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Title:

Nature-Based Solutions for Climate-Neutral Neighborhoods: Scenarios for 21 Neighborhood

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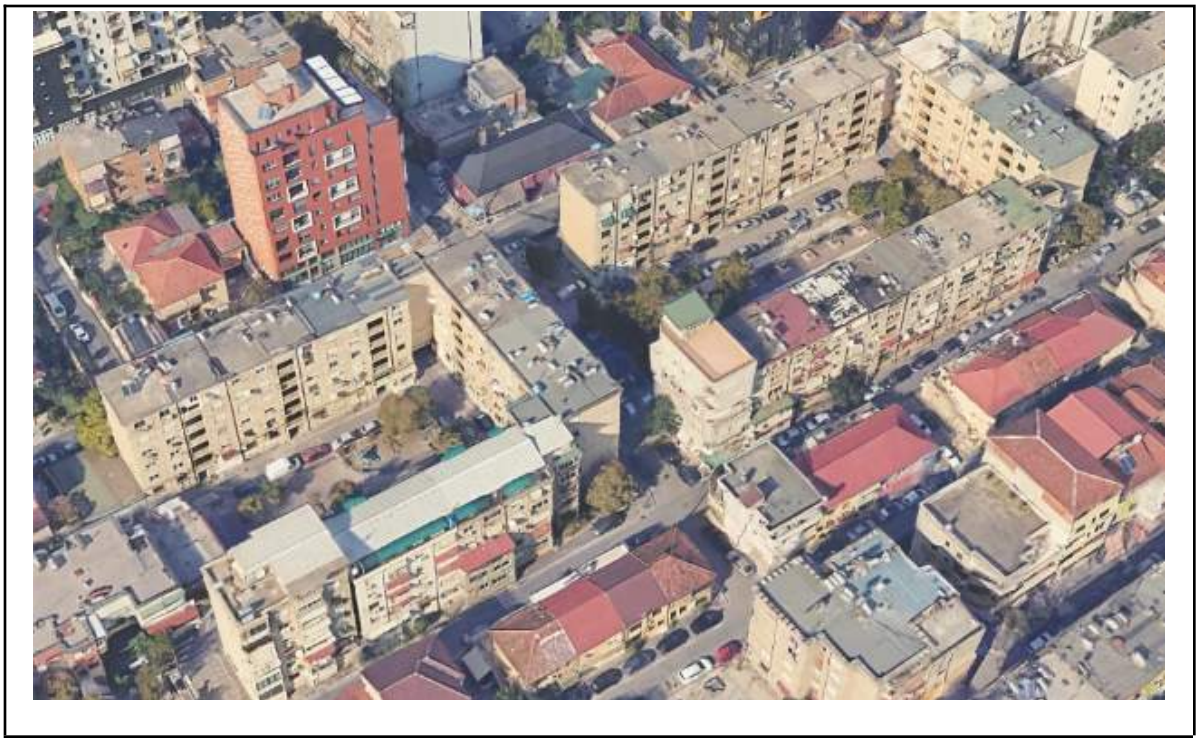

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1. Introduction

The selected neighborhood faces significant challenges regarding environmental sustainability and public space functionality. It is located near the city center and experiences high urbanization pressure, leading to excessive vehicle presence and inadequate green infrastructure. The dominant material in the built environment is concrete, making public spaces uncomfortable for pedestrians and contributing to increased surface temperatures.

One of the main issues in the neighborhood is uncontrolled vehicle parking, which occupies most of the available public space, leaving little room for pedestrians. Green spaces are almost nonexistent, and the existing trees are mostly in poor condition. Additionally, the neighborhood lacks permeable surfaces, exacerbating water management problems such as urban flooding and poor drainage. The extensive use of impervious materials, such as concrete, further reduces the area's ability to regulate temperature and absorb rainfall. The facades of buildings are deteriorated, leading to significant energy losses and reduced environmental efficiency.

Design Scenarios with Nature-Based Solutions (NBS)

To address these challenges, several strategies based on Nature-Based Solutions (NBS) have been proposed:

- **Introduction of Green Spaces**: Creating urban green corridors and small parks to enhance biodiversity and improve air quality.
- **Permeable Surfaces and Water Management**: Implementing permeable pavements, rain gardens, and bioswales improves water infiltration and reduces surface runoff.
- **Reducing Parking Pressure**: Redesigning public spaces to prioritize pedestrian movement and introducing regulated parking zones.
- **Microclimate Improvement**: Planting new trees and vegetation to improve overall comfort in public areas.
- **Community engagement:** The planting of trees and vegetation aims not only to enhance environmental quality and urban resilience but also to engage the local community, fostering a sense of ownership and participation in the transformation of their neighborhood.

2. Area Profile & Observations

2.1 Neighborhood Overview

The 21 Dhjetori neighborhood covers an area of 11,941 m², with a perimeter of 521 meters. The neighborhood consists of a total of 11 residential buildings, each with five floors, making it a typical example of a medium-density urban residential zone. This neighborhood consists of buildings from Albania's communist era and has undergone significant transformations over time due to urbanization.

2.2 Existing Conditions

Previous analyses conducted in this area indicate that air quality is better compared to the surrounding urban areas, also confirmed through a field visit. This can be attributed to the neighborhood's urban morphology, which acts as a

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barrier, mitigating the infiltration of polluted air into the inner parts of the neighborhood. Additionally, these previous analyses showed that the area does not experience significant urban heat island effects and in fact, temperatures tend to be lower, while humidity levels are relatively high. However, the neighborhood faces significant ecological challenges, primarily due to the lack of green spaces, which are essential for improving air quality, regulating temperature, and preserving ecological balance.

Another notable thing to mention is that residents have expressed concerns regarding the use of concrete for benches and park surfaces, as this material discourages the use of public spaces during winter due to its cold and uninviting nature. The dominance of impermeable surfaces, such as concrete and asphalt, further contributes to water management problems. Due to poor drainage, rainwater accumulates after precipitation, which can lead to urban flooding and complicate the daily functioning of residents.

Based on estimates and conversations with residents, the majority of the community consists of families with three to six members, often with young children. There are also elderly people living in this area. This demographic structure highlights the need for adequate green, recreational spaces but also accessible spaces,, which are currently lacking. The absence of safe and functional playgrounds for children, as well as communal spaces for gatherings, further reduces the quality of life in the neighborhood.

During the conversation with the residents of the 21st neighborhood, the residents shared several significant issues that affect the quality of life in this part of the city. One of the main issues highlighted was the lack of benches in public spaces, which makes it difficult to spend time outdoors, especially for elderly people and families with young children. Another issue was that the concrete stairs in the park make it difficult for elderly people to access the park and also it is problem for the childrens safety.

One of the key suggestions made by several residents was the separation of areas for children's playgrounds and dog-walking spaces. The residents believe that the current shared space for both children and dogs is impractical and unhygienic, and they proposed creating separate areas to ensure better conditions for play and the safety of children.

Additionally, during the interview, the residents expressed a desire for the arrangement of gardens and green spaces in communal areas. They suggested allowing residents to plant their trees, which would encourage participation in their cultivation and maintenance. This approach would not only improve the ecology of the neighborhood but also contribute to strengthening cooperation among residents, positively impacting social cohesion in the community.

The residents expressed their willingness to actively engage in these initiatives, believing that such steps would improve the quality of life and contribute to creating a more pleasant and healthier environment for everyone.

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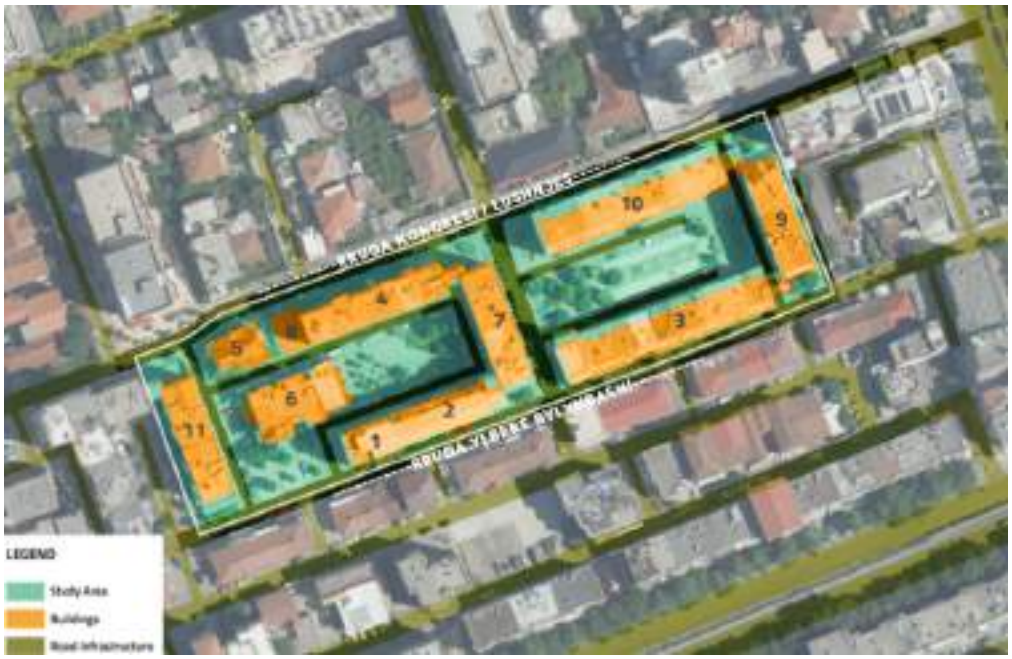

Figure 1. The area of study

Picture 1. General conditions of the area.

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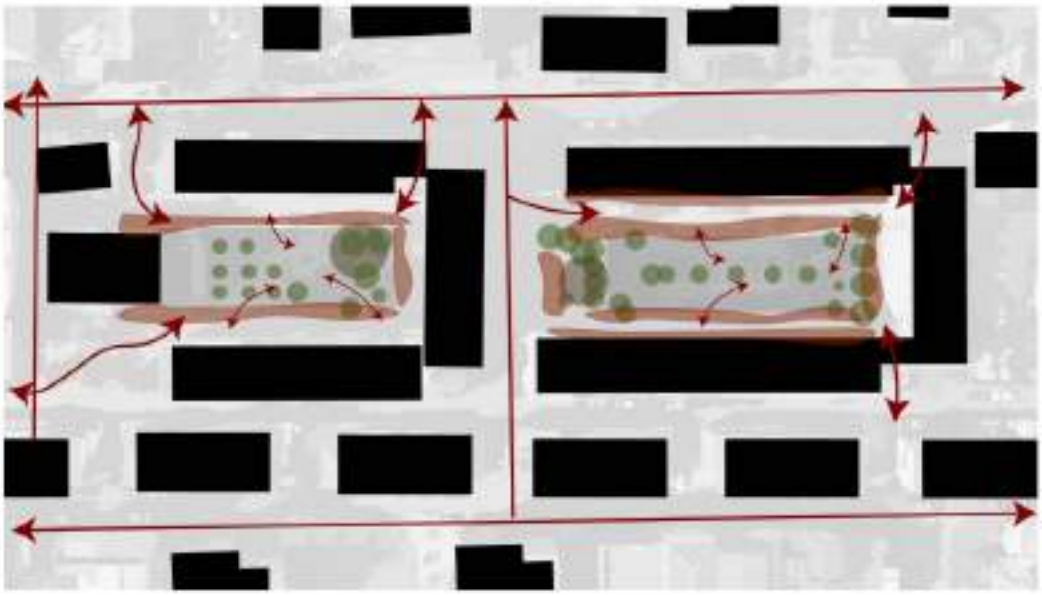

Figure 2. Another problem in the area was the cars parking everywhere, not leaving any space for people. There were only trees present in the area, most of them not in good condition. there was also a lack of permeable surfaces. the dominant material was concrete, uncomfortable for the people. The red spots represent all the places where the cars were parked and the arrows represent the main entrances.

3. Environmental and Ecosystem Services Assessment

3.1 Environmental/Societal Demand

This assessment aims to enhance urban spaces through two integrated scenarios: one focused on water management and the other on optimizing space utilization. Sustainable strategies, including permeable pavements, rainwater collection, and flood-resilient pathways, improve stormwater management, mitigate flooding risks, and strengthen environmental resilience. These solutions promote water absorption, reuse, and long-term sustainability.

Additionally, the implementation of inclusive design elements such as fenced play areas and traffic barriers enhances accessibility and safety, particularly for vulnerable groups like children and the elderly. These measures create a safer, more inclusive public realm by preventing accidents and ensuring a clear functional separation between different urban areas.

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Water Managment	Why we need it? How much improvement?	Area Utilization	Why we need it? How much improvement?
Permeable Pavements	Reduce water pooling and flooding because the rain remains for a long time.	Inclusivity	Different types of population, mostly used by children and elderly, recreation
Rainwater Collecting	To store rainwater for reuse, reducing demand and managing stormwater overflow.	Fencing for Play Areas	Seperating the parking area and public area to prevent any accident.
Flood-Resilient Pathways	Water drainage and absorption Accessibility for all users Pathway protection and durability Environmental sustainability	Traffic Barriers	Keeps kids safe by separating the playground from nearby roads.

Table 1. Environmental/Societal demand table

3.2 Ecosystem Services Supply Assessment

Scenario 1:

Supply indicator	Method and calculation	Value per unit	Is it relevant for the area? 1- not relevant - 5 very relevant
Climate Change and Increased Rainfall	-Climate data analysis from official sources -Extreme rainfall intensity study -Short-duration intense rainfall analysis	-1247 mm/year -80 mm -32 mm [illegible] [illegible]	Poor land use planning Traffic congestion 2
Urbanization Without Proper Planning	Analysis of urban studies and regulatory plans	60% of prefabricated buildings require infrastructure upgrades [illegible]	Biodiversity enhancement Native plant species Pollinator habitats 3
Low Permeability of Surfaces	Analysis of satellite imagery and land use data	Approximately 75% of urban surfaces are impermeable (PubMed Central)	High impermeability Excessive paved areas Poor water infiltration Stormwater accumulation Flooding risk 5
Lack of Water Storage and Retention Systems	Analysis of urban infrastructure and planning documents	Approximately 30% of urban areas lack adequate water storage and retention systems [illegible]	Water retention systems Rainwater harvesting Stormwater management Permeable surfaces Sustainable drainage 5
Runoff avoided due to infiltration	Visual assessment of grass areas and soil permeability, based on observation	Limited runoff reduction due to insufficient grass areas and an underperforming drainage system	The ability to reduce water runoff after rainfall is low in this area due to a lack of sufficient green spaces and an underperforming drainage system. 5

Table 2. Ecosystem service supply assessment for scenario 1.

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Scenario 2

Supply indicator	Method and calculation	Value per unit	Is it relevant for the area?1-not relevant – 5 very relevant
Lack of facilities	GIS spatial analysis Field mapping	number of facilities	Absence of recreational spaces 4
Lack of shade and greenery	GIS spatial analysis + field mapping	Percent %	Limited green spaces Inadequate landscaping 5
No shelter for rain or wind	Rain Cover Analysis	Cover percentage %	3
Slippery or unsafe surfaces	Field inspection	no unit	Slippery surfaces Unsafe pathways Unsecured sidewalks 3

Table 3. Ecosystem service supply assessment for scenario 2.

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4. Scenario Design Process

Scenario One and Scenario Two both aim to improve the neighborhood by addressing environmental and social challenges through nature-based solutions (NBS). Scenario One focuses on environmental sustainability by integrating permeable pavements in parking areas, rain gardens, and 50 trees across two blocks. These trees and green spaces will help manage stormwater, reduce flooding, improve air quality, and enhance biodiversity. The rain gardens act as natural filtration systems, promoting water infiltration and reducing runoff.

Scenario Two, on the other hand, emphasizes community integration, accessibility, and inclusivity. In this scenario, permeable pavements are implemented in parking areas and children's play areas, while community gardens create a space for residents to engage in communal activities and grow plants. These green spaces improve biodiversity and provide safe, accessible spaces for people of all ages and abilities. The design also includes shaded areas and pedestrian-friendly pathways, enhancing the neighborhood's accessibility and promoting physical and social activity. Scenario Two creates a more comfortable and engaging environment for residents. Both scenarios work together to enhance environmental resilience and create inclusive, green spaces that support public health and community well-being, ultimately fostering a more sustainable and livable urban future.

4.1 Scenario 1 –Enhancing Water Management

The analysis of environmental conditions in the 21st neighborhood, scenario one, highlights significant challenges related to climate change, urbanization, and water management. The average annual precipitation amounts to 1,247 mm, while intense rainfall can reach 181 mm in a short period, creating a high risk of urban flooding. Due to the lack of permeable surfaces, water accumulates on concrete and asphalt surfaces after rainfall, further complicating drainage and increasing the risk of infrastructure damage.

One of the key issues in the neighborhood is poorly planned urbanization, where as much as 60% of prefabricated buildings require infrastructure upgrades. The dominance of impermeable surfaces in the urban area presents a serious challenge-approximately 75% of the surfaces are non-permeable, significantly reducing the ability of water infiltration and increasing surface runoff issues. Additionally, 30% of urban areas lack adequate water storage and retention systems, leading to stormwater management problems and reducing the neighborhood's resilience to extreme weather conditions.

The lack of green spaces further contributes to negative environmental effects. The absence of vegetation reduces the neighborhood's ability to regulate temperature and mitigate the urban heat island effect, which can impact residents' quality of life. Moreover, the lack of biodiversity and natural elements in public spaces negatively affects the community's mental and physical health.

To address these challenges, a nature-based water management system is proposed, integrating permeable pavements, rainwater collection, and a rain garden as key components. The permeable pavements, installed in parking areas and pedestrian pathways, will allow water to infiltrate gradually, reducing runoff and replenishing

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groundwater. Excess rainwater will be directed through a system of shallow trenches or underground pipes to a centrally located rain garden in the neighborhood's mini-park. The rain garden, designed to capture and filter stormwater, will improve drainage efficiency while enhancing biodiversity and urban cooling. Any overflow from the rain garden will be redirected to a secondary drainage outlet or stored for non-potable reuse, ensuring effective water management.

By implementing these strategies, the neighborhood will become more resilient to flooding and enhance the overall environmental quality. These interventions will also contribute to increased sustainability by promoting natural water absorption, reducing infrastructure strain, and creating a healthier urban environment.

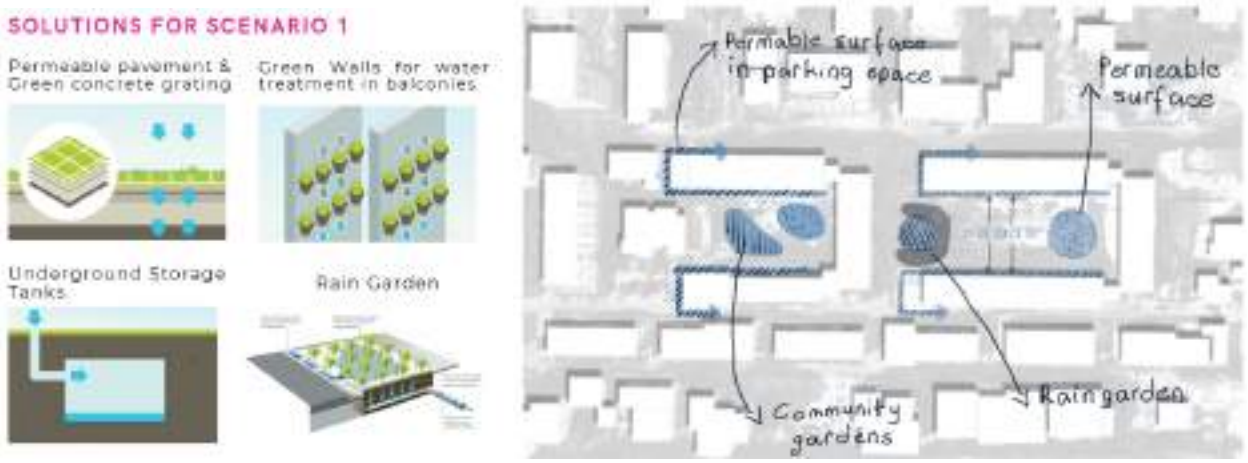

Figure 3. Concept for Scenario 1

Figure 4. Master plan for Scenario 1

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4.2 Scenario 2 – Utilizing the Public Space Effectively

Scenario two identifies key urban and environmental challenges related to the lack of public amenities, insufficient green infrastructure, and unsafe pedestrian environments, all of which significantly impact the neighborhood's functionality and residents' quality of life.

A major concern is the absence of recreational spaces, as revealed through GIS analysis and field research. The lack of parks, playgrounds, and sports facilities limits opportunities for physical activity and social engagement, particularly for children and the elderly. This issue has been assessed as highly relevant (4/5) in the context of urban planning interventions for the area. Despite the presence of a small park in the neighborhood, it remains inadequate in terms of accessibility and environmental quality. The park is predominantly covered in concrete, with little to no greenery, limiting its ability to provide thermal comfort, promote biodiversity, or support social interaction. The lack of shaded areas and natural elements reduces its usability, particularly during extreme weather conditions, further emphasizing the need for strategic improvements in public space design.

Furthermore, unsafe pedestrian infrastructure poses a significant safety hazard. Field assessments indicate that many pathways are uneven, poorly maintained, or composed of materials that become hazardous when wet. These conditions create risks for all users, particularly for vulnerable groups such as children, the elderly, and individuals with disabilities. This issue has been rated as moderately critical (3/5), highlighting the need for targeted interventions to improve accessibility and pedestrian safety.

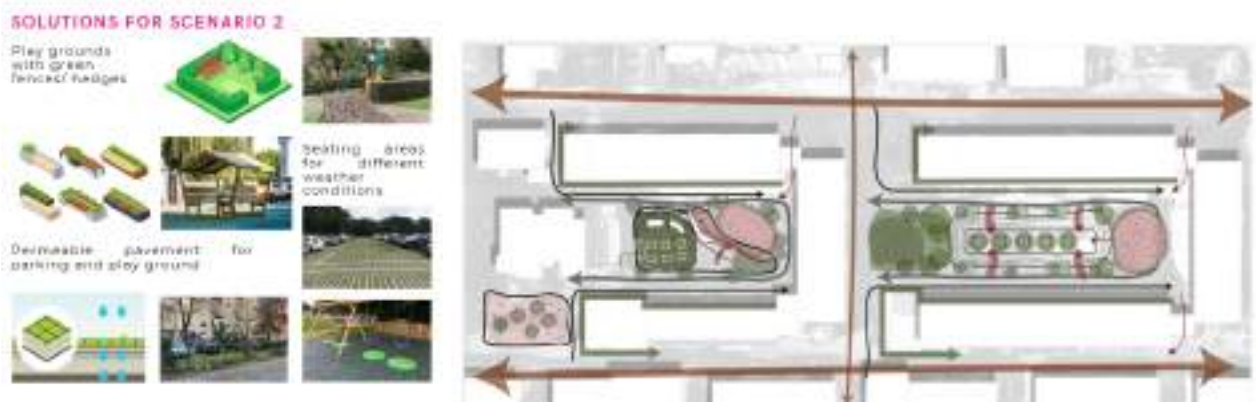

Figure 5. Concept for Scenario 2

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Figure 6. Master plan for Scenario 2

5. Environmental Performance & Ecosystem Service Outcomes

5.1 Assessment of Ecosystem Services – Scenario 1

This report provides an assessment of the ecosystem services that will be enabled through the implementation of Nature-Based Solutions (NBS) in two blocks, with a focus on tree planting, green spaces, and sustainable urban infrastructure. The primary goal is to enhance the urban environment through green interventions, improve the quality of life for residents, and provide ecological, social, and economic benefits.

In the first block, a total of 30 trees will be planted, while in the second block, 20 trees will be planted. The overall design of both blocks includes additional green elements such as grassy areas, rain gardens, and permeable sidewalks. The proposed tree species include pine trees, evergreen species with waxy leaves (possibly linked to Mediterranean varieties), as well as mandarins. The following calculations and estimates provide the monetary value of the ecosystem services that these NBS measures will provide.

1. CO_2 Sequestration (Carbon Dioxide Retention)

Tree planting is one of the most effective ways to sequester carbon dioxide and mitigate climate change. The tree species proposed for planting in both blocks are known for their ability to absorb and store CO_2 over time.

Average CO_2 sequestration per tree: On average, a mature tree can sequester around 22 kg of CO_2 annually.

Total CO_2 sequestration from 50 trees: 50 trees * 22 kg/tree = 1,100 kg of CO_2 per year.

This CO_2 sequestration can be monetized using the social cost of carbon, which is often used to estimate the economic damages caused by CO_2 emissions. The current estimated value of the social cost of CO_2 is around 50 EUR per ton of CO_2.

Monetary value of CO_2 sequestration annually: 1.1 tons * 50 EUR/ton = 55 EUR annually.

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2. Air Quality Improvement and Health Benefits

In addition to CO_2 sequestration, trees also help improve air quality by absorbing pollutants such as nitrogen oxides (NOx), particulate matter (PM10), and sulfur dioxide (SO_2). Trees have a proven effect in reducing respiratory diseases, heat stress, and improving mental health.

Studies show that tree planting can reduce healthcare costs by improving air quality. For this estimate, we take the average annual reduction in healthcare costs of 100 EUR per tree due to improved air quality and public health.

Total health benefits from 50 trees: 50 trees * 100 EUR/tree = 5,000 EUR annually.

3. Stormwater Management (Rain Gardens and Permeable Surfaces)

Rain gardens and permeable surfaces are key elements in stormwater management, reducing flood risk, and mitigating the urban heat island effect. These gardens will absorb rainwater and allow it to percolate into the soil, reducing runoff and improving water quality.

The permeable surfaces will allow water to infiltrate and be absorbed into the soil, reducing surface runoff and preventing floods.

By installing these measures, the community will benefit from reduced flood damage, improved water quality, and decreased need for expensive stormwater infrastructure improvements. In financial terms, stormwater management systems can save up to 500 EUR annually in avoided infrastructure and flood damage costs.

Total savings in stormwater management: 500 EUR annually.

4. Temperature Regulation and Energy Savings

The presence of trees and green spaces plays a significant role in temperature regulation, especially in densely urbanized areas. Trees provide shade and cool the surroundings, reducing the need for air conditioning and energy consumption.

Energy savings: On average, one tree can reduce air conditioning costs by about 30-40 EUR annually. Given 50 trees planted in both blocks, this could result in savings of 1,500 EUR annually on energy bills for the community.

5. Biodiversity and Social Benefits

Adding various tree species, such as pine, mandarin, and evergreen species with waxy leaves, will improve local biodiversity and create habitats for pollinators, birds, and other wildlife. Social benefits include providing a pleasant environment for residents, especially children, who will have a safe and green space to play, as well as reducing stress in the community.

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While it is difficult to quantify in monetary terms, the positive impacts of improved public health, community engagement, and environmental education significantly contribute to the social well-being of the neighborhood. The proposed NBS in the two blocks, including tree planting, green spaces, rain gardens and permeable surfaces will provide significant ecological, social, and economic benefits to the community. The total annual value of the ecosystem services from these measures is estimated at 7,055 EUR. These interventions will improve air quality, mitigate the urban heat island effect, enhance stormwater management, and improve biodiversity, contributing to a more sustainable and resilient urban environment.

By implementing these strategies, the neighborhood will not only address current ecological challenges but also lay the foundation for a greener, healthier, and more sustainable urban future.

5.2 Assessment of Ecosystem Services – Scenario 2

This report analyzes the ecosystem services enabled by the implementation of natural solutions within Scenario 2. The focus will be on the introduction of permeable surfaces, and community gardens, along with the installation of permeable surfaces in parking spaces. The goal is to improve the urban environment through sustainable infrastructure that contributes to the ecological, social, and economic well-being of the community.

Within Scenario 2, the following natural solutions are proposed:

The two blocks will incorporate permeable surfaces in the parking areas and children's play zones, enhancing stormwater management and reducing surface runoff. Additionally, community gardens and green spaces will be established across both blocks, allowing residents to grow plants and vegetables. These spaces will foster biodiversity, support community engagement, and improve the urban environment. The design emphasizes inclusivity and accessibility, ensuring that all residents, including children, the elderly, and people with disabilities, can fully engage with and benefit from these areas. By integrating green infrastructure and promoting community interaction, this design will enhance the quality of life in the neighborhood.

1. Carbon Sequestration and Air Quality Improvement

Trees and vegetation on permeable surfaces can contribute to carbon sequestration. In combination with other plant species, these surfaces can help reduce carbon dioxide emissions, which has long-term benefits for mitigating climate change.

- Carbon Sequestration: Although permeable surfaces do not sequester CO_2 like trees, the addition of plants and trees to green spaces certainly contributes to reducing carbon dioxide in the atmosphere. The total carbon sequestration is estimated at 15 kg per plant annually.

Average CO_2 sequestration per tree: On average, a mature tree can sequester around 22 kg of CO_2 annually.

Total CO_2 sequestration from 50 trees: 40 trees * 22 kg/tree = 880 kg of CO_2 per year.

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Green spaces reduce the levels of air pollutants such as nitrogen oxides (NOx) and particulates (PM10). By reducing pollution concentration, public health improves, especially respiratory health.
Total health benefits from 50 trees: 40 trees * 100 EUR/tree = 4,000 EUR annually.

2. Stormwater Management

On parking areas and other green spaces, these surfaces will allow rainwater to permeate the soil, reducing surface runoff and the risk of flooding. By reducing the need for investments in traditional stormwater infrastructure, these measures can save approximately 400 EUR annually.

3. Temperature Regulation and Energy Savings

Trees and vegetation provide shade, reducing the need for air conditioning and lowering energy costs. Green spaces also improve the microclimate in urban environments. The estimated energy savings for the community could be around 1,200 EUR annually.

4. Biodiversity and Social Benefits

By introducing different plant species, including those used in rain gardens and the community garden, biodiversity in the urban environment will be enhanced. These spaces provide habitats for pollinators, birds, and other wildlife.

The community gardens will create a space for communal activities, promote socialization, and engage the community. This space will also contribute to the creation of educational and recreational zones for children and adults, further improving the quality of life in the neighborhood.

5.3 Comparison Table – Ecosystem Services Achieved

Exemplary services:

Urban ecosystem service	Scenario 1 contribution	Scenario 2 contribution
Cooling Effect	Increasing permeable surfaces and rain gardens can contribute to reducing temperature, but may not have a large cooling effect.	Green spaces and community gardens can help regulate the temperature in the area.
CO_2 Sequestration	Trees and green spaces reduce CO_2, but won't have a major effect without larger-scale implementation.	More green spaces and gardens directly contribute to higher CO_2 sequestration.

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Air Quality Improvement	Rain gardens and permeable surfaces can improve air quality by reducing pollution, but the effects may not be immediately noticeable.	More green spaces improve air quality by filtering dust and pollutants.
Flood Mitigation	Implementing permeable surfaces and rain gardens together with rainwater retention systems significantly reduces flood risk through water infiltration.	Green spaces and permeable surfaces further reduce flood risk, especially in urban areas with heavy rainfall.
Biodiversity Enhancement	Green spaces, though beneficial, may not provide a large diversity in urban environments.	Community gardens and diverse green spaces can significantly increase biodiversity.
Recreational Value	Increasing green spaces can improve recreational opportunities, but more space might be needed.	Community gardens and well-designed green spaces create significant opportunities for recreation and social interaction.

6. Social and Economic Impact Assessment

6.1 Health Benefits

Scenarios 1 and 2 implement natural solutions that have a significant impact on public health. In both scenarios, the use of permeable surfaces and rain gardens contributes to the improvement of air quality. Green spaces reduce pollution levels, such as nitrogen oxides (NOx) and particulate matter (PM10), which positively affect the respiratory system, lowering the risk of diseases such as asthma and bronchitis. Trees and vegetation absorb carbon dioxide and reduce pollution, directly benefiting citizens' health.

In Scenario 1, the focus is mainly on permeable surfaces that allow water infiltration, reducing the risk of urban flooding and overheating, while Scenario 2 includes community gardens, which provide space for social activities and relaxation. Green spaces in both scenarios contribute to the microclimate, lowering temperatures during summer months, thus decreasing the risk of heat strokes, which is particularly important for the elderly and children.

In addition to physical benefits, green spaces have a significant impact on mental health. Community gardens and recreational areas provide opportunities for socialization, reducing stress and anxiety among residents. Interaction with nature is known to positively affect mental well-being, improving emotional state and quality of life in urban areas.

Both scenarios contribute to creating healthier, more sustainable, and pleasant urban spaces for living.

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6.2 Economic Benefits and Costs

The scenarios involving the implementation of natural solutions such as permeable surfaces, rain gardens, and community gardens have a significant impact on the economy, both through savings and the creation of new economic opportunities.

Both scenarios provide potential energy savings. Green spaces decrease the need for air conditioning during the summer, resulting in savings of around 1,200 EUR annually. Additionally, the introduction of permeable surfaces reduces the need for stormwater infrastructure, leading to savings of about 400 EUR per year. Green spaces, especially rain gardens, facilitate the absorption of rainwater, further reducing water management costs.

The implementation of green solutions opens opportunities for new green jobs. This includes jobs related to the design, installation, and maintenance of green spaces, rain gardens, and community gardens, as well as training and educating local workers for these specialized roles. These jobs can provide significant support to local communities and economies.

The total cost of implementing both scenarios includes the purchase of materials for permeable surfaces, plants for rain gardens and community gardens, as well as the installation of necessary stormwater management systems. The expected cost for Scenario 1 is around 10,000–12,000 EUR, while Scenario 2, which includes additional infrastructural elements, may cost about 15,000 EUR. However, long-term savings and economic benefits from reduced energy, water costs, and new job opportunities can offer a return on investment.

6.3 Inclusivity Benefits

Both scenarios have a significant impact on accessibility, social cohesion, and community engagement, promoting more inclusive urban environments.

Both scenarios prioritize the creation of accessible green spaces, such as permeable surfaces and community gardens, which are available to all residents. In Scenario 1, rain gardens and permeable surfaces contribute to a safer environment by reducing the risk of flooding, improving walkability, and creating spaces that are more pedestrian-friendly. Scenario 2, with the inclusion of community gardens, further enhances accessibility by providing shared spaces where residents can engage in gardening and other communal activities.

The development of community gardens fosters social cohesion by allowing residents to participate in shared activities. Gardening offers an opportunity for connection, interaction, and cooperation, helping to bridge social gaps and promote inclusivity within communities with diverse social and cultural backgrounds. These shared spaces help create a sense of ownership and belonging, where people from different backgrounds come together to care for their environment.

Both scenarios encourage community engagement by providing opportunities for residents to actively participate in shaping their surroundings. In Scenario 1, permeable surfaces and rain gardens engage residents in discussions about sustainability and ecological responsibility. Scenario 2 goes further by promoting active participation in community

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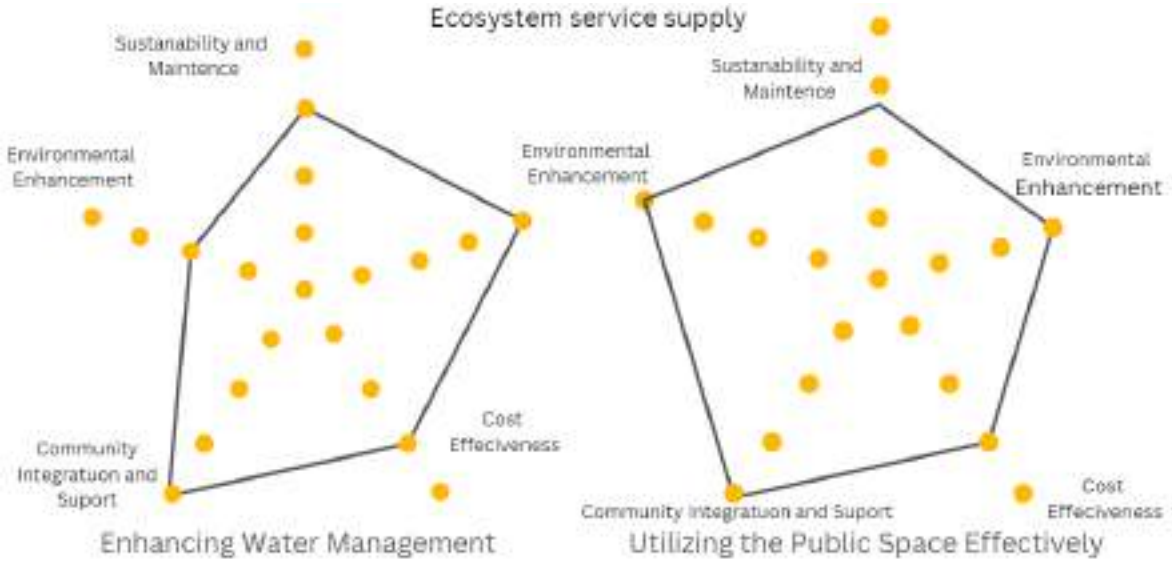
gardening projects, allowing residents to directly contribute to improving the local environment and strengthening social ties within the community.

7. Star Tool Evaluation



"Enhancing Water Management" scenario scores relatively well in sustainability, environmental enhancement, and maintenance, though it ranks lower in community integration and cost-effectiveness while "Utilizing the Public Space Effectively" scenario shows a better balance across all factors, particularly excelling in community integration and environmental enhancement, making it more socially inclusive.

Final Comment:

The "Utilizing the Public Space Effectively" scenario appears to be the most desirable as it ranks higher in most factors. While both scenarios contribute to sustainability, public space utilization better integrates environmental benefits with community needs and cost-effectiveness, making it a more holistic and socially beneficial choice

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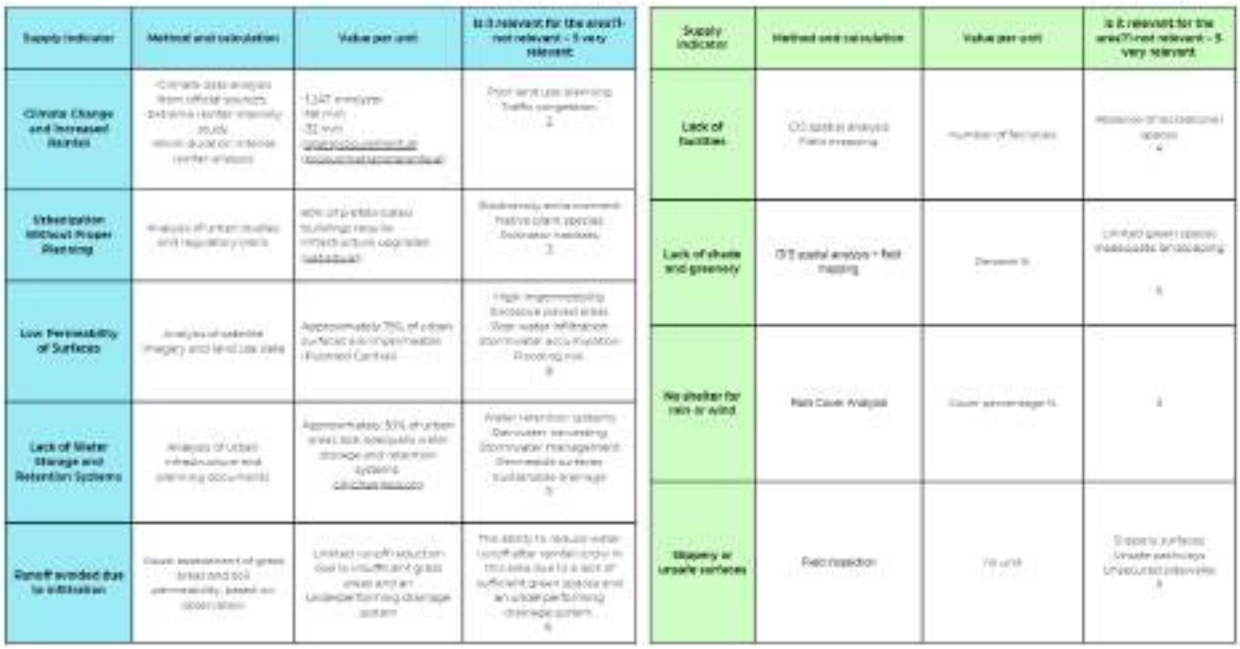

Supply indicator	Method and calculation	Value per unit	Is it relevant for the area? (1-not relevant – 5-very relevant)
Climate Change and Increased Rainfall			
Urbanization Without Proper Planning			
Low Permeability of Surfaces			
Lack of Water Storage and Retention Systems			
Runoff avoided due to infiltration			

Supply indicator	Method and calculation	Value per unit	Is it relevant for the area? (1-not relevant – 5-very relevant)
Lack of facilities			
Lack of shade and greenery	GIS spatial analysis – field mapping		
No shelter for rain or wind	Rain Cover Analysis		
Slippery or unsafe surfaces	Field inspection		

Figure 7. Ecosystem service supply analysis tables

According to the left table, the biggest challenges are related to the low permeability of surfaces and the lack of water storage and retention systems, which are highly relevant for the area. These factors directly impact the city's ability to cope with climate change, increased rainfall, and flood risk. Due to poor infiltration infrastructure, water runoff becomes problematic, while increasing permeable surfaces and installing water retention systems could significantly improve the situation. Scenarios that address these challenges (especially with permeable surfaces and rain gardens) have the greatest potential for improving the quality of the urban environment and reducing ecological risks.

According to the right table, the most significant challenge in the urban space is the lack of green areas and shade, which has the highest relevance (5). This factor directly impacts the quality of the environment, reducing comfort and the health of residents. Additionally, there is a lack of recreational facilities (relevance 4), which negatively affects the community's social cohesion and quality of life. Issues with lack of shelter from rain and wind and slippery surfaces (relevance 3) also present barriers to safety and comfort but have a lesser impact on the overall quality of the living environment.

8. Community Simulation Game Outcomes

During the simulation game, the community voted on the proposed scenarios, with the results showing strong support for increasing green spaces, permeable surfaces, and rainwater retention systems. Scenario 2, which includes community gardens, received the most support as residents recognized the value of these spaces for social cohesion and community engagement. Scenario 1, with an emphasis on permeable surfaces and rain gardens, received solid support, but some representatives highlighted the need for additional amenities, such as recreational spaces.

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The main arguments raised by the community were:

- Increasing green spaces
- Enhancing accessibility and social cohesion through community gardening projects.
- A need for better rainwater retention systems due to frequent flooding and poor infrastructure.
- Concerns about the lack of recreational spaces and inadequate shelter from sun and rain in public spaces.

Based on the community's feedback, the following changes were made:

- Larger areas for communal activities were added to Scenario 2 to meet the need for recreation.
- Plans were made to incorporate more rain gardens and permeable surfaces in Scenario 1 to improve water retention capacity and reduce flood risks.

9. Conclusion & Recommendations

Summary of Key Findings
The analysis examined two scenarios for improving the urban environment, addressing key challenges such as increasing green spaces, surface permeability, rainwater retention, and social cohesion. The community most strongly supported Scenario 2, which includes community gardens, as these spaces were recognized as important for improving social connections and engagement. Scenario 1, which focuses on permeable surfaces and rain gardens, also received solid support, but representatives highlighted the need for more recreational spaces and better rainwater retention systems.

Recommendations for Future Steps and Scalability
Based on the simulation results, it is recommended to further explore and implement more community spaces in Scenario 2, including expanded recreational areas and better integration of rainwater retention systems. Additionally, increasing the number of permeable surfaces and rain gardens in Scenario 1 is crucial to reduce flood risk and improve water infiltration. These solutions can be scaled and applied in similar urban environments, particularly in cities facing flooding issues and a lack of green spaces. It is recommended to collaborate with local authorities to ensure the continuity and long-term sustainability of these initiatives.

Lessons Learned (Technical, Social, Governance)

- **Technical Lessons**: Technical challenges involved integrating new rainwater retention systems and permeable surfaces, which require detailed analysis of urban conditions and infrastructure adjustments. While implementation is technically feasible, it is important to ensure adequate resources for maintaining

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these systems over the long term.

- **Social Lessons**: Community participation in the design process was key. Feedback from citizens showed a strong desire for more shared spaces that enable social interaction and cohesion. It is also important to consider the diverse needs of citizens when it comes to access to rest and recreational areas.

- **Governance Lessons**: Managing projects of this type requires close collaboration with local authorities, as well as ongoing communication with communities. It is recommended to establish partnerships with organizations focused on sustainable development and urban planning to ensure long-term support for implementing the proposed solutions.

10. Annexes

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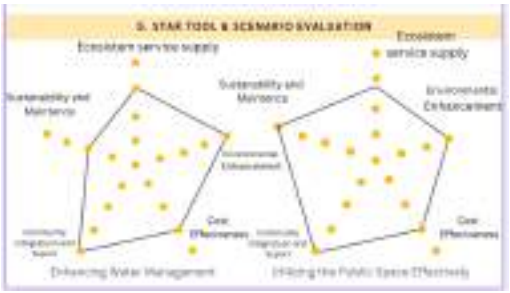

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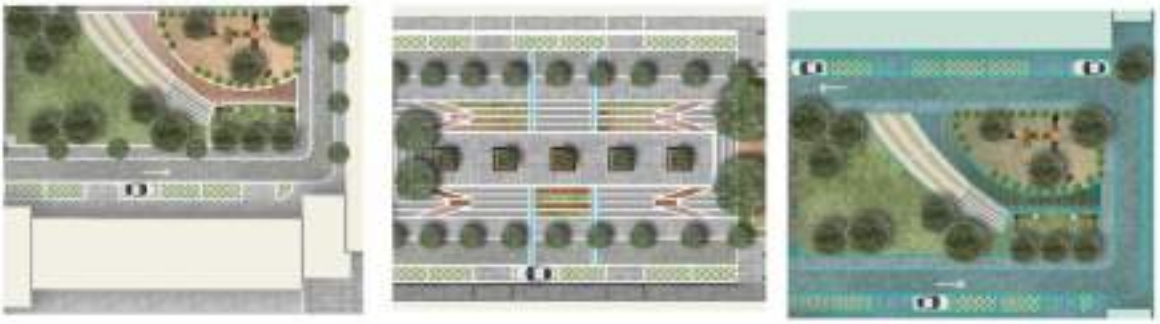

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