeller for the ATENAS scenario analysis, after two years of intense communication with stakeholders, and analysing pros and cons, and acceptability of different NBS, led to formulation of four scenarios. Three out of them have been further analysed with NasCanvas approach for social, policy and economic set up (subsequent section of this report).

We constructed the FCM of key actors and their attitudes towards variety of NBS together with evidences of impact of those NBS on the most discussed city challenges (Fig. 1.2.3), such as: drought severity, heat island, flooding, damages to urban greenery, but also issues emerging from those topics - efficient (sprawl-preventing) spatial planning, condition of urban infrastructure or sewage treatment overflows. By changing the strength of interactions towards desirable enforcements of some of them, we checked the outcome.

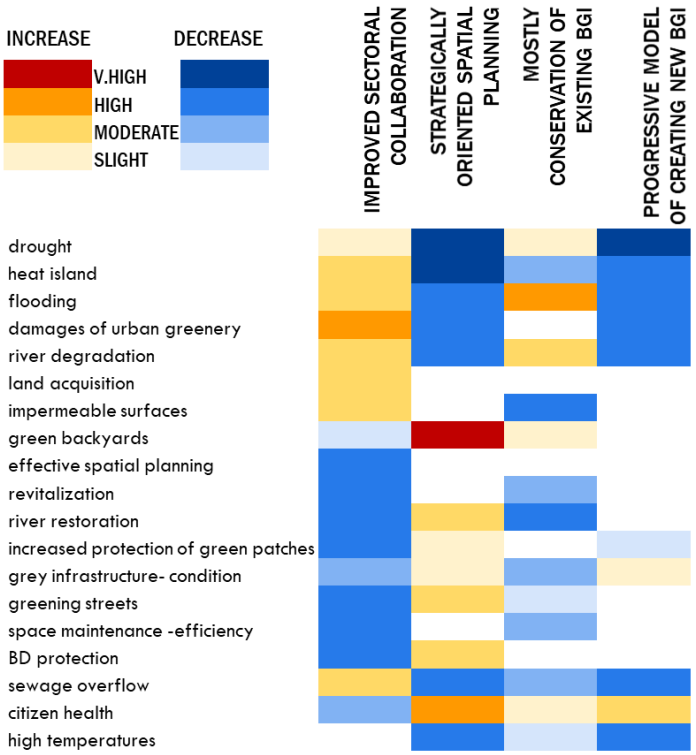
IMPROVED SECTORAL COLLABORATION – it is the model the most discussed by the citizens and the most frequently declared by city officials. As indicated by NA, it is not really in operation yet. The desired state assumes that the NBS related actions are back upped by city strategies and policies, led by one trans-sectorial body, funded by variety of sectors and partnerships, and conducted towards the same and clear aims: strengthening BGN, increasing cooling effect of ecosystems, rebuilding high quality greenery accessible to people and sustaining wildlife, reconnecting and restoring rivers and their corridors. Such aspects like: drought, heat island, flooding, damages of urban greenery, river degradation, land acquisition, and impermeable surface area will unlikely to improve under this scenario, as even more efficient and organize collaboration will not counteract rigidity of procedures, lack of competences, lack of attention and will or no cohesion between strategies, operation, and funding. It will also not change mentality of stakeholders.

STRATEGICALLY ORIENTED SPATIAL PLANNING – scenario assuming adoption of one, coherent strategic plan for city development and adjustment of spatial planning to its goals. Potentially this could be a clear step towards SMART vision of Łódź 2038. This scenario seems to really secure efficient prevention of floods and droughts – mostly through opening space to nature and its services, stopping encroachment of urbanization in the critical areas, decreasing urbanization intensity in areas of high deficiency of greenery and ecosystem services. It may be however not that efficient in protection of biodiversity, as it will not influence maintenance of greenery, it will not operate efficiently on private lands.

MOSTLY CONSERVATION – scenario forced by bottom up initiatives, which however miss the holistic picture of the city and don't fight in "the neighbour battle". The city is viewed from perspective of valuable or functional patches, not health of nature neither economic needs. Keeping status quo will not allow to combat droughts and floods under climate change, as more active planning and management of spaces is needed. It serves some habitats, however will not guarantee increased access to high quality greenery, which requires rather aggregation of greenery in bigger patches connected with corridors, what means scarifying some individual lots. Also uncritical maintenance of current BGI may in fact leave out some areas of bigger potential but still unrecognized, in favour of better lobbed ones.

PROGRESSIVE GREENING – model proposed by ATENAS, starting from survey of blue-green infrastructure, its valuing with respect to long-term or non-monetary values, setting the nature protection, restoration and re-establishing targets, with clear standards to be achieved and systems of revenues. It requires the adoption of stricter rules and strict control of NBS-related compliance, seeking for innovative solutions also in sector of finances and insurance, putting the thresholds to investors' freedom in accordance with low-impact development rules.

Currently the City switches in between business as usual and conservative approach depending on the citizens' mobilization and motivation level, what leaves some space for NBS, but not in accordance with holistic and integrated planning.



SCENARIO	
IMPROVED SECTORAL COLLABORATION	City uses its collaboration network in less than 20% (Kronenberg et al. 2015), scenario assumes 30% increase
STRATEGICALLY ORIENTED SPATIAL PLANNING	There is no systemic approach to spatial planning, with clear delineation of hot-spots requiring either protection or low-impact development & setting rules to development
MOSTLY CONSERVATION	Many citizens and NGOs focuses on protection of individual patches of greenery, they often don't consider city development and related impacts
PROGRESSIVE GREENING	Ecohydrological approach based on preservation of regulatory ecosystem services through development of BGN and systemic implementation of NBS

Fig. 1.2.3 Mental Modeller based scenario building with respect to 4 main discussed actions needed for NBS implementation and city climate adaptation.

Formal, legal, funding paths for the freelance implementation of NBS in Łódź

STEP 1

Starting point: determination of the formal and legal status of the land/property.

a) On the own ground the owner can proceed according to regulations listed below without any additional formal steps;
b) If the plot of land is municipal/ ZDiT (in road corridor)/co-owned, implementation requires an agreement and land use consent.

STEP 2

Verification of the status of the land and checking if NBS or its associated facility, requires a building permit according to the Construction (Building) Law. In some cases, only notification to particular city office is needed (The law has been amended and changes were introduced by the Act of 7 July 2022 amending the Act - Building Law and some other acts (Journal of Laws of 2022, item 1557)).

NBS facilities that don't require a building permit:

- Garden houses up to 35m^2
- Culverts up to 0.85 m^2
- Water ponds up to 50 m^2
- Water reclamation facilities
- Bank walls
- Hydro-geological survey equipment (piezometers)
- Small infrastructures as long as they are not on public land
- Fences up to 2.2 m high
- House terraces up to 35 m^2
- Ponds and reservoirs not exceeding 1000 m^2 and 3 m in depth - on agricultural land.

Facilities requiring notification:

- Sewage treatment plants with a capacity of 7 m^3/day
- Temporary structures up to 180 days (not connected to the ground)
- Piers up to 25 m long and a height of 2.5 m from the bottom of the water body
- Dredging and levee structures up to 1 meter (outside conservation areas)
- Fences over 25m
- Terraces over 35 m2
- Small architecture items in public areas
- Ponds and reservoirs over 1,000 m^2 and 3 m deep - on agricultural land.

Other cases - building permits required

- Facilities of no building permit or requiring notification only, if an environmental impact assessment and NATURA2000 sites are required.
- Construction work on buildings listed in the monuments registry.

STEP 3

Checking the land functions according to the local legislation - local plans, and development conditions (if exists for the lot) according to the Planning and Development Act.

If the land has assigned development conditions (WZ) or the NBS exceeds the parameters of allowed developments or does not fall into free of permit group, then it requires a notification and building permit

If there is no local plan the building conditions are not required.

You need a decision on the location of a public purpose investment if there is no local zoning plan in force for the property and you want to realise a public purpose investment on it. You need to obtain such a decision if you want to build, among other things, the following networks: water, sewage, heating, electricity or gas.

It means that legal bodies owning the land: individuals, companies and housing associations or cooperatives can easily implement small scale NBS with associated small architecture and other facilities, such as rainwater gardens, ponds, detention and retention basins, infiltration diches, green walls, and vertical gardens (if not violating the construction of the buildings).

STEP 4

Funding-wise upscaling of ATENAS-like NBS is empowered by availability of small grants released every year by the municipality of Łodź and by the National Fund for Environmental Protection and Water Management (MyWater).

Rainwater collection

The grants offered within rain water collection can be used for:

- rainwater and snowmelt tanks with installation for connection to the gutter;
- bioretention systems;
- permeable paving;
- irrigation systems using collected rainwater and snowmelt.

Lodz residents can receive 80% reimbursement of eligible costs. The maximum amount of the grant for carrying out the investment on one property is PLN 10,000.

City greening (ZazieleniaMy)

The “greening” grants are for:

- planting of perennial plants (trees, shrubs, perennials, climbers, bulbous/bulbous plants) including preparation of the area for planting (staking, debarking, spreading of agro-fibre);
- the establishment of lawns and/or flower meadows.

An absolute condition is the location of the property in the revitalisation area included in the Communal Revitalisation Programme of the City of Łódź, what includes big part of the Łódka River catchment analysed in ATENAS project. The Office offers reimbursement of 80% of eligible costs. The maximum amount of support that a beneficiary can obtain is PLN 20,000 gross.

The ZazieleniaMy Łódź 2023 grant covers such NBS actions like:

- purchase of materials for perennial planting (trees, shrubs, perennials, climbers, bulbous/bulbous plants); the minimum trunk circumference of tree seedlings measured at 100 cm height should be 16 cm;
- replacement of soil with fertile soil;
- creation of an aeration system - applicable to trees;
- implementation of stabilisation (stakes and/or underground stabilisation system) - trees;
- laying agro-textile fleece;
- mulching with composted woodchips or bark;
- creation of lawns and/or flower meadows;
- maintenance work on existing greenery;
- treatments to protect the existing stand, including the establishment of ties and supports;
- debarking.

MyWater

Individuals who are owners or co-owners of a property on which a single-family residential building is located may become beneficiaries of the scheme.

Funding under the "My Water" programme may be obtained for the construction, commissioning, assembly, installation and purchase of:

- above-ground rainwater tanks with a capacity of at least 2m³ (or a set of 2x1m³) - it is important that the total volume of tanks is not less than 2m³,
- underground rainwater tanks with a capacity of min. 2m³,
- infiltration boxes or tunnels,
- ponds,
- drainage systems in green roofs (without planting),
- pumps, filters, pipes and all components for drainage or rainwater harvesting.

The project in question must be used for a period of 3 years from the date of its completion. The amount of the grant cannot exceed 80% of the cost of the installations included in the project (maximum PLN 5,000 per project). The total value of the investment cannot be less than PLN 2,000.

All the activities that are funded with the grants have been carried in the ATENAS demonstration sites, and the experiences have been shared on the website dedicated to the project. That way ATENAS reinforced upscaling of NBS by those interested in application for the grants.

2.3 Helsinki Metropolitan Region

Malmi

ATENAS case study in Malmi, Helsinki examined different ways to apply NBS to urban storm water management in the densifying sub-centre of Malmi. The aim was to understand how potential synergies between water management goals and other ecosystem services related benefits created by NBS can be measured. Different NBS scenarios were formulated including business as usual, green roofs emphasis, focus on vegetated yards and combined green roofs, and vegetated yards. The results of the analysis indicated that NBS can significantly increase the provision of several ecosystem services and improve storm water management. Green factor for districts was found to be a practical tool for NBS scenario assessment. It recognizes the multifunctionality of the green structure and presents it in a clear form. Modelling the water flow with SWMM tool produced results that were in line with the green factor tool. Key finding was that there is a need to apply several types of NBS, both green roofs and permeable surfaces and plan storm water management and green infrastructure together with buildings and transport. This finding can be taken into account particularly in similar types of densification and urban renewal projects that will take place in different parts of the city. Therefore, the opportunities for upscaling are extensive.

The renewal of Malmi sub-centre is currently ongoing. The city has decided to build a new express tramline across Malmi centre, which has an impact on land use and space available for NBS, and limits the possibilities to develop the most green-intensive scenario. The city planners involved in the case study reported that their key finding were the benefits of vegetated permeable surfaces and thick soils that enable the infiltration to ground water compared to decked surfaces with only thin soil layers on the top for vegetation. This finding will be further examined and taken into account in future plans.

The green factor for districts is taken into use in city planning and will be applied in other planning areas. Further cases have already been discussed and prepared. The tested approach can be repeated rather easily. Much of data used in ATENAS demo site were existing publicly available data.

In storm water modelling with SWMM, small sub-catchments were classified based on land cover distinguishing yards and building roofs on a detailed level. Each sub-basin was given a single land cover type. Differences between scenarios were defined by changing the land cover of sub-catchments to represent different types nature-based solutions (NBS). The methodology offers a flexible and adjustable way to examine impacts. Detailed storm water modelling is mostly based on publicly available data but requires data on storm water network which is typically only in restricted use in the cities.

Upscaling of ATENAS Malmi case methodology takes place in the city of Helsinki and other cities. While green factor for districts still needs further development and standardization, the universities and research institutes have an important role enhancing its use. SYKE will continue to apply the developed approach in future projects. Planning consultancies are also key stakeholders in upscaling, as many municipalities order detailed storm water management plans from them.

Vantaa

The key objective of ATENAS in Helsinki metropolitan region was to support developing and evaluating alternatives for regional urban planning in newly developed residential area and decentralized storm water management in the planning phase. There were no concrete implementations of nature-based solutions during the project but based on results the city aim to develop and implement NBS as a part of planning process. The aim of the Helsinki metropolitan case was to (i) develop a systematic and interactive approach to support multi-objective urban planning in general and (ii) to test the approach in the ongoing urban planning process. Kivistö

development area is a new residential area of about 20 ha, where dense urban construction is planned. A central part of storm water management is building a reservoir for the retention of the flood water. Multi-criteria decision analysis was selected by the researchers to be a key tool for co-planning and support decision making. Researchers at SYKE are experienced in facilitating use of MCDA. SYKE has used the same approach in other cases and it easy to scale up to other situations. It will be used in other projects. In addition to methodological collaboration, SYKE has continued close collaboration with city authorities in Vantaa in another Biodiversa and Water JPI joined funded project Binatur (see more here: https://bringingnatureback.com/). The method and main results were published by the city of Vantaa in openly available document "Public report on multi-criteria decision analyses (MCDA) in urban planning and evaluation of storm water management options - Kivistö case study and recommendations for applying the method collaboration were presented in the publication". The report presents the process and gives recommendations how successfully implement MCDA as a part of urban planning. Permanent link to the document: https://www.vantaa.fi/sites/default/files/document/Monitavoitearviointi-kaupunkisuunnittelussa-ja-hulevesien-hallintavaihtoehtojen-arvioinnissa-vantaa-kivisto.pdf (only in Finnish).

City of Vantaa has developed nature-based solutions in storm water management already for many years. First storm water management program was published in 2007 and it raised the interest of city officials, local residents. Also other Finnish municipalities used the program as an example. After the publication of the first program, storm water legislation has developed and awareness of the impacts of climate change has increased. Latest storm water program of the City of Vantaa was published in 2023 (City of Vantaa 2023[1]). According to the latest program, the quality of storm water is receiving increasing attention in addition to controlling storm water quantities. The densification of urban form in Vantaa and loss of biodiversity have growing significance in storm water management. EU directives and national legislation aim to the good condition of surface waters, and land use planning of the city is seen to have a major significance on how the objectives can be reached. The city of Vantaa involved a large group of stakeholders in the preparation of the new program and the implementation of the program will continue for many years. The comprehensive management of storm waters is stated in the program to call for interdisciplinary expertise, courage to apply new solutions as well as co-operation and commitment of involved actors.

The number of nature-based storm water management solutions in the city of Vantaa has multiplied after the publication of the first storm water program in 2007 (Fig. 1.3.1). According to city planners interviewed in ATENAS project, storm water management NBS have developed over the years, when information has been gathered on the functionality of the first implementations. Latest NBS are better planned in their local context than the first ones.

[1] City of Vantaa (2023). Vantaan hulevesipohjelma. https://www.vantaa.fi/sites/default/files/document/vantaan-hulevesiohjelma-2023.pdf

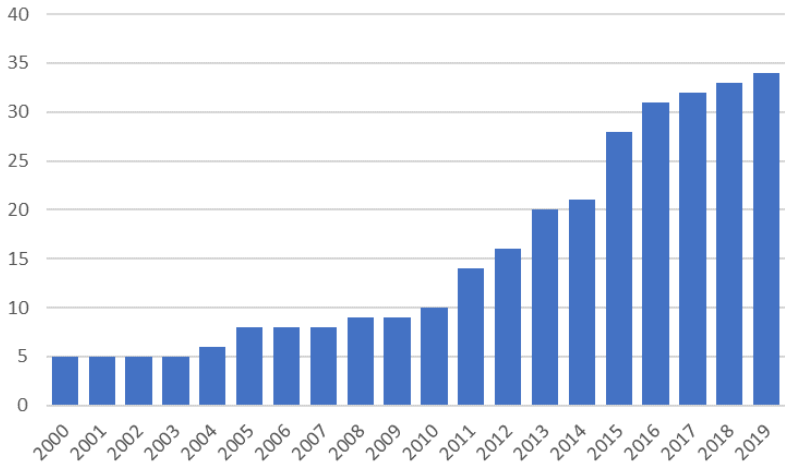


Fig. 1.3.1. Number of storm water structures in the city of Vantaa 2000-2019 (Kennan 2021[2]).

The implemented storm water management NBS have concentrated on certain parts of the city. NBS have been implemented to control and process storm waters from streets and other impervious areas including the airport and to improve the water quality of urban brooks and rivers. Most NBS are located in parks and other greeneries offering also recreational benefits. Several NBS are located in the newly built Kivistö. It has been easier to implement NBS in new neighbourhoods or areas of urban renewal. Many existing areas with lower level of development have only a few NBS implemented in green areas and close to urban brooks. Dense urban environments, such as the city centre Tikkurila, didn't have any NBS in their central parts.

Fig. 1.3.2. Location of existing storm water management structures (red) and urban brooks and rivers (blue) in the City of Vantaa (City of Vantaa 2023).

There is a clear demand to enhance NBS planning and implementation in different parts of the city of Vantaa. There are many neighbourhoods with intensive land use without any storm water

[2] Keinänen, H: (2021). Hulevesiohjelman toteuttaminen Vantaalla. Hulevesiwebinaari 2021. https://www.sitowise.com/sites/default/files/2021-06/Hulevesiwebinaari_2021_KOONTI.pdf

structures. In existing built-up areas, improvements in storm water management usually take place in the connection to larger development project. In the city of Vantaa, there are several densely built sub-centres that face similar type of questions than in the ATENAS case study in Kivistö and Malmi case in Helsinki. When Kivistö case deals with dense greenfield development, most new areas of development are located either in existing centre or residential areas or brownfield development areas.

3. Knowing socio-economic framework for upscaling

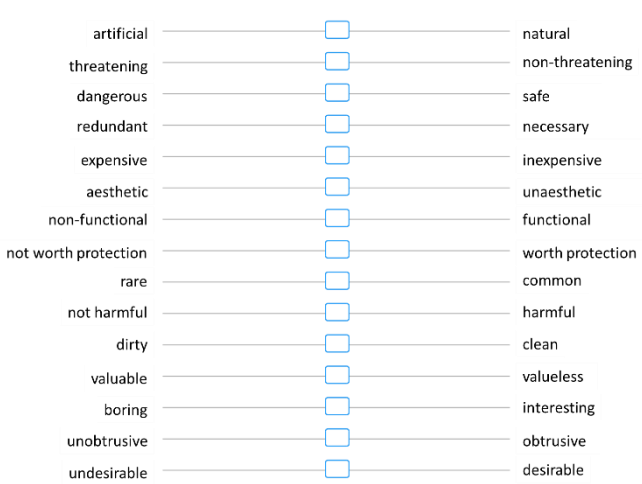
Identifying and analysing public acceptance of NBS, ATENAS cases

During the project the internet-based public survey was conducted. We were interested if residents are satisfied with current climate adaptation policy and tools. Survey was developed to ascertain the values that residents of three demo sites assigned to the water and NBS in cities, In our survey we gathered information through standardized on-line questionnaire (including the series of questions with pre-defined answers to choose from) filled by the respondents. In Łódź we collected 309 filled questionnaires, in Helsinki 115, and in Lyon 26 (youngsters) over 2020-2021. The questionnaire in Lyon was distributed to students in the Master's program in Water Sciences at the University of Lyon. The respondents were trained in water resource management issues. They will later be entrusted with missions in this very broad field (biology, hydraulics, watershed management). It was therefore interesting to test the sensitivity of this specific sub-sample.

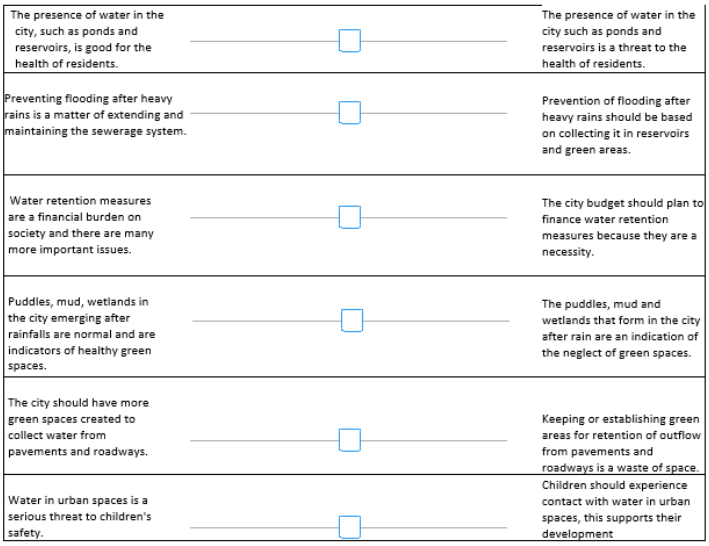
We asked about perception and acceptance of different NBS in cities and whether management measures to improve water resilience are valued by residents.
Gathered information:

- Acceptance of water and different nature-based solutions
- Values of urban water
- Management of water in cities
- Information sources
- Background information of respondents (e.g., age, gender, education, nature activism, relations to water)

Table 3.1. Most important questions in developed questionnaire

<table>
<tr><th>Question</th><th>Answers / results</th></tr>
<tr><td colspan="2">Respondents socio-economic background</td></tr>
<tr><td>Questions about education, age…</td><td>Proportion of respondents:
Male and female
Level of education (primary, secondary, high)
Different age groups</td></tr>
<tr><td colspan="2">NBS presence in the urban space / distance</td></tr>
<tr><td>Would you like the: i)reservoir / ii) infiltration reservoir (dry) / iii) rain garden for water storage to be located:</td><td>
<table>
<tr><th></th><th>Definitely yes</th><th>Rather yes</th><th>Difficult to say</th><th>Rather not</th><th>Definitely no</th></tr>
<tr><td>on the outskirts of city</td><td>o</td><td>o</td><td>o</td><td>o</td><td>o</td></tr>
<tr><td>in my neighbourhood</td><td>o</td><td>o</td><td>o</td><td>o</td><td>o</td></tr>
<tr><td>in my housing estate</td><td>o</td><td>o</td><td>o</td><td>o</td><td>o</td></tr>
<tr><td>in the immediate vicinity of my place of residence</td><td>o</td><td>o</td><td>o</td><td>o</td><td>o</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Water in urban space / emotion</td></tr>
<tr><td>Seeing a puddle on your lawn makes you feel:</td><td>☐ distrust
☐ comfort
☐ disgust
☐ anger
☐ joy
☐ indifference
☐ contentment
☐ don't know</td></tr>
<tr><td>Pairs of features that oppose each other, Tick the feature in each pair that you think best describes the characteristics of water in urban spaces.</td><td>Proportion of replies for different scores (1-5):


</td></tr>
<tr><td colspan="2">Water retention / emotion</td></tr>
<tr><td>Activities that increase moisture and water retention, e.g. leaving lawns unmowed?</td><td>Proportion of respondents to different categories:
o unnecessary and unsightly
o unnecessary but aesthetically pleasing
o necessary but not aesthetically pleasing
o both necessary and aesthetically pleasing
o I don’t have an opinion</td></tr>
</table>

The sentences represent two opposing views on water retention	Proportion of replies for different scores (1-2): 
Knowledge / information about water collection	
the sources of information that spreading opinions about water collection	TV, internet, books and newspapers, acquaintances, school / work, family, own experience /observation statement whether these opinions are positive or negative
Tick all the statements that apply to you	☐ I follow current media information on water storage, ☐ I browse websites and forums for information on climate change ☐ I watch documentaries and popular science programmes on drought and drought management, ☐ I often spend my free time on the water, ☐ I have visited institutions or organisations working to protect water resources, ☐ Difficult to say
Engagement in water retention activities	
If such a situation arose, would you join a project facilitating water retention	○ Yes, the city's water shortage needs to be addressed as soon as possible ○ Yes, if it would not be permanent assistance ○ No, officials should act in this regard ○ No, I do not see the need for this ○ No opinion ○ Other, which,,,

Łódź:

In general, respondents gave positive values for water in cities and supported measures to improve water resilience. They supported activities that increase moisture and water retention especially such as green walls - which were recognized as needed and safe by 78%. Permeable paving was described as needed and functional by 64%. The fewest, 54%, supported leaving the lawns untouched and described it as necessary and aesthetically pleasing in the city, but 37%, described it as necessary but did not consider it an aesthetically pleasing measure. Residents do not necessarily want to see all types of NBS close to their home. They are more in favour for raingardens in the immediate vicinity, in housing estate or neighbourhood than for water reservoirs or infiltration reservoirs. Water reservoirs or infiltration reservoirs they would like to see rather in the neighbourhood. The lowest percentage of respondent's support NBS on the outskirts of Łódź, and the least popular in this context are rain gardens (Fig. 3.1). When evaluating the city's water features, mostly respondents chose positive terms such as: natural, safe, necessary, worth protection, valuable, inexpensive, not-threating, clean, interesting, functional, not harmful, desirable, unobtrusive, aesthetic. Respondents agreed also that: “The presence of water in the city, such as ponds and reservoirs, is good for the health of residents”, “Prevention of flooding after heavy rains should be based on collecting it in reservoirs and green areas”, “The city should have more green

spaces created to collect water from pavements and roadways", "Children should experience contact with water in urban spaces, this supports their development".

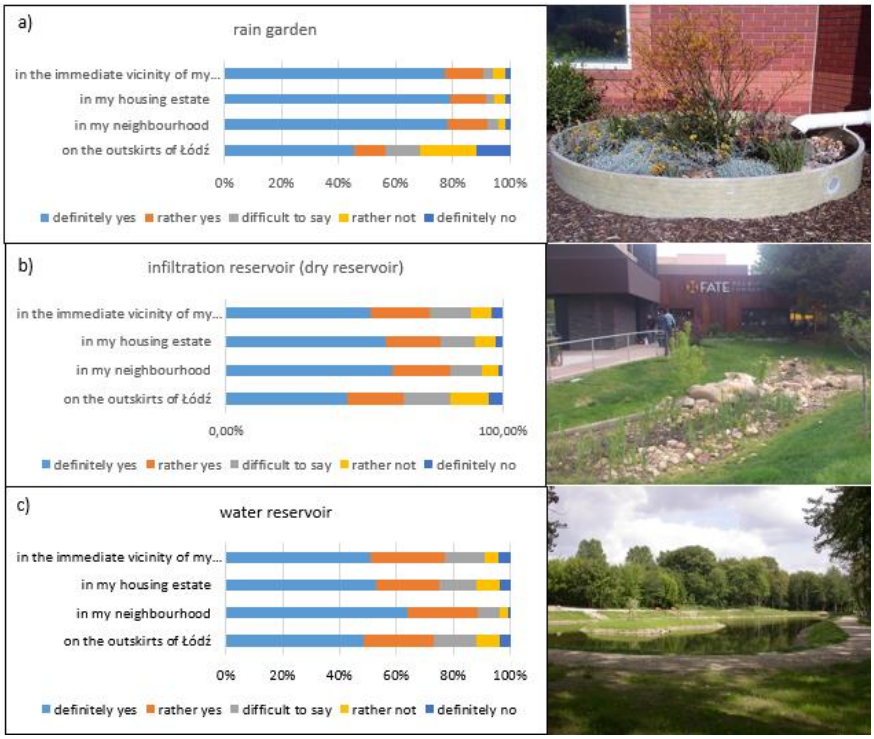


Figure 3.1. Residents' preferences for the location of the 3 types of NBS: a) rain garden, b) infiltration reservoir (dry reservoir), c) water reservoir, in relation to their place of residence: the immediate vicinity of place of residence, in housing estate, in neighbourhood, on the outskirts of Łódź, Poland case.

Lyon:

The main findings show that proximity to water is generally well accepted in urbanized areas, Indifference and satisfaction dominate for the presence of puddles in his lawn. The presence of water in urbanized areas is considered artificial, more or less threatening, even dangerous, but necessary, rather not aesthetic, but functional, rather rare, rather harmless, quite valuable, interesting and desirable. The presence of water is desired but in a secure way. Actions that increase humidity in the city are rather necessary but mainly in the ground. Leaving lawns unmowed are considered as necessary and aesthetically pleasing by 62% respondents. Green walls are perceived as needed and safe by 46%. Permeable paving met with the greatest acceptance – 92% considered it as needed and functional. The presence of visible or hidden water is generally considered good for the health of residents. Flood prevention should instead be based on the collection of water in reservoirs and green spaces. Investments should be dedicated to these developments. The functioning of green spaces in wetlands after rains is considered rather normal. Young people do not necessarily want to see all types of NBS close to their home. They are more in favour for raingardens in the immediate vicinity, in housing estate or neighbourhood than for infiltration reservoirs, However, they are strongly opposite to see rain gardens on the outskirts of the city. Water reservoirs or infiltration reservoirs they prefer to be located in their neighbourhood on housing estates. The lowest percentage of respondent's support NBS on the outskirts of city (Fig. 3.2). The development of green spaces in urban areas is overwhelmingly supported.

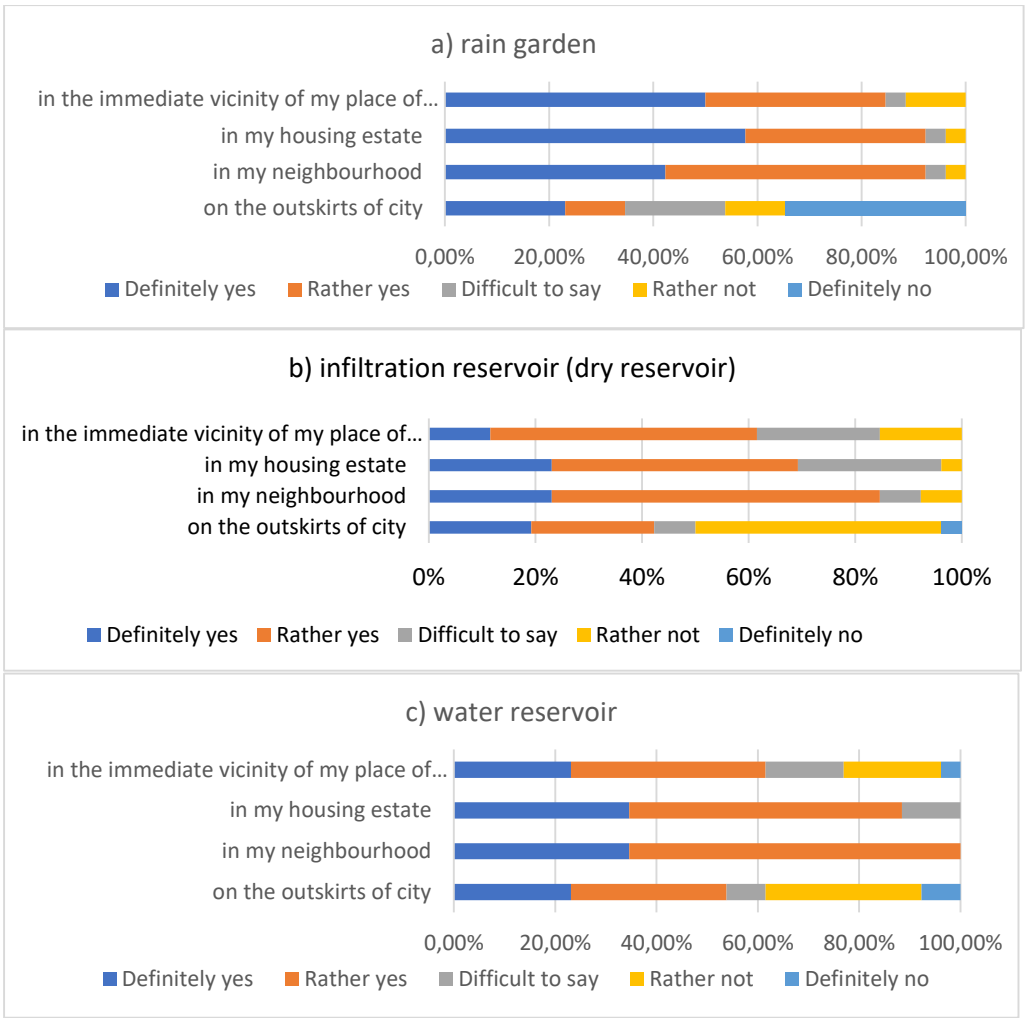


Figure 3.2. Young people's preferences for the location of the 3 types of NBS: a) rain garden, b) infiltration reservoir (dry reservoir), c) water reservoir, in relation to their place of residence: the immediate vicinity of place of residence, in housing estate, in neighbourhood, on the outskirts of Lyon, France case.

Helsinki:

Urban ponds were perceived highly attractive by Finish respondents, similarly as natural wetlands. However, opinions about open channels were more ambiguous. Water in the city was perceived as natural, necessary, aesthetic, worth protecting, valuable, interesting, and desirable element. However, seeing a puddle on own lawn evoked mixed feeling, from distrust to comfort. Respondents agreed that "The city should have more green spaces created to collect water from pavements and roadways", "Prevention of flooding after heavy rains should be based on collecting it in reservoirs and green areas" "Children should experience contact with water in urban spaces, this supports their development", Respondents were positive towards constructed NBS, as seen in their answers: "*more seasonally drying infiltration reservoirs!".* However, similar to Lyon and Lodz case residents do not necessarily want to see all types of NBS close to their home. Their definitely agreed to urban ponds in all 4 locations (the least support is for location in the immediate vicinity of place of residence). Wooded wetlands and open channels were supported mainly in neighbourhood are on the outskirts of residential area (Fig 3.3). Actions that improve water holding capacity and humidity in cities are perceived as necessary, mainly replacing lawn with meadow, and providing semi-pervious paving materials. Green roofs and green walls are also perceived necessary but in this case unattractive.

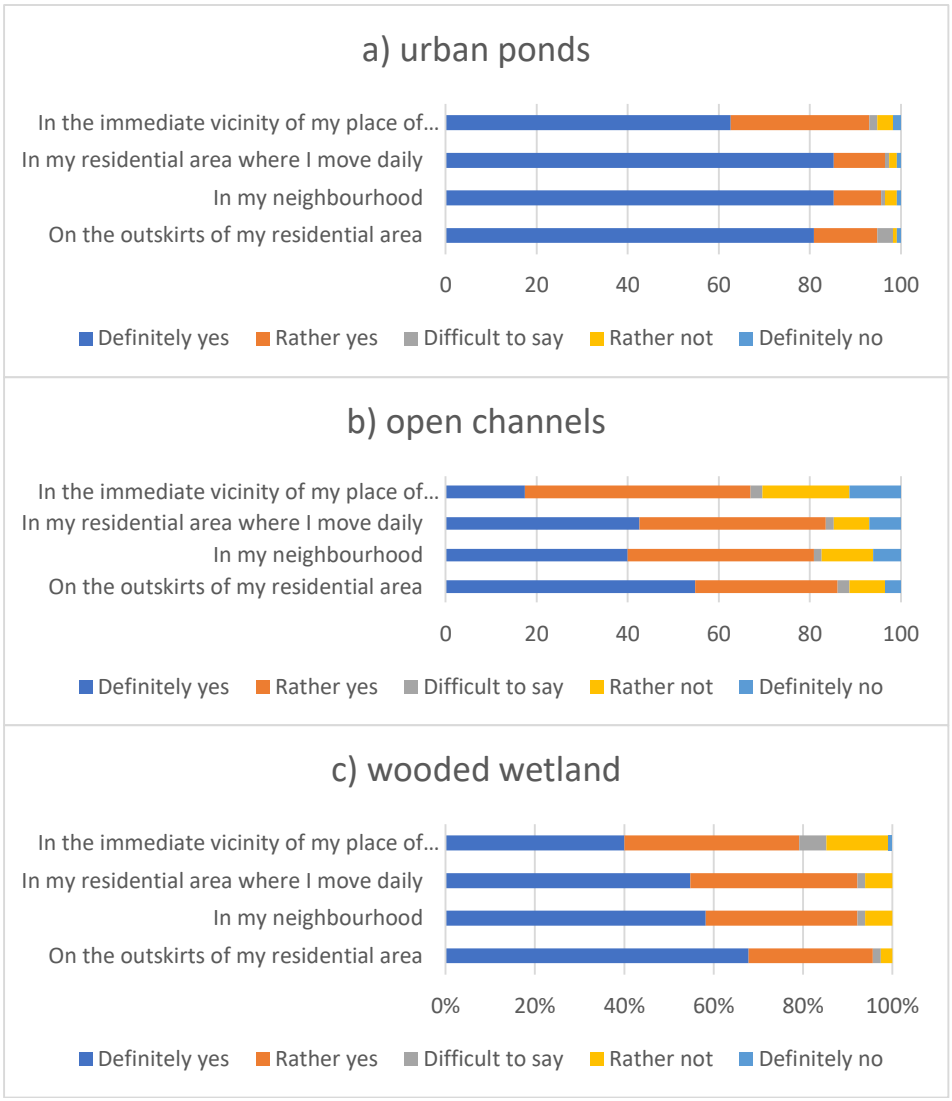


Figure 3.3. Residents preferences for the location of the 3 types of NBS: a) urban pond, b) open channels), c) wooded wetland, in relation to their place of residence: the immediate vicinity of place of residence, in housing estate, in neighbourhood, on the outskirts of city, Finland case.

In general, residents in three countries gave positive values for water in cities and supported measures to improve water resilience. However, their values and acceptance of NBS in general are contradict as residents do not necessarily want to see all types of NBS or forms of water close to their home. We argue that there is a need for collaborative knowledge production and planning of NBS to decrease resistance of local residents towards NBS.

NasCanvas socio-economic model

The critical issues of NBS upscaling are:

1. Clear definition of problem and common understanding amongst the stakeholders of its impact;
2. Interplays between problem owners, clients and beneficiaries of its solving,
3. The existing (or lack of) urgency imposed by either bottom-up pressures from clients and problem owners suffering socio-economic losses or top-down ones imposed by the legal or economic framework;
4. The costs of implementation and (un)foreseen revenue streams.

The often and common challenge in implementation of NBS for water management, is that the water - related problem belongs only to one or very few players, while the client sector and beneficiaries may form a bigger group. It is difficult to convince someone not directly affected by water-related risk to invest in the solutions, especially unconventional ones. Meanwhile NBS are efficient only when multiplied, carefully located, and planned for very particular locations and purposes. In majority of cases those are municipalities or public syndicates, which are charged with water management and protection of common assets, while water risks emerge from legacies: long-term practices, subsequent policy and infrastructure failures, attitudes of players, changing particular interests, etc.

In ATENAS we applied NAIAD NasCanvas methodology (annex 1) to answer the questions:

- What is exactly the water gap problem in the demo case and what value is associated with it?
- Who is the owner of the water gap problem?
- Who is impacted?
- Who is the payer?
- Who benefits from problem solving?
- What is a legal framework?
- What are the real costs of solutions?
- What are / can be revenue streams?

NasCanvas – Łódź

In Łodź ATENAS carried NasCanvas for 3 levels, using expertise of scientists, city officers and local investors: 1) the most common situation of NBS implementation - in fact all the water related NBS existing in the city fall into this category – when this is an international project or cohesion fund being used, the ATENAS implementations belong to this set; 2) private development in a city quarter scale, which hardly apply any NBS at all; 3) the city-scale model.

The project scale NasCanvas model (Fig. 3.4)

Project – based NBS implementations are the most popular in Łódź and its region, Usual problems that are to be dealt is degradation of the local spaces / greenery, flooding problems (never drought) and water quality issues (step 1). If NBS effect could be amplified by multiplication of ATENAS (in-land) solutions or the ones applied directly to water bodies (http://www.arturowek.pl), the consequence would be recharge of groundwater, avoided water logging at water treatment plant, maintenance of ecological flow in at least some rivers and opening the restoration options. Inhabitants would earn also improved air purification services, aesthetic and climate resistant green spaces, and social cohesion (step 2).

However, the problem owner here is not very powerful – those are citizens of the place neighbourhood, who may get empowered by the municipality only if also the latter is affected by the

problem (step 9). In case of applying NBS for problem solving the number of beneficiaries is much bigger (step 10). It includes also investors of nearby lots who could but rarely do support upgrade of public or common spaces, although they have enough power and funding to do so. Part of the problem is national legislation, which in fact doesn't consider blue-green infrastructure as a tool for water-risk management, neither secures access to greenery. So it does not embrace NBS implementation in cities. The second factor jeopardizing multiplication of NBS is lack of trust and experience. The project basis is a safe application mode. The responsibility for ecological and social effect lies completely on the shoulders of project coordinator, as well as funding of the solution (steps 4-7). The city usually enables the space and sometimes communication channels. The impact of such small local NBS is usually negligible unless it helps to build the standing of the municipality.
The funding procedures are simple, because project leader is expected to cover all the costs and usually to maintain the implementation in the project life-time step 8). Much more problematic is NBS maintenance beyond the project. Experiences of ATENAS founding projects i.e., FP6 SWITCH, Life + EHREK, and some simultaneous projects i.e., WWF project of Establishing the habitats for urban pollinators, prove that there is no general strategy for development of coherent network of NBS, no standards for servicing, no budget for maintenance. In case of ATENAS some services are provided by local community however no check on their effects is done from the city level who is the owner of the site.
The incentive of project - based NBS is involvement of the locals, attracting attention to the problems of urban ecosystems, building know-how at different levels and creating showrooms for NBS to prove their role in water management.

Project – based NBS upscaling is the most probable scenario, however such implementations are scarce, small – scale and are not able to really contribute to closing the water cycle gap in the time-window the city needs to react to climate change.

NasCanvas for medium-scale investment (Fig. 3.5)

In the centre of the City of Łódź more than half of the area is owned by either the municipality or by the state. The proportion changes towards private ownership with proximity of the border of the city. However currently with boom for housing and office buildings, many lots have been sold to private investors. There are far going consequences of this more and more common phenomenon. The municipality diversifies the functions of the lots, and in some cases old tenement houses are even replaced by green yards and pocket parks. There is also more control over the general accessibility of green areas. Private investors are entirely gain motivated, and the masterplan and local spatial plans are often violated to increase building intensity at costs of biologically active surfaces, nature, and water storing / infiltrating facilities. All the more, often the pre-war water regulation facilities (drainage / irrigation systems) are removed or destroyed during the construction as without general strategy of protection of natural resources including water cycle each lot is considered as separate entity, and not much more than architectural or urbanistic aspects are considered when the building conditions or permits are issued.
The limited responsibility of investors is also related to the fact that after accomplishment of the construction, the infrastructure is sold to the users and no long consequences of environment's mismanagement are borne by the initial owner. Therefore, water related problems can be formulated as: "Creation of attractive space that does not pose any visible problems". So in short term the owner of the problem is indeed the investor, while in longer term either the owner of neighbouring infrastructure, or end users of the built infrastructure, or owners of the end-of-the pipe infrastructure.

NasCanvas revealed that investors-based NBS upscaling is handicapped mostly by:

- Lack of clear responsibility for rainfall water and waterbodies in the construction sites, neither in terms of quality or quantity;

- Transfer of water related costs to buyers (taxes and tariffs for rainwater recharge, greenery watering, maintenance);
- No reference of local building conditions to nature stewardship in the city masterplan neither its strategies;
- Hardly any economic leverage or revenue available that could at least compensate lost opportunity costs,

Additionally, changing approach from conventional to progressive and climate-adaptive requires having an access to key resources (step 6) and key partners (step 7). Those are hardly achievable due to relatively scarce and young market for NBS related services. Without strong legislative pressure it is unlikely that investors will make an effort and the market will develop.

NasCanvas for Łódź Blue-Green Network development (Fig. 3.7)

The general NBS implementation framework in the city of Łódź is the Blue-Green Network, acknowledged in the master plan and strategic documents as the city system of nature (Fig. 3.6).

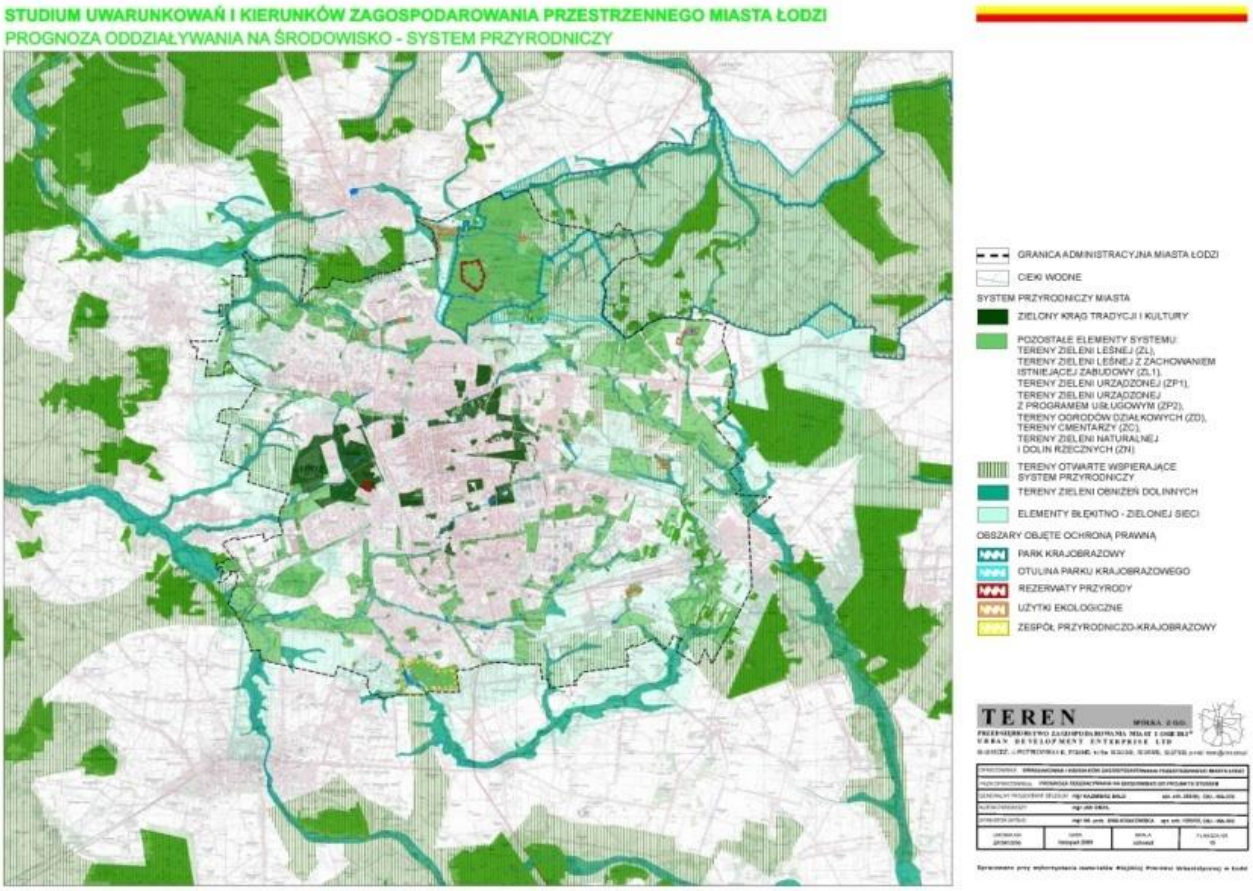


Fig. 3.6. The map Blue-Green Network in the city master plan,

In 2009 Łódź made decision to respect ecosystems and their services and to ground its development on the adaptive capacity of nature (see ATENAS D 4.1.), In order to achieve it, all the stakeholders signed up for protection, wherever possible, as well as restitution / establishing of new NBS. In particular, actions were to be focused on river corridors, agricultural areas, informal greenery forming patches and stepping stones for nature, and roads, which construction involves big part of city finances. There was also an idea to upgrade formal green spaces to enable better water management. Those were municipal departments, civilians, academics, syndicates and investors, who declare their support.

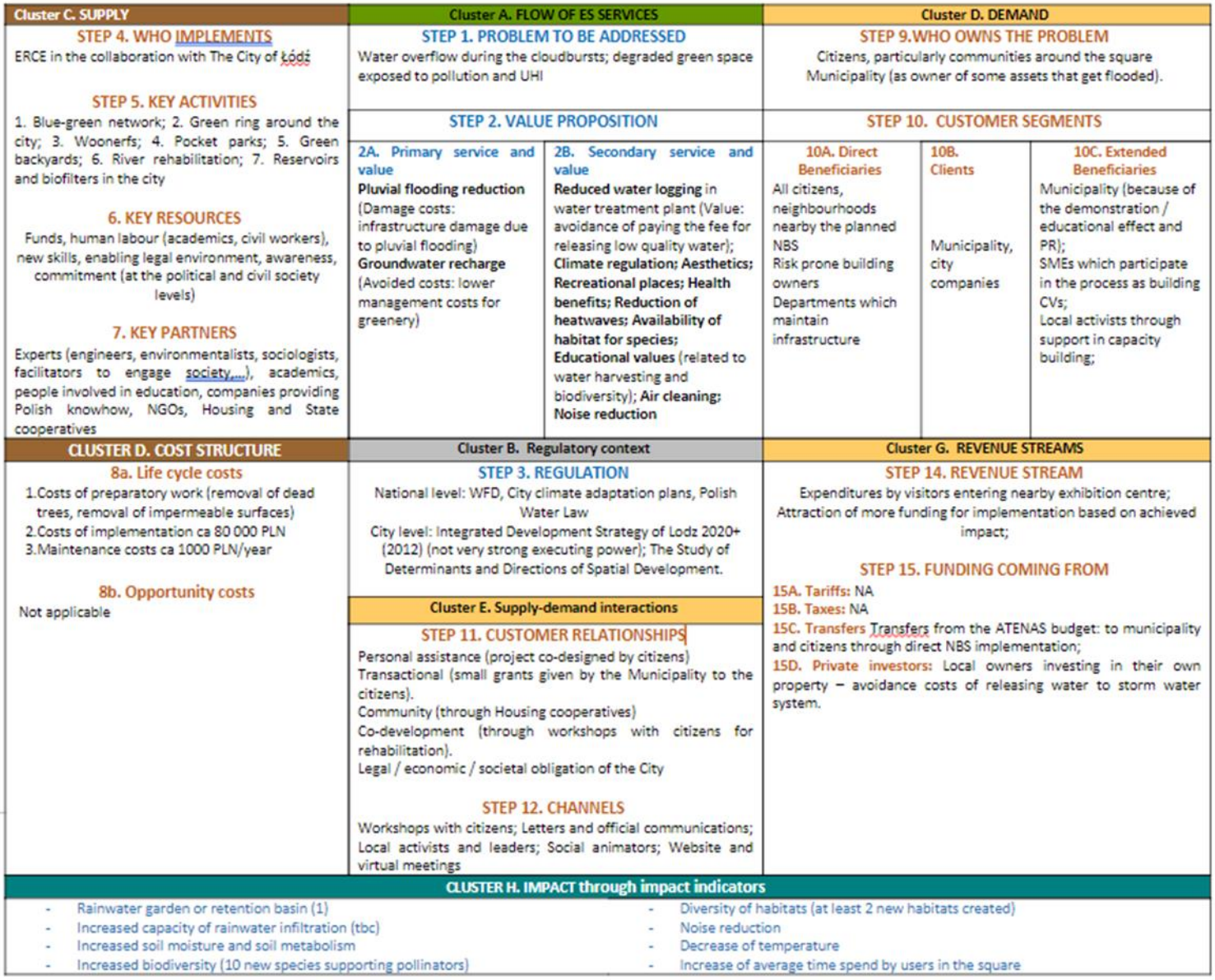


Fig. 3.4. The NasCanvas model of ATENAS-like NBS implementation (project driven).

Fig. 3.5. The socio-economic context of private investments into city's nature.

NasCanvas, carried 15 years later, shows that such broad scale action is rather unlike. The general problem can be formulated as: “Create and maintain an ecologically healthy space”: able to sustain ecosystem services, friendly to inhabitants, favouring green innovation and business. Then the value is nature able to sustain adaptive potential of the city, which should be considered as a deposit securing the human and nature health in the future. There are two owners of the problem - due to ownership of the land – the municipality and private owners. The first one with power (legal, administrative and financial) and urgency although inconsequent across the sectors, but not necessarily legitimacy and knowledge, the second is represented by individuals lacking power and legitimacy, and having no funds to invest, and companies which have all three attitudes however making use mostly with power. There is a broad range of clients and beneficiaries of potential actors, and many of them gain without investing, and not necessarily from really green investments.

Regulatory context is very weak. It includes the masterplan for the city, giving directions for land development, unspecific strategies, e.g., not based on real survey on natural capital, threads and management options, and building conditions and permits issued for single lots and never considering broad scale aspects of water management and climate regulation. The latter allow building up of any green lot in the city just based on the evidences of the way the neighbouring lots are managed, e.g., intensity of building up, the height of buildings, the functions are completely dominated by architectonic and economic aspects, not for example ability of the river to receive extra rainwater from increased impermeable area (Fig. 3.7 A).

The real challenge is however the cost structure (Fig. 4.7 B – current model). Independently of the private or municipal ownership of the land part of costs – accompanying infrastructure (power, water supply, sanitation, roads) is entirely on the shoulders of the municipality. Released from the obligation of e.g., managing own rainwater, the developer doesn’t care much about it, as long as gets connected to the city system. Moreover, the city monetizes land but not the ecosystem services, even if the health, social or economic consequences backfire its development in other sectors. The immediate gain is selling the ground or lease the facilities, thus opportunity costs of deciding for blue-green solutions are hardly accepted.

The main sources of return are depreciation costs of new investments. Thus the higher the costs the better because more funding is released to cover other city costs. However, NBS projects are simply too cheap and allow to feed too few investors to be interesting for bigger player. It means that NBS can happen only as a “side-effect” of construction projects, and their regulatory services not at all considered, and are overrun by the range of cultural and aesthetic ones.

From time to time, mostly in highly conflicting cases, the municipality follows the conservative model of managing the problem. It is mostly based on keeping the status quo of the land and bear with opportunity costs or compensational payments, whenever land development raises strong objections of local communities.

The progressive model - the one which would secure continuous multiplication of NBS following defining and quantification of environmental risks and opportunities – requires complete transformation of first thinking about the city and its future assets, second establishing strong local regulations and control system of law obedience, broader implementation of public-private partnership clearly empowering nature-responsible business, truly circular economy based on reuse of material as well as natural and human resources, and the most of all – removal of all corruption-prone instruments (some of which are rooted already in national legislation / administrative system). Although there are many good examples worldwide, some of them coming from Helsinki ATENAS case study, the rigidity of the administrative system, and slow growth of awareness among the stakeholders indicates that the city is not yet ready for transformative change.

C. SUPPLY

Step 4. Who implements

City - UMŁ all departments of the real estate management company

Step 5. Key activities

Protection, creating and servicing BZS, counteracting corruption; creating regulations and controlling obedience, education, upbringing, management of grey infrastructure; importing innovative solutions;

Step 6. Key resources

Funds, land, favourable legislation, knowledge, science, biodiversity, water, UMŁ, culture, people

Step 7. Key partners

people, science, universities/school, authorities national, regional, NGO, EU, sponsors, technology providers, PIU insurers, artists,

Step 8. Provision of services

Recreation, safety, aesthetics, integration, education

A. FLOW OF ES SERVICES

Step 1. PROBLEM TO BE ADDRESSED

Creation and maintaining an ecologically healthy space

Step 2. VALUE

Blue-green network: residents' deposit handed over to officials for management

B. Regulatory context

Step 3. Regulation / Policy

Regional: Integrated Development Strategy of Lodz Metropolitan Area 2020+, Environmental Protection Program for Lodz Region for the Years 2012-2019;
City: Integrated Development Strategy of Lodz 2020+; Spatial Development Strategy of Łódź; EcoPact – Green Deal implementation plan; Municipal Management and Environmental Protection Policy of the City of Lodz 2020+; The Study of Determinants and Directions of Spatial Development; City climate adaptation plan; Local development plan, programs for environmental protection, air and noise protection;
National: Water Law, European Green Deal, EU policy, National environmental policy 2030; National plan for energy and climate2021-2030, Lex Developer

D. DEMAND

Step9. THE "OWNER" OF THE PROBLEM

City of Łódź and private owners

Step10. Customer Segments

City of Łódź and private owners

10A. Direct beneficiaries
assets owners or tenants

10B. Clients
Land, infrastructure owners

10C. Additional beneficiaries
contractors / services

City of Lodz, residents, investors, developers; green transport, farmers, property owners, recreation sector, education, silver economy (seniors)

F. COST STRUCTURE

Step13A. Life Cycle Costs

Project costs, costs of work and materials

- Budget on blue-green infrastructure

1) Present model (loss)
2) Middle model (we don't lose)
3) Future model

Step 13B. Opportunity costs

- Compensation for lost investment opportunities
- Compensation for limited land use rights

E. SUPPLY-DEMAND INTERACTIONS

Step11. CUSTOMER RELATIONSHIPS

Regulations, projects, programs, media communication, finance, education, standards, prevention of irregularities, strategy, social practices, values, traditions, blocking lobbies

Step 12. CHANNELS

BZS - increasing the value, ventilation channels, river valleys and rivers, phytotechnologies, elimination of spatial barriers,
UMŁ: digital tools, media, events, technologies, catalogue of risks– values, insurance, design, art, handicraft, local regulation, master plan and local plans

G. REVENUE STREAMS

Step14. Revenue stream

Potential: green professions, employment growth / activation, new competences, innovation, new infrastructure, reduction of service replacement costs, sponsorships, subsidies; access to EU funds (Green Deal); avoided costs of infrastructure failure, substitution of ES; increase of taxes due to new inhabitants

Step 15. SOURCES OF FUNDING

15A. Tariffs, penalties, PES

15B. Taxes

15C. Transfers subsidy: subsidy projects in which there are no usage fees for 5 years

15D. Private investors: sponsorship – takeover part of the environmental risk (formerly urban planning), funding compensatory measures; Filling the revenue gap: Earning a dividend when providing services instead of a public partner

H. INFLUENCE

Step 16. KEY PERFORMANCE INDICATORS

No of newly planted trees of survival exceeding 3 years, copiced trees; area of greenery the same or greater, NDVI greater than or equal, list of debtors generating an ecological footprint, funds transferred to blue-green infrastructure, km of restored rivers, m3 of infiltrated water per average rainfall, materials reused for NBS construction, new habitats for native species established, No of revitalized sites with significant temp. drop; at least half-limited loss of trees; No of LIDs; km of roads with NBS; km of BGN restored

A)

F. Cost structure and G. Sources of return

	Current model(loss)	Conservative model (fixed level)	Progressive model (profit)
Cost structure	• The city borrows to consume, greenery is not an investment • No calculation of NBS and nature benefits going into price list • Uneconomic choices under public procurement (increased costs)	Opportunity costs	• appraisers' costs, compensation, own resources of fixed assets • Land redemption • Expropriations • Land consolidation: fees of surveyors, planners, lawyers • Compensation costs • Costs of tidying up, garbage collection, securing the area • Small infrastructure, monitoring
Sources of return	• Depreciation costs that influence overuse of grey infrastructure in „green" projects; • tax from real estate after land sale, • Land sale – for private investors • Increased parcel value in proximity of greenery • Exchange green coins on grey coins: EU grants as green subsidies • Connection tax, land tax	Substitution	• Sale: brands, tickets, services • cultural/agricultural park; good for private stakeholders • Public purpose investment? • Greenhouse: tickets, licenses, eco business, production • bioenergy -utilization? • Tariffs - savings, e.g. on rainwater • ZOO, public spaces - gains food, seeds, siblings, compost, • Taxes from new inhabitants • Tourism | new technologies – LID enforces creativity in use of space, art and architecture; • Less spendings on: health, social cohesion, senior's care; • Trusts – raising public responsibility for BGI

B)

Fig. 3.6. Analysis of socio-economic and legal framework of NBS implementation in the scale of the whole city (Blue-Green Network) (A – the model, B, detailed subsections F and G).

NasCanvas – Helsinki: Vantaa (Fig. 3.7)

The Vantaa demo of ATENAS operated as a kind of exemplary case. Its starting point was logically similar to the Łodź case, however it differed operationally. The Helsinki metropolitan area needs to accommodate more commuters and simultaneously to secure high living standards to better control the regional development and flow of people. Managing water resources under intense land development (step 1) means accommodating surplus of rain water in highly multi-functional landscape. In order to succeed, municipalities keep the ownership of the grounds and the planning rights, while leasing it to investors and end-users. The lease allows actions to be better targeted at primary and secondary services, like: less flooding and related damage, increased access to recreational areas, enhancement of water and nutrient regulation by ecosystems through quantification of demand and adjustment of service supply areas. This seems to be a lesson to learn to Łódź, which area is still 50% greenery, but land rights are massively sold out what has dramatic consequences when simultaneously regulations are weak. The owners of the problem in Vantaa are the key infrastructure and land owners operating within the framework of national Water Service Act, and city level Municipality's storm water management plans followed by guidelines and standards (step 3). The stakeholders being customers and resources of the NBS implementation plan are well networked and systematically involved in the identification of ecological and cultural values of developing areas as well as analysis of economic opportunities that different scenarios may bring. The revenue streams go beyond the simple ground or property values on the market and it incorporates far more the other aspects like green business options, sponsorships, employment activation, indicating that there is enough critical mass of awareness and competences around nature and NBS to open floor for creativity and innovative thinking.
The Vantaa approach to NBS planning applied in ATENAS, proved to fit well the societal needs and legal settings while bringing in-deep understanding of pros and cons of different NBS and range of the location options. The approach itself is getting common for every new land development project. In terms of upscaling – via NBS multiplication – it stimulates integrated water planning. It means that selection and broad use of NBS and hybrid solutions is inherent feature of the approach and a guaranty of it.

NasCanvas – Lyon: Yzeron watershed (Fig. 3.8)

The Lyon NasCanvas reflects small scale project, which can be replicated in the scale of one or several rivers. The uniqueness of the case refers to limited and very well defined number of problem owners encompassing mostly institutions formally responsible for water quality, and anglers being ultimate end users of river ecosystem, and immediately affected by deterioration of its status. The extended beneficiaries – villagers, academics – are customers not much dependent on that status, therefore not in much urgency to act, neither willingness to interfere with existing approaches and procedures.
There is also precisely defined short list of must-be-done: i) Limit runoff at source (less waterproofing), ii) Separate storm water and sewer systems, iii) Rehabilitate and increase the self-purification capacity of watercourses altered by urbanization, with constructed wetlands and in-river solutions. The solutions can be implemented and maintained at low costs, and there is potentially a stable funding source – taxes and tariffs for water use. It doesn't bring any opportunity costs and the risk associated with NBS failure is very low. The benefit can be achieved if the project succeeds, but its failure causes keeping undesirable status quo of water bodies.
As the river monitoring procedures are established and monitoring is obligatory under WFD, as well as achieving good ecosystem state, the NBS which clearly demonstrate positive influence on water parameters are very likely to be multiplied. The money transfers – like the one from ATENAS to local syndicates – allow to test and improve pilots, secure maintenance and monitoring. In fact, lack of clear revenue streams does not impact the upscaling options as avoidance of violation WFD, and not meeting the management targets pays for itself.

<table>
<tr><th>Cluster C. SUPPLY</th><th colspan="2">Cluster A. FLOW OF ES SERVICES</th><th colspan="3">Cluster D. DEMAND</th></tr>
<tr><td>STEP 4. WHO IMPLEMENTS
The City of Vantaa in the collaboration with Helsinki Region Environmental Services HSY, planning consultancies who also implement. Different City of Vantaa units are involved

STEP 5. KEY ACTIVITIES
Planning, designing, implementing, maintaining and monitoring nature-based solutions for urban stormwater management, including different stormwater retention and detention structures, bioswales, and restoration of urban brooks and rivers.

6. KEY RESOURCES
Stormwater fees paid by property owners, municipality’s budget funding, working time of city officials, expertise on nature-based solutions in stormwater management, databases and other information resources

7. KEY PARTNERS
City officials from different city units (water management, urban planning, environment, streets and parks), consultancies, experts of Helsinki Region Environmental Services HSY, research partners, state level environmental administration, private property owners, construction companies, NGOs, local associations</td><td colspan="2">STEP 1. PROBLEM TO BE ADDRESSED
Challenges in stormwater management, pluvial flood risks, water quality problems in urban brooks, insufficient sewage system capacity during heavy rain events causing overflows, inadequate retention of stormwater and lowering of ground water causing lack of water for vegetation during drought periods, degraded environmental quality.

STEP 2. VALUE PROPOSITION
2A. Primary service and value
Water retention
(Damage costs: less flooding and less damage to infrastructure, buildings, and recreation use of environment. Avoided costs: green area management costs)
Water purification
(Avoided costs: water purification, other ways of restoring urban brooks)

2B. Secondary service and value
Aesthetics, recreational benefits, health benefits, local identity creation, reduction of heatwaves, increasing biodiversity, availability of habitat for species, educational values, supports scientific research</td><td colspan="3">STEP 9.WHO OWNS THE PROBLEM
City of Vantaa (municipality that is responsible i.a. for land use, streets and stormwater management), property owners, local residents, users of the environment, Helsinki Region Environmental Services HSY (water and sewage systems) , the Finnish Transport Infrastructure Agency (main roads and their environments)

STEP 10. CUSTOMER SEGMENTS</td></tr>
<tr><td></td><td colspan="2"></td><td>10A. Direct Beneficiaries
Municipality, residents nearby the planned NBS, regular users of the area, risk prone property owners, city units that maintain infrastructure, property owners that experience improved environment and rising property values</td><td>10B. Clients
Municipality, property owners</td><td>10C. Extended Beneficiaries
Residents, visitors of the area, planning consultancies, universities and research institutes</td></tr>
<tr><th>CLUSTER D. COST STRUCTURE</th><th colspan="2">Cluster B. Regulatory context</th><th colspan="3">Cluster G. REVENUE STREAMS</th></tr>
<tr><td>8a. Life cycle costs
1.Costs of planning: 10 000 – 40 000 € per year (the portion that municipality funded) + additional costs (the portion that private funder funded)
2.Costs of implementation: 50 000 – 200 000 € per year
3. Additional costs: 10 000 – 40 000 € per year (research and monitoring project)
4.Maintenance costs: 50 000 – 150 000 € per year</td><td colspan="2">STEP 3. REGULATION
National level: Land Use and Built Act, Water Services Act (stormwater management)
City level: Municipality’s stormwater management plan, Master plan, stormwater management guidelines, street and stormwater planning guidelines

Cluster E. Supply-demand interactions

STEP 11. CUSTOMER RELATIONSHIPS</td><td colspan="3">STEP 14. REVENUE STREAM
Improved state of the environment and recreation opportunities enhances property values in the area leading revenues for property owners in real estate markets, attractive areas offer opportunities for businesses (services, events, recreation equipment sales). Improved water quality and flood control create savings and investment opportunities to further development of the area.
STEP 15. FUNDING COMING FROM
15A. Tariffs: Stormwater fees paid by property owners
15B. Taxes: Municipality’s budget, Helsinki Region Environmental Services HSY budget</td></tr>
</table>

Fig. 3.7. The NasCanvas model illustrating the Helsinki-Vantaa case of NBS planning.

<table>
<tr><th>Cluster C. SUPPLY</th><th colspan="2">Cluster A. FLOW OF ES SERVICES</th><th colspan="3">Cluster D. DEMAND</th></tr>
<tr><td>STEP 4. WHO IMPLEMENTS

The decision is made by the river manager, who has three objectives: protection against flooding, shared management of water resources, and achievement of the ecological status objectives assigned by the WFD, He must obtain the approval of his steering committee, made up of representatives of the partner municipalities,</td><td colspan="2">STEP 1. PROBLEM TO BE ADDRESSED:

IMPACT OF URBAN RUN OFF ON RIVER SYSTEM</td><td colspan="3">STEP 9. WHO OWNS THE PROBLEM (who is affected)

Fishing association, river syndicate (in charge of WFD objectives), sewerage syndicate (looking for ways to improve its sewerage network), local authority (member of river syndicate and financial contributor)</td></tr>
<tr><td rowspan="2">STEP 5. Key activities

(Measures composing the strategy to address the problem)

Limit runoff at source (less waterproofing), encourage infiltration into wetlands with high biodiversity, use rain barrels, No longer send urban runoff into combined sewer systems, but into constructed wetlands, Rehabilitate and increase the self-purification capacity of watercourses altered by urbanization, This will make it possible to treat the uncontrolled part of urban runoff and meet WFD objectives,</td><td colspan="2" rowspan="2">STEP 2. VALUE PROPOSITION
(Damage costs/avoided costs + value of co-benefits)

Improving the ecological status of watercourses (chemical, biological and hydro geomorphological quality), improved water quality for users and wildlife, avoidance of WFD related penalties,</td><td colspan="3">STEP 10. CUSTOMER SEGMENTS</td></tr>
<tr><td>10A. Direct Beneficiaries
of primary value

• Sewer system syndicate (avoid costs)
• Fishery association;</td><td>10B. Clients
the ones who pay for the service

• The river syndicate,</td><td>10C. Extended Beneficiaries

• City/ villages citizens;
• Educational bodies;</td></tr>
<tr><td>STEP 6. Key resources
needed to implement
• Political will
• Specific scientific knowledge (because it is innovation)
• Agreement of stakeholders & river owners
• Legal framework: the WFD, which requires watercourse managers to achieve good ecological status (or good potential status),
• Knowledge of ecohydrological engineering to suggest a favourable location, explain how the NBS works, describe monitoring indicators and visit frequencies,</td><td>2A. Primary Value

• Improving water quality in urban river
• Low-flow support by storing water in the porous ramp with delayed release</td><td>2B. Added Value – (co-benefits)

• Increase/protection of biodiversity
• Erosion control,
• Fish biodiversity / habitat /production
• Security of infrastructure,
• Recharge of groundwater</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>STEP 7. Key Partners
key stakeholders you need to engage with to obtain the resources</td><td colspan="2">Cluster B. Regulatory context
STEP 3. Regulation / Policy
• WFD objective of mandatory good ecological status for the Yzeron watershed, Europe can impose fines on inactive member states,</td></tr>
</table>

- Watercourse managers (river syndicates) and wastewater system managers (wastewater syndicates)
- Regional water agency, which measures the ecological status of watercourses
- State services to ensure compliance with regulations
- Local river users, such as the fishing federation,

- The water resource management plan for the Yzeron catchment area aims to prevent run-off water from flowing rapidly into sewer systems and watercourses. To adapt to climate change, "Every drop of rain counts", The sharing of resources between different uses, including biological flows, is considered,

Cluster E. Supply-demand interactions

STEP 8. SERVICE PROVISION

8A. Primary Service – *economic terms* *(direct service provided to address the target problem)*	**8B. Secondary Services** *(indirect supply of services)*
• Water purification, low flow regulation, water cycling • WFD objectives to reach a good ecological status	• Keeping habitat diversity • Restore habitat diversity and self-purification capacity in rivers constrained by urbanization • Maintaining fish stock

STEP 11. CUSTOMER RELATIONSHIPS
(type of communication between service provider and clients)

- Agreements between water public service providers;
- Contracts in terms of scientific support of innovative solutions
- Obligations of agencies/ responsibility for services

STEP 12. CHANNELS
(means of communication between service provider and clients)

- STRATEGY of water management
- Proof of concept=evidence=pilot cases;
- Media communication
- Revitalization / renovation of infrastructure

Cluster F. COST STRUCTURE

STEP 13 / FA. Life Cycle Costs
Costs of implementing the NBS measure

- Implementation cost: construction cost plus material - 2500 euro / ramp (small/medium river)
- Maintenance / repair costs – up to 2500 euro but depends on return period of flood
- Small monitoring costs (if it works correctly)

CLUSTER H. IMPACT

STEP 16. IMPACT THROUGH impact indicators

Two performance indicators:

- The average thickness of accumulated sediment - must be greater than or equal to 0,3m,
- The colour of the sediment water: a black colour indicates effective biodegradation of organic matter,

Two early warning indicators:

Cluster G. REVENUE STREAMS

Step 14. Revenue stream:
(Income streams associated with services/value generated)

The solution does not create a direct revenue stream, but allows to avoid penalties, Ecohydrological engineering must be transferred to engineering firms for duplication of the system,

2 simple operating indicators + 2 early warning indicators *Extra cost in case of upscaling: consider multiplying the cost by 1 m3 of pebbles or stones placed, i.e., 650€* • incidental land maintenance regarding increased local flooding risk, Porous ramps are best installed in low-stake areas (crops, meadows, peri-urban forests), • In case of upscaling – land price to get access to the river (private ownership of riverbank)	• Loss of material at the tip of the porous barrier, following a major flood, Requires intervention, • Spontaneous vegetation on part of the surface of the sediment stock. This requires removal of the vegetation, **A monthly visit allows us to check these 4 points and intervene at a lower cost if necessary,**	**Step 15. Funding coming from:** collective financing by the municipalities in the area, supplemented by state funding (regional water agency, Region, Department), **15A. Tariffs –** municipalities pay to maintain river system via the sanitation syndicate**,** **15B. Taxes –** tax from water supply funds NBS targeted at sewage capture **15C. Transfers -** Project (research/monitoring by scientist) **5D. Private –** *Increased value of properties*
STEP 13B. Opportunity costs *Avoided benefits from implementation of alternatives***,** **Not applicable** There are no benefits that can be lost due to ramp establishing or construction of wetlands, To improve water quality and achieve good ecological status (WFD), we need to disconnect urban storm water from combined sewer systems and repair the faulty networks,		

Fig. 3.8. NasCanvas model for in-stream activities in Yzeron watershed – project scale.

4. Final remarks

The outcomes of ATENAS have a high potential for implementation in all three demonstration sites.

- The French pilot has been already bought out by the water managers, seeing the possibility to counteract further deterioration of water quality in Lyon's rivers. The chances for successful multiplication are all the greater given that the funding mechanisms for the measures are already in place, the problem owners are defined, not numerous, and determined to find low-cost, high-efficiency solution to meet the standards imposed by WFD. There is also an interest among the academics to improve the systems and modify them according to local conditions as well as good engagement mechanisms to make other clients (i.e. anglers) part of innovation and implementation group.

- The Polish demo is a challenging one in terms of upscaling. Unclear responsibilities, fragmented competencies and obligations, lack of clear revenues from NBS implementation as well as unfixed budget for city-scale actions, finally a number of competing targets which are prioritized according to power of the lobbying groups, bring concerns over the future of Blue-Green Network and NBS becoming a significant part of integrated water management. On the other hand, survey on stereotypes related to water, which revealed very positive and full of understanding view over presence of water in the city (even the inconvenient one), no formal obstacles to individual actions on NBS, and options to get co-funding for NBS, leave hope for more and more bottom up initiatives. ATENAS provided hints and tools for such individual activists to get involved in restoration of water cycle.

- The Finnish case demonstrate how the numerous NBS can be implemented in harmonized way to restore or maintain water cycle under increasing land development. It also presents a best practice in forecasting ecosystem supply and demand relationships in landscape scale, and making a conscious choice over the land development. The mechanisms of discussing the options with different sectors, setting clear goals for sustainable development in regional scale, analysing alternatives, and getting consensus over the choices are worth broader implementation, also in other ATENAS' cities.

5. Annex 1 – the H2020 NAIAD NasCanvas model

The NAS canvas is an adaptation of the traditional business model canvas tailored to the specificities of Nature Based Solutions and their contextual framework. The business model canvas is traditionally used to support companies and businesses to identify and structure their value proposition and the elements required to develop a strong and feasible business model. An example is the canvas by Osterwalder and Pigneur (2010); available at https://strategyzer.com/canvas.

The NAS canvas thus builds on the traditional model canvas, and is expanded to incorporate elements of both the so called 'PPP canvas' for ecosystem services developed by the Inclusive Business Hub[3] and the economic analysis methodology developed in WP4, in order to allow capturing the extended array of co-values, actors and contextual settings inherent to NBS that will ultimately determine and condition the structure and feasibility of a NAS business model.

Business model is a description of the rationale of how an organization creates, delivers, and captures value, in economic, social, cultural or other contexts (adapted from (Osterwalder, Pigneur, & Clark, 2010). It defines the way by which an organization offers value to customers, entices customers to pay for value, and converts those payments to benefits. In the context of NAIAD, due to the often hybrid nature of services (public and private) we will consider how a different organization - be it public, private e.g., an enterprise, an NGO, or a community of citizens - can deliver value to end users. Thus, it also considers the social value (see WP4 for discussion on benefits – private and public and co-benefits). A business model reflects management's hypothesis about what end users want (link to WP3), how they want it, and how an organization can structure and plan to best meet

[3] http://www.inclusivebusinesshub.org/pppcanvas-a-simple-tool-to-tackle-complex-business-models-of/

those needs, i.e., in the case of a private enterprise get paid for doing so and make a profit. For example, we will look at social business models at the community level to reduce national funding gaps for the maintenance of structural and non-structural adaptation measures. New viable business models in which costs structure and revenue streams are considered in such a way to make the value propositions interesting to different categories of stakeholders and investors.

The sequential description of the process and components is described here below.

CLUSTER A: FLOW OF ECOSYSTEMIC SERVICES

This cluster defines the problem to be addressed and the value proposition (i.e., the main service and additional value provided) in relation to damage costs and/or avoided costs, Supporting NAIAD documents to complete this part are Damage Costs (T4.3.) and Co-Benefits (T4.3.)

STEP 1: Problem to be addressed, Cite the main problem to be addressed by the NAS strategy.

STEP 2: Value proposition, In the traditional canvas the Value Proposition is the reason why customers turn to one company over another. It solves a customer problem or satisfies a customer need. The value and main selling point of the NAS strategy will be the capacity to solve the problem (risk reduction function) plus the additional benefits it provides (additional values) which are not provided by other grey alternatives, Therefore, the value proposition is composed of the *primary value* generated by the main function (risk reduction measured through avoided damage costs) and the added value (value generated by the co-benefits). The total value can be estimated as the sum of steps 2A+2B, and will reflect the comparative advantage with other alternatives.

2A. Primary Value: in the NAIAD framework, the main value is reduction of impacts from extreme water related climate events expressed as economic losses (risk function - avoided costs (damage costs)) by risk reduction and prevention.

2B. Added value: all additional values provided that are not obtained with other alternatives (co-benefits) and provide a competitive advantage. These values should be expressed quantitatively when possible or qualitatively otherwise.

CLUSTER B: REGULATORY CONTEXT

STEP 3: Regulation, Regulation impacting or articulating the target problem management. A lack of regulation that should be required could be also highlighted.

CLUSTER C: MAPPING THE SUPPLY

STEP 4: Who implements, Identify the main agent/s responsible for implementing the strategy. If necessary, distinguish by measures within the strategy.

STEP 5: Key activities, List of activities required for the implementation of the measures composing the NAS strategy (NBS/Hybrid/grey/soft). Please list the main activities involved for the implementation of each NBS measure/s and, if possible, of any accompanying grey or soft measures.

STEP 6, Key resources, Resources needed to implement the strategy (existing and non-existing at present-non-monetary) e.g., knowledge, people and capacity, legal frame, political support, other, …,

STEP 7, Key partners, Partners required to implement the solutions and provide the service, i.e., technology centres, regional public administrations, developers, operators, …

STEP 8: Service provision, Describe the services provided by the strategy distinguishing between:

8A. Primary service: main service provided (main target of the implemented strategy)

8B. Secondary services: array of additional services resulting from the implementation of the strategy,

Support Documents T9.4, Stakeholder Mapping and D3.2, Roles and Responsibilities

CLUSTER D: MAPPING THE DEMAND

STEP 9: who owns the problem, Who is directly impacted by the problem or suffers the problem.

STEP 10: Customer segments, Customers can be segmented into distinct groups based on needs, behaviours and other traits that they share. A customer segment for NAS may be defined through spending behaviour (customers, clients), interests, and motivations.

Supporting NAIAD documents: D9,4, Stakeholder Mapping; D 3,2, Institutional Analysis; D8,2, reg framework and D7,1, IVE Fact Sheets.

10A, *Direct beneficiaries of primary value*: agents that benefit from the solution through damage costs/avoided damages.

10B, *Clients:* the ones who are actually paying for the service. They may - or may not - own the problem, being directly responsible for it.

10C, *Indirect beneficiaries*: the extended beneficiaries of real and potential benefits and co-benefits who are currently not paying for the service but may be potentially interested to pay for the co-benefits generated when fully aware of their value.

CLUSTER E, MAPPING THE SUPPLY-DEMAND INTERACTIONS

STEP 11: Customer relationship, Type of relationship between customer and service provider or implementer. The possible types of relationships are personal assistance (human interaction), dedicated personal assistance (dedicating a customer representative to an individual client), self-service (no direct relationship with customer), automated (self-service with automated processes), communities (creation of a community of users that communicates through a representative), co-creation (both customer and implementer/service provider generate value). In terms of the duration of the relationship, it can be transactional, long-term, and purpose.

STEP 12: Channels, In the traditional canvas, the communication, distribution, and sales channels comprise a company's interface with customers. Channels are customer touch points that play an important role in the customer experience, In the NAS canvas, channels are the vehicles by which the different stakeholders involved NAS implementer, possible service providers and customers communicate, i.e., email, social media, formal letters, periodic meetings, …

CLUSTER F: MAPPING THE COSTS OF THE SERVICE

STEP 13. Cost structure: different type of costs associated to the implementation of the strategy.

Support documents: WP4 Guidelines; NAIAD Indicators (under construction)

13A. Lifecycle costs: includes capital costs and operation and maintenance costs.

13B. Opportunity costs: the benefit, profit, or value that would have been generated by implementing other alternatives.

CLUSTER G: MAPPING THE ABILITY/WILLINGNESS TO PAY

STEP 14: Revenue streams, This component represents the cash a company generates from each Customer Segment. Income streams generated as a result of the service provision/value generated (PLEASE include private streams as well as public goods) for which each customer segment is willing to pay and can thus provide an economic return, Identify the different values (including both primary and additional values) that can be "payable" by the different customer segments, indicating a monetary or non-monetary quantity when possible.

STEP 15: Funding, Funding is the money required to implement the measures, that can be obtained from a single source upfront, or from the customer segments. Some of the revenue streams identified in the previous step may need to be devoted to cover the LCC costs of the measure through the economic instruments explained below. Specify the existing or potential funding streams to be used for the implementation of the strategy. These can include or be a mixture of:

15A. Tariffs: Paid by the users of the product or service as a "price" (i.e., water tariff…)

15B. Taxes: paid by the users of the product or service as a fix percentage of the value (i.e., VAT)

15C. Transfers: money provided by external actors such as primarily official development assistance, philanthropic donations, grants, etc.,

15D. Private funds or investment: money invested by the private sector or private investors.

CLUSTER H: IMPACT

STEP 16: Impact KPIs, List of tangible impacts achieved by the implementation of the measure described through KPIs or key performance indicators that should be used to track the performance and efficiency of the strategy.

In order to complement the identification of elements required to generate feasible and successful business models, the process includes two more final steps aimed to identify the main conditions for success and potential barriers for implementation of the NBS strategy.