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Modified urban design tools with NbS-related information

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Content

Executive Summary

In the context of rapid urbanization and environmental degradation, the integration of nature-based solutions (NbS) into urban design has emerged as a pivotal strategy for fostering sustainable urban environments. This approach not only addresses ecological challenges but also enhances the quality of life for urban inhabitants. As cities in Europe and Latin America face unique challenges such as climate change, biodiversity loss, and social inequities, it becomes increasingly essential for design practitioners to incorporate NbS into their work. This deliverable aims to present the effort realized within INTERLACE to integrating NbS into urban design tools, focusing on three key platforms: ArchDaily, SketchUp, and Unlimited Cities. By leveraging these tools, practitioners can cultivate a holistic approach to urban design that harmonizes built environments with natural ecosystems.

Understanding nature-based solutions

Nature-based solutions refer to strategies that utilize natural processes and ecosystems to address urban challenges. These solutions can range from green roofs and urban forests to permeable pavements and wetlands that manage stormwater. The rationale behind NbS is grounded in the understanding that healthy ecosystems contribute significantly to human well-being, environmental resilience, and economic stability.

In the context of Europe, NbS has gained traction as a response to pressing issues such as air pollution, urban heat islands, and flooding. The European Union has actively promoted NbS through policies and funding initiatives, recognizing their potential to enhance urban resilience. Similarly, in Latin America, cities face challenges like inadequate green spaces, vulnerability to climate impacts, and social inequities. Integrating NbS into urban design practices in these regions can yield significant environmental, social, and economic benefits. However, despite the proliferation of these references, NbS remains a specialised subject, mainly because the sources of information on NbS remain within the circles of specialists in the subject and have not yet been able to reach a wider audience. This is the case for the world of design, urban design and architecture, which works on the landscape functions of the city but still has only a superficial knowledge of the issues linked to NbS. INTERLACE seeks to address this limitation by offering new information content relating to NbS in the tools and information channels usually dedicated to design.

The role of urban design tools

Urban design tools are essential for practitioners to visualize, analyze, and implement their design ideas. These tools facilitate communication among stakeholders and allow for the exploration of various design scenarios. The integration of NbS into these tools is crucial for fostering a design culture that values ecological integrity alongside urban development.

By enhancing urban design tools with specific technical information related to NbS, practitioners can improve their design outcomes significantly. INTERLACE focused on three key platforms—ArchDaily, SketchUp, and Unlimited Cities—which can be leveraged to incorporate NbS effectively, emphasizing the introduction of relevant articles, 3D objects, and enriched participatory features.

ArchDaily as an inspirational resource: enriching content with technical articles

ArchDaily, a prominent online platform for architecture and design, serves as an invaluable resource for practitioners seeking inspiration and knowledge. The website features a plethora of projects that successfully integrate design within urban settings, highlighting innovative design approaches that more and more prioritize ecological sustainability. By showcasing case studies from around the world, ArchDaily enables practitioners in Europe and Latin America to learn from successful implementations of urban design projects.

Archdaily currently lacks references and articles devoted to NbS. There are more and more projects that incorporate urban agriculture, green corridors, and biophilic design elements, but these are still presented from the angle of formal aesthetics rather than from the perspective of the environmental and social functionality of the techniques used.

ArchDaily, as a leading architectural platform, is ideally positioned to disseminate knowledge about NbS. By integrating a series of technical articles focused on NbS, practitioners can gain insights into best practices, case studies, and innovative applications. These articles are based on the knowledge and tools developed within INTERLACE and aim at covering a range of topics, including:

1. **Case study**: Introduction of a successful NbS project developed within INTERLACE in the latin american context which can serve as valuable reference for practitioners.
2. **Guidelines and frameworks**: Reference to INTERLACE guidelines for implementing NbS in urban settings, addressing critical design considerations and how to deal with inclusive co-design processes. This information aims at inviting practitioners to modify their usual practices.
3. **Combining science and design**: how to design urban projects with NbS while optimising their impact, i.e. by being able to master the scientific knowledge associated with them in order to make the best use of urban nature to meet the technical objectives of these projects.

By curating this content, ArchDaily can facilitate ongoing education for design practitioners. It also invites designers to engage in dialogue with local NbS experts to collectively improve practices.

SketchUp for 3D urban proposals: developing a comprehensive object library

SketchUp, a widely used 3D modeling software, allows design practitioners to create detailed urban proposals that incorporate NbS. The platform's user-friendly interface and extensive library of plugins make it an ideal tool for visualizing complex design elements. By integrating NbS into their 3D models, practitioners can effectively communicate their design intentions to stakeholders and the public.

For instance, by utilizing SketchUp to model green roofs, urban forests, and water management systems, designers can assess the spatial relationships between natural and built elements. This capability not only enhances the visual appeal of urban proposals but also facilitates the evaluation of environmental performance metrics such as heat reduction, biodiversity enhancement, and water retention. Furthermore, SketchUp's ability to generate realistic visualizations can help to garner support from community members and decision-makers, thus facilitating a smoother implementation process.

By developing a library of 39 3D objects specifically tailored for NbS, INTERLACE allows practitioners to streamline the design process and visualize their concepts more effectively. These objects include:

1. **Nature-based solutions for private properties**: These solutions are particularly well-suited for construction projects and the immediate surroundings of buildings. While some can also be applied in public spaces, they are especially relevant for private developments where designers seek multifunctional approaches to challenges such as water management, enhancing biodiversity, food production, or on-site recycling.

2. **Nature-based solutions for streets and urban infrastructure**: These solutions are tailored for streets and communal public areas, addressing issues such as stormwater runoff management, providing shade, cooling urban environments, and mitigating the dispersion of air pollutants.

3. **Nature-based solutions for open public spaces**: These solutions are designed for integration into large open areas like parks, adding additional functional benefits, such as flood management capabilities.

4. **Nature-based solutions for natural areas**: These solutions focus on peri-urban regions and aim to enhance the integration of natural areas within urban settings.

The INTERLACE NbS library includes technical specifications for each object. This information can guide practitioners in selecting the most appropriate solutions based on specific site conditions and design goals.

Unlimited Cities for participatory processes: new features and enhanced capabilities

The significance of participatory processes in urban design cannot be overstated. Unlimited Cities is an innovative platform that fosters community engagement by enabling citizens to contribute their insights and preferences to urban planning processes. Integrating NbS into participatory design initiatives enhances the capacity of practitioners to understand and address community needs.

In Europe and Latin America, where social inequalities often manifest in access to green spaces, incorporating NbS into participatory processes can empower communities to advocate for their environmental rights. By engaging local residents in discussions about green infrastructure, urban gardens, and biodiversity preservation, practitioners can ensure that design solutions are tailored to the unique contexts of their communities.

Unlimited Cities allows practitioners to visualize community input and integrate it into their urban proposals. This collaborative approach not only enhances the legitimacy of design outcomes but also fosters a sense of ownership among community members. As cities evolve, the sustained engagement of residents becomes crucial for the long-term success of NbS.

INTERLACE has worked with the Open Urbanism Foundation to facilitate the integration and understanding of NbS when using Unlimited Cities by adding the following elements

1. **New NbS objects:** Expanding the object library within Unlimited Cities to include most of the 3D NbS objects developed for SketchUp allows users to incorporate these elements directly into their participatory designs. This consistency enhances the usability of both platforms.
2. **Technical information integration:** Providing users with access to awareness information about each NbS object directly within the platform allows for informed decision-making during the design process. The information is synthesised with "tags" that inform about the key impact delivered by each object.
3. **Impact evaluation:** The new INTERLACE version of Unlimited Cities integrates a tool to assess the share of potential impacts of the proposed NbS for each participatory design proposal. It allows to quickly visualise and evaluate the main strategy proposed by the participants.

The enriched features in Unlimited Cities can facilitate community engagement through interactive design workshops. By enabling community members to visualize and modify designs incorporating NbS, practitioners can ensure that the solutions address both local needs and preferences.

Furthermore, incorporating feedback mechanisms allows community members to share their insights and experiences related to NbS. This iterative process not only strengthens the designs but also fosters a sense of ownership and stewardship among community members.

Introduction

Traditional approaches to urban planning and design do not consider nature as a functional element of urban dynamics. While the garden city concepts of the early 20th century introduced green spaces as a fundamental component of the urban model, the notion of ecosystem services was still missing. From a 21st century perspective, these interesting and pioneering concepts have gradually given way to other theories, such as the industrial city or the city of the modern movement, which left little room for nature in the city other than in a purely ornamental role.

Today's urban planning still builds on this legacy. Although the concept of the sustainable city, which emerged in the 1990s, has gained strength and is now firmly established, the use of nature as a tool for urban resilience has only really emerged with the concept of nature-based solutions (NbS), i.e. very recently. NbS encompass a range of strategies that utilize natural processes and ecosystems to address urban issues, including green roofs, urban forests, permeable pavements, and rain gardens. NbS have emerged as a viable strategy for enhancing urban resilience, improving ecological health, and promoting sustainable development. While the potential of these solutions is profound, urban design practitioners often struggle to fully comprehend the breadth and depth of NbS applications, leading to underutilization in design projects. Despite the increasing availability of references, NbS continues to be a specialized topic. This is primarily because information sources about NbS remain confined to expert circles and have yet to reach a broader audience. In fields such as design, urban planning, and architecture, which engage with the landscape functions of cities, there is often only a superficial understanding of the issues related to NbS.

This report aims to present the achievements of the INTERLACE project for integrating NbS into urban design tools to empower practitioners in both Europe and Latin America. The ability to navigate the complex landscape of NbS is critical for designers who seek to create multifaceted solutions that not only address environmental challenges but also enhance the quality of life for urban residents. Furthermore, the inclusion of NbS-related information in design tools can bridge the gap between awareness and implementation, equipping practitioners with the knowledge they need to make informed design decisions.

Urban design practitioners frequently encounter barriers to accessing comprehensive information about NbS. The diversity of solutions, coupled with the varying urban contexts across Europe and Latin America, complicates the process of identifying appropriate NbS for specific projects. Without adequate resources and guidance, practitioners may default to traditional, gray infrastructure solutions that fail to capitalize on the benefits offered by NbS. This situation underscores the importance of design tools that not only facilitate visualization and analysis but also incorporate essential information about NbS.

The tools available to urban design practitioners play a crucial role in shaping their approach to integrating NbS into their work. Platforms like ArchDaily, SketchUp, and Unlimited Cities provide invaluable resources that can enhance the design process and facilitate better decision-making. However, these tools must be enriched with relevant NbS-related information to maximize their potential.

ArchDaily serves as a premier architectural platform that can showcase a wealth of knowledge on NbS, featuring case studies, guidelines, and technical articles that inform and inspire practitioners. By curating content that highlights new methodologies and tools facilitating the use of NbS across diverse contexts, ArchDaily can empower designers with the insights they need to adopt innovative approaches in their own projects.

SketchUp, a widely used 3D modeling tool, allows practitioners to visualize and communicate their design ideas effectively. However, until now it did not include NbS in its 3D object library, which is a real obstacle for practitioners who then have to design everything in an NbS solution from scratch. By incorporating 3D models of NbS like green roofs, urban trees, and permeable pavements, practitioners can easily integrate these solutions into their designs, promoting a more comprehensive understanding of how NbS can function within urban environments.

Unlimited Cities, a participatory urban design platform, is another critical tool for engaging communities in the design process. Enhancing this platform with NbS-related features—such as an expanded object library, technical specifications, and impact assessment tools—can empower both practitioners and community members to collaborate on designing solutions that meet local needs while addressing broader environmental challenges.

The target audience for this report includes urban design practitioners—architects, landscape architects, urban planners, and environmental designers—who are looking to incorporate NbS into their projects. By equipping these professionals with the knowledge and tools necessary to implement NbS effectively, we can foster a new paradigm of urban design that prioritizes ecological integrity, resilience, and community well-being. This approach is also fully aligned with other INTERLACE products such as the urban design methodology integrated into the NbS evaluation framework also developed in WP3, and the INTERLACE MOOC through which these different tools are mentioned.

To ensure that these design tools are effective in supporting the integration of NbS, an agile approach was employed for their enhancement. This approach emphasizes iterative development and continuous feedback from practitioners and stakeholders. To achieve this, an dedicated Impact Task Force made up of practitioners based in Latin America (Gensler) and Europe (Tecnalia) was set up and consulted throughout the development work. By involving users in the enhancement process, tools like ArchDaily, SketchUp, and Unlimited Cities can evolve to meet the specific needs of urban design professionals, ensuring that they remain relevant and user-friendly.

1. Working process

1.1. Agile workflow

An agile methodology was used to structure the development process of the three tools. This process commenced with an update of the initial diagnosis conducted by the INTERLACE team, which recommended the development of these three types of tools. The knowledge base surrounding NbS has evolved at a rapid pace in recent years, as have urban planning practices to integrate the challenges, particularly in relation to climate change (and also, to a lesser extent, biodiversity loss). It was therefore essential to update the needs analysis in terms of urban design tools, compared with the initial analysis carried out when the proposal was being prepared between 2018 and 2019. This was achieved by means of a questionnaire presented below.

In addition, the development of the tools is organised through a dialogue established with stakeholders identified as potential users of these tools (Impact Task Force). These stakeholders are:

- The INTERLACE cities representatives, reached through the programme dedicated to exchanging experiences between cities, which involves representatives, through the programme dedicated to exchanging involves a comprehensive survey of each city's current practices and identified needs.
- Experts from the private sector involved in urban design operations in various capacities.
  - Design: the Gensler team based in Costa Rica, which is involved in major urban projects throughout the entire region; the YES Innovation design team, which is involved in Ecuador, focusing mainly on green infrastructure projects.
  - Technical support is provided in the following areas: project definition, decision support and impact assessment. Tecnalia, based in Spain, provides impact simulation services to cities and project designers. CEUS assists local authorities in Serbia in integrating NbS as effectively as possible.

Following the initial discussions on the objectives of this task, a more regular working group has been established between YES Innovation, Tecnalia and Gensler.

1.2. Adjusting the purpose of the task

1.2.1. Questionnaire to interrogate current practices and needs regarding NbS-related knowledge

A questionnaire was developed to survey INTERLACE cities and practitioners involved in this task. The aim was to gain insights into current practices in both the public and private sectors regarding urban

planning and NbS integration. In addition, the questionnaire aimed to identify the most relevant vectors for the integration of NbS-related information. The questionnaire was structured as follows (see the full questionnaire in Annex 1 for details).

- Internal organisation and design methodology: understanding who carries out the urban designs and how the outsourcing of certain processes is managed.
- Co-creation processes: understanding the practices and tools for co-design processes
- Diagnosis: understanding what the most common practice in terms of initial diagnosis is
- Defining strategies: identifying the particular methods used to formulate intervention strategies and the place of nature in these practices
- Inspiration and ideation: understanding the common practices used for inspiration and reference tools
- Design: identifying the tools used

1.2.2. Results of the questionnaire

The questionnaire was answered by 6 municipal technicians from 4 of the 6 INTERLACE cities (Granollers, Metropolia Krakowska, CBIMA and Portoviejo) and by 7 people from the urban design team of GENSLER Latin America (mainly urban designers and landscape architects). The main conclusions are set out below:

Internal organisation and methodology

In INTERLACE cities, projects are mainly organised internally, introducing multidisciplinarity into the teams and collaborating with external experts when necessary (10 out of 13 responses). The tools used for planning and monitoring urban projects are traditional project management tools on the city side, collaboration management tools and technical tools for designers in the private sector (GIS and BIM tools, applications such as Rhino are the most frequently mentioned).

Co-creation processes

Co-creation processes are integrated into respondents' urban projects not systematically, but regularly (often: 50%, occasionally: 37%). Cities use tools such as participatory budgets, urban forums and consultative workshops, while private teams use visualisation workshops, 3D rendering tools and tools such as Miro.

Among the tools and features that could facilitate a co-creation processes with NbS, respondents mention the possibility of involving experts in the process, the ability to communicate project proposals (visualisation tools, preferably simple ones), tools that facilitate criticism and can specify impacts. Finally, processes such as placemaking and urban design competitions are mentioned, provided they are given sufficient time. Note the specific suggestion of a private designer who, in terms of requirements for co-creation solutions, names "[e]lements that allow visualisation in a simple way so that the communities involved can understand the scale and impact of the project".

Diagnosis

The diagnostic phase requires a wide range of approaches and tools, of which GIS tools are the most frequently mentioned, as well as a general analysis of existing studies and documentation about the intervention site. Initial discussions with local people are also mentioned. The technical analysis of the site is also detailed by the private sector respondents (slopes, runoffs, elevations, views, vegetation cover, climatic data), which can be complemented by a more biological approach (analysis of the ecological systems in which the project is implemented at the micro/meso/macro scale - landscape units). In terms of specific tools, the use of topographic analysis, existing geographic data on GIS and orthophotos is mentioned several times. The explicit mention of Rhino with Grasshopper plug-ins to enable urban and environmental diagnostic analysis is also noteworthy.

Defining strategies

In the case of INTERLACE cities, intervention strategies are defined with the help of experts, on the basis of existing examples and using the strategic vision of the city already formulated by the city or its administrators. They also use generic contextual analysis and prioritisation tools such as SWOT or PESTEL. Private sector planners tend to move straight into the design phase, using it to compare scenarios, assess the opinions of local stakeholders and openly discuss/criticise proposed ideas.

This process is almost always carried out in teams. The tools used include thematic working groups, reference to local strategy documents and guidelines such as project calls. In practice, brainstorming and stakeholder interviews are also common. On the private practitioner side, visualisation workshops as well as more generic tools such as Miro or Mentimeter were mentioned.

There are many difficulties in integrating nature into projects at this stage of strategy definition. The cities surveyed mentioned the novelty of NbS and the lack of local experience, both among municipal staff and businesses. Social acceptance, the lack of legal instruments and the need to involve experts are also mentioned as difficulties.

For private practitioners, the problem of access to relevant data and the difficulty of convincing clients of the added value of NbS are mentioned first and foremost. This is particularly acute when clients prioritise the economic viability of projects over all other criteria. Existing tools do not facilitate this process of demonstrating the benefits of NbS.

Inspiration and ideas

In terms of inspiration, the use of online sources has become systematic (11 out of 13 respondents). Specialist guides are used quite often, as well as local references (emblematic projects). Sources are either local (immediate region) or international (multilateral actors and specialised international cooperation). The use of specialised websites (Archdaily, Pinterest and Landezine are mentioned, all of which focus on 'generic' design) is also a key source for all actors, whether through direct access (preferred by municipal technicians) or through social networks (preferred by private practitioners).

Existing tools and sources are considered deficient in terms of the lack of technical details on NbS (for 10 out of 13 respondents) and the proposed NbS are often difficult to adapt to the local context (12 out of 13 respondents). The fact that professional tools do not include elements related to NbS is also considered a major obstacle for private sector planners, but a secondary one for municipal technicians.

In order to address these issues, respondents consider it necessary to develop tools that facilitate the practical application of solutions (dimensioning, impact calculations, technical specifications), taking into account the local legal context. Campaigns to raise awareness of NbS are also considered insufficient. It is essential for designers to be able to rely on precise technical information adapted to their local context (e.g. a specialised library of technical solutions). It would also be more practical to be able to use a single design tool rather than having to combine different analysis, design and visualisation tools.

Design

For the design phase of proposals, while cities mention generic approaches and, in particular, the hiring of specialised experts, private designers focus on a number of specific tools such as Rhino, Revit, SketchUp and Illustrator. These tools correspond to the group of solutions commonly used in architecture and urban planning offices to design projects and do not integrate specific information on NbS. The latter is one of the problems identified for the integration of nature in design proposals, as well as the lack of local specifications and the lack of coherence between different scales, which is often key to the easy implementation of NbS.

To facilitate the design phase with NbS, municipal technicians propose organisational solutions such as the creation of specialised teams, the development of specific water management approaches, or even the formalisation of practical tools such as instructions for the use of NbS. Private sector planners refer fully to the tools themselves, stressing the importance of being able to rely on tools that integrate contextual information, offer modules that facilitate work at different scales, and integrate design and implementation guides to the NbS. We also note in particular the following requirement for the integration of NbS-related information: "Easy access to valuable information about nature-based solutions in a single design tool or analysis software. All with long and short term visualisation".

1.3. Co-development of the tools

The task adjustment process confirmed the interest to work with ArchDaily, SketchUp, and Unlimited Cities and enhance their capacity to promote the use of NBS.integrating dedicated information. ArchDaily provides valuable case studies and guidelines, while SketchUp allows for 3D visualization and design of NbS elements, improving design communication. Unlimited Cities facilitates community engagement by incorporating NbS into participatory design processes. Enriching these tools with NbS-related information empowers urban designers to create sustainable, innovative solutions that address urban challenges. This holistic approach fosters ecological integrity and improves the quality of life, contributing to the long-term sustainability of urban environments in Europe and Latin America. The three tools are presented with details in the following chapters.

The tools were enhanced in cooperation with their developers in the case of Unlimited Cities (Open Urbanism Foundation) and by using the tools made available to users to enhance the databases in the case of Archdaily and SketchUp.

2. NbS in an inspiration tool: Articles in Archdaily

The first tool developed in INTERLACE corresponds to the inspiration phase of the urban design process. As described in D3.3 for Stage 3 of the Design Module in the NbS evaluation framework, designers often look to existing examples or past projects for inspiration, whether it is to define broad design principles for a project or very specific details of a particular technique. Platforms such as Pinterest or Archdaily, and online media such as Dezeen, provide up-to-date information on design projects on a global scale. In addition to providing inspiration, the use of inspiration tools supports the communication process with local stakeholders by showing examples of what could be achieved for an urban intervention with NbS. Introducing the aesthetic aspect of the proposal facilitates dialogue and frees up ideas, simultaneously helping to structure the landscape proposal.

In order to be able to integrate information on NbS based on the work, developments and experience of INTERLACE, this task started with the first feedback from the application of the NbS evaluation framework in INTERLACE cities. On this basis, the topics to be covered in the articles were defined by YES Innovation and Tecnalia and first proposed to Archdaily before starting the writing process. At the time of writing, the publication of these articles is still being evaluated by Archdaily and we do not have a precise timeline for this; the project team will adjust if necessary the articles according to comments received by the Archdaily editorial team.

We introduce in this chapter the Archdaily platform by describing its model of informing architects, urban planners and landscape architects through exemplary projects. And we introduce the four articles proposed to introduce new NBS-related information into the platform, articles which are otherwise presented in the appendix.

2.1. Archdaily

Archdaily has been chosen as the channel for disseminating NbS-related information for Tool No. 1. Archdaily was founded in Chile in 2008 and has established itself as the world's leading source of information and inspiration for architects and designers over the course of ten years. It's a great success story from Latin America, but above all it's a platform that offers a high-quality information service, with 13.6 million visitors per month from 230 countries, making it the most popular source of information on architecture in the world to date.

Urban planning is not a central theme on Archdaily, but many urban projects are presented, particularly from an urban design point of view. The approach of the articles is systematically design-oriented and then opens up the information to related topics. Specific information on NbS is rare on the platform, regardless of the language used. While a search for "nature-based solutions" yields almost 20.000 entries, the articles refer mainly to projects in which the term NbS was mentioned. Only a handful of articles deal with NbS concepts in more detail.

The proposed articles focus on the design of urban public spaces and the ways in which this can be implemented using NbS. Using examples, they highlight the strong points of the concept, namely its multifunctionality, the parallel technical and environmental approach, and the ability of these environmental solutions to contribute to the urban landscape in a way that is as original as it is effective.

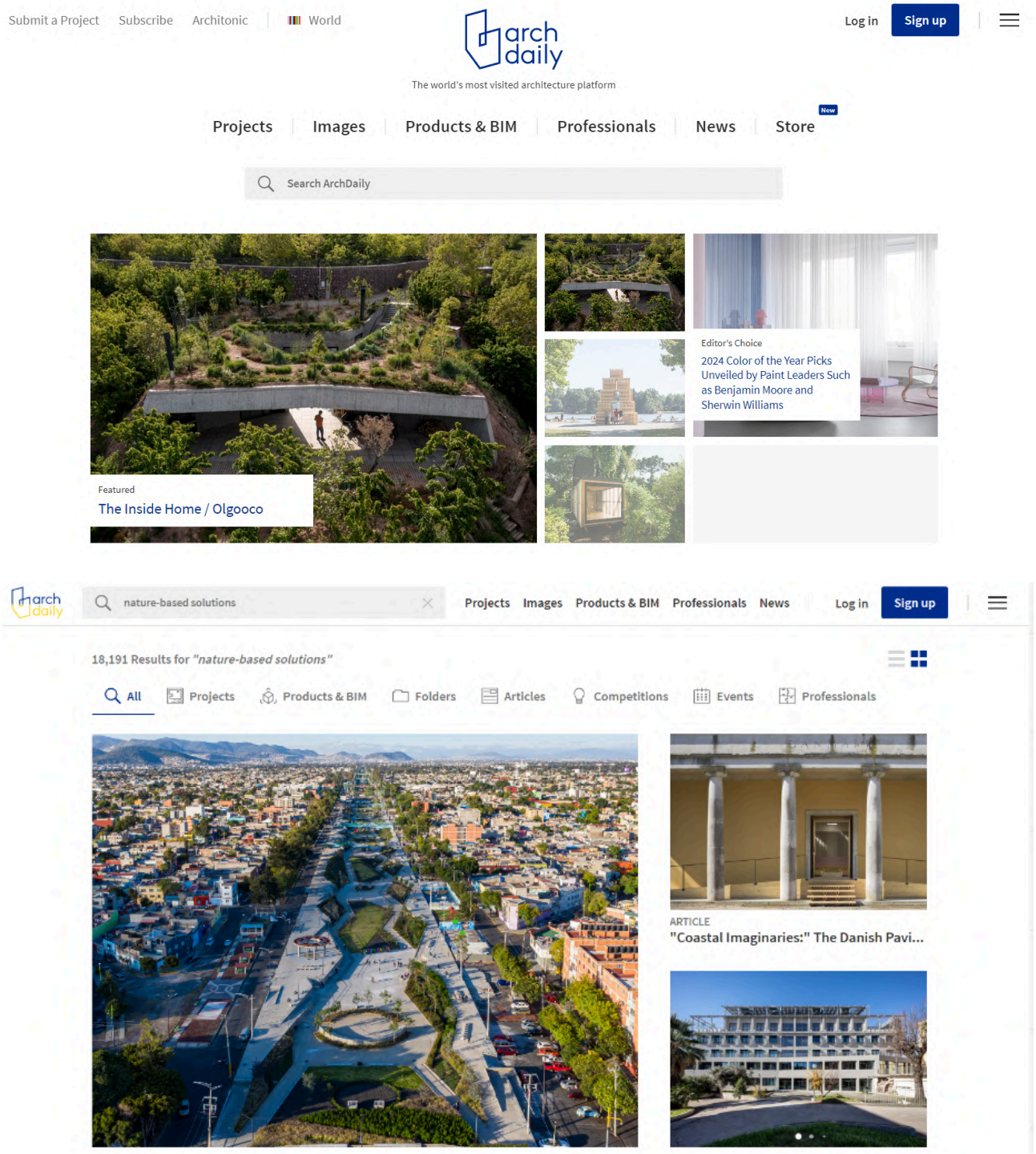


Figure 1: Screenshots of the Archdaily platform: welcome page (above) and research about nature-based solutions (below)

2.2. Articles

The proposed topics are directly related to the activities developed in INTERLACE and the knowledge generated in the project. The titles and articles are intended to reflect the editorial line of Archdaily, which is oriented towards the design of buildings and urban spaces.

- ***New tools promoting nature-based solutions for urban design and co-creation.*** The article focuses on how nature-based solutions are effective strategies for improving sustainability and resilience in urban areas, benefiting both people and the environment. While these approaches are becoming better known in European cities, they are still less known in Latin America. The INTERLACE project aims to promote the implementation of NbS globally, using a co-design approach to engage communities in restoring and reconnecting ecosystems.
  INTERLACE partners have been developing and testing innovative tools such as the Unlimited Cities application in co-design workshops. This app allows residents to visualise and propose NbS for neighbourhoods by creating "digital collages" of proposed changes. A new library of NbS objects with tags such as #Water and #Biodiversity has been added to the app, making it easier for people to understand and contribute to urban planning. The new version was tested during a co-design workshop in the Miraflores neighbourhood of Quito.

- ***Integrating NbS in an urban rehabilitation project with the INTERLACE approach: design of Mamey Park in Portoviejo (Ecuador).*** The article highlights that the INTERLACE project focuses on restoring and reconnecting ecosystems using NbS through a collaborative, multi-stakeholder approach in both Europe and Latin America. In Ecuador, the community of Portoviejo is a key partner, working to reduce flood risks and protect biodiversity along the Portoviejo River by creating an ecological corridor with seven parks, only one of which is fully operational. A key objective is to restore the Mamey Park, a culturally significant but degraded site, into a multifunctional urban space. YES Innovation, a private company, has partnered with the city to engage local stakeholders - including community groups, professionals and architecture students - in the co-design process. This collaborative effort has led to the development of a design proposal that focuses on water management, ecological enhancement and community-driven architecture. The project aims to create a sustainable, flood resilient space that serves as green infrastructure and a biodiversity hotspot for the city.

- ***How to integrate nature-based solutions in street design?*** The article explains NbS, defined by the European Commission as nature-inspired approaches that deliver environmental, social and economic benefits while enhancing resilience. NbS contributes to reducing greenhouse gas emissions, mitigating climate risks such as floods and heat stress, and supporting ecosystem services. Integrating NbS into urban design requires a structured process, starting with a site diagnosis to assess local challenges and future climate scenarios. This step is followed by the co-creation of design strategies with stakeholders, using tools such as modelling and metrics to compare alternatives. Key criteria for the final designs include feasibility, urban integration,

ecosystem restoration and social acceptability. Successful implementation and replication of NbS can contribute to climate adaptation at both local and urban levels.

- ***NbS for urban thermal comfort in public spaces: impact evaluation of comparative scenarios in Envigado.*** The article highlights how simulation models are valuable tools in urban planning, allowing the prediction and evaluation of different urban designs and solutions, particularly for the implementation of nature-based solutions. These models, based on 3D representations, help to compare alternatives and inform decision making by urban planners and policy makers. Two key variables analysed through simulations are runoff and thermal comfort, both of which are relevant to climate adaptation.
  It is explained how thermal comfort is assessed using the PET index, which assesses how outdoor conditions affect the human body. Simulations, such as those using ENVI-met software, can model different climate and urban design scenarios to measure the effectiveness of NbS. These models help identify areas of thermal stress and determine the best solutions, such as planting trees, to improve comfort in public spaces. In cities such as Envigado, simulations have shown the importance of vegetation in reducing heat stress, but also the limitations of relying on trees alone. Comprehensive urban design, including both buildings and NbS, is crucial to improving thermal comfort and climate resilience at the micro scale.

3. NbS in a design tool: 3D objects integrated in SketchUp

The second tool that INTERLACE proposed to enrich with NbS-related information is the design software SketchUp, used mainly for3D modelling. This software integrates libraries of pre-modelled objects that the designer can then integrate into his project and adapt according to his needs and strategies. Object libraries have grown considerably with the spread of BIM (Building Information Modelling) in construction projects, and many industrialised construction products can now be found in these libraries. Manufacturers themselves model their products and make them available to architects. These objects are primarily 3D models, but they are also associated with specific characteristics such as materials, price, performance and environmental impact.

This approach is very practical because it allows the designer to configure a space with real solutions, while at the same time a budget is automatically created for it and renderings of the proposal are also based on pre-existing realistic elements. By using this type of tool, designers are more likely to choose solutions that are already available in the object library, rather than creating all the solutions or objects in their proposal from scratch.

Although most of these libraries do include vegetation (mainly trees as well as indoor and outdoor plants), it is for ornamental purposes only, as they are generally not assigned any functional properties. Similarly, there are few, if any, NbS-related solutions, i.e. those that incorporate a range of techniques designed to provide a range of services to the site of implementation. With this INTERLACE task, we aim to partially close this gap by integrating a series of NbS-related objects into the library of one of these tools. With over 30 million registered users, SketchUp offers significant potential for the dissemination of NBS in the architectural and urban design sector.

In this chapter, we briefly mention the main features of the SketchUp object library. The 39 NBS objects developed as 3D models are then presented in detail, together with the model itself and the descriptive information associated with it in the library. We also describe the process of disseminating these objects, initiated by their inclusion in the SketchUp library, and the initial results of monitoring their use by SketchUp users worldwide.

3.1. SketchUp

The original plan was to work with a BIM (Building Information Modelling) tool such as Revit or ArchiCAD, which are central tools in architecture today and work on the basis of object libraries. However, these tools focus on the design of buildings and are not commonly used for urban spaces. An alternative is the SketchUp tool, which is also based on the BIM approach, but mainly used for the initial design phases of projects of different typologies, including outdoor and public spaces. This choice was also supported by the survey and discussion with the Impact Task Force.

While the 4.8 million objects in the SketchUp library (called the 3D Warehouse) include elements of outdoor furniture, lighting, flooring and vegetation, most NbS techniques are missing. A designer who wants to include a rain garden, for example, has to design it from scratch, whereas a bench or public playground can be downloaded directly into the project.

SketchUp reports that over 33.000 objects are downloaded by its users every hour. The practice of using the library is therefore well established in the design process, and a practical way of encouraging the use of NbS is to simplify its integration into 3D modelling work by having a set of pre-modelled solutions at hand.

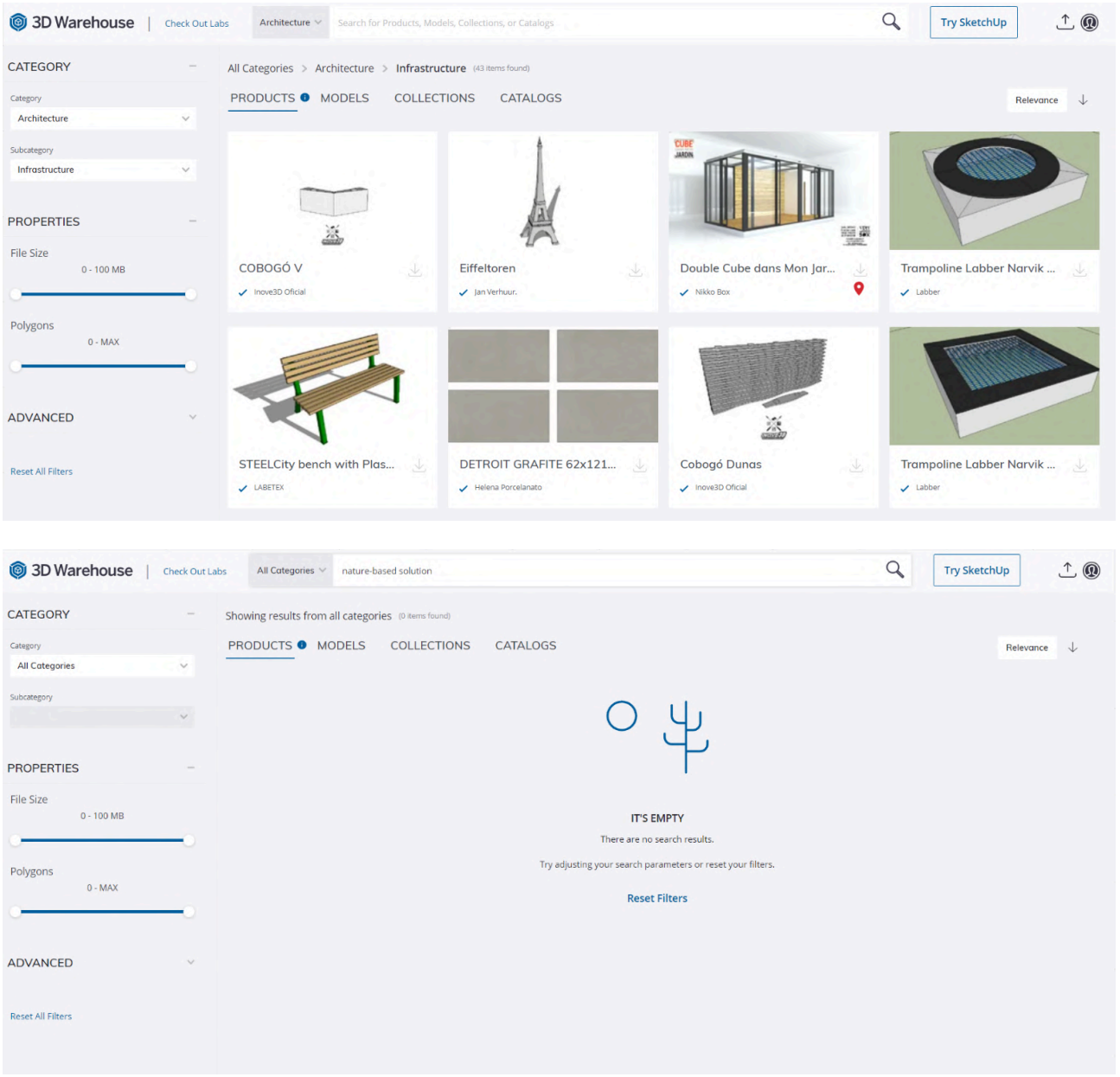


Figure 2: Screenshots of the SketchUp 3D Warehouse (above) and of the missing objects under the name “nature-based solutions” (below)

3.2. INTERLACE NbS objects library

A set of 39 objects has been defined and modelled in 3D based on a selection of urban issues and approaches that correspond to the needs of cities for urban ecosystem restoration in both Europe and Latin America. These models were initially developed by YES Innovation and verified by Tecnalia.

The NbS developed as 3D models for the SketchUp library are presented below by application category:

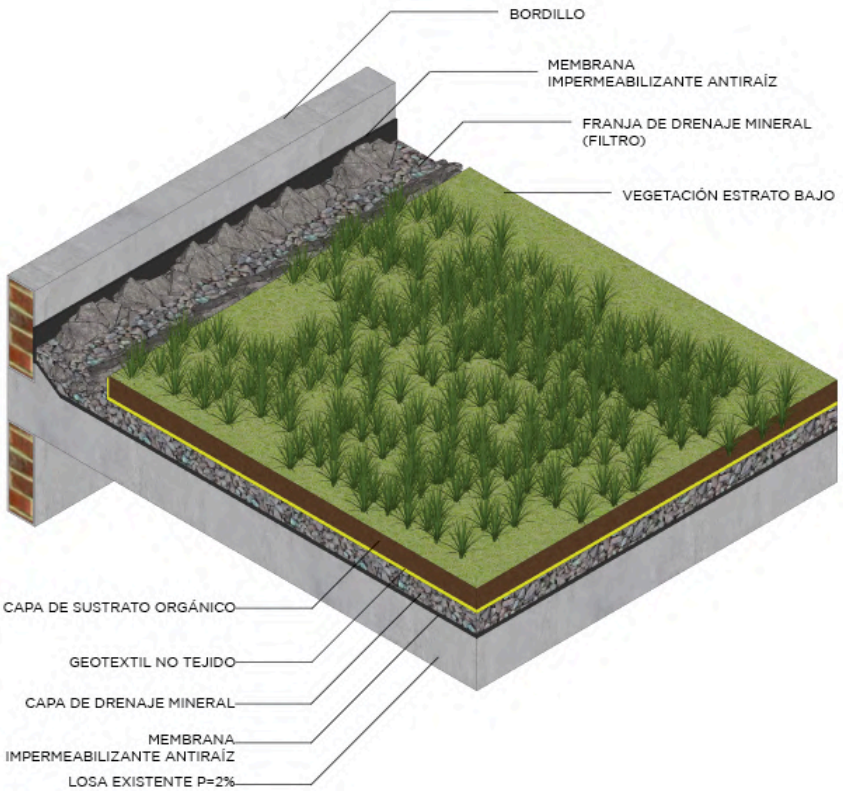
- ★ NbS for private properties: These are solutions that are ideal for construction projects or the immediate surroundings of buildings. Although some can also be used in public spaces, they are particularly relevant to private projects in which the designer is looking for multifunctional solutions to issues such as water management, biodiversity support, food production or on-site recycling.
- ★ NbS for streets and urban infrastructure: Solutions ideally suited for streets or shared public spaces, whether for managing run-off, providing shade and cooling the city, or preventing the spread of urban air pollutants.
- ★ NbS for open public spaces: Solutions that can be integrated into large open spaces, such as parks, to add an extra functional dimension such as floodability.
- ★ NbS for natural areas: Solutions designed primarily for peri-urban areas or to better integrate natural areas into the city.

Below, we present the objects modelled in each category with a short description.

3.2.1. NbS for private properties

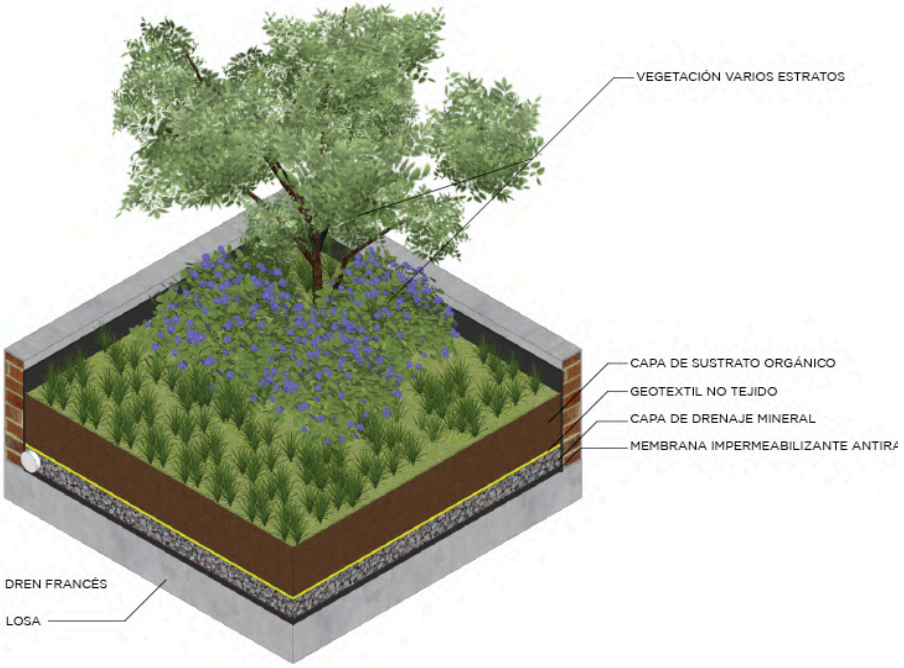
Extensive green roof

Extensive green roofs are mainly used for rainwater management and to reduce the temperature of building roofs. This solution is capable of absorbing peak flows of rainwater during heavy rainfall events. Its retention capacity is proportional to the thickness of the solution. The green roof provides a habitat for local biodiversity (insects, birds and plants) and, when visible, a high quality urban landscape for its neighbours. This solution also reduces the exposure of the roof to the sun, reducing its deterioration, facilitating a reduction in the temperature of the building and extending the life of the waterproofing system.
The extensive version is less than 10 cm thick, allowing it to have a minimal weight on the roof.



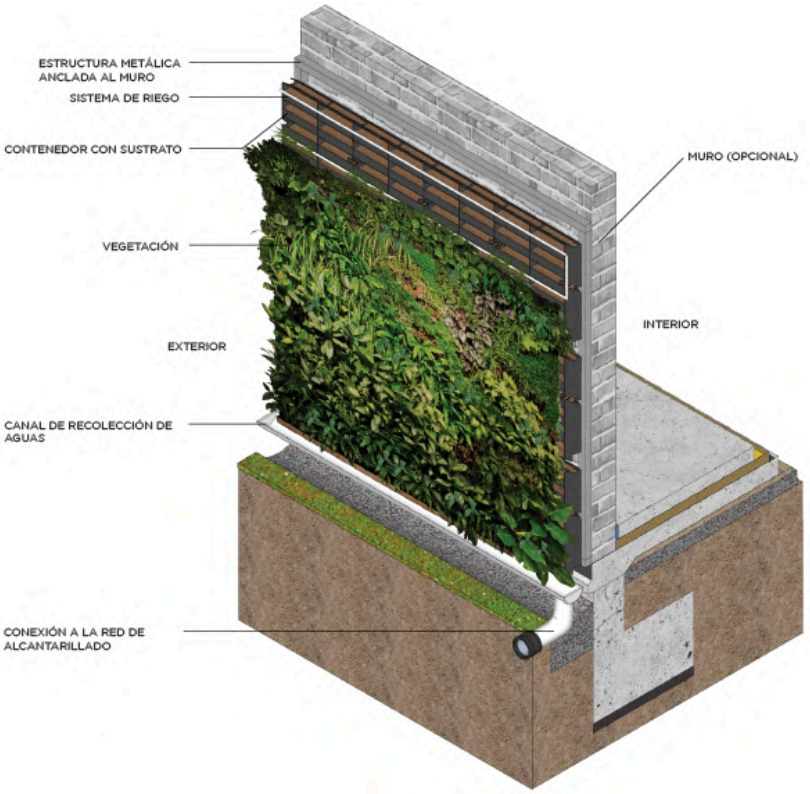
Intensive green roof

Intensive green roofs have a greater thickness of organic substrate, which allows for multi-layered vegetation, including small trees. The space can be landscaped and used by residents.



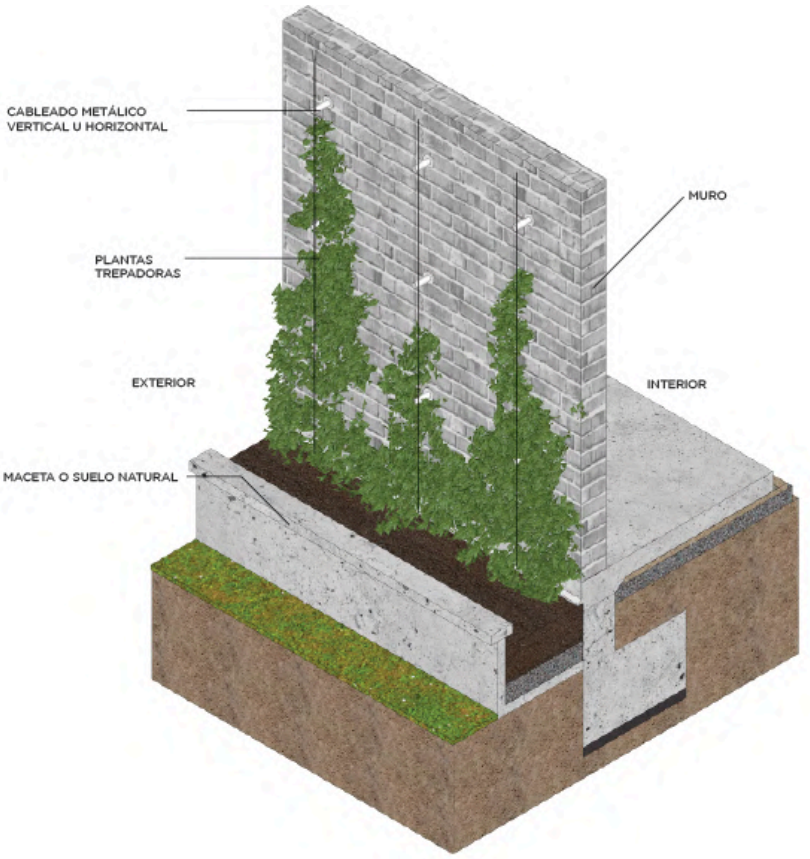
Green facade - container with substrate

System that allows vegetation to be installed on internal or external walls, creating a naturalised urban or internal landscape. The vegetation provides micro-shading on the façade, reducing the heat input into the building and the adjacent outdoor environment.



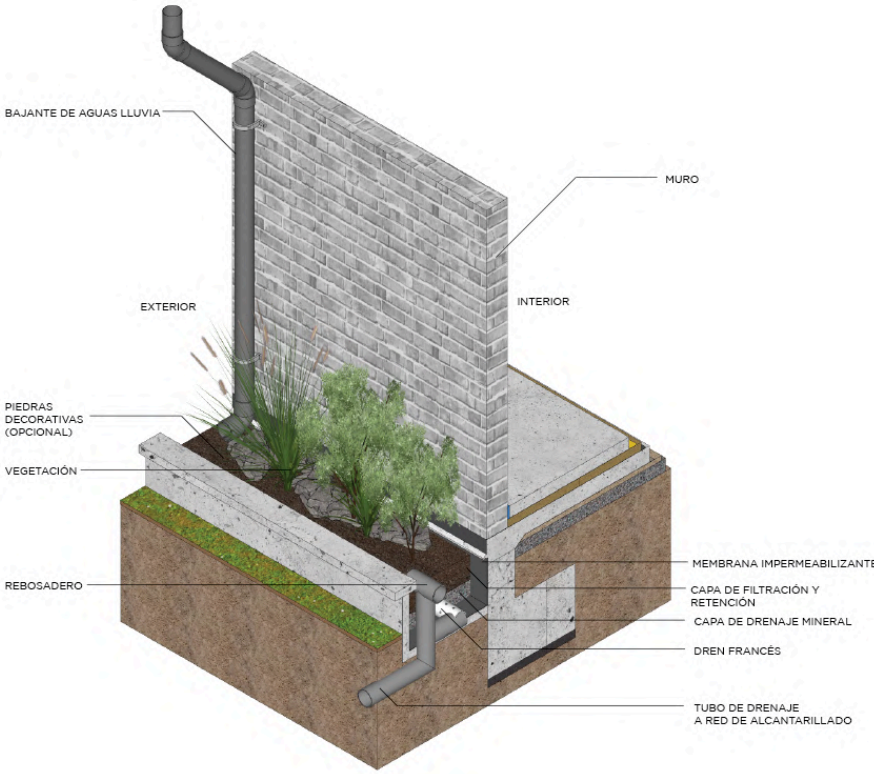
Light green facade

Climbing plants are installed on the lower part of the wall and can grow up the facade via a network of cables. This system is much cheaper than the container-based green facade system, but offers a simpler aesthetic.



Retaining pot

A simple and effective rainwater retention technique that prevents immediate runoff during heavy rainfall events. Like the green roof, it slows and delays the peak flow of water during a storm. It also contributes to the landscape wherever it is installed.

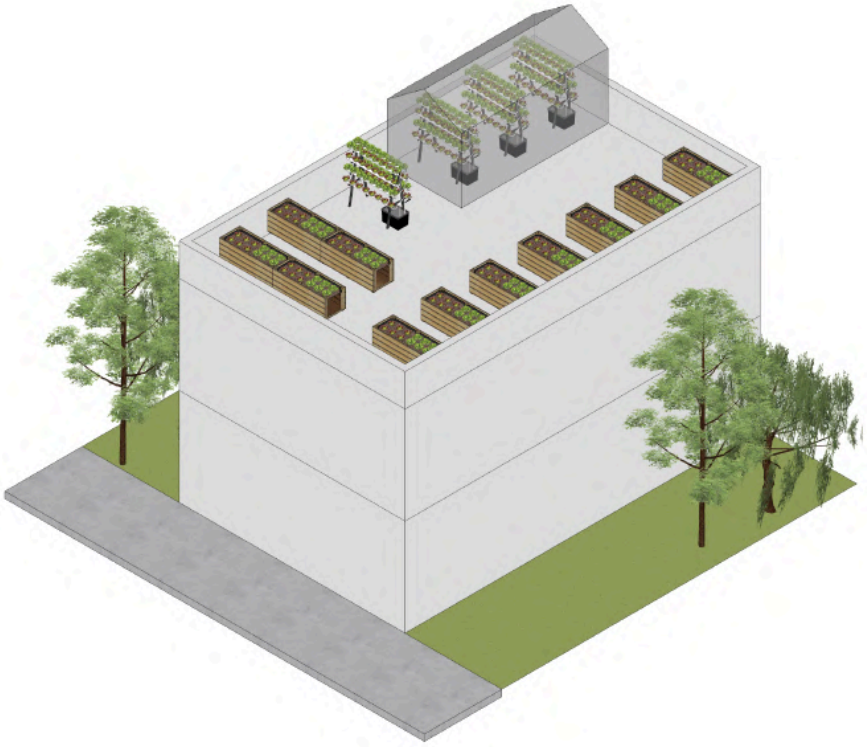


Green balcony

A system that allows the integration of vegetation into the façade, using the balcony balustrade as a support structure. The amount of vegetation implemented can be significant, creating a green landscape for both the interior and exterior of the building for the enjoyment of all.

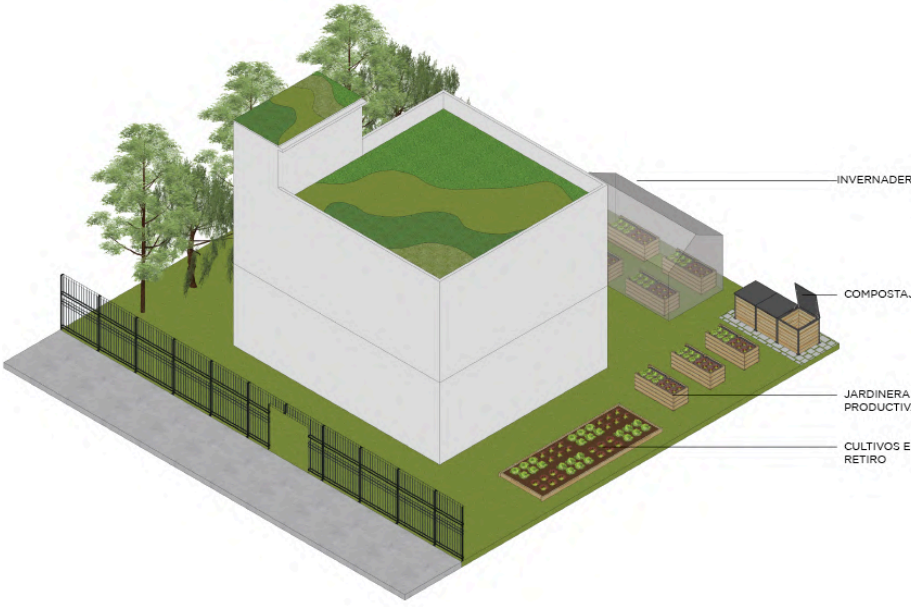
Productive roof

An alternative version of the green roof, where the roof is used to grow vegetables. An often under-utilised and sun-exposed space is used for a food-producing activity while providing a high quality roof landscape.



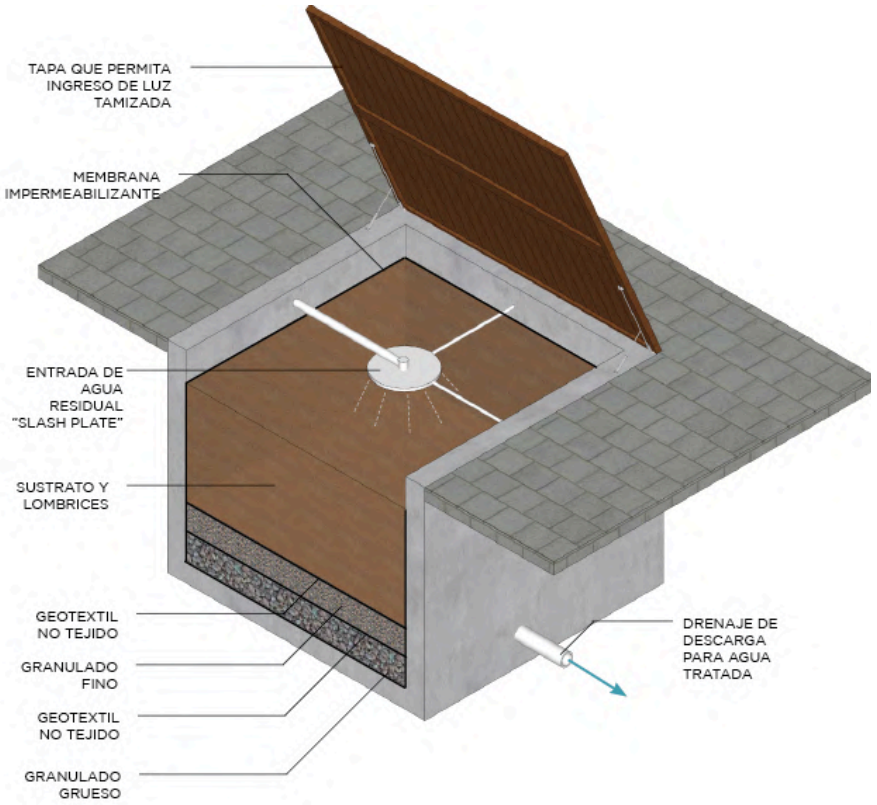
Productive plot

Urban farming can be achieved by utilising open spaces within a plot, by using prepared soil on site or by using modular pots.



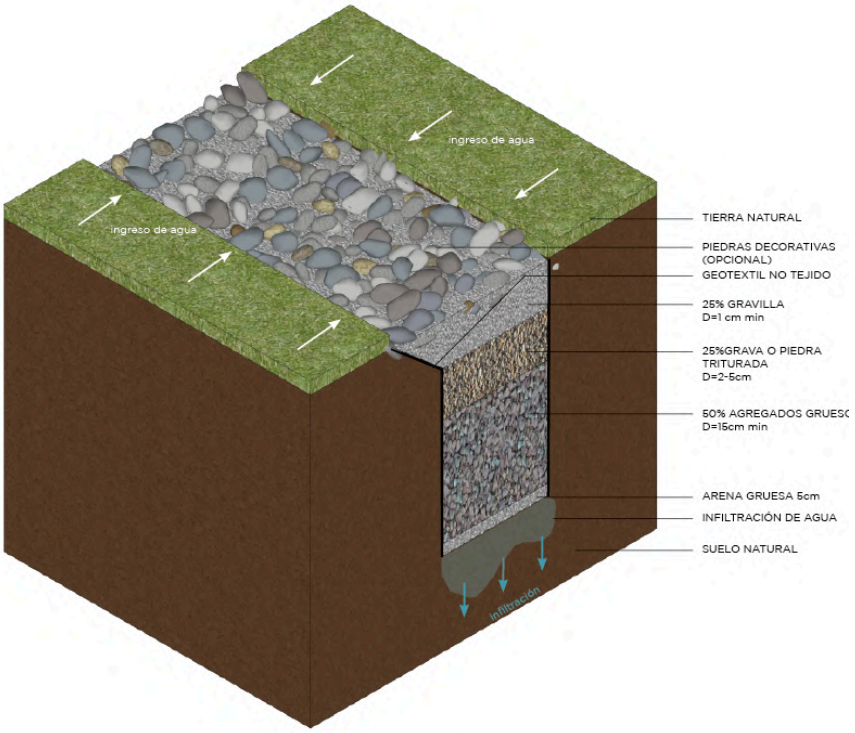
Autonomous wastewater treatment

There are several systems for autonomous wastewater treatment. The one proposed below is an easily replicable and compact vermifilter that is ideal for urban or peri-urban contexts.



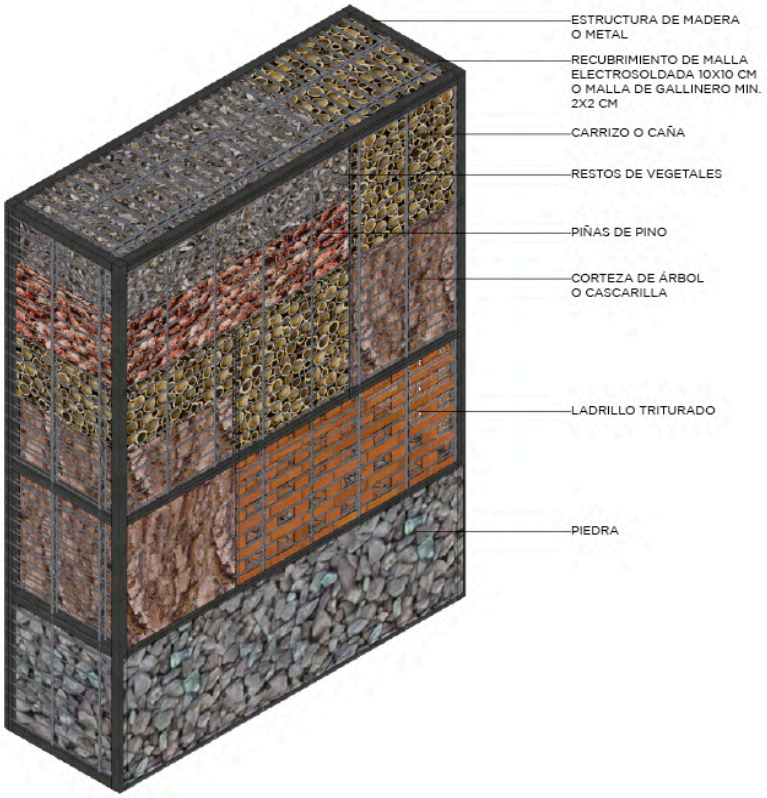
Infiltration wells

Infiltration wells manage runoff water in gardens or public spaces, facilitating its infiltration into the ground. It is a simple and economical tool that can be easily integrated into a landscape design. It can multiply the retention capacity of a space and achieve zero runoff targets for private properties.



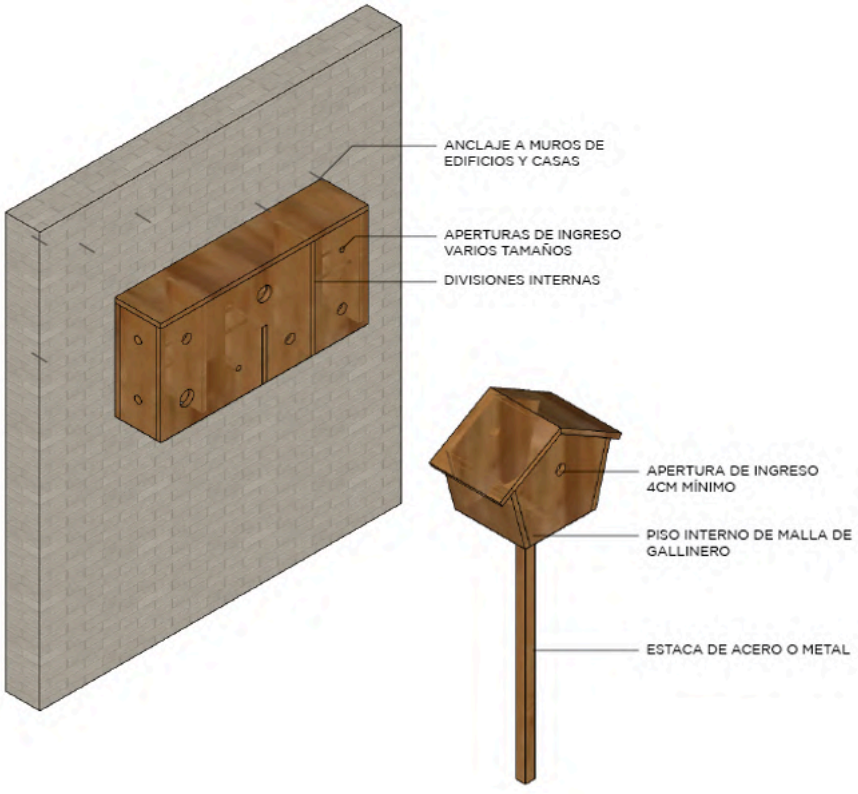
Insects hotel

Being able to offer insects a habitat in the garden offers a great opportunity. This will ensure pollination of the plants on site and create a protective environment. While storing old tree trunks and branches or leaving natural areas of vegetation create the most suitable habitats, more controlled devices can be used in the city. The solution is to create a variety of natural hiding places for insects with different needs. The device presented here combines urban space, natural aesthetics and habitat creation.



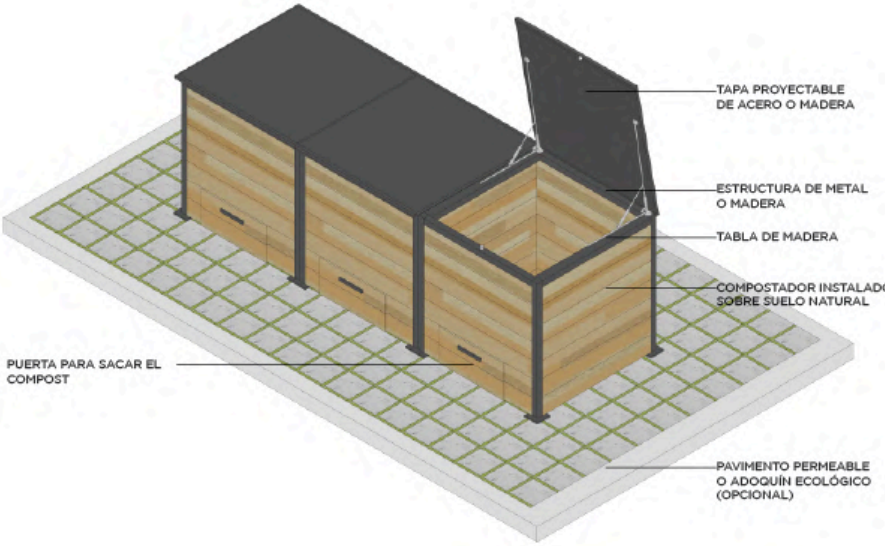
Birds habitat

Two types of bird habitat areas are proposed for urban areas. The first is large and contains several independent areas for birds of different sizes. It can be anchored to the walls of buildings, houses and enclosures.
A smaller module has also been designed to be placed in parks or gardens as it is self-supporting.



Communitary compost

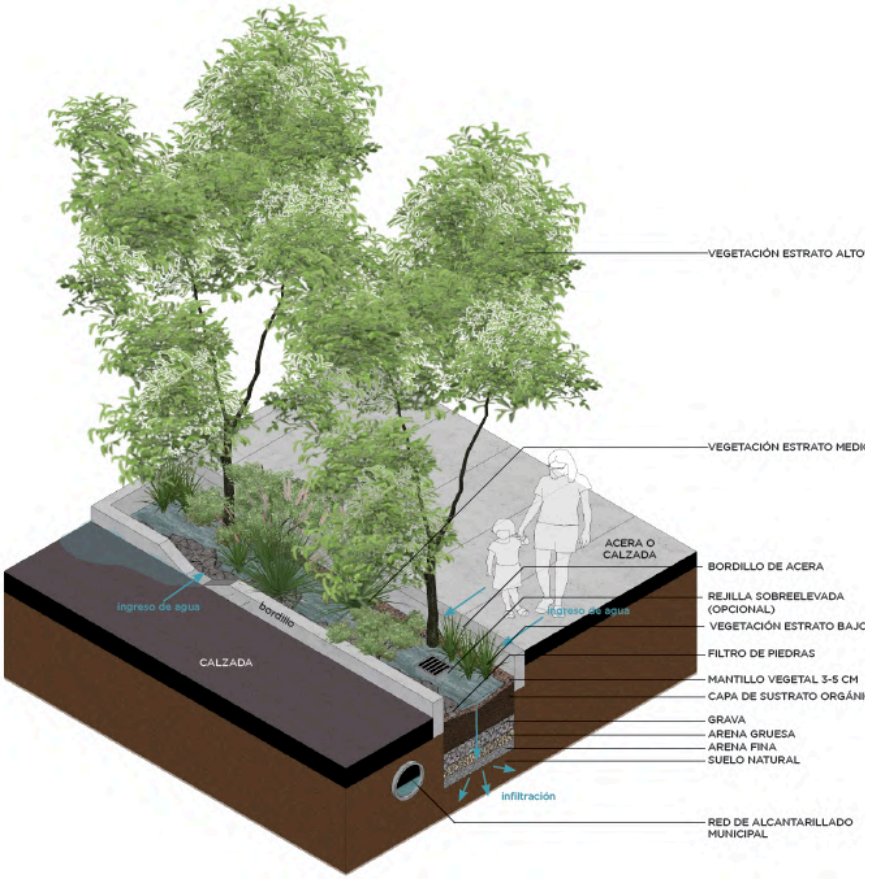
Composting units allow daily vegetable or garden waste to be turned into compost that can be used for both indoor and garden plants. The community version also allows for an environmental education process in the community.



3.2.2. NbS for streets and urban infrastructure

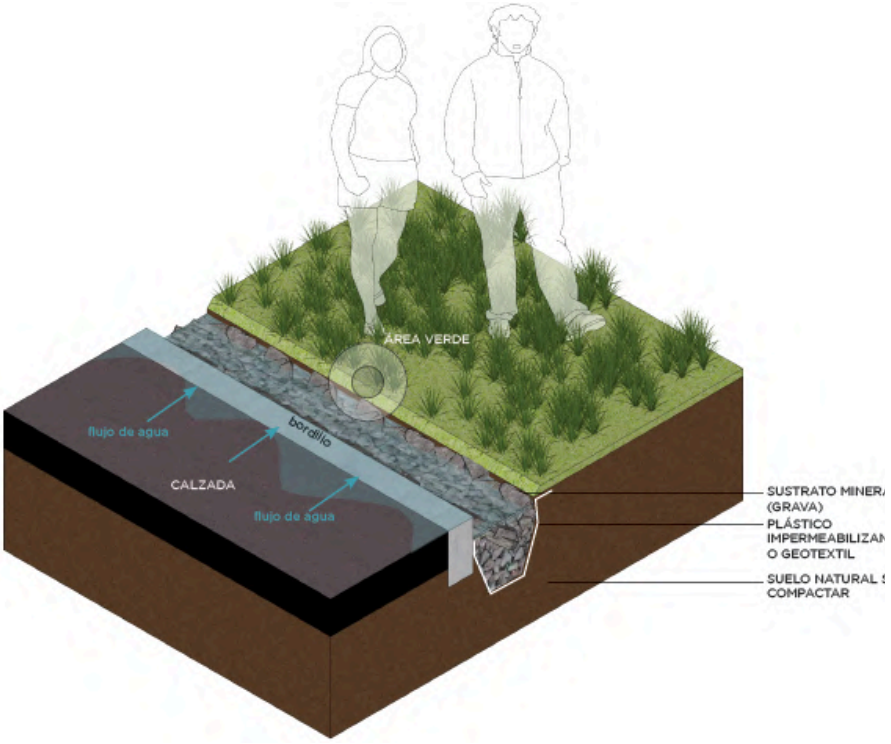
Rain garden

This flagship NbS solution transforms the landscape of streets, squares and parks with a functionality primarily focused on runoff management. Implemented at a level lower than the road and street level, it is flooded during periods of heavy rainfall to retain the water and then allow it to infiltrate and/or evaporate. By multiplying this type of solution in urban areas, it is possible to significantly reduce the discharge of rainwater into the sewerage system and avoid saturation of sewers and treatment plants. In addition, the water that infiltrates into the ground recharges the aquifer. Pollutants in the runoff (oils, metals, microplastics) are trapped in the upper layers and do not contaminate the groundwater. Vegetation integrated into the rain garden can include trees to provide shade and an interesting vegetated landscape.



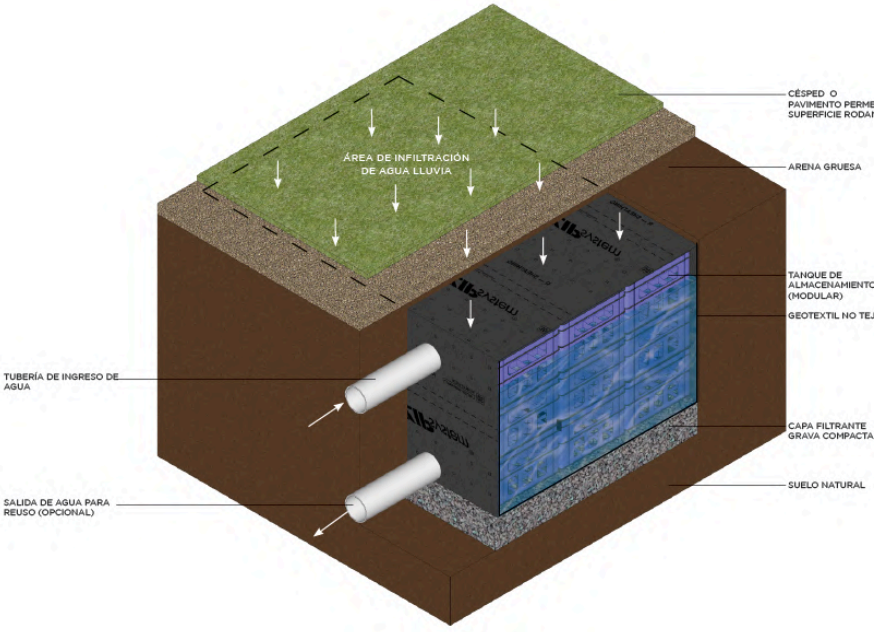
Drainage strip

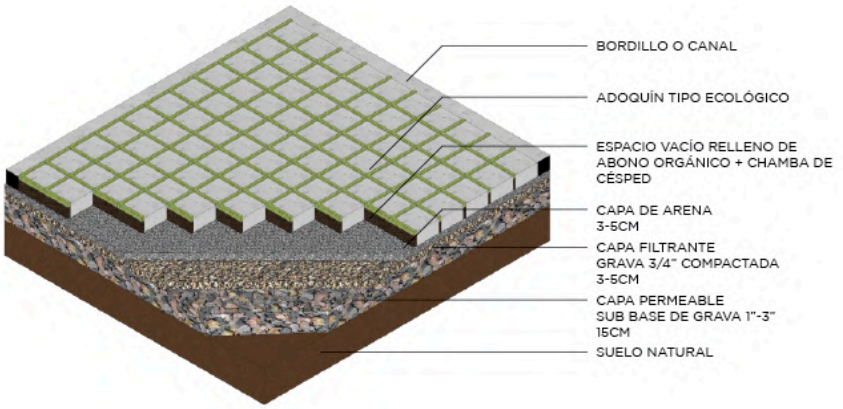
A system that allows runoff to be intercepted and conveyed to a retention, infiltration or flood area. This aggregate version is an economical water drainage technique that can be easily integrated into the urban landscape.



Underground rainwater storage

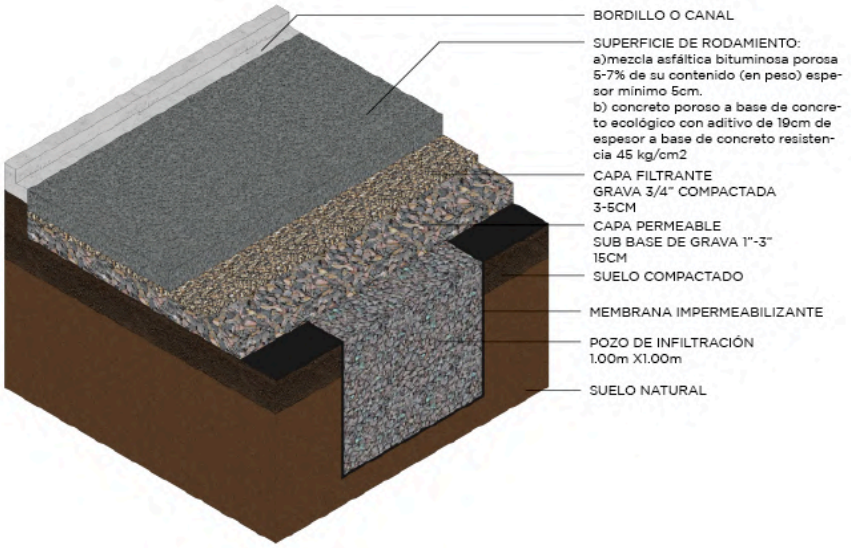
Water storage cells are placed under public spaces, roundabouts or roads to collect large amounts of rainwater during heavy rainfall. The water seeps into the ground or is gradually drained away. This type of reservoir avoids the massive and immediate discharge of rainwater into the sewer and prevents the risk of saturation and flooding. These plastic cells are lightweight but can withstand the passage of vehicles once installed. They are considered NbS in the sense that they provide in-situ stormwater management rather than attempting to evacuate stormwater as traditional grey infrastructure does.





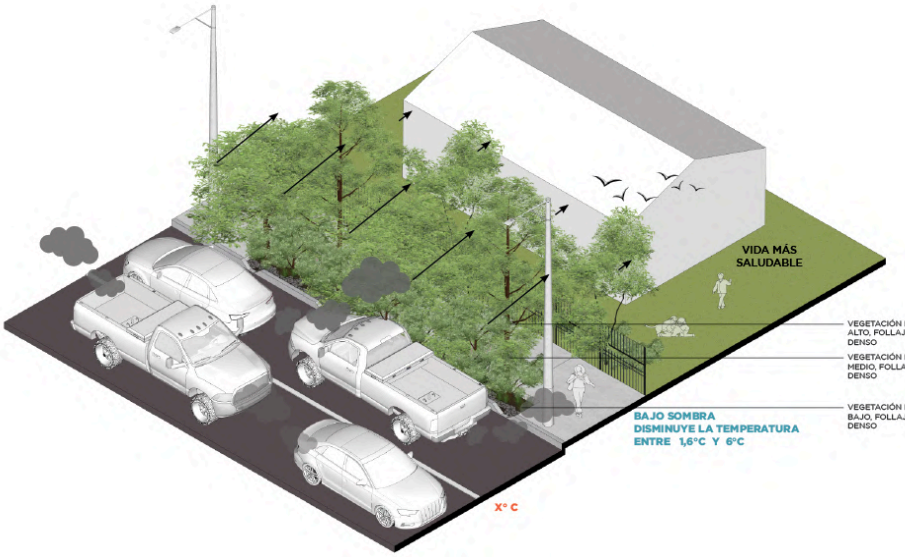
Permeable paving

The use of permeable paving materials helps to manage runoff and prevent flooding.
Two options for permeable paving materials have been modelled: permeable concrete and permeable paving.



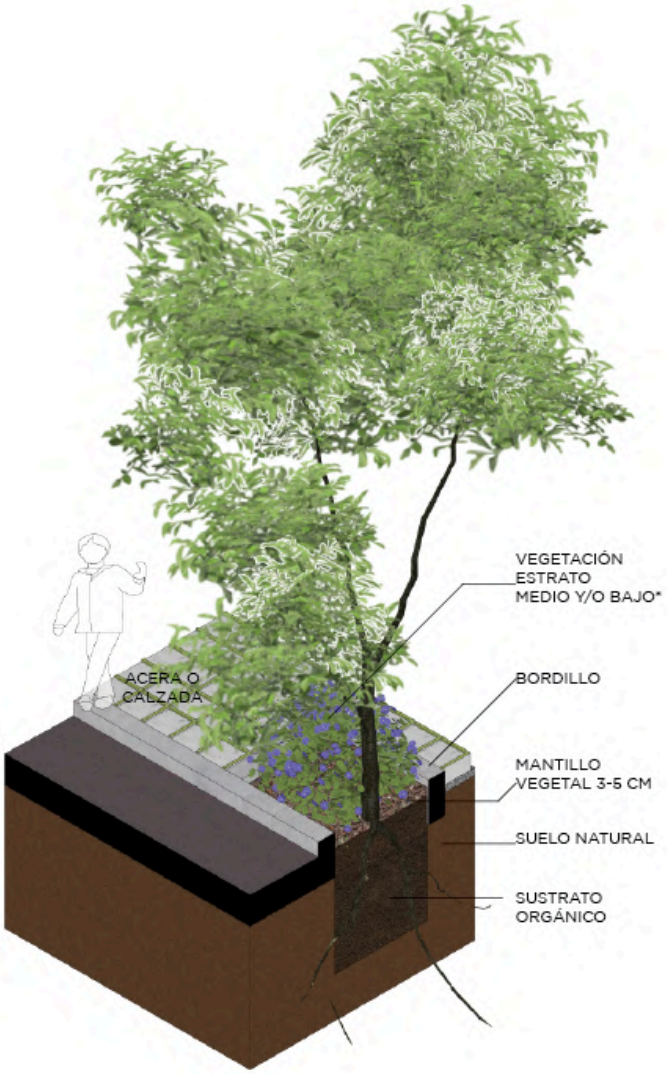
Green barrier

The ability of dense vegetation to act as a barrier to pollutants from vehicles, especially particulate matter, has been demonstrated. A good configuration can then protect urban areas or facilities (e.g. schools) adjacent to major roads and sources of recurring pollution (e.g. bus corridors). The use of trees allows for the creation of higher barriers and thus optimal containment of the spread of pollutants over large areas.



Urban trees

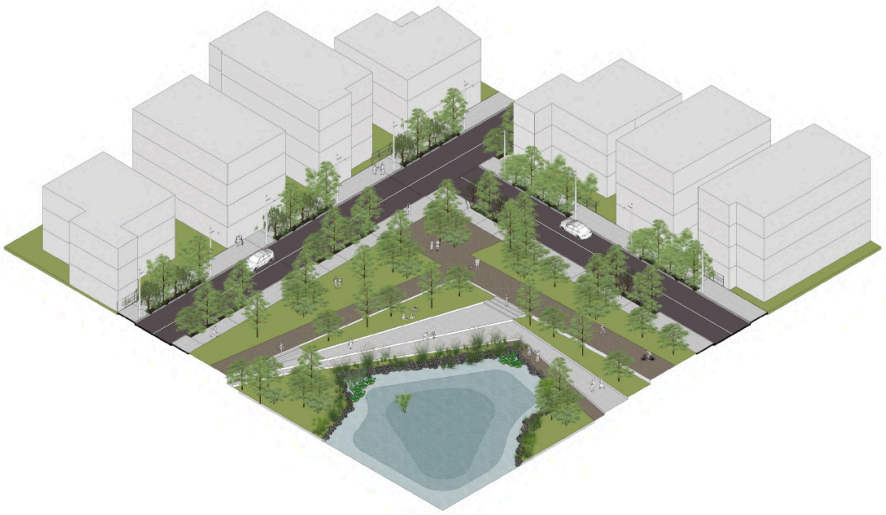
Urban trees are a traditional solution in cities. But the dominance of the car in public spaces has relegated them to a purely decorative function in many places. Instead, the essential functions that trees fulfil for the city (air quality, CO2 storage, habitat for biodiversity, local heritage with native and emblematic species) and for the users of the street or public space (shade, local cooling by evapotranspiration, vegetation, mental health) need to be rehabilitated and maximised.



3.2.3. NbS for open public spaces

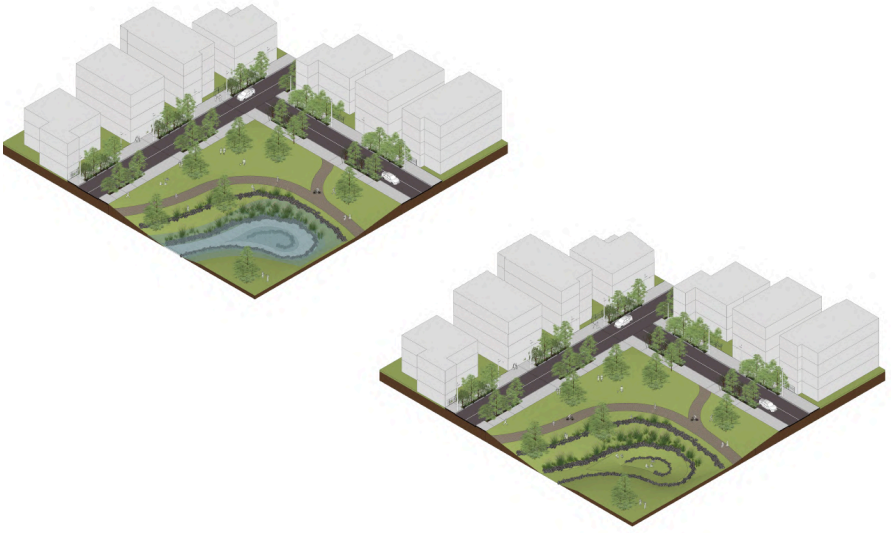
Retention ponds - Artificial wetlands

Urban constructed wetlands make it possible to manage areas that receive water naturally (through underground sources or topography) in a natural or semi-natural environment that enhances local biodiversity and urban nature. It is an asset for a natural urban landscape that can host original flora and fauna, and, as such, is also an interesting vector of environmental awareness of nature and the water cycle. The wetland can also have a technical function in rainwater management, for example as a retention area during heavy rainfall events.



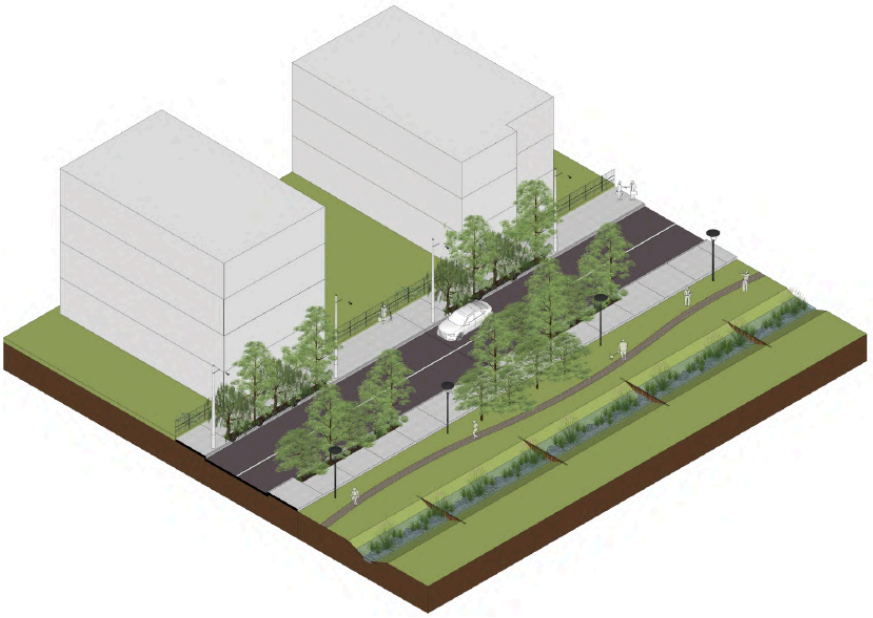
Floodable parks

Floodable parks are multifunctional park areas that serve as recreation in normal times and can absorb large amounts of rainwater during heavy rainfall events, up to and including flooding. This device is the end point of a sponge city strategy at the urban micro-catchment scale, and the capacity of the whole system may depend on its size or storage capacity. These systems also provide citizens with an insight into the water cycle and raise awareness of environmental protection and associated risks.



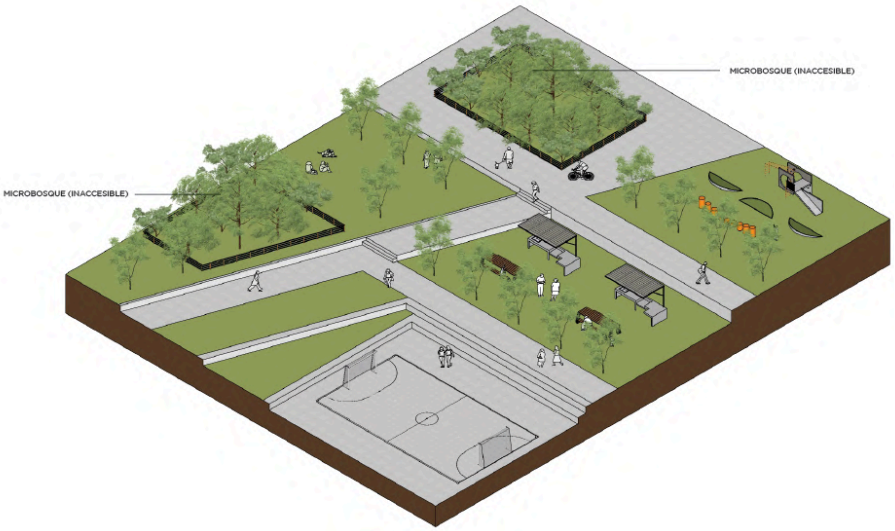
Retention and infiltration trench

Trenches are devices that can be used in roadsides, parks, car parks and other areas with large impervious surfaces to receive large volumes of rainwater and gradually convey it downstream while retaining water for infiltration and/or evaporation. The water retention capacity can be very large with low implementation costs. It is a solution that can be easily integrated into different types of landscapes as it can include different types of vegetation and paving, creating an interesting naturalised landscape proposal.



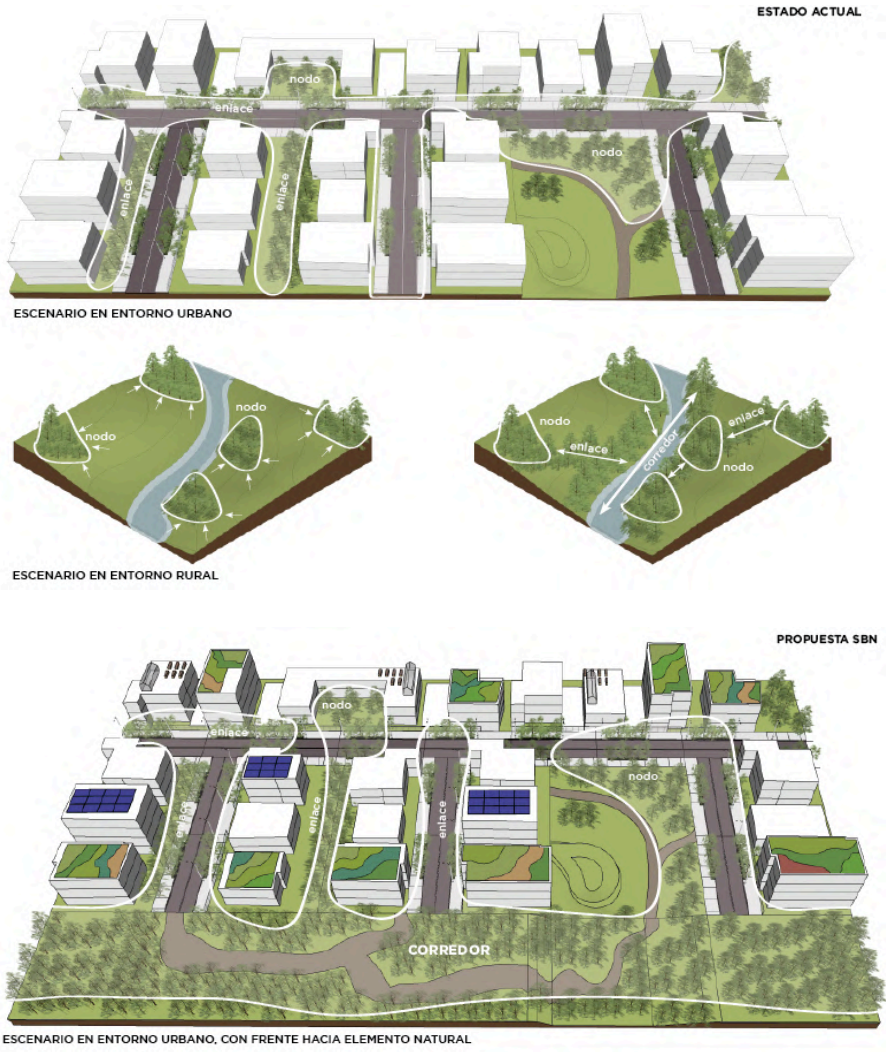
Urban microforests

Urban tree planting is artificial and isolated trees, even in parks, do not provide the necessary habitat for certain species. It is essential to have natural spaces in the city where the complexity of the vegetation configuration is conducive to providing habitat for local species, which means that access must be prevented and maintenance limited to the minimum necessary. Another advantage of these spaces, in the case of the Miyawaki microforests, is the accelerated growth of the trees due to the competition they have with each other due to the high density of planting. This accelerated growth means greater CO2 storage capacity.



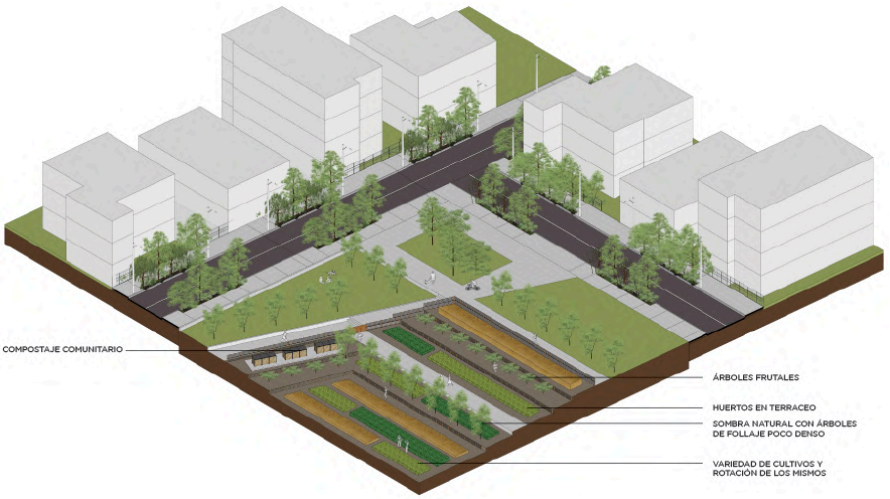
Biodiversity corridors

Biodiversity corridors aim to create links between urban ecological cores and/or nodes to improve the functioning of urban ecosystems.
The ecological cores and nodes within the intervention zone must be determined, their condition and biological needs qualified, and the physical barriers created by the urban environment identified. The introduction of new vegetation elements with appropriate characteristics is intended to create the missing links and propose a vegetated landscape for the neighbourhood.



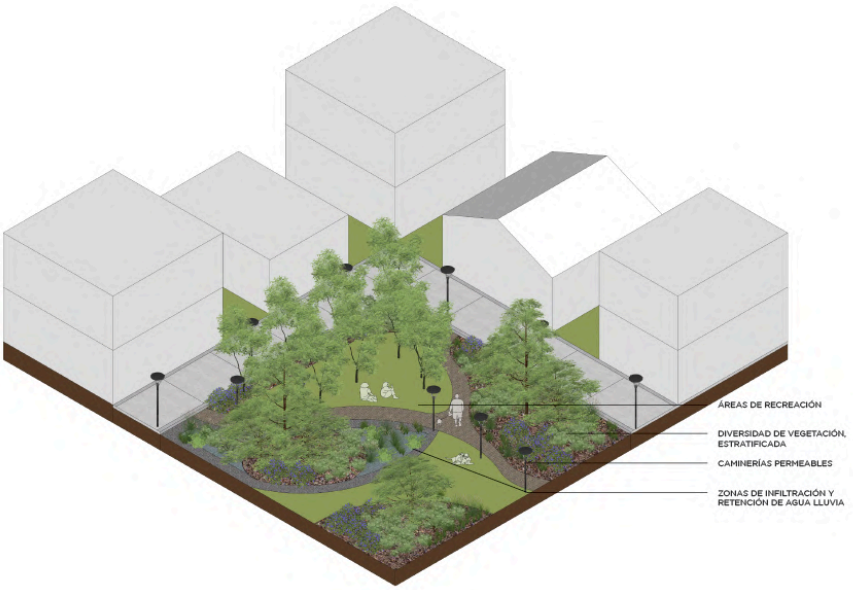
Community garden

They are shared spaces with a management model that associates a landowner (public or private) and a group of urban farmers, with a management model based on exchange, sharing and healthy and ecological production. It combines an environmental impact due to the growth of diverse crops, provided that it is carried out according to the rules of ecological agricultural production, and a social impact due to the dynamics of cooperation and awareness, in addition to the production of food, which in certain cases can mean a new income.



Urban nature

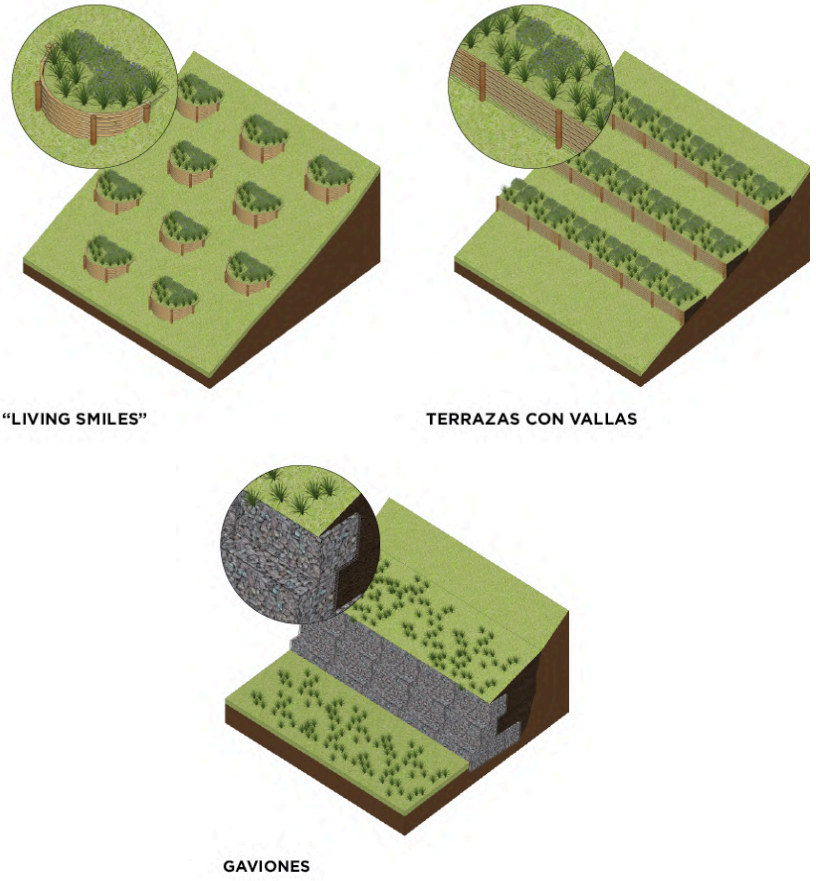
Another opportunity is trying to naturalise even more spaces than currently naturalised, with the aim of making urban users aware of nature in its unaltered state (i.e. with a minimum of control). We present two examples. The first is municipal parks, where more natural and less artificial spaces can be integrated, for example, by using a stream and a higher density of vegetation or by landscape design proposals that aim to recreate local ecosystems. The second is private properties, where the front lawn or courtyard can be converted into a natural garden that offers rainwater management, a diversity of native vegetation, a habitat for biodiversity, as well as enjoyment and mental health benefits for the inhabitants. The proliferation of gardens on private properties is a major benefit to the city in terms of resilience and sustainability.



3.2.4. NbS for natural areas

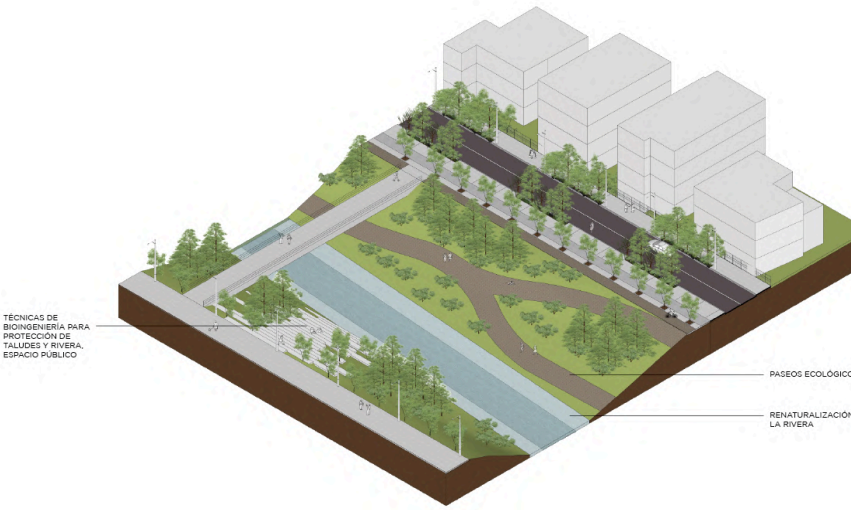
Slope protection solutions

These are some of the techniques that take advantage of the properties of vegetation to prevent erosion and restore the native environment. Vegetation can be used alone or combined with structural elements such as stone, wood, concrete or steel, depending on the type of soil and slope of the terrain.



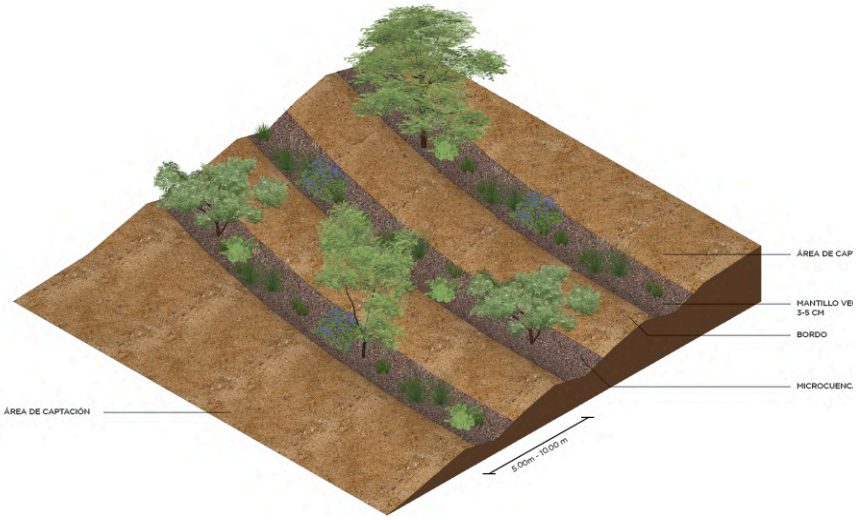
Renaturalisation of urban rivers

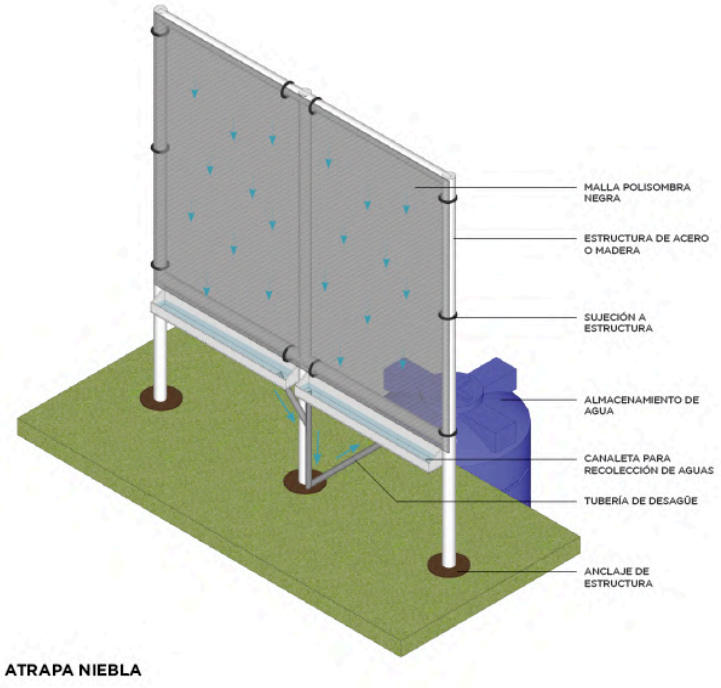
Many cities have channelled their rivers to control their flow and make use of urban space. An interesting solution to return valuable natural space to the city is to try to rehabilitate urban rivers in order to improve their coexistence within the city. Projects of this type show the great capacity of these rehabilitated spaces to compose valuable ecosystems, without abandoning the relationship with the city in terms of walking, observation and leisure functions. The view of the river is also a call to care for it, an excellent driver of environmental awareness. Finally, it provides a high quality landscape that benefits everyone in the city.



Water harvesting systems

Harvesting systems allow rainwater to be collected and stored easily and economically in specific contexts. Two techniques have been modelled, the first to reduce soil erosion, revegetate an area or reduce irrigation costs in agricultural areas. The second focuses on capturing and storing water from fog, which has been shown to be highly efficient in foggy areas.





3.3. Integration into the SketchUp Warehouse

The INTERLACE NbS library in the 3D Warehouse can be found here: https://3dwarehouse.sketchup.com/.../INTERLACE-Project

In order to integrate the 3D models into the SketchUp 3DWarehouse, it was necessary to create an account with a 3D Warehouse ID for the INTERLACE project, as this is a requirement for uploading

information to the platform. In this way, all uploaded models would be associated with the same account, allowing the analysis of total downloads, total views and total likes to be tracked over time. The account allowed us to include the link to the INTERLACE website in the profile.

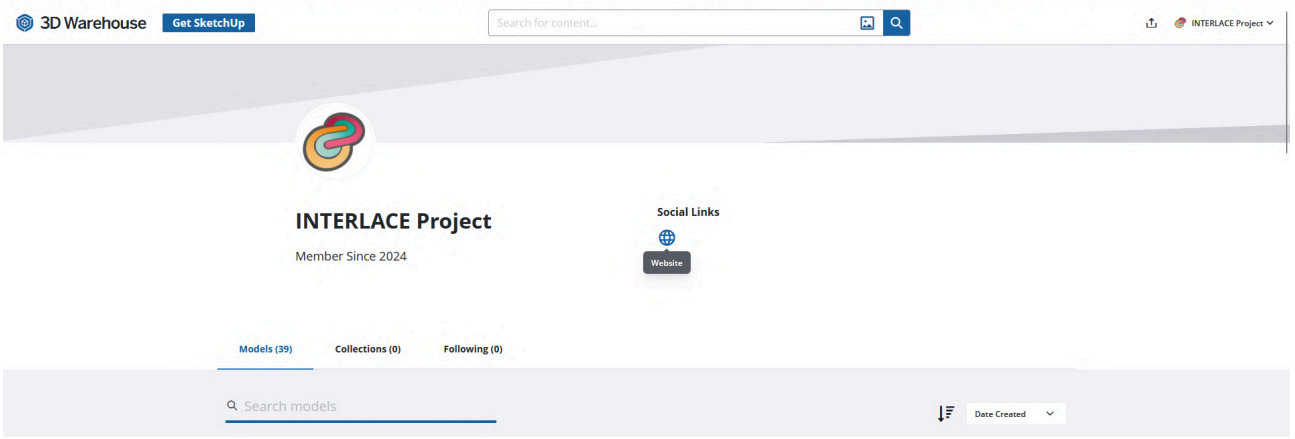


Figure 3: Screenshot of the INTERLACE profile from SketchUp 3D Warehouse.

The 3D models were first checked to ensure that they were all well positioned on the origin (X, Y, Z axes), in an isometric view and without any objects that did not correspond to the model. After this check, each object was saved with the name of the NbS in .skp format (SketchUp file format) and then uploaded to the platform. Finally, all the models (39 in total) were uploaded. Each of the models was assigned a category: landscape, building products and furniture. These categories are the ones that are more related to each model, as there is no defined category for NbS.

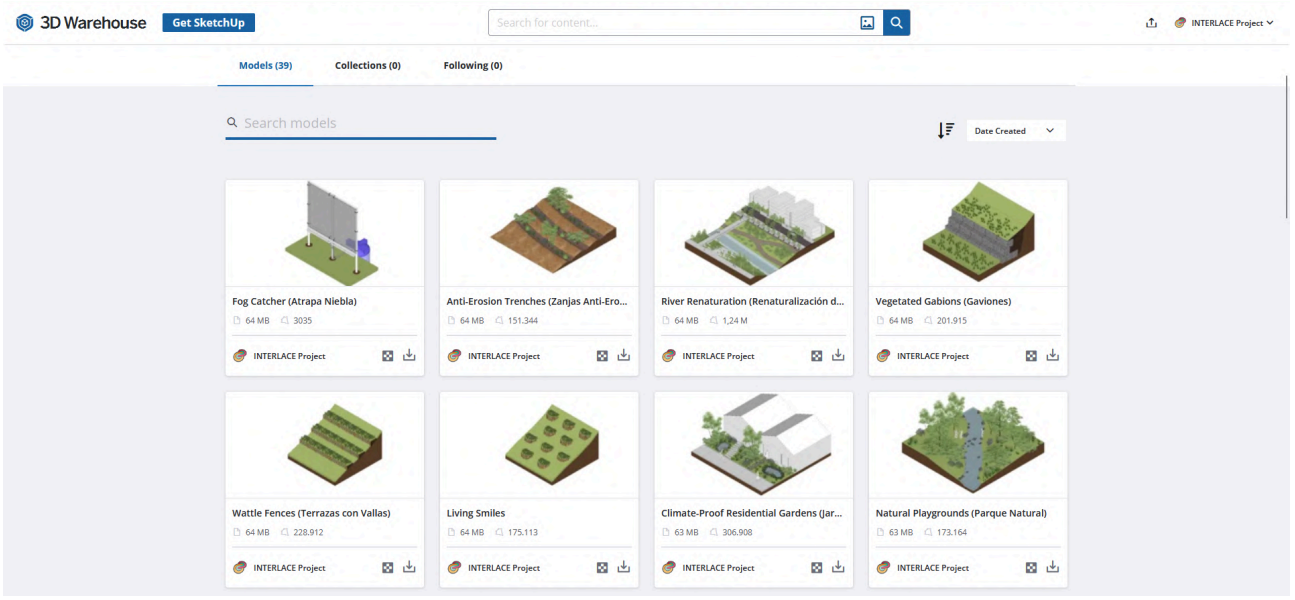


Figure 4: Screenshot of how some of the models are displayed in the profile from SketchUp 3D Warehouse.

Each model includes the following information:

1. Name of the NbS in English and Spanish.
2. Description of the NbS. It is necessary to click on 'Read more' to read the full information.
3. Model info, which includes: polygon count, file size, material count, tag count, boundary, distance from origin, units of measure and date modified.

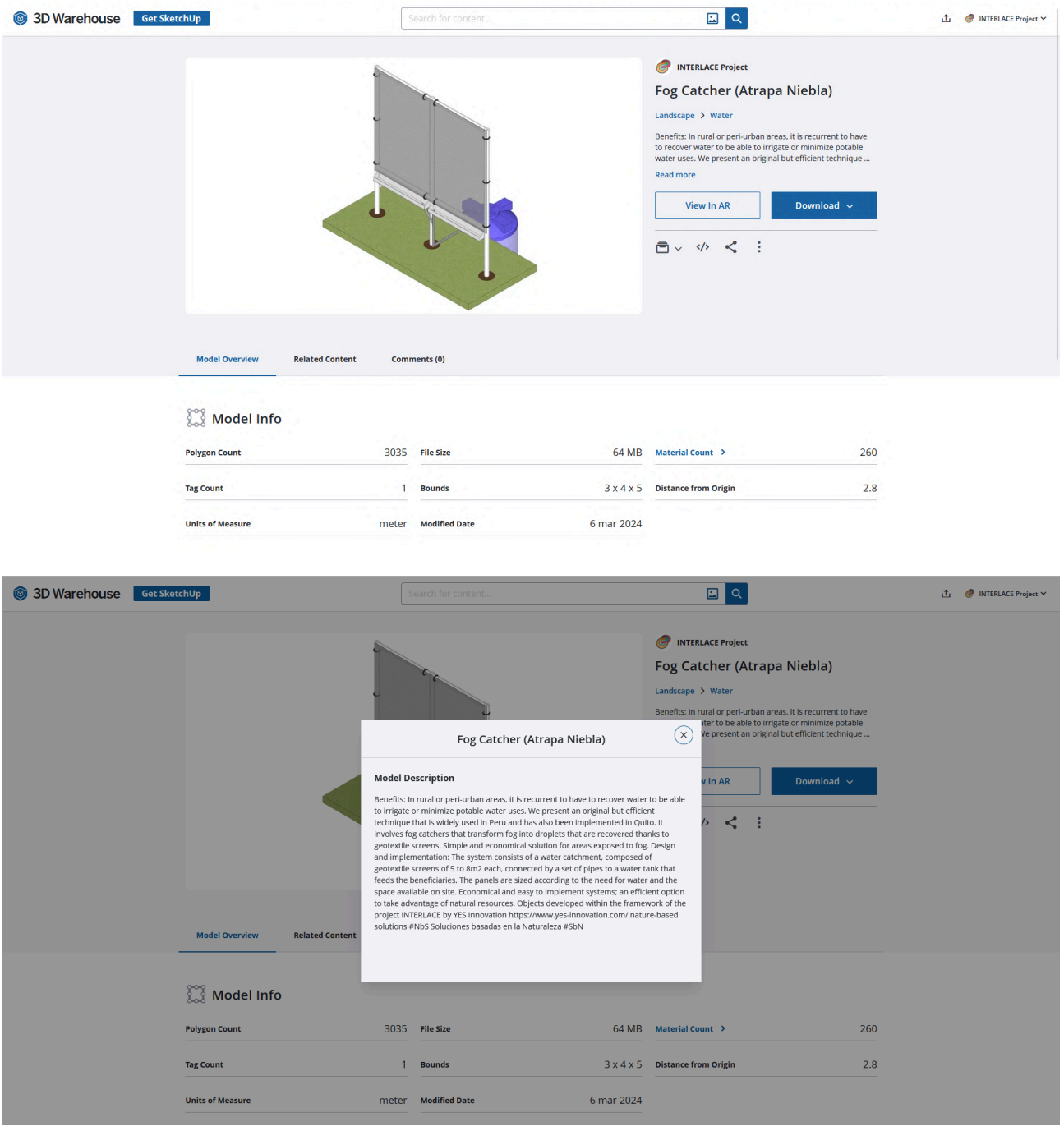


Figure 5: Screenshots of the information for each object in SketchUp 3D Warehouse: name, description and model info (above), extended description of the model (below).

3.4. Dissemination results

To spread the word about these new 3D objects, information was published on social networks and on OPPLA. The new library was also presented at a number of conferences and webinars on NbS and sustainable urban design.

Figure 6: Images posted in the OPPLA newsletter and on social networks to disseminate the 3D objects library on SketchUp Warehouse.

All the models were uploaded at the beginning of March 2024. It is important to note that, in addition to the distribution that has taken place, 3D Warehouse users have free access to all the models uploaded to the platform through keyword searches and the existing categories.

As a result, from the first day the models were uploaded until September 19th 2024, there were a total of 4k downloads, 11k views and 196 likes for all models combined.

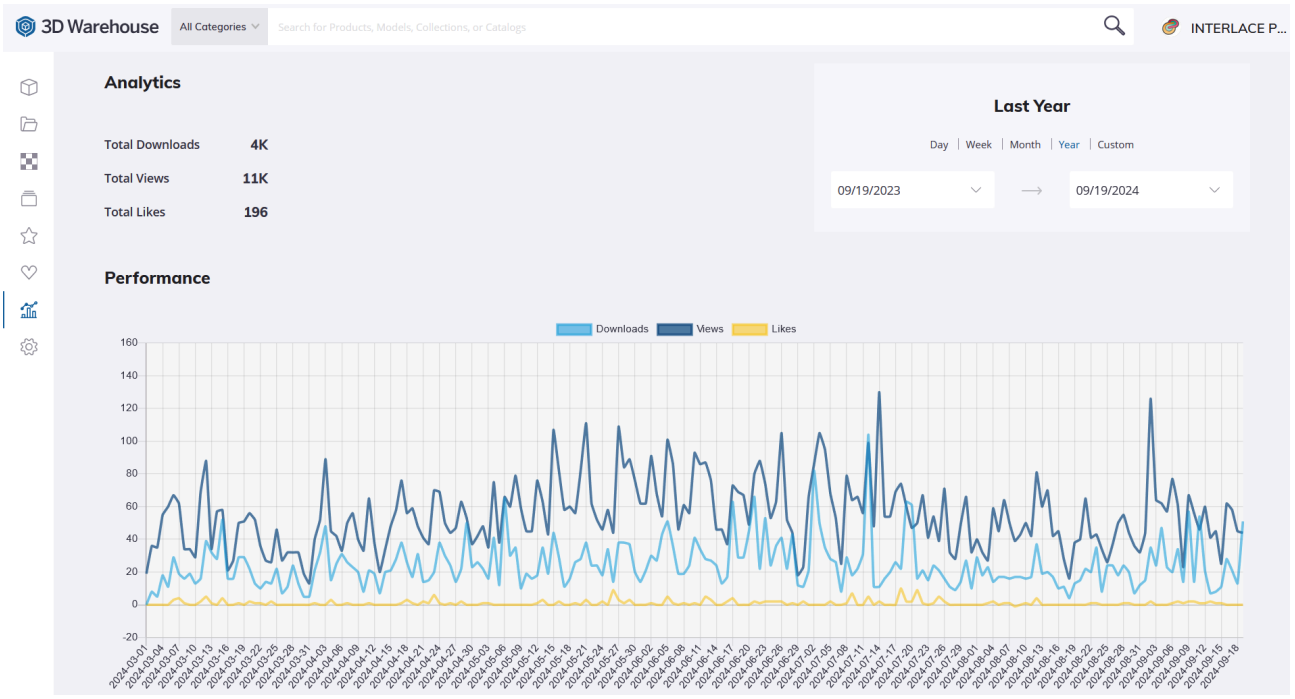


Figure 7: Screenshot of the analytics from March to September 2024 based on downloads, views and likes.

The information can also be viewed by model. The most popular model is “Green facade with climbing plants (Fachada Vegetal Liviana)” with a total of 1019 downloads, 2018 views and 15 likes. The second most popular is the rain garden, with the least popular one so far being a bird habitat model.

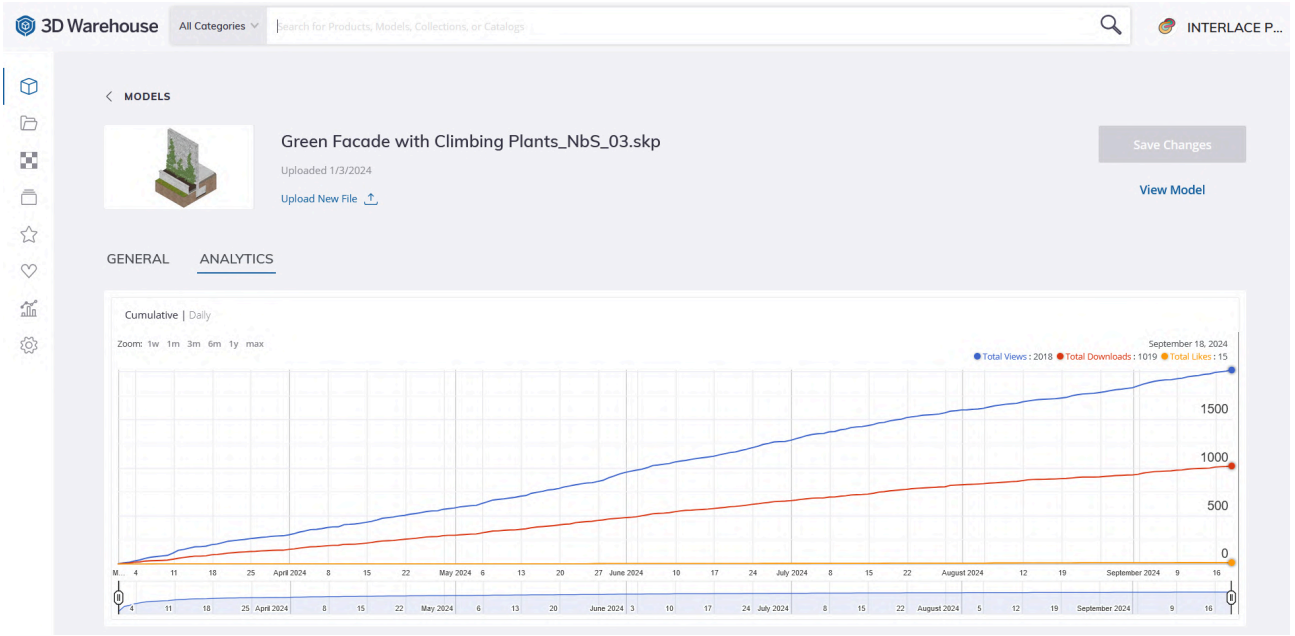


Figure 8: Screenshot of the cumulative analytics based on downloads, views and likes for the most popular model. The data has been considered until September 18th, 2024.

4. NbS in urban design tools: objects and information integrated in Unlimited Cities

For the third tool, it was proposed to work on the integration of NbS into urban planning and urban design tools. Current urban design tools face several limitations in promoting the use of NbS. One significant challenge is the lack of comprehensive information on NbS within these platforms. Many tools primarily focus on traditional design methodologies and may not provide adequate resources, case studies, or guidelines related to NbS applications, hindering designers' understanding and ability to implement these solutions effectively.

Additionally, existing tools often lack integrated modeling capabilities that consider the ecological functions and benefits of NbS. For instance, many software programs do not offer features for simulating environmental impacts, such as improved air quality or stormwater management, making it difficult for designers to quantify the advantages of incorporating NbS into their projects.

Furthermore, urban design tools may not support participatory processes effectively, limiting community involvement in decision-making. Engaging local stakeholders is crucial for the successful implementation of NbS, as it ensures that solutions are tailored to the specific needs of the community.

Lastly, the complexity and variability of NbS, depending on local contexts and conditions, are often not adequately addressed in current tools, leading to a one-size-fits-all approach that may not be suitable for diverse urban environments. These limitations underscore the need for enhanced tools that prioritize and facilitate the integration of NbS in urban design.

For this task, two approaches were developed:

1. Integrate a scientific assessment of the impact of NbS into the urban design process. This approach is directly linked to the design module developed as part of the NbS assessment framework. Simulation tools such as ENVI-met can be used to assess spatial configuration scenarios in terms of their impact on the urban microclimate. This type of tool is therefore particularly relevant for analysing the effectiveness of NbS in urban areas.

   This is not an enrichment of the tool as such, but rather a demonstration of the capability of such tools for urban designers. As this work is detailed in deliverable D3.3, it is only briefly presented in this chapter to mention the complementarity of this approach with the tools presented in the present report.

2. Incorporate pieces of information about NbS into tools that facilitate co-creation and participatory processes. Discussions with stakeholders can take on a new dimension if they are fuelled by easily assimilated technical information. This is the aim of the work carried out in INTERLACE to improve the Unlimited Cities tool, in collaboration with the Open Urbanism Foundation, which is developing and proposing the tool.

We present in this chapter each of these two approaches by detailing further the work of re-developing Unlimited Cities. The tool and its functionalities in the traditional version are thus introduced, to then present the NBS-related information integration work carried out with the Open Urbanism Foundation team who originated the tool and disseminate it worldwide. The new features of the tool are explained and we present the tests carried out on the intermediate and final versions of the re-developed tool.

4.1. NbS simulation integrated into the design process

There are a number of tools that can be used to make better informed planning decisions. For example, modelling exercises can be used to simulate various urban design alternatives, which facilitates a comparison of their performance under different climate conditions.

Incorporating different NbS into the planning/urban design alternatives could allow evaluation of their effectiveness, for example, in reducing thermal stress in public spaces or improving water runoff, as well as enhancing other social and environmental co-benefits.

This was the case for the micro-scale modelling exercises carried out in Envigado and Granollers that were aimed at improving thermal comfort through NbS in urban design.

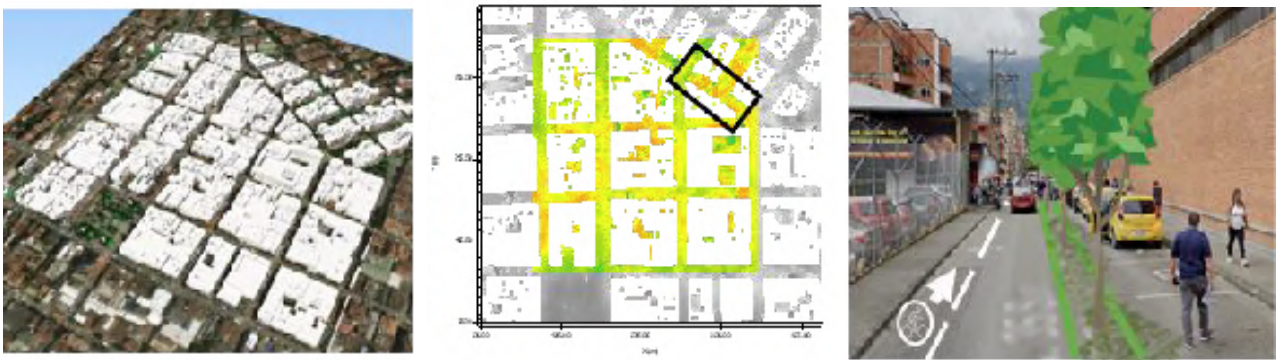


Figure 9: Examples of thermal comfort simulations realised in Envigado (Tecnalia)

The urban microclimate model used to model the thermal variable is ENVI-met. It is a 3D fluid dynamics model that reproduces the processes of the urban climate system by calculating air flows between buildings, the impact of vegetation and of water masses on the microclimate as well as the exchange of radiative fluxes between the ground, surfaces and walls of buildings. ENVI-met is designed for micro-scale modelling with a typical horizontal resolution between 0.5 and 10m, typical time periods of 24 to 48 hours and time intervals of 1 to 5 seconds.

The results were presented with details in the deliverable INTERLACE D3.3.

4.2. NbS performance indicators embedded in Unlimited Cities

For the development of the version of Unlimited Cities enriched with information on NbS, an Impact Task Force was created with the aim of including potential practitioners for this new version of the tool, in line with the basic principle of agile methodology. Given the difficulties in involving players not directly linked to INTERLACE by a commitment (due to lack of availability), this ITF was finally made up of two major players who had expressed an interest in participating in this development:

- GENSLER: a very large architecture and urban planning firm, with global activity and a presence in South America through its head office in San José. Emma Grun, director of design and urban planning for South America, who is also a member of the INTERLACE advisory board, was the main participant.
- TECNALIA: a large-scale technology centre based in Spain which supports urban planning players in their climate transition and which includes a group specialising in the use of NbS in the urban environment. Gemma Garcia and Igone Garcia, both NbS experts and partners in the INTERLACE project, were the main participants.

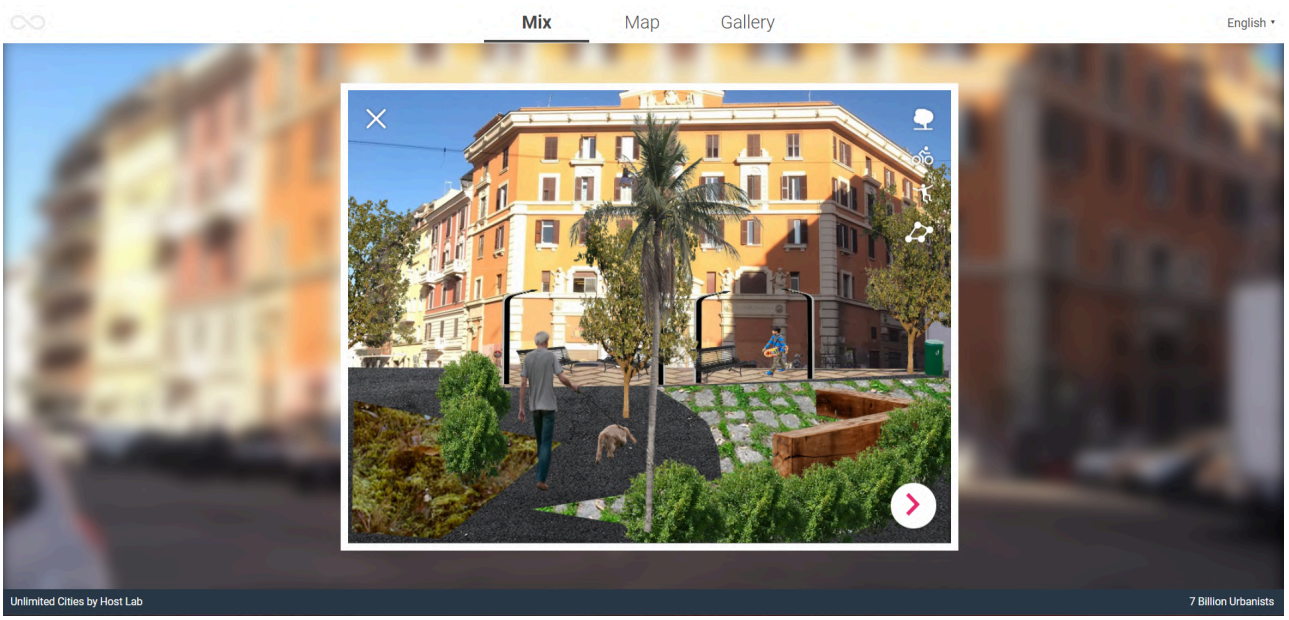
The development was coordinated by YES Innovation as the lead for this task within INTERLACE, in cooperation with the Open Urbanism Foundation, a non-profit organisation based in Switzerland which specialises in citizen dialogue processes for urban planning projects using open source tools, and which develops and promotes the Unlimited Cities tool on a global scale.

4.2.1. Unlimited Cities

Unlimited Cities is an application that emerged from several EU-funded research projects in 2011. It aims to facilitate the involvement of civil society in urban transformation. Unlimited Cities DIY is the latest open source update of the tool. Originally developed by the urban planning agency UFO in partnership with the architecture and urban planning firm HOST, then by the 7 Billion Urbanists Foundation, it is now managed and developed by the Open Urbanism Foundation, based in Switzerland.

The application, designed for use on mobile devices (tablets and smartphones), enables members of the public to provide their views on the future development of a neighbourhood before professionals draw up plans. The application offers a straightforward interface that allows users to provide a realistic representation of their expectations for a given site (we call it a “mix”). To achieve this, users select and implement urban objects (such as vegetation and furniture) in the area under consideration.

Figure 10: the Unlimited Cities tool in one of its first version (picture from: www.collaborative-urbanism.com)



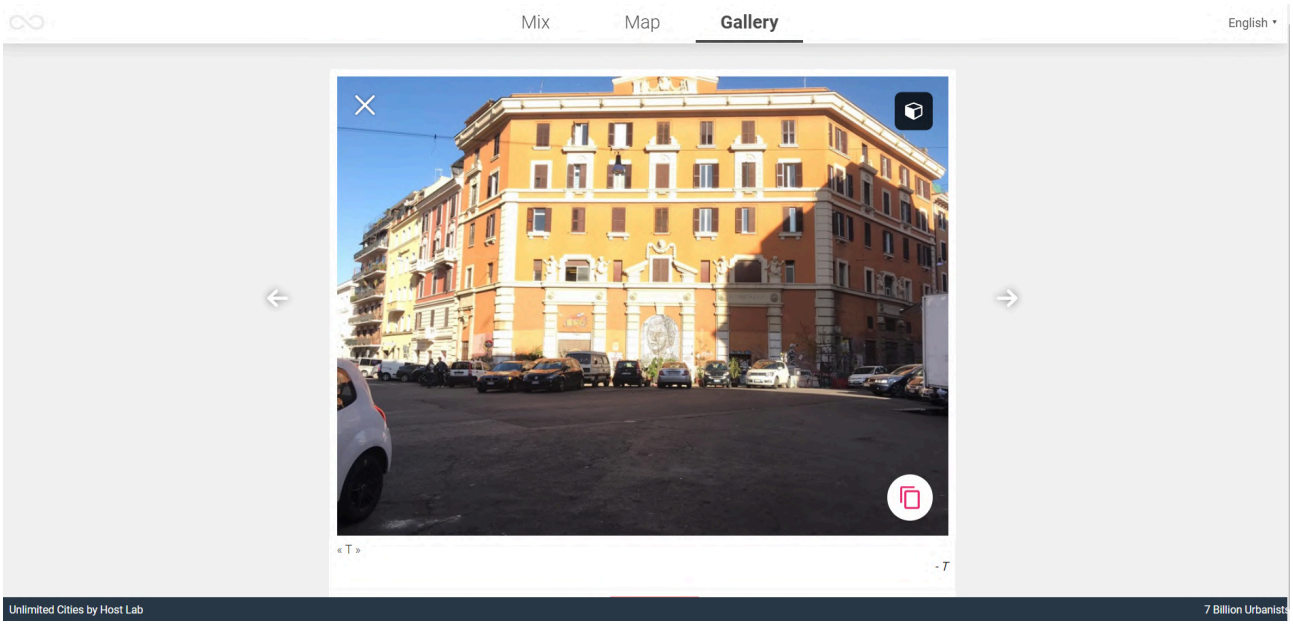


Figure 11: Unlimited Cities in its last version (DIY) with the Mix option allowing to modify the urban area through adding specific elements. Modified picture (above) and original picture (below)

The application passes this information on to the main developers of a given urban project before they start planning, while also encouraging people to question their design wishes and thus take ownership of the project to be implemented. The Unlimited Cities method allows civil society to act and co-design urban developments with professionals, without being subject to predetermined solutions from experts and public authorities.

The tool is an engaging and playful element of a co-creation process that can be conducted on the street using tablets. By spending several weeks in the local area, we can engage with a much larger number of people than would be possible using traditional consultation methods, which often prove difficult to use for reaching a large and diverse audience.

Figure 12: Pictures of the application of Unlimited Cities in Quito in 2018 (YES Innovation)

4.2.2. Development process for integrating NbS-related information

The Unlimited Cities solution offers the flexibility to integrate a variety of urban objects into the design mix. The team at the Open Urbanism Foundation previously prepared the list on a project-by-project basis, taking into account the specific location and including objects that were typical to that area.

Figure 13: Examples of objects which can be integrated in a mix in Unlimited Cities

The objects are organised into categories, with the current version featuring a dedicated category for vegetation, identified by the name of the species.

It is proposed that the information related to the NbS be integrated into the updated version of Unlimited Cities. To achieve this, we must define:

- How should NbS be integrated into the tool? It may be beneficial to create a dedicated category with a more detailed description of each solution. Furthermore, the 3D objects modelled in SketchUp as part of the same task (Tool #2) could be used to shape the list of options.
- What information should be provided to demonstrate the value of NbS to the urban proposal and the potential for its use? It is essential to define the appropriate level of information for effective communication, taking into account both global and local issues, as well as the typical concerns of local stakeholders involved in this project.
- What is the best way to communicate this information? It is essential to analyse the language, complexity of information, message presentation and frame of reference (e.g. ability to compare with a baseline) to ensure effective communication.

4.2.2.1. Co-development workshops

A series of test and ideation workshops was conducted with the objective of co-constructing the new version of UC. The workshops were based around the aforementioned questions, with the objective of identifying the most pertinent levers to facilitate the integration of NbS into projects (through the proposed “mixes”) while ensuring that this was done with comprehensive knowledge of the facts and not merely for aesthetic purposes. Additionally, inquiries were made regarding the content (the information provided to the user) and the form (how it is delivered and at what point in the tool's usage).

The workshops were conducted in three stages with an expert audience, concluding with a focus on the most 'practising' participants, meaning those who implement participation and consultation processes on a day-to-day basis to design new public spaces. Please refer to Appendix 4 for details of the inputs received.

- Workshop 1: INTERLACE consortium at the Envigado annual meeting (2023). Demonstration, test and co-creation workshop on how to integrate NbS into UC. The INTERLACE team is a consortium of multi-theme experts in NbS but there are relatively few designers.
- Workshop 2: Group of participants from the Cities Talk Nature event held at Envigado (2023). The same process was followed, with discussions within the group and an online questionnaire to gather suggestions. This group included a few more designers from the private and public sectors, particularly from Colombia.
- Workshop 3: Workshop organised online with our ITF, extended to the design teams at Gensler and Tecnalia and with the participation of the Open Urbanism Foundation team. The participating teams are urban designers and technical experts in NbS. The workshop covered the details of how to use the tool in different NbS integration scenarios.

Based on the information and opinions gathered during these three workshops, a series of proposals was selected and then submitted to the Open Urbanism Foundation's team of IT developers and technically validated to initiate their development.

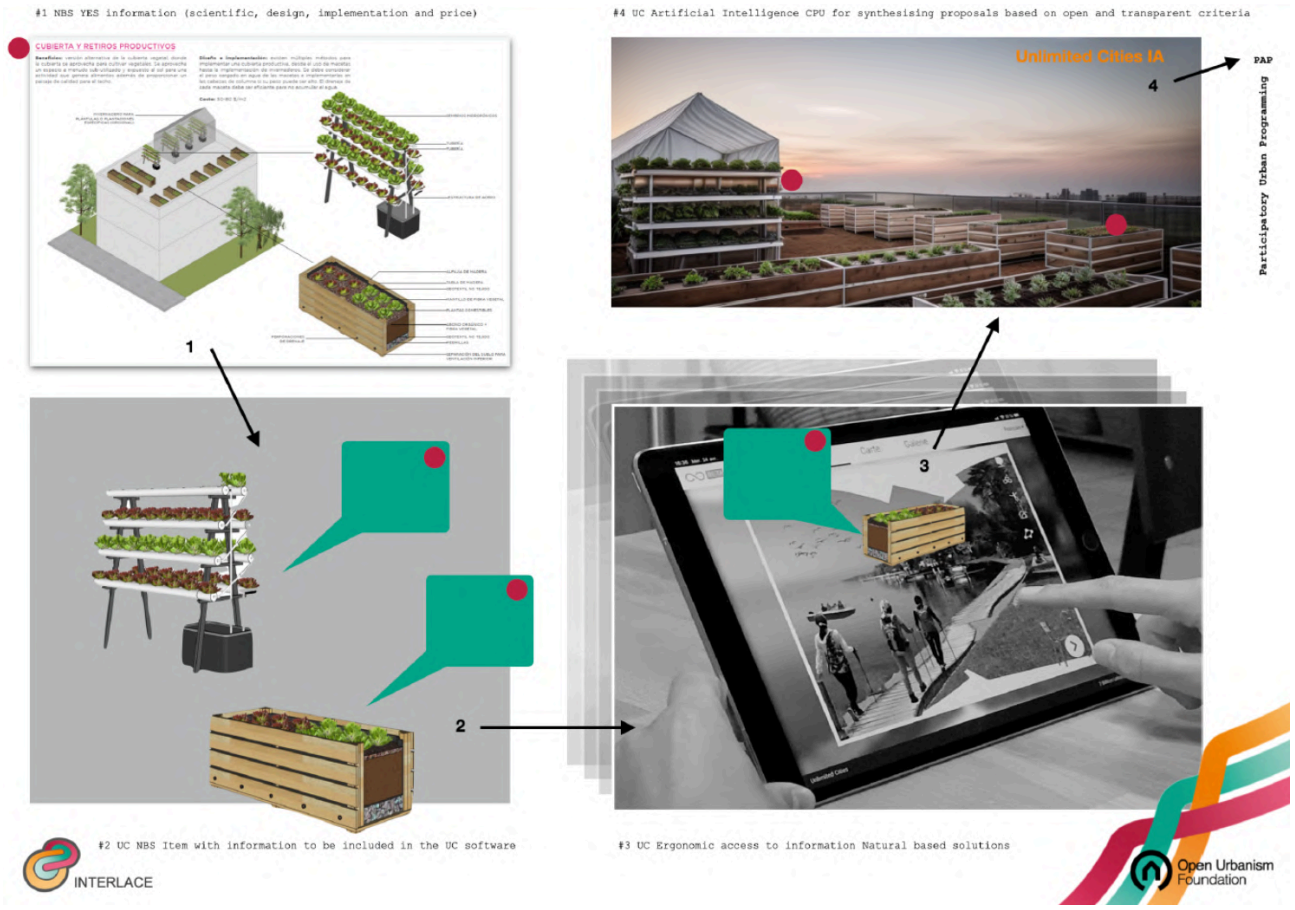


Figure 14: Conceptualisation of the evolution of Unlimited Cities to integrate NbS using the INTERLACE library of NbS objects and integrating information relating to their impacts (Open Urbanism Foundation, 2024)

Main insights

Throughout the workshops, as users interacted, there were recurring insights that are summarised below:

- ★ Include a demonstration of the benefits of implementing NbS.
- ★ Show the costs of implementation.
- ★ Include information on the integrated elements and their benefits.
- ★ The importance of the visual impact of NbS on the space (before and after visualisation, types of visualisation) with simple elements.
- ★ There are limits to what can be integrated.
- ★ The resulting visualisation can create expectations that might not be met.
- ★ The elements need to be locally adapted to use in different contexts.
- ★ It is important to remember that citizens are not necessarily urban planners.

- ★ There must be a way to make the inclusion of NbS mandatory.
- ★ The use of graphical elements could increase interaction.
- ★ Two options were highly debated: 1. preparing beforehand a set of pictures as a baseline, allowing for a more structured process; 2. allowing the free use of any picture of the project (even pictures taken on the fly), promoting total freedom for the participants to propose any idea of implementation.

4.2.3. New version of Unlimited Cities enriched with NbS information

The new version of Unlimited Cities developed for INTERLACE is available for INTERLACE cities and for the INTERLACE consortium, and can be used on request by contacting the Open Urbanism Foundation.A number of new features and information have been added to this new version. We present them below.

New home page

The UC home page has a special function of informing users. Users can use the tool on their own as part of a participatory workshop, or they can be accompanied by a facilitator, particularly when the co-creation process is carried out in the public space itself. In both cases, this page can be used to provide basic information about the project.

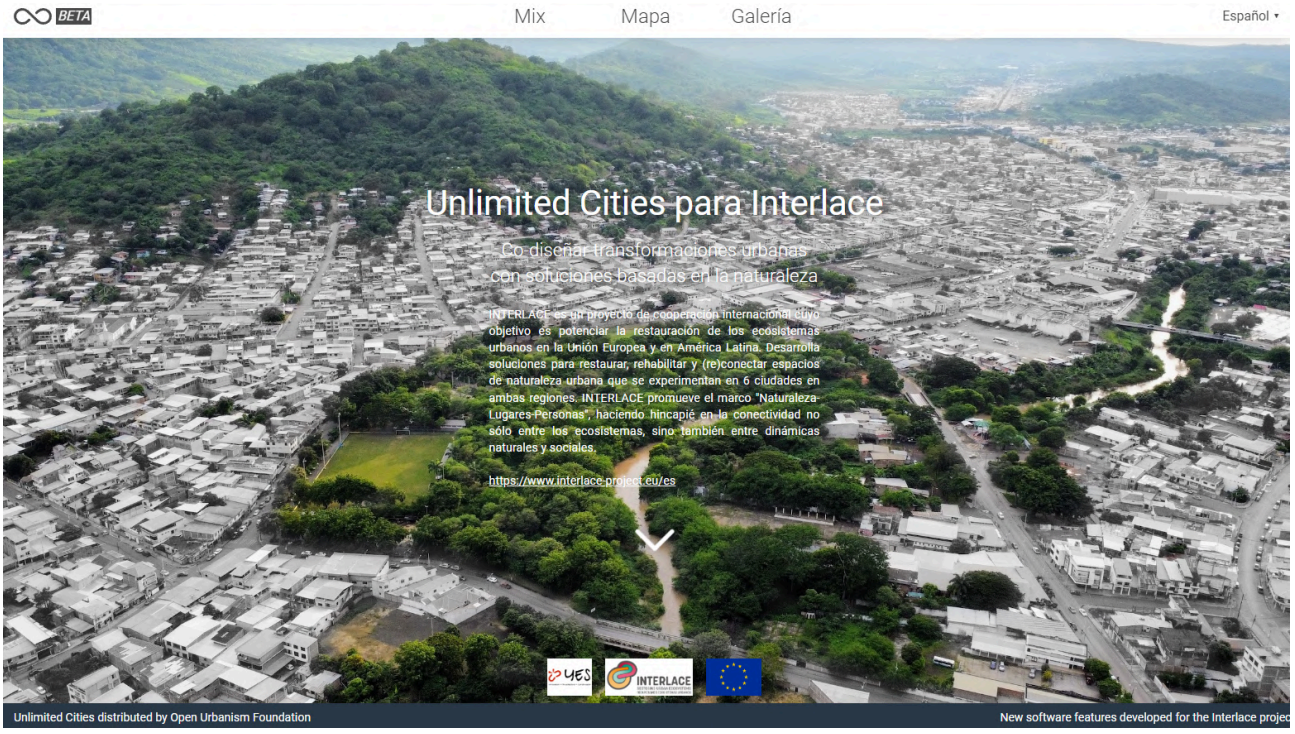


Figure 15: Landing page for Unlimited Cities for Interlace

The tool has been designed to be minimalist in every respect to ensure that its functions are intuitively understood and that it can be used immediately to create mixes in just a few minutes. This means that written information is kept to a minimum throughout the tool. The home page is therefore the main means of informing users about the urban project they are being asked to contribute their point of view to, but also, in our case, about NbS, their definition and their potential functions in the urban space. A short introductory text has therefore been formulated to indicate the development framework for this new version (the INTERLACE project) and the role that NbS can play in the configuration of an urban transformation. Links have been included to give the curious user access to further information, particularly in the case of an online session.

Short descriptions for NbS objects

Until now, there had been no qualitative information on the objects and mixes offered in Unlimited Cities. Users could therefore only rely on their perception of the object (mainly aesthetic and functional) to define their mix proposal.

For this new version of the tool, short definitions have been introduced for each NbS proposed. These are intended to provide information on the nature of the solution and to raise awareness of its ecosystemic contribution. Only the NbS are accompanied by this short description, which reinforces their structuring character for this version of UC.

Figure 16: Description and colour tags for each NbS object integrated in Unlimited Cities

NbS impact signalled through dedicated tags

'Tags' have been included in the tool in order to, for one, provide users with qualified information on each of the NbS to be integrated into the public space, particularly with regard to their impact, and for another, to then be able to efficiently evaluate the various proposals made by the participants. These

key words associated with each of the NbS make it possible to understand their main impact or the issues to which they respond.

The following tags have been integrated for the NbS:

- Biodiversity
- Heat island
- Water
- Slope control
- Urban agriculture

The tags are displayed when you select the objects to be included in the mix, and are colour-coded to reinforce their structuring role in the tool. The colours also make it clear that there can be different types of solutions to the same problem. Tags included in a mix are also mentioned at the bottom of the mix so that the user is aware of the implications of the proposed solutions.

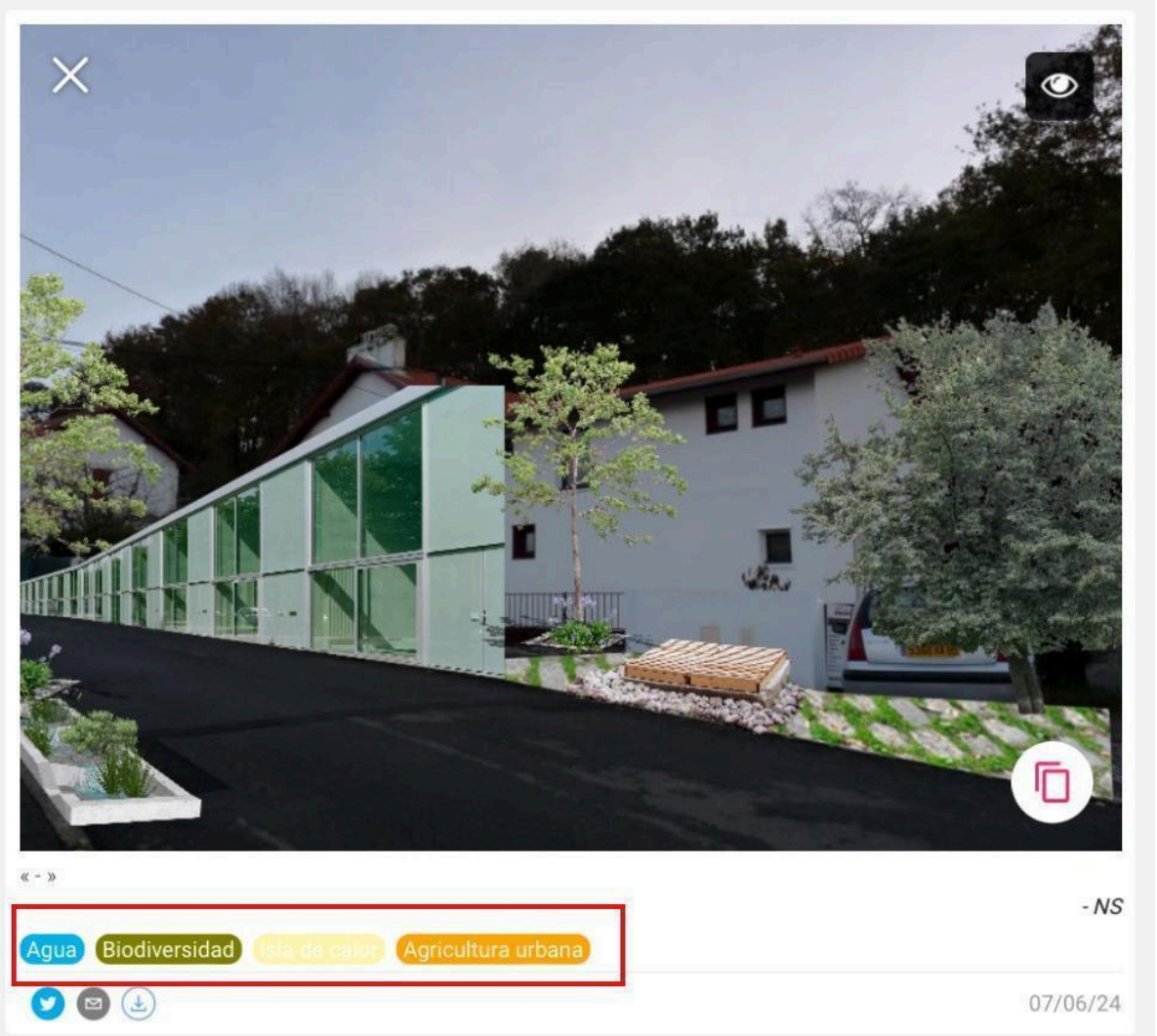


Figure 17: Mix proposal with the corresponding tags mentioned at the bottom.

Introduction of a complete new set of NbS objects to be selected by users

A set of 23 NbS objects has been added to the tool, each with its own description and tag. The descriptions are intended to be easy to understand for a general audience, highlighting the importance and benefits that each solution can offer in everyday life. NbS are included in the vegetation category.

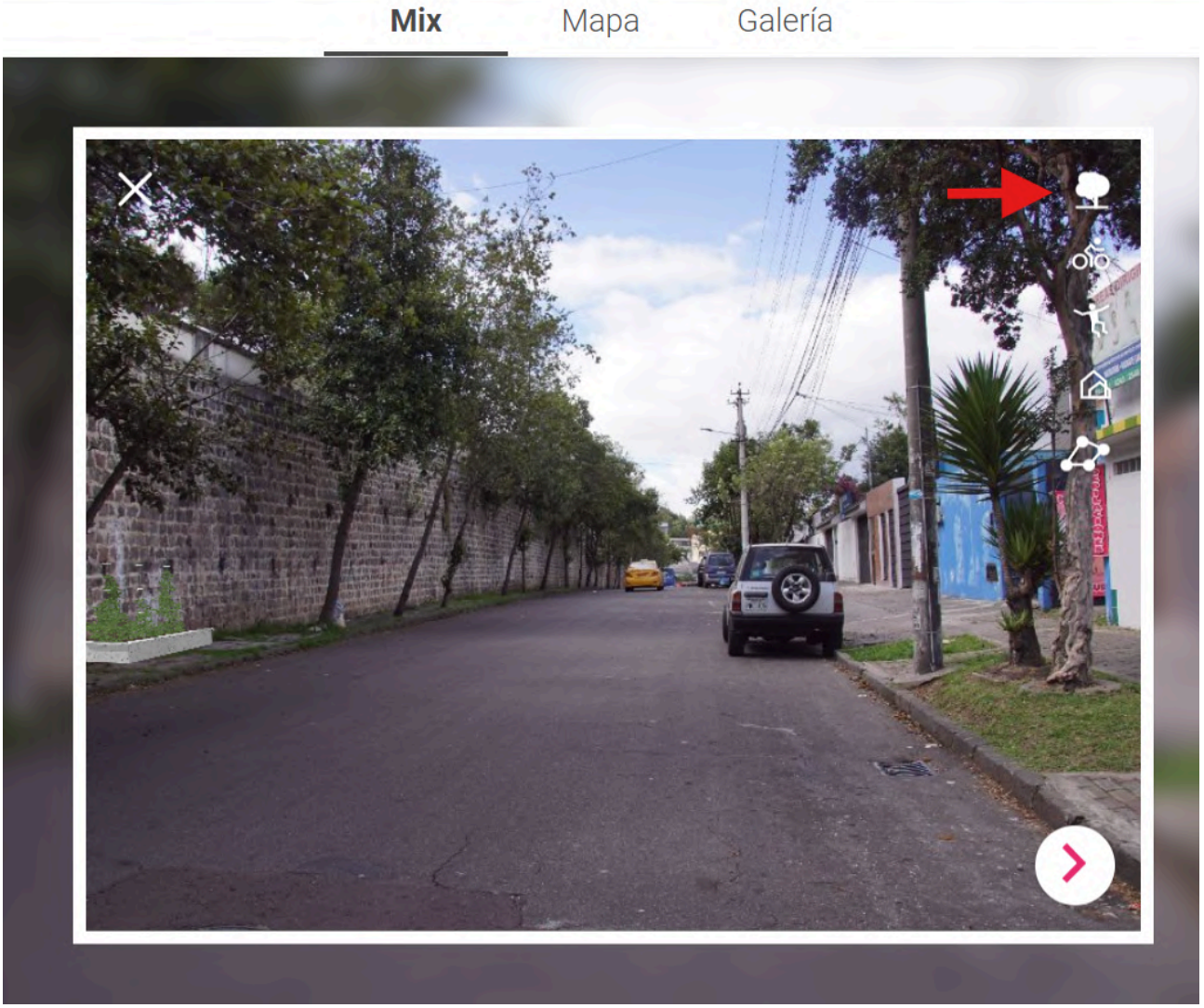


Figure 18: Objects categories available in Unlimited Cities. NbS are integrated in the category usually dedicated to trees and vegetation.

The 23 objects were selected from the INTERLACE NbS library based on their compatibility with the Unlimited Cities application and the insights from the co-creation workshops. The main parameter to determine the inclusion – or omittance – of the objects was whether the NbS could be observed in a photograph from a pedestrian perspective. Thus, large-scale strategies such as green corridors that cannot be fully seen were not included.

The objects have been adapted to a perspective view for ease of placement. Some are based on the existing 3D models, others are modified photographs.

Figure 19: Examples of NbS objects selection in Unlimited Cities

Below is a list of the 23 NbS objects, their description and associated tags:

Title	Description	Tags
Urban tree green	A tree in the city fulfils several essential functions: it improves air quality, stores and sequesters CO2, is the habitat of biodiversity and represents local heritage. It also fulfils essential functions to increase the quality of life of citizens, such as providing shade, cooling by evapotranspiration and vegetation landscape, which collaborates with mental health.	#Biodiversity #Heat Island
Urban tree with flowers	A tree in the city fulfils several essential functions: it improves air quality, stores and sequesters CO2, is the habitat of biodiversity and represents local heritage. It also fulfils essential functions to increase the quality of life of citizens, such as providing shade, cooling by evapotranspiration and vegetation landscape, which collaborates with mental health.	#Biodiversity #Heat Island
Fog catcher	Allows water recollection in areas with low access to it. The fog catcher transforms the fog into droplets that are recovered thanks to geotextile screens. It is then stored in tanks and can be used for agricultural irrigation or domestic tasks.	#Water #Urban agriculture
Green balcony	Allows the integration of vegetation on the façade, taking advantage of the balcony handrail as a support structure. The amount of vegetation implemented can be significant, and generates a vegetated landscape for both the interior and exterior of the building, for the enjoyment of all.	#Biodiversity #Heat Island

Compost bin	Individual or communal, it is very simple to implement and maintain. It allows to recycle waste from daily vegetable or garden consumption, and reintegrate it as hummus in indoor or garden plants. This strategy reduces the amount of solid waste in a family, building more sustainable cities.	#Urban agriculture
Hydroponic farming	It can be implemented in indoor spaces, inside greenhouses on terraces or retreats. The space is used to grow food and promote urban agriculture, generating more sustainable cities.	#Urban agriculture
Vegetable facade, container with substrate	It allows the installation of vegetation in reduced spaces. The vegetation provides micro-shading on the façade allowing to lower the heat input inside the building as well as in its surroundings. A support structure for the plant species is placed on the façade.	#Biodiversity #Heat Island
Light vegetal facade	It allows the installation of vegetation in reduced spaces. The vegetation provides micro-shading on the façade allowing to lower the heat input inside the building as well as in its surroundings. This technique requires a network of wires and climbing plants planted in pots.	#Biodiversity #Heat Island
Bird habitat	It provides a safe haven, and nesting space for birds in the city. A variety of designs can be generated to accommodate more than one family of birds.	#Biodiversity
Insect habitat	Provides safe spaces for insects, which are essential for plant pollination and reproduction	#Biodiversity
Rain garden	Infiltrates rainwater runoff, allowing to recharge natural subway aquifers. They also reduce the amount of water that enters the sewage system, preventing it from collapsing during rainy seasons. In addition, they provide an attractive vegetative landscape on city streets.	#Water #Biodiversity #Heat Island
Rain garden in slope	Infiltrates rainwater runoff, allowing to recharge natural subway aquifers. They also reduce the amount of water that enters the sewage system, preventing it from collapsing during rainy seasons. In addition, they provide an attractive vegetative landscape on city streets. This design is implemented in areas with slopes greater than 15%.	#Water #Biodiversity #Heat Island
Rain garden in open spaces	Its main objective is to infiltrate rainwater runoff, allowing to recharge natural subway aquifers. They also reduce the amount of water that enters the sewage system, preventing it from collapsing during rainy seasons. In addition, they provide an attractive and aesthetically pleasing vegetative landscape in open areas of the city as parks and parking lots.	#Water #Biodiversity #Heat Island
Floodable gardens	These gardens can be implemented in the front or backyard, providing a space for rainwater infiltration, diversity of native vegetation and habitat for biodiversity. They also contribute to environmental awareness and the mental health of the inhabitants.	#Water #Biodiversity #Heat Island
Retention pot	It is a simple and efficient rainwater retention technique that avoids the immediate discharge of rainwater into the sewage system during high rainfall events, preventing its collapse. It also provides a landscaping contribution where it is implemented.	#Water #Biodiversity #Heat Island

Mini forest	These are fenced-in natural spaces, where human access is prohibited in order to allow the natural development of the interior and provide a suitable habitat for several species of the area. In addition, their high planting density allows for greater CO2 capture capacity.	#Biodiversity #Heat Island
Floodable parks	These are multifunctional spaces in parks that are normally used for leisure, but whose design allows them to hold large amounts of rainwater until it floods, protecting other areas of the city during extreme rainfall.	#Water #Biodiversity #Heat Island
Slope protection living smiles	They can be placed on steep slopes to reduce the risk of landslides in these areas, since their shape breaks the physical tensions in the soil, preventing landslides. These systems can also be used to grow crops or to implant green nuclei on the slope.	#Slope control #Heat island
Slope protection terraces	They can be placed on steep slopes to reduce the risk of landslides in these areas, since their shape breaks the physical tensions in the soil, preventing landslides. These systems can also be used to grow crops or to implant green nuclei on the slope.	#Slope control #Heat island
Slope protection gabions	They can be placed on steep slopes to reduce the risk of landslides in these areas, since their shape breaks the physical tensions in the soil, preventing landslides. These systems can also be used to grow crops or to implant green nuclei on the slope.	#Slope control
Wastewater treatment	Small-scale water treatment avoids contamination of rivers and soil. It is especially useful in rural areas or areas without sewage service, in addition to allowing the reuse of water for secondary activities.	#Water #Urban agriculture
Modular nursery	It can be implemented inside greenhouses on terraces or retreats. The space is used to grow food and promote urban agriculture, generating more sustainable cities.	#Urban agriculture
Infiltration trench	Allows intercept rainwater runoff and delivers it to a retention, infiltration or flooding zone. This version using aggregates is an economical technique for water drainage that can be easily integrated into the urban landscape.	#Water
Retention and infiltration trench	They can be used on roadsides, parks, parking lots or large impermeable surfaces to capture large amounts of rainwater and gradually release it downstream. At the same time, it infiltrates and helps water evaporation. The retention capacity can be very large with low implementation costs.	#Water

Impact assessment using a new colour gauge

The final new feature is the addition of two colour bars, which reflect the number of tags used in all mixes for a given project. These function as an indicator list, allowing planners to receive a summary of the data for each session in terms of object type preferences versus those integrated with their respective tags.

The first bar shows the division of objects per category, while the second shows the amount of NbS objects integrated in the mixes, considering their tags.

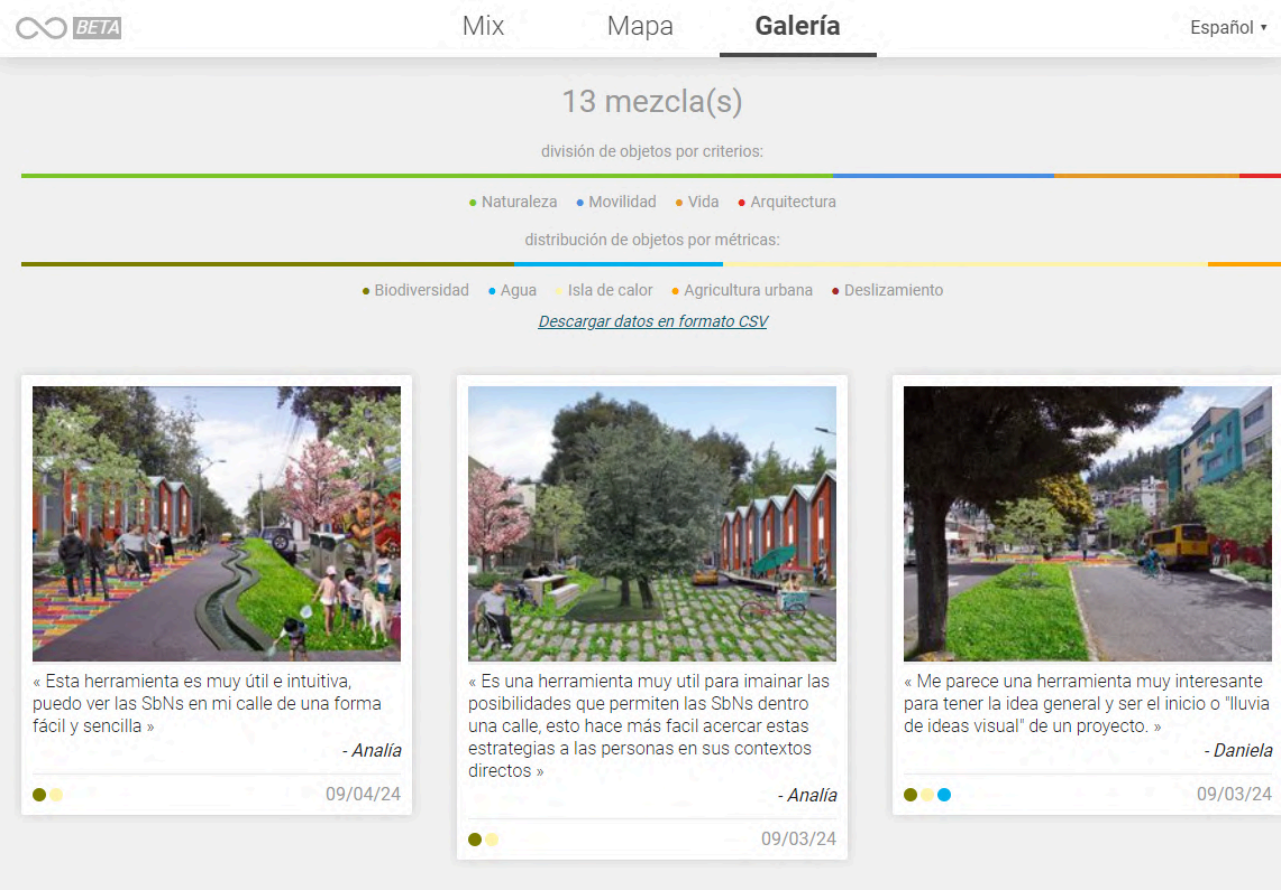


Figure 20: Colour bars for each set of mixes in Unlimited Cities for INTERLACE

4.2.4. Testing of the new version of Unlimited Cities with NbS for Interlace

Following the incorporation of the new features, a series of tests was conducted on the beta version of the tool. Initially, these were carried out internally at YES Innovation. Subsequently, a group of university professors and students in architecture were invited to participate in a real-case study. Finally, public officials from the municipality of Portoviejo, as an INTERLACE partner city, were invited to take part.

4.2.4.1. Initial internal test

The YES Innovation team trialled the new version of the tool using three photographs of an ongoing urban transformation project in the Miraflores neighbourhood in Quito. Please find the results and comments on the process below.

Figure 21: Comparative mix, before and after, using the Unlimited Cities for INTERLACE prototype (YES Innovation, 2024)

In this first example, the tool was straightforward to use and allowed for the concept of expanding the green space on the road to be conveyed, along with the incorporation of pedestrian-oriented activities. In this particular instance, a retention and infiltration trench was constructed at the boundary of the new linear park to facilitate the retention of runoff water. Furthermore, rain gardens and urban trees were incorporated into the design to enhance air quality and provide additional ecosystem benefits. The result is a solution that incorporates water management, biodiversity and heat island reduction principles.

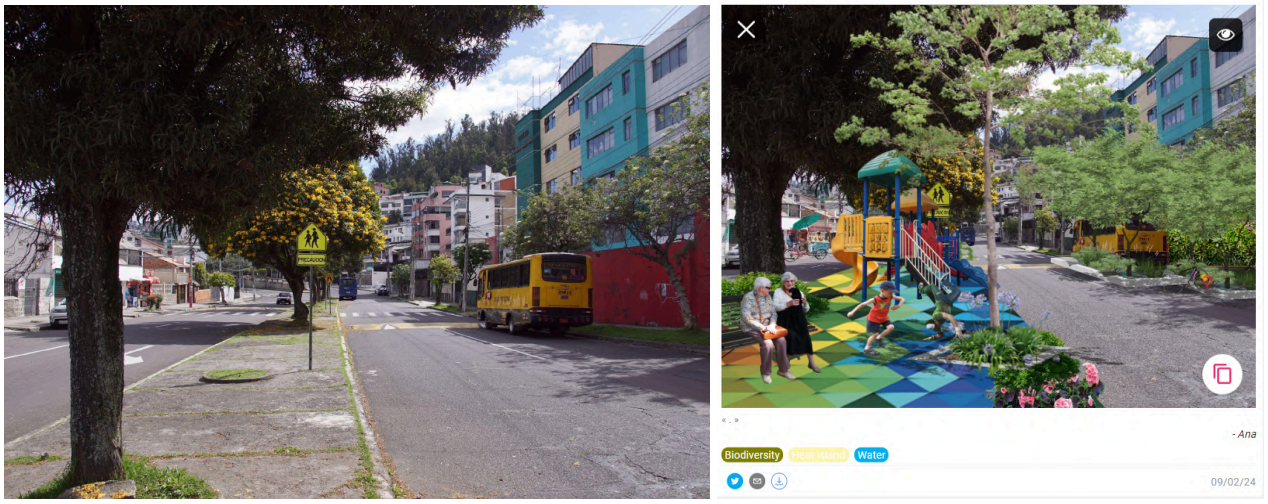


Figure 22: Comparative mix, before and after, using the Unlimited Cities app, test 2 (YES Innovation, 2024)

The second photograph demonstrates how the addition of a playground and complementary vegetation in an underutilised concrete area can help to visualise new uses for the space. Rain gardens have been incorporated into the design to facilitate the infiltration of runoff water. Additionally, urban trees, green facades and flowers have been included to mitigate the heat island effect and promote biodiversity.

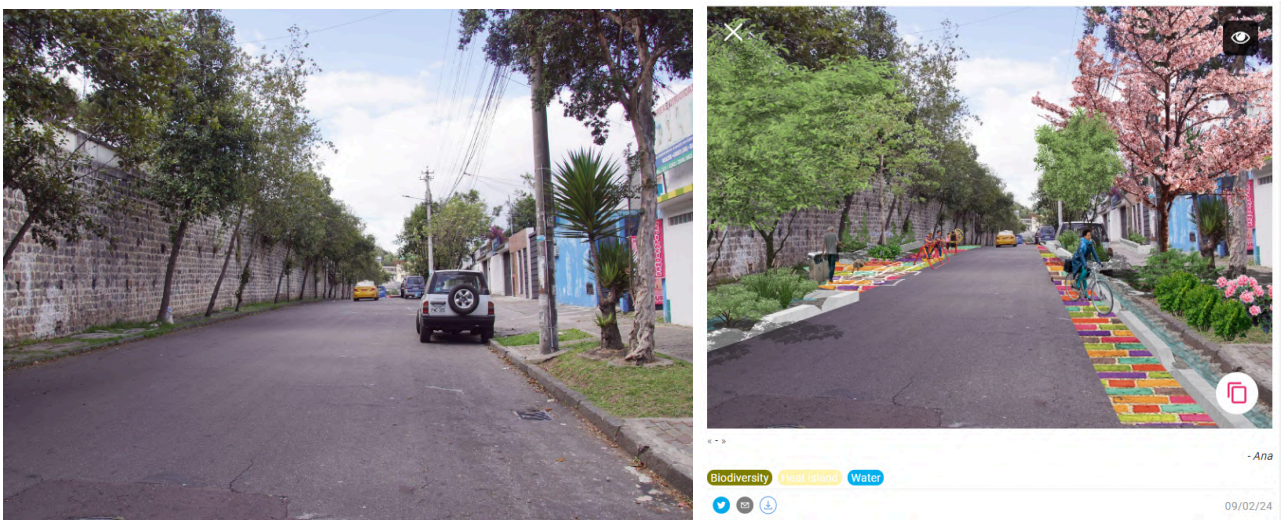


Figure 23: Comparative mix, before and after, using Unlimited Cities for INTERLACE (YES Innovation, 2024)

The final test phase comprised the greening of the pavements with the installation of retention pots, urban trees and flowers. To manage runoff water, an infiltration trench has been incorporated into the roadway design as well. The linear park features rain gardens, light plant facades on the retaining wall and new activities for children and the elderly that will enhance the park's appeal to a wider audience. As with the previous stages of the project, the principles of biodiversity, the heat island effect and water management have been maintained.

General comment: *The new version of the tool enables the general public to gain insight into complex concepts related to climate change and NbS as well as understand the importance of green and blue initiatives. Furthermore, the tool enables the illustration of tangible measures and infrastructure solutions that can be employed to mitigate the impact of climate change in urban environments. Some minor issues have to be adjusted.*

4.2.4.2. Test with external urban designers

To gain insight into the perceptions of others regarding the tool, an online workshop was conducted with 10 professionals in the field of architecture who had limited or no experience with NbS.

The participants were first introduced to the Unlimited Cities for INTERLACE webpage and the associated application. Subsequently, the participants were presented with three images and asked to choose one to use as a basis for their own design, created using the application.

Once the individual mixes had been completed, each person presented their results and responded to a series of questions about their experience, which were recorded on a Miró board.

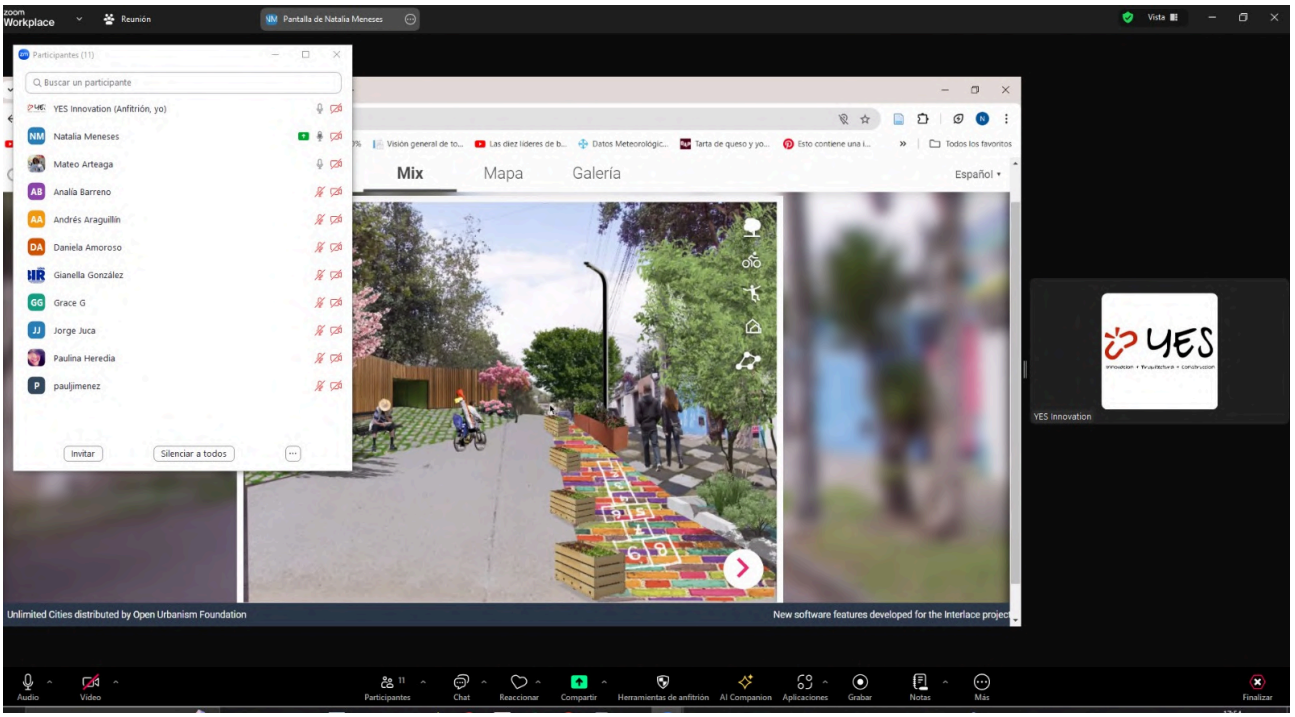


Figure 24: Online testing session of Unlimited Cities for INTERLACE with external designers

The following questions were posed:

- Please indicate whether the tool is user-friendly.
- Please indicate whether the library is sufficiently comprehensive. Are there any objects missing that could be used to express a specific idea?
- Please provide your feedback on the use of colour bars to group and summarise data.
- Please provide a brief evaluation of the tool and its potential use in your projects.
- Please indicate whether you found the description of the NbS clear.

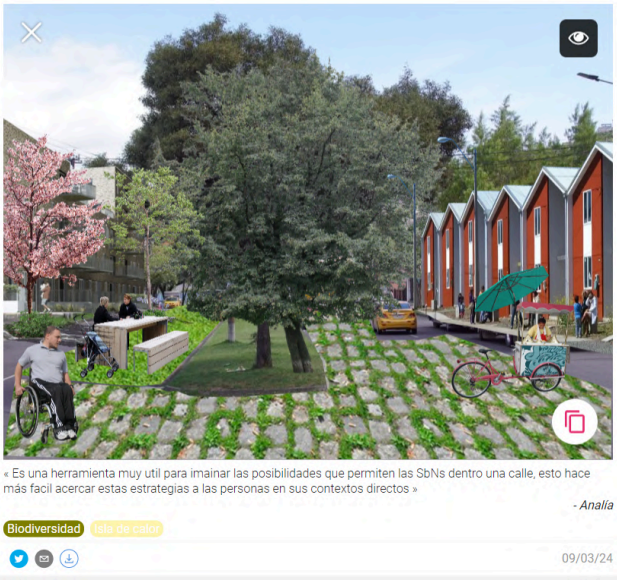
The attendees concurred that the tool is intuitive and straightforward to use. They identified a challenge in capturing the optimal perspective without the ability to rotate the image. Furthermore, the library was deemed to be sufficiently comprehensive, although the inclusion of a few additional textures would enhance its suitability for modelling permeable floors and green facades.

In regard to the colour bars used to summarise data, the attendees noted that this information can assist in identifying the aspects that are of greater significance to the people in that area. One attendee proposed that percentage statistics could be made more specific and useful.

The attendees found the tool to be highly useful, particularly in participatory processes, as it provides a rapid means of gathering primary insights and understanding the local population, regardless of their academic background. Furthermore, the tool could be employed in interdisciplinary workshops with professionals from other fields. It was proposed that the tool could be used on a larger scale in

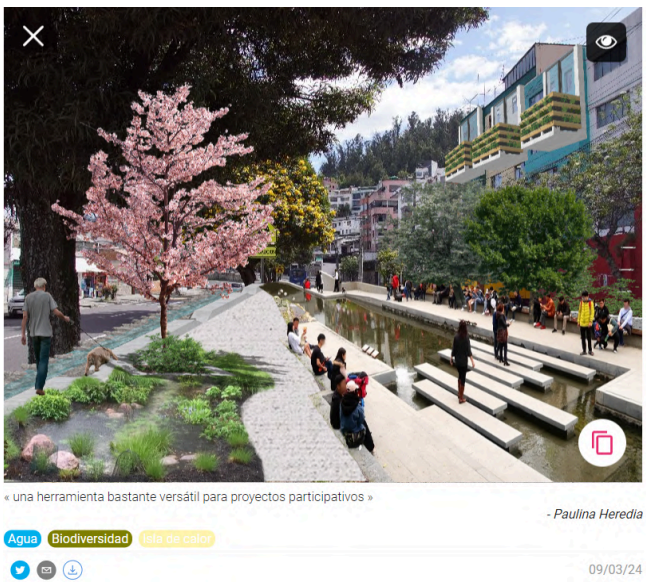
conjunction with floor plan photographs to provide greater clarity on the scope of an NbS. Regarding the NbS descriptions, opinions differed as to whether the descriptions should be less technical and shorter, or whether they require more detail to convey the full concept.

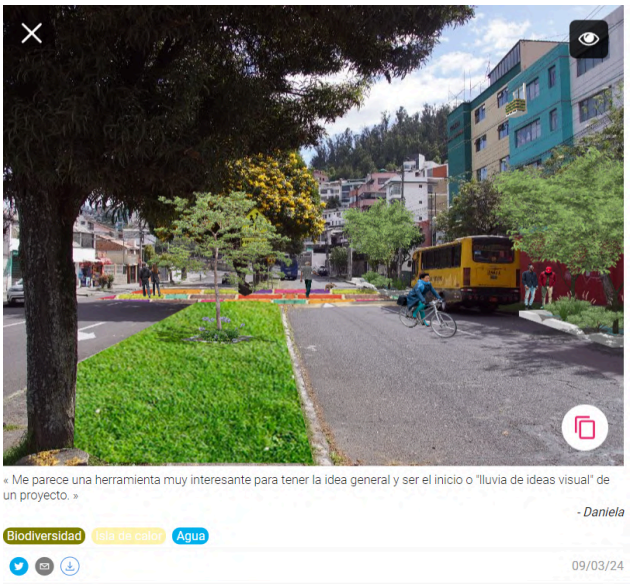
The following images illustrate the results of the workshop, accompanied by brief statements from the contributors.



- *"This tool is an invaluable resource for replicating the potential of NbS within a street. It facilitates the dissemination of these strategies to a wider audience in a more accessible manner." Analía*

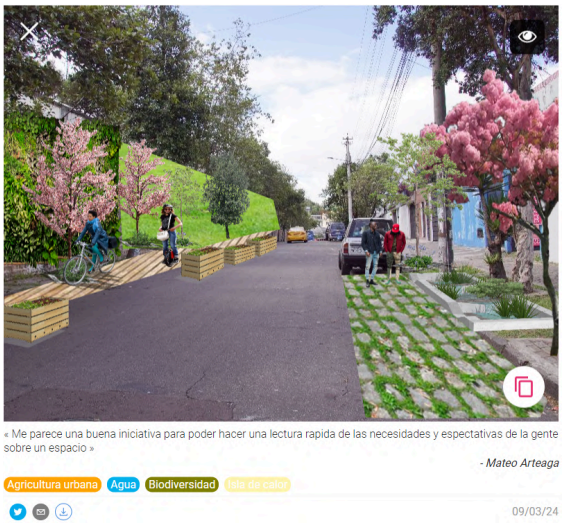
- *"The new NbS information is straightforward but provides a valuable opportunity to discuss the impact of urban nature with neighbours." Grace*





- *“A versatile tool for use in participatory projects.” Paulina*

- *“I find it an invaluable tool for developing a general concept and initiating the visual aspects of a project.” Daniela*



- *"The option to modify the perspective of elements and images can be added. Additionally, the option to add further resources will be available, dependent on the specific requirements. The tool is an effective solution for generating and modifying ideas in a prompt and efficient manner." Natalia*

- *"I believe this is an excellent way to quickly assess the needs and expectations of people regarding a space." Mateo*

- *"This tool is highly beneficial and user-friendly. It provides a straightforward and convenient way to view the NbS in my neighbourhood." Analía*

4.2.5. Diffusion

This new version of Unlimited Cities will be disseminated using the communication resources of the INTERLACE project, OPPLA and the tool's development team (YES Innovation and the Open Urbanism Foundation). The application will be launched by YES Innovation during the 16th Conference of the Parties (COP16) to the United Nations Convention on Biological Diversity (CBD) to be held in Cali in October 2024.

This new version will be proposed by the Open Urbanism Foundation to its new users, for urban planning projects worldwide. Unlimited Cities is also being revised as part of the DUT Multigination project, the version developed through INTERLACE will be used as part of this project.

Unlimited Cities is an open-source tool made available by the Foundation. Planners and cities interested in using it for a participatory process or an urban development project can contact the Open Urbanism Foundation through Alain Renk

ANNEX 1

Questionnaire diffused to INTERLACE Cities and Gensler urban design team

1. Internal organisation and design methodology

How are urban spatial design projects organised in your administration?

- With a dedicated team in one unit
- With several teams in different units
- With systematic external subcontracting
- With internal team and subcontracting
- Other (explain)

How is the environmental dimension integrated into the design process for the integration of nature-based solutions?

- In-house team is multidisciplinary
- In-house team partners with other municipal entities (e.g. the entity in charge of environmental issues)
- Collaboration with experts from outside the municipality
- Other (please explain)

What kind of tool do you use for planning and monitoring an urban design project and its progress?

2. Co-creation processes

Do you use particular tools to carry out co-creation processes with local stakeholders and facilitate urban design?

What kind of tools or functionality could facilitate the implementation of co-creation processes in the case of design of urban spaces with nature-based solutions?

3. Diagnosis

At the beginning of an urban space design project, what processes and tools do you use for urban diagnosis and environmental diagnosis?

4. Definition of strategies

What methodology do you use to move from ideas to design strategies?

Is this process done individually or as a team?

What tools do you use to generate these strategies?

What specific difficulties do you encounter when integrating nature into your strategies?

5. **Inspiration and ideation**

What are your sources of inspiration for designing urban spaces and integrating nature-based solutions?

- Dedicated guides on NbS or nature in the city; which ones?
- Technical trainings; which ones?
- Specialised repositories; which ones?
- Social media posts; can you mention some relevant information sources you use?
- Specialised sites; which ones?
- Local references; can you give examples?
- Other; can you give examples?

How often do you look for inspiring examples of solution/design?

- Always
- Sometimes
- Never

What are the limitations of these sources/tools for your urban design work and for the integration of nature?

- Sources/tools that have NbS do not explain technical details or parameters that can inform their implementation or operation.
- Sources/tools do not consider NbS specifically.
- Sources/tools with NbS are from other places that cannot be applied locally (technology, resources, etc).
- The sources/tools we use have no NbS at all.

What information/functionality/media could facilitate your knowledge of NbS and allow you to integrate them more easily into urban projects?

6. **Design**

What tools do you use to design your urban intervention projects at the pre-project level?

What are the limitations of these tools for integrating nature-based solutions?

What functionality could facilitate the design of NbS in your projects?

ANNEX 2

Answers to the questionnaire

e- Answers in Spanish: Granollers, CBIMA, Portoviejo
p- Answers from Poland: Metropolia Krakowska
g- Gensler team (Costa Rica)

INTERNAL ORGANISATION AND DESIGN METHODOLOGY

How are urban spatial design projects organised in your administration?

- With dedicated equipment in the same unit: e4, p3
- With several teams in different units
- With systematic outsourcing: p1
- With in-house equipment and subcontracting: p1
- Other (explain)

For the integration of nature-based solutions, how is the environmental dimension integrated into the design process?

- The internal team is multidisciplinary p3, e1, g7/8
- The in-house team partners with other municipal entities (e.g. the entity in charge of environmental issues), e1
- Collaboration with experts from outside the municipality p3, e1, g6/8
- Other (explain)

What kind of tool do you use for planning and monitoring an urban design project and its progress?

e:

- Regulations, municipal action programme (the programme of the government's political team), internal or external technical reports, subsidies from other administrations, supra-municipal working groups, and more recently participatory processes
- General operational baseline studies and Master Plans
- Timetable of activities in each discipline

p

- Supra-local development strategy, action plan for cooperation in the field of space management
- Work in geographic information systems (QGIS) programmes
- Analysis of statistical data, online surveys addressed to the inhabitants of the commune, strategic workshops, expert work, public consultations with residents and organisations operating in the Zielonki commune

g

- Gensler's in-house software (GBlox) and multi-criteria matrix
- Research processes, participatory design and observation. Autocad, Rhino, BIM, GIS.
- Rhino, revit
- Analysis and design software
- Software - Geographic Information Systems - multi-proposite matrix - community participatory design tools - design guides - project phasing and implementation projections - existing conditions surveys - validation tools - BMS implementation guides

- Analysis and design software such as ArcGis, Gblox, Rhino, among others.
- Collaborative processes, ideation sessions, qgis, rhinoceros, grasshopper, internal software "gblox", lands design

CO-CREATION PROCESSES

Do you usually implement co-creation or participatory processes for urban projects? (only g)

- Systematically: 1
- Often: 4
- Sometimes: 3
- never

Do you use particular tools to carry out co-creation processes with local stakeholders and facilitate urban design?

e:

- Yes, through participatory budgets (citizens present proposals for action and the most voted proposals are carried out with a co-design between the City Council and the people promoting the action) and various European projects that have participatory work forums (Interlace among them).
- In some, but not all projects
- Field meetings with the inhabitants

p

- Forums with municipal employees involved in spatial planning in municipalities Reports on the state of the metropolis
- Promotion of metropolitan activities outside
- Consultation meetings with the local community, consultations at sessions of the commune council, meetings with village leaders
- Yes

g

- Strategy processes
- Miro, file sharing tools
- Visualisation workshops at the start of projects
- Yes
- It depends on the project and the team, but ideally, visualisation workshops with all actors involved.
- Yes, usually 3D modelling or any other drawing tool to make it easier for local actors to see everything
- Depending on the project and the team, the tools can be more or less sophisticated and systematised
- No

What kind of tools or functionality could facilitate the implementation of co-creation processes in the case of designing urban spaces with nature-based solutions?

e

- The creation of a specific line of work within the municipality. It would be necessary to have a team made up of technical specialists in BDS and technical experts in participation. This working group would promote BDS projects and also proposals to incorporate BDS in local regulations.

- Citizen participation through project presentation, surveys, workshops...
- Placemaking with extended deadlines

p

- Legal empowerments giving the metropolis the possibility of managing space
- For example, architectural and urban design competitions

g

- Co-creation tools
- Visualisation tools
- The use of digital collaboration dashboards such as Miro, excel matrices
- Tools for intuitive use and critical perspective on data collection and organisation
- Visualisation tools
- It depends on the community, but in any case, any tool that is critical and allows conclusions to be drawn in a simple way will work.
- Elements that allow visualisation in a simple way so that the populations involved can understand the scale, impact, etc.
- No

DIAGNOSTIC

At the beginning of an urban space design project, what processes and tools do you use to carry out the urban diagnosis and environmental diagnosis?

e

- We have a lot of GIS mapping information of the whole city, which is very useful at the beginning of the work. We usually also consult other municipal departments or external public bodies on specific reports (facilities, services, flooding, urban greenery...).
- The physical condition of the space in which to operate and its use, as well as an analysis of the type of public for which it is intended
- On-site inspections, meetings with inhabitants, information gathering, topographical surveys, ordinances, institutional manuals

p

- Analysis of the validity of planning document
- Document analysis, surveys, individual or group interviews, observations

g

- Observation tools, GIS, internal software, Gblox
- Firm workshops based on "Start smart" workshops, visualisation and process work with clients.
- Analysis, diagnosis, projection, alternatives, design and follow-up
- mapping of existing conditions and stakeholders - analysis of the ecological systems in which the project is implemented at the micro/meso/macro scale - landscape units
- 3D visualisation tools with data analysis. For example, Rhino with grasshopper plug-ins that allow for urban and environmental diagnostic analysis or ArcGis
- Land use plans, local regulations, site analysis (slopes, runoff, heights, views, vegetation cover) climograms and climate analysis (solar, wind, radiation)
- Discussions, information matrices, aerial photographs, modelling and topographical survey.

DEFINITION OF STRATEGIES

What methodology do you use to move from ideas to design strategies?

e

- Consultation with internal or external experts, sometimes even contracting companies to support this process.
- Following examples made
- Self-Organised System (Current Situation/Strategies-Prefeasibility/Outcome)

p

- Implementation documents (Action Plans)
- Works of municipal urban planning and architectonic commissions, implementation of the vision of the commune administrator, collecting applications from the local community regarding changes in land use, implementation of visions included in the commune's development strategy, e.g. SWOT analysis, analysis of the PESTEL environment, internal diversity of the commune, through the presentation of data for individual villages (if it is possible to analyse)

g

- Scenario planning
- We do not have a specific methodology
- Scenario evaluation
- Workshops and validation of results
- Coworkings, design alternatives and socialisation to always come up with the best strategy
- They usually emerge from the conclusions of the initial visualisation sessions
- We discuss ideas, we incorporate client feedback, we discard, we bring in team members who bring different opinions and expertise.

Is this process done individually or as a team?

e

- The burden tends to fall on the person leading the project, but there tends to be a lot of teamwork.
- As a team
- Group

p

- Team x3

g

- Team x8

What tools do you use to generate these strategies?

e

- Local regulations, plans and programmes, land stewardship agreements, calls for grants, local council working groups and other external fora.
- External technical support
- Brainstorming and User Interviews

p

- Thematic forums with municipal employees
- Action plans for individual strategic domains taking into account strategic objectives, operational objectives and exemplary directions of activities, as well as priority tasks to be implemented

g

- In-house design software (Gensler GBlox)
- BIM, Rhino, Autocad
- With Miro, virtual pods with Mentimeter, in-house tools like Rhino's Gblox
- Analysis tools, scenario comparison tools, co-creation strategies with customers and users
- 2D and 3D drawing tools

- No particular tool, apart from visualisation sessions with clients/actors
- G-blox, excel, and others

What specific difficulties do you encounter in integrating nature into your strategies?

e

- It is easier to act in new projects than in redevelopment projects where the city is already built. - Many conventional urban projects have never included nature beyond classic landscaping (street remodelling, new urbanisation...) and including NbS is a novelty for some technicians and municipal politicians that can become a barrier when they have to go out of their comfort zone - There is little experience regarding NbS in cities and therefore few companies prepared to carry it out. This means that projects can be a bit more expensive financially, although their long-term benefits are much higher than those of traditional projects.
- Governance, economic and social acceptability.
- It depends on the geographical characteristics of where the projects are built (close to the river, slopes, ravines) of the projects, for which specialised engineering studies must be contracted prior to the execution of the designs.

p

- Lack of appropriate legal tools
- We don't have any Natura 2000 sites, we don't have protected areas, so it's easier for us.
- Reluctance of some residence to change their habits/existing habits among some residents e.g. to save water, concreting yards, burning garbage, changing the way houses are heated, collecting rainwater

g

- Lack of soil or general geospatial data
- Specific tools within the software
- The customer's opinion, the desire to make everything as cost-effective as possible
- Business constraints (feasibility, budget, occupations...)
- Ecosystemic vision/understanding that working with nature takes time and results are not immediate
- Lack of information on the terrain or site to be developed. This makes it very difficult to generate integration strategies between nature and other elements.
- There is sufficient relevant data to support the ideas and strategies, and to be able to clearly prove the benefit to clients.
- Customer acceptance

INSPIRATION AND IDEATION

What are your sources of inspiration for designing urban spaces and integrating nature-based solutions?

- Guidelines dedicated to NbS and nature in the city; which ones? e 2/3 municipal and national guidelines, p1/3 g5/8 (international case studies, city public reference guides for the development of urban spaces, NATURE 4 CITIES, IFLA AND IUCN, books, documents or reports on the use of NbS globally)
  https://biocorredores.org/biodiver-city-sanjose/catalogo-de-soluciones-basadas-en-naturaleza, Google images

- Technical trainings; which? p2/3, e1/3 g2/8

- Specialised repositories; which ones? e ⅔ (local, NbS-ECLAC, NbS-WWF), p1/3, g 3/8 NGOs, multilaterals

- Social media posts; Can you mention some relevant sources of information you use? p2/3, e 0/3, g6/8 (pinterest, open mapping, gehl, reference sources, archdaily, instagram, pinterest, instagram)

- Specialised sites; which ones? e 3/3 specialised external equipment, p 1/2, g 4/8 (landezine, NbS website, world geographic information base, landezine)

- Local references; can you give examples? p 1/3 e 3/3 local museum, locally executed examples, g6/8:Yes, a local design studio called Vida Masterplaning Yes, large urban spaces with successful results (Parques del Río Medellín, SUDs...), BIODIVERCITY (COSTA RICA), successful nature-based projects in Colombia. https://biocorredores.org/biodiver-city-sanjose/catalogo-de-soluciones-basadas-en-naturaleza

- Other; can you give examples? Several examples in Barcelona of SUDS implementation, permeable floors by laying ecological paving stones, Successful examples of solutions in other municipalities, suggestions of residents during the Rural Meetings, International benchmarks of resilient solutions.

How often do you look for inspiring examples of solution/design?

- Always e2 p2 g7/7
- Sometimes e1 p1
- Never

What are the limitations of these sources/tools for your urban design work and for the integration of nature?

- Sources/tools that have NbSdo not explain technical details or parameters that could inform their implementation or operation p2/3 e3/3 g5/7
- Sources/tools do not consider NbS specifically e1 g5/7
- Sources/tools with BNS are from other places that cannot be applied locally (technology, resources, etc.) p3 e3 g6/7
- The sources/tools we use have no NbS e1 g2/7 at all.

What information/functionality/media could facilitate your knowledge of BDS and enable you to integrate them more easily into urban projects?

e

- Training courses
- Concrete tools for the calculation of SUDS dimensioning and construction details
- Application manuals with regulations and specifications of the elements involved.

p

- Facilitation at national or statutory level; Examples of tools adapted to the Polish legal system, indicating the metropolitan level
- ways to encourage local communities to use NbS
- Social campaigns about NbS, brochures, publications, etc. informing how NbS can be implemented in practice

g

- Solutions by latitude
- Tropicalised proposals

- Infographics and summary information to help you find what you are looking for more quickly.
- A specialised reference library that can be applied to different contexts.
- A tool that compiles the functions performed by different design software into one. That makes it easy to design integrated with nature at the same point.

DESIGN

What tools do you use to design your urban intervention projects at the pre-project level?

e

- GIS, inter-departmental meetings, field visits, consultation (and/or contracting) of external expertise
- None in particular
- Topographical survey, logbook information from previous projects

p

- As a metropolis, we do not create planning documents
- We use a logical cause-and-effect analysis that occurs between the different levels of goals, results and actions. Analysis is a tool for planning and project management, and its structure is dynamic due to the functioning of the project in a specific environment.

g

- Rhino, Gblox, Revit
- Rhino, Autocad, Photoshop, Illustrator
- Rhino, Revit
- 3D and 2D drawing software, including metric measurement
- Visualisation workshops
- Sketchup, rhinoceros, illustrator, arcgis

What are the limitations of these tools for integrating nature-based solutions?

e

- The price, the novelty of its implementation, the lack of knowledge of its maintenance, the long-term results
- Governance, economic and social acceptance
- Several of the NbS are not applicable or have limitations in city projects.

p

- Dynamics of development

g

- No local specifications or palettes
- They do not have a specific focus on nature, they are more focused on planning.
- The lack of components for such software
- Lack of coherence between design scales
- Realistic projection of expectations
- You have to migrate from one tool to another continuously to get a single specific project.

What functionality could facilitate the design of NbS in your projects?

e

- The creation of a specialised working team
- Problems with water management: floods and drought
- That they are set out in a user manual

p

- Lack of sufficient belonging to the municipality
- Creating a common vision of greening the city and a strategy of effective action, thanks to which programmes and projects implemented by various units will function comprehensively and synergistically; development of a plan - serving as a reference point for various units/cells carrying out activities potentially related to greenery, which will support the mainstreaming of NbS in these activities; increasing coherence between different decision-making bodies and processes, which will ensure the optimisation of the benefits of multifunctional green areas and NbS (such as the health and well-being of residents, mitigating climate change, reducing air and water pollution, reducing the risk of floods, droughts and heat waves, reducing noise, sustainable economy, etc.); raising awareness of environmental challenges and the potential of NbS

g

- Background information
- Availability of blocks or solutions easily adaptable to projects and scales
- Details - time projections - implementation guidelines
- Ease and access to valuable information on nature-based solutions in a single design tool or analysis software. All with long- and short-term visualisation
- Transforming conventional solutions into much more sustainable solutions

Any other comments?

e

- Promote a European regulation that obliges the incorporation of SUDS in all projects financed by the EU itself.
- Establishing a manual with the application of the NbS under the ordinance would allow its evaluation and application in all projects.

ANNEX 3

Articles for Archdaily about the use of NbS in urban spaces

1. New tools promoting nature-based solutions in urban design and co-creation

Ana Belén Suárez[1], Nicolas Salmon[1], Grace Yépez[1]
[1]YES Innovation, El Oro y Armero Oe7-261 y José de Armero, Quito-Ecuador

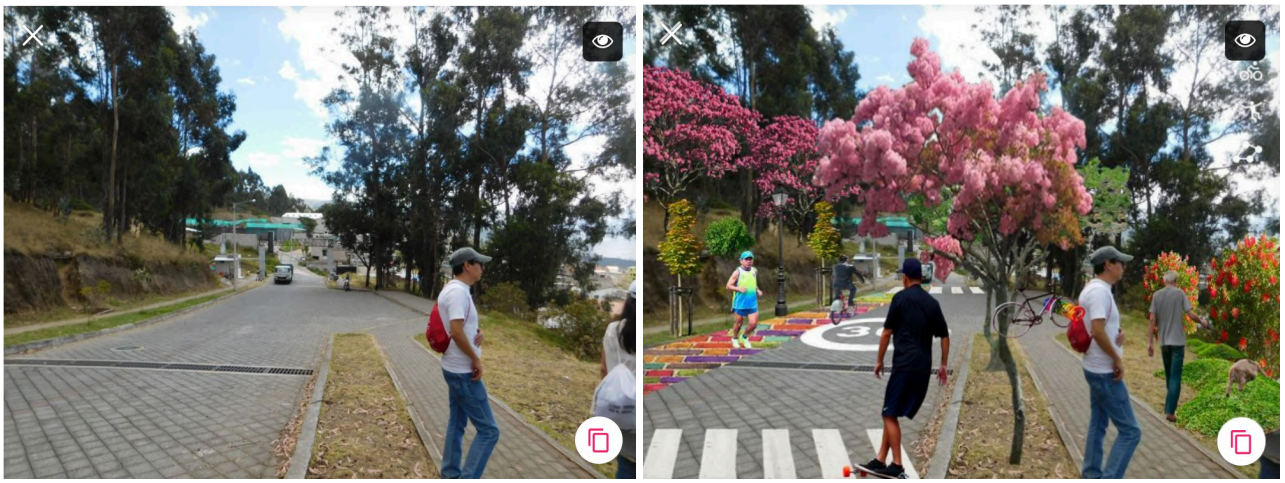
The effectiveness of nature-based solutions (NbS) in enhancing sustainability and resilience in urban areas is becoming increasingly recognised. By integrating them into urban planning and development, cities can also become more attractive places to live, which benefits both people and the environment. Urban NbS are strategies and approaches that utilise nature and natural processes to address a range of urban challenges. These solutions make use of the benefits of ecosystem services and biodiversity within urban environments, although not everyone is aware of their existence.

In European cities, the majority of planners and urban developers are aware of the necessity for NbS and the significance of co-design methodologies aimed at creating multifunctional urban spaces and empowering communities. However, in Latin American cities, the majority of planners and technical professionals are largely unaware of these strategies.

The INTERLACE project was established with the objective of promoting the implementation of NbS on a global scale. It aims at implementing measures to restore, rehabilitate and reconnect ecosystems. Furthermore, the initiative employs a multi-stakeholder, co-design approach to develop plans and programmes in collaboration with partners in Europe and Latin America.

YES Innovation, an INTERLACE partner in Ecuador, has trialled innovative tools in co-design workshops in Quito. New technologies, such as apps and programmes, provide the general public with the ability to learn about and even build new solutions that were previously the domain of specialists and designers. In the current climate, developers have found a way to utilise these new possibilities in co-design workshops, thereby fostering ownership and empowerment among the general public.

Unlimited Cities (UC) is an innovative free app that enables users to convey their concepts through a digital collage, using a photograph of the location where the project is to be implemented. This tool effectively gives insight into the needs and aspirations of the local population, while also fostering a sense of community ownership. The application allows users to add various items from the library to the photograph in order to indicate their desired future activities, natural features, or new infrastructure. The application can be used on a tablet or a high-quality mobile phone.



Mix made in San Enrique de Velasco-Quito by a neighbour during a co-design meeting (2018)

The INTERLACE project has two main objectives: firstly, to foster participatory engagement in the co-production and promotion of ownership of guidelines, decision support systems and tools for the design, construction and monitoring of cost-effective restorative NbS; and secondly, to raise awareness and understanding of the benefits of healthy (peri)urban ecosystems for social, cultural and economic well-being. In order to achieve these objectives, the project has proposed Unlimited Cities as a new solution to promote NbS for the benefit of the general public.

A new object library has been incorporated into Unlimited Cities, comprising 39 objects illustrating 26 NbS that can be observed in a photograph from a pedestrian perspective.

Each NbS object includes a brief description of the strategy, outlining its purpose and contribution to the city environment. The objective was to provide a straightforward and accessible overview for the general public, free from technical jargon, while still conveying the complexities of climate change and potential mitigation strategies.

A new set of tags has been included in the latest version of UC. It includes the following topics: #Water, #Biodiversity, #Heat Island, #Urban agriculture, and #Slope control. These tags allow users to easily identify which solution relates to another solution for the same problem.

2. Integrating NbS into an urban rehabilitation project with the INTERLACE approach: designing the Mamey Park in Portoviejo (Ecuador)

Ana Belén Suárez[1], Nicolas Salmon[1], Grace Yépez[1]
[1]YES Innovation, El Oro y Armero Oe7-261 y José de Armero, Quito-Ecuador

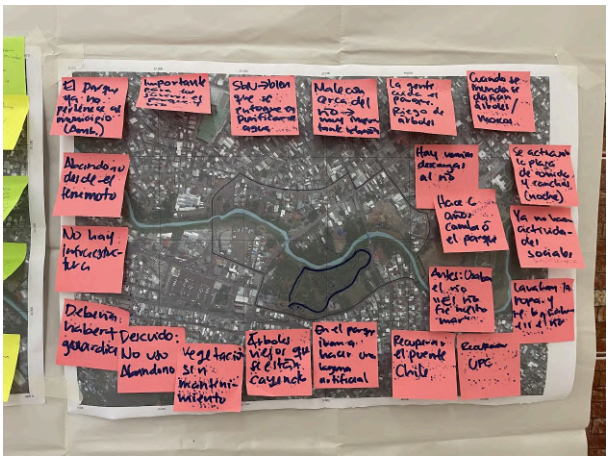
The INTERLACE project aims to implement actions to restore, rehabilitate and (re)connect ecosystems through nature-based solutions (NbS). The initiative employs a multi-stakeholder and co-design approach to develop plans and programmes in collaboration with partners in Europe and Latin America.

One of INTERLACE's partners is the Portoviejo municipality, a middle-sized city in Ecuador, South America. Portoviejo is situated along the Portoviejo River, and in light of the city's flood risk, the municipality has developed the Portoviejo River Ecological Corridor. The corridor has two main objectives: to mitigate the effects of flooding and to protect biodiversity. The plan includes seven public parks, each with different purposes. However, only Las Vegas Park is currently operational. Mamey Park, located near Las Vegas on the Portoviejo riverside, is in poor condition but has a rich cultural history and is fondly remembered by the community, especially the elders.

The municipality's objective is to restore and enhance the park by incorporating nature-based solutions (NbS) and revitalising the site with new activities, thereby creating a multifunctional urban space for the city. Following an assessment by YES Innovation, a private enterprise specialising in urbanism with a climate change approach in Ecuador and an INTERLACE partner, the co-design process has commenced.

The first step was to identify and engage with key stakeholders to ensure their involvement in the process and beyond. It was interesting to discover various groups and organised communities working

near or even within the park, including the “Club Parque Puerto Mamey” (The Mamey Port Park Club), the communal vegetable garden primarily managed by elderly people, the Merchants of the Park Association, the Rio Verde Foundation and neighbourhood representatives. The previous sports clubs for children have ceased to exist due to the impact of the global pandemic and the increasing insecurity in the city.



The municipality and YES Innovation engaged with these groups in a series of workshops and meetings to gain insight into their needs for and experiences with the park. This involved conducting site visits and identifying both potential areas of improvement and challenges.

Another important group to work with was the academy. Through workshops and classes, architecture students from a local university learned about the NbS and, after a site visit and data collection process, they proposed some valuable ideas for the development of the park.

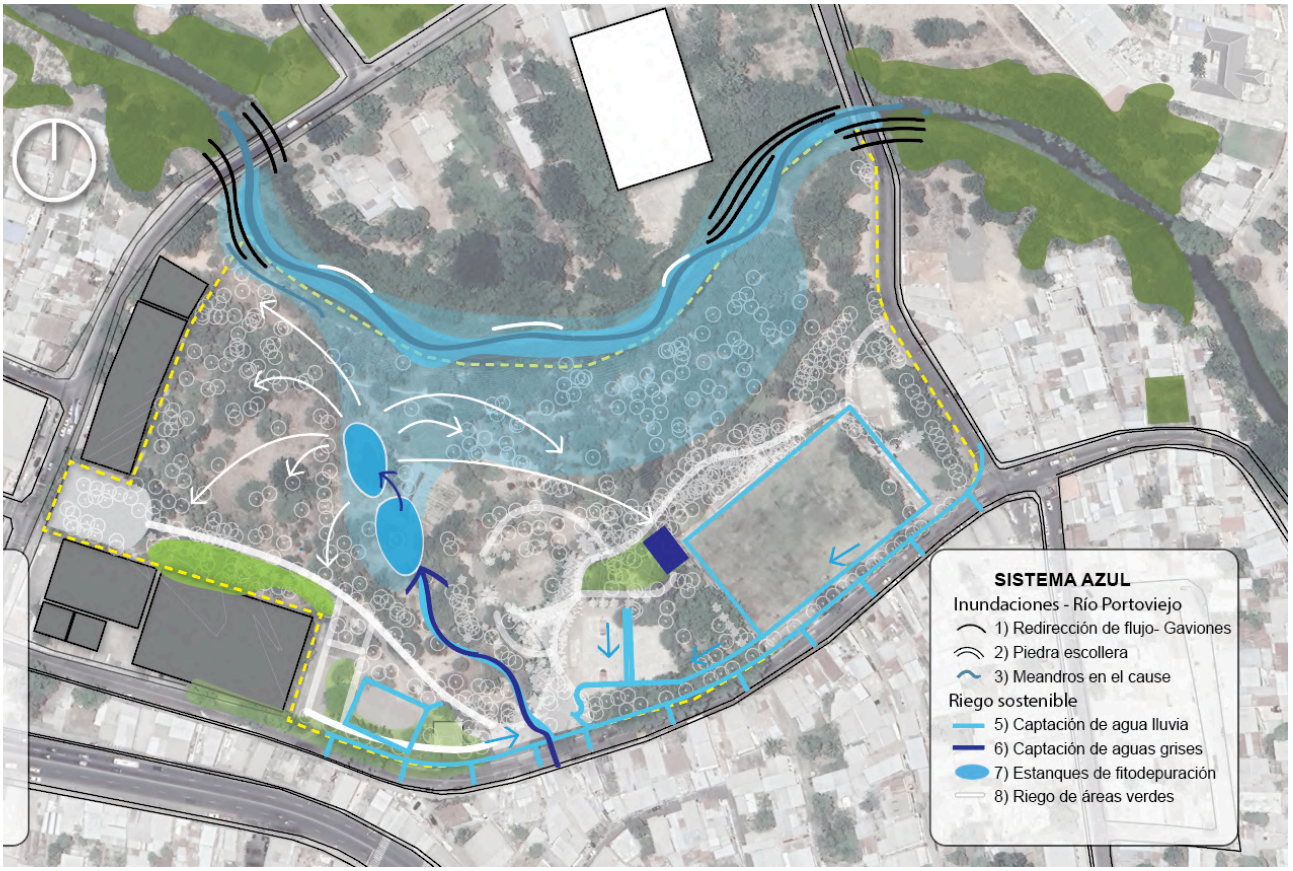
Finally, meetings and information requests were held with experienced local professionals. Meetings were conducted with representatives from “Portoparques”, a public enterprise responsible for parks and public spaces, as well as “Portoaguas”, a public enterprise overseeing potable water and sewage. Additionally, meetings were held with independent environmental specialists and technicians from the municipality. The objective was to gain a technical opinion based on the experience of these professionals and gather as much information as possible to start the design process.

During these meetings and workshops with the various stakeholders, the objectives were refined, and eight main objectives were identified. Subsequently, the participants were requested to assign weights to the criteria. This resulted in the identification of the primary topics to be addressed in the design:

1) Level of insecurity
2) Historic cultural potential associated with the river and the park
3) Important ecological qualities and strategic location

The Portoviejo Municipality and YES Innovation have developed a design proposal, which can be summarised in three diagrams. The first diagram addresses water management of the site to ensure sustainability through nature-based solutions (NbS). The second diagram pertains to the green system, which aims to enhance the ecological qualities and transitional role of the park between the city and the river. These two systems focus on technical details crucial for mitigating flooding and the effects of climate change. The third diagram relates to the architectural programme of the park, which has been conceptualised with input from the community.

The INTERLACE team is committed to a successful completion of the process, which will result in the delivery of a high-quality public space to the city. In addition, the project will serve as urban green infrastructure and a biodiversity hotspot.



Blue system proposal for the Mamey Park in Portoviejo (YES Innovation, 2024)

Green infrastructure proposal for the Mamey Park in Portoviejo (YES Innovation, 2024)

Functional programme proposal for the Mamey Park in Portoviejo (Municipality of Portoviejo, 2024)

3. How to integrate nature-based solutions into street design?

Igone Garcia[1], Adrian Glodeanu[1], Gemma Garcia-Blanco[1]
[1]Tecnalia Research & Innovation BRTA. Climate Change Adaptation Team. Energy, Climate and Urban Transition Unit. Astondo Bidea, Edificio 700. Parque Tecnológico de Bizkaia. E-48160 Derio (Bizkaia)

According to the European Commission[1], nature-based solutions are "nature-inspired and nature-supported solutions that simultaneously deliver environmental, social and economic benefits and contribute to strengthening resilience". Nature-based solutions must therefore benefit biodiversity and support the provision of a range of ecosystem services. This approach values the multifunctionality and environmental, social and economic co-benefits of nature-based solutions, allowing them to address multiple urban challenges simultaneously with good cost-effectiveness[2].

Nature-based solutions (NbS) are highlighted as actions that can make a positive contribution to mitigation commitments by reducing greenhouse gas (GHG) emissions through carbon absorption and sequestration. They also promote adaptation by reducing risks associated with climate change such as flooding, heat stress, sea level rise, erosion, forest fires, landslides, etc.[3]

Urban planning and design could play a crucial role in the adaptation process and, from this perspective, NbS could be seen as vehicles for urban transformation towards resilience[4]. In this context, the integration of NbS into urban design requires their consideration from the very early stages of urban planning and project configuration in order to ensure successful implementation and effectiveness of the solution.

A logical sequence for integrating NbS into urban design could be described as follows:
As a starting point, a site diagnosis should be carried out to establish the baseline, which will allow the identification of the challenges that the site faces in terms of climate resilience, social requirements and the expected uses and functions of the area. These challenges determine the actual capacity of the site to integrate NbS in terms of quantity, type and location.

When we talk about climate adaptation, it is important to provide a clear vision of future climate scenarios and how the area will be affected by them as part of this baseline.
The expected outcomes of this step are climate conditions, key local ecosystem parameters, landscape perception/design, place functionality and risk associated with the area.

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[1] Nature-based solutions | NetworkNature
[2] Tyrväinen L.; A. Ojala, K. Korpela, T. Lanki, Y. Tsunetsugu y T. Kagawa: <<The influence of urban green environments on stress relief measures: A field experiment>>, *Journal of Environmental Psychology*, 38, 2014, pp. 1-9, DOI: 10.1016/j.jenvp.2013.12.005 .
[3] Directorate-General for Research and Innovation (European Commission). Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners; Publications Office of the European Union 2021. Available online: https://data.europa.eu/doi/10.2777/244577
[4] Epelde, Lur et al. 2018 "Guía para la evaluación de la efectividad y el diseño de Soluciones Naturales como medidas de mitigación y adaptación al cambio climático"
https://www.adaptecca.es/sites/default/files/documentos/2018_naturadapt-lr.pdf

The relative importance of each of these challenges at the local level is key to defining the urban design, but this should be framed within the city's climate adaptation and restoration strategies. The ultimate goal is to ensure that the decision made at the site level is consistent with the city's strategies.

This site diagnosis is performed iteratively with the identification of the design strategies that can be applied to the site. These two steps require a co-creative approach involving the relevant stakeholders, including local partners and citizens. A multidisciplinary vision is essential at this stage. On a technical level, urban designers often enrich their team with environmentalists, biologists, engineers, sociologists, etc., as NbS require a holistic approach to be successful.

The expected outcomes of the design of strategies are the following: restoration drivers, type of NbS that could be used and where to implement and expected functionalities.

Inspiring the design of the place will require these different approaches in different iterations. Expert knowledge of each variable in its application in place will require the use of different evaluation tools, including modelling that facilitates the comparison of scenarios. Feeding this inspiration is linked to the comparison of alternatives, which requires the definition of metrics and KPIs that can be expressed spatially to facilitate decision making at the micro scale. This scale of intervention requires the use of tools that provide as much detail as possible on the inputs to define which NbS are appropriate, where they can be applied and how they can be implemented.

At this stage, the expected outputs are intervention locations for each NbS, as well as types of techniques and basic dimensions, combined with a 3D representation of the project, integrated in its environment, and renderings that can illustrate the different designs.

The comparison of alternatives should take into account different criteria:

- Viability/feasibility check: land tenure, infrastructure, ongoing or planned projects, public policy, budget, etc.
- Urban integration: functionality, accessibility, landscape, etc.
- Ecosystem restoration: reducing impacts, restoring ecosystem functions, supporting natural recovery
- Social acceptance: inclusion, co-design, social value, etc.

Once all the variables have been considered, the final urban design solution is selected. If the applied process has been successful, this option has explored the maximum capacity of the place to accept NbS. The process ends with an analysis of the effectiveness of the NbS (and the urban design as a tailored solution) in addressing the challenges identified in the initial diagnosis. This information is relevant to extract lessons learned and key messages to be considered in other urban designs. The intention is to mainstream NbS into urban design processes that contribute to the replication of these solutions.

The expected final outputs are the following: layout, cross-sections and technical details. The relevance of the replication process is related to the benefits of NbS, which will be maximised through replication and up-scaling strategies that contribute to climate adaptation not only at local level (such as thermal comfort or runoff reduction) but also at city level (such as urban heat island or flood risk).

4. NbS for urban thermal comfort: impact evaluation of comparative scenarios in Envigado

Igone Garcia[1], Adrian Glodeanu[1]
[1]Tecnalia Research & Innovation BRTA. Climate Change Adaptation Team. Energy, Climate and Urban

Simulation models are tools used to predict and evaluate the impact of different urban designs and solutions on certain variables. These simulations are based on numerical models that take into account different variables based on a 3D model of the area. From a baseline, different design alternatives can be simulated to inform urban planning and design decisions through comparative effectiveness analysis. These simulations are a valuable tool for designers, urban planners and policy makers to make informed decisions about the implementation of NbS in urban areas.

Modelling is a well-researched tool at the micro level that can be applied to very different variables, such as air quality and noise, but also to those directly related to the potential adaptation of public spaces to climate change scenarios: Drainage and thermal comfort.
Drainage is a highly conditioned variable, but the characteristics of the basin in which the urban design is planned and the NbS can provide a complement to more integral solutions. Nevertheless, in thermal comfort, NbS can provide a direct added value for adaptation through shading and evapotranspiration, which also affect the mean radiant temperature (TMRT).

This provides an opportunity to explore the role of NbS for thermal comfort in the urban design process, since the increase in heat events is a strong public concern, as some urban configurations create areas where the rising temperatures will have greater impact, also considering future climate scenarios.

The index used to define human thermal comfort is PET (Physiological Equivalent Temperature). It assesses the impact of the thermal environment on the human body, taking into account various variables such as air temperature, humidity, air velocity and radiation, but also the physiognomy and clothing characteristics of an “average person”. It represents the equivalent temperature that an individual would experience in a comfortable indoor environment, given the specific outdoor conditions.

The steps involved in micro-scale thermal modelling are the following:

Characterisation of the study area

The climatic conditions and the land use of the study area are analysed. As input, the time distribution of the different simulation variables should be considered: air temperature, relative humidity, wind direction and intensity and TMRT. The importance of defining the climate and urban design scenarios for the thermal simulation should be emphasised:

- Climate scenarios: in addition to the current scenario, climate change should be analysed in order to assess the cost-effectiveness of NbS over time. This refers to the choice of one of the possible emission pathways (RCP2.6, 4.5 or 8.5) and a time frame (2041-2070, 2071-2100) that would affect the result and the assessment of the effectiveness of the NbS.
- Urban design scenarios: in addition to the baseline scenarios and the final solution, different urban alternatives can be modelled and compared in order to inform the design and quantify the thermal impact of the decisions taken.

Computer simulation process

The characterisation information is integrated into the ENVI-met modelling software. Advanced numerical models are used to simulate different scenarios. A resolution of 1 or 2 metres is required for the microscale and to inform urban design.

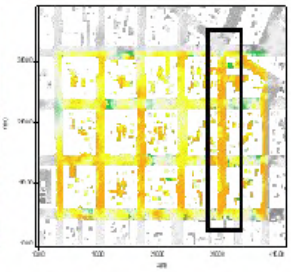
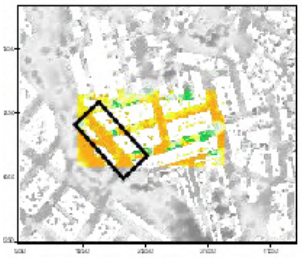
Comparison of alternatives and indices

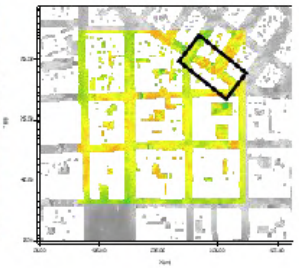
The post-processing of the modelling results provides effectiveness indices that analyse the evolution of the variables over time or make comparisons between different scenarios and alternatives. To facilitate this comparison, the indices should relate to a specific area and the information obtained must be spatially explicit.

Understanding how different building configurations, land uses and vegetation types affect local thermal comfort allows decision-makers to make more informed choices. In this context, the relevance of CFD calculations goes beyond immediate comfort considerations and highlights the central role of informed design strategies in promoting environmentally conscious and resilient cities.

In the following paragraphs, some thermal modelling exercises in Envigado are presented. The main intention is to show how the thermal variable (understood as the comfort of the user of the public space) can become part of the decision variables in the design of new urban spaces. For this purpose, as already mentioned, the spatially explicit information on the comfort level is useful to identify, at the microscale, the specific spaces where there is more thermal stress, but it is also applicable to use an aggregate index that allows us to know, with a single value, which of the different urban scenarios designed is more efficient.

The following table summarises the results obtained in Envigado:

Neighbourhood	Brief description of the Neighbourhood	Images	Current Scenario		Climate future scenario	
			% of surface with PET compatible with a comfortable use (>41°C)	Differences of PET in the areas with and without NbS	Increment of PET in comparison with current scenario	Role of NbS in the area in the future
Mesa	A central space with a mix of commercial activities and residential uses. The buildings provide little shade and natural solutions play a fundamental role. Thermal comfort varies significantly from one street to another, as trees are very unevenly distributed in this neighbourhood.	  	24 %	19 °C	1-3 °C	Reduce PET in 0,5 °C
Flores	A small residential area dominated by paved areas and large trees of various species. Houses are usually three storeys high with limited shading.	 	29 %	21 °C	1-2 °C	Reduce PET in 3 °C

						
Central	A commercial and residential area in square blocks dominated by asphalt and narrow pavements. Sometimes, there are trees that provide shade, but in other cases their canopy is not dense enough or absent. There are large differences between neighbouring streets.	  	29 %	16 °C	1 °C	Reduce PET in 1 °C
Alcalá	A residential area in rectangular blocks with generally three-storey houses. The lack of natural solutions in most streets is criticised, which is compensated for on some pavements by the shading of buildings. The main arteries, on the other hand, have comfortable public spaces. Areas compatible with the level of risk of heat		34 %	17 °C	1-2 °C	Reduce PET in 3 °C

	stroke are the majority in space.					

As can be seen from the results presented, urbanism can have a significant impact on the microscale climate. Buildings, vegetation and roads can cause changes at the microscale, and computer simulations can become an interesting tool for diagnosis.

Trees can provide shade, reduce pollutants and air temperature, and increase humidity. In places such as Alcalá and Flores, the number of large trees influences the amount of area compatible with human comfort. This is relevant in the context of urban greening. Trees alone may sometimes not be enough, which is where homes and buildings can influence thermal comfort at the city level. However, as is the case in all the neighbourhoods analysed in Envigado, they have limited shading capacity. This can increase heat stress and exposure to direct solar radiation.

In addition, nature-based solutions are often lacking in the urban areas of Envigado, due to factors such as land use pressure, lack of awareness or lack of funding. In this case, simulation tools can be an important intervention tool to look for potential areas to implement new NbS. They can be installed in relation to the rectangular block layout of neighbourhoods, particularly in the central and mesa areas. This arrangement can create wind tunnels, but can also increase wind chill. In addition, the layout of the central areas can create canyon effects that need to be studied in order to prevent NbS from creating thermal discomfort.

In general, urbanism and thermal comfort at the microscale level are linked, and in the management of urban interventions, urbanism can have a significant impact on the climate at the microscale level.

ANNEX 4

Workshops for co-creating the Unlimited Cities version enriched with NbS information

Two ideation workshops were held and followed the agenda described below:

1. PRESENTATION of the UC tool + experience in SEV/Quito: 10 min.
2. TEST of the UC tool: 40 min.
    - QR code to connect to the app, each person with their phone + tablets/tablets/ordi
    - Photos of public spaces in Envigado (computer projection or integration already done before)
    - Each person develops two spaces alone or in a group (one after the other).
    - The map is projected on the screen with the proposals that appear.
3. FEEDBACKS Mentimeter 10 min
    - How would you rate the tool?: Useless (0) – Very useful (10)
    - In one word, how would you define the tool? > word cloud
    - What are its strong points? > word cloud
    - What are its weaknesses? > word cloud
4. QUESTIONS on the use of the tool: 10 min

    1. Use of the tool

        - How could the tool be used? For what purposes and at what point in time?
        - How could it be used in INTERLACE?

    2. NbS integration

        - Which BMS should we integrate in the tool?
        - What information about the NbS should we propose to the user (impact indicators, technical explanation, description, relevance, ...)?
        - How should this information be presented (figures, symbols, short text, measurement graphics,...)?

Ideation workshop 1

Tuesday 21/11 - 14:30–15:30 - Parallel Session

During the INTERLACE meeting in Envigado, with the INTERLACE consortium.

Feedbacks from Group 1:

1. NbS to integrate into the tool
   - ★ Benefits of green space

★ Good examples of already created works ★ How not to make the ground impermeable (permeable materials) i. Sustainable Urban Drainage Systems (SUDS)
2. Information to propose to the user about NbS ★ Spaces for plants and animals in the city ★ Benefits of plants
3. How to present the information? ★ Informative buttons ★ Show before and after

Feedbacks from Group 2:

1. What elements? Local species (climate adapted) NbS menu - Green roofs	2. Info Budget/costs Benefits	3. Functionality - Street view - Bird's eye view
Blue-green factor elements (photo examples)		

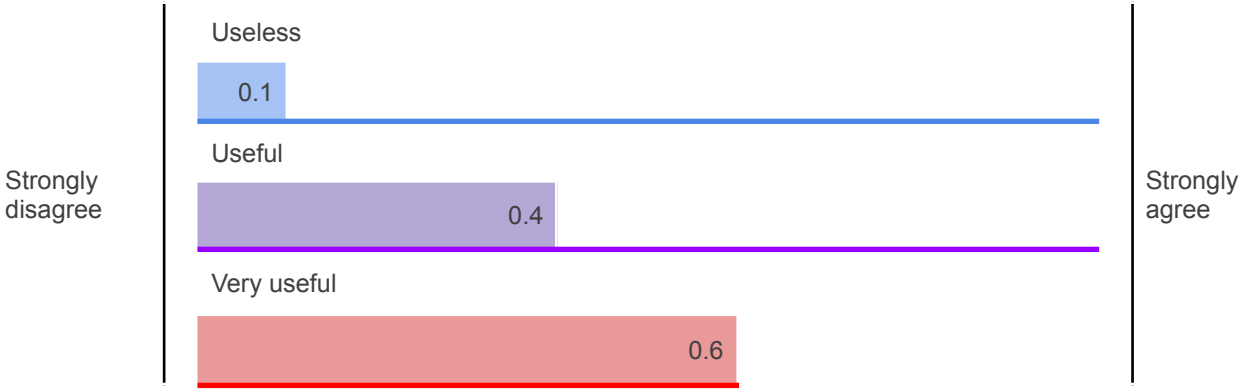
Feedbacks from Group 3:

1 - SUDS - Trees - Green roofs - Green facades - Rain gardens - Park elements - Horticulture - Flowering meadows/perennials - Ponds	2 - Ecosystem services provision - Vulnerability adaptation capacity - Technical description - Costs	3 - Qualitative info bar, responding on elements you enter in the design - Like barometer

Ideation workshop 2

During the Cities Talk Nature event in Envigado, with the event's audience:

- **How would you rate your experience with the tool?**



- **What are the strengths of the tool for planning urban projects with NbS?**

1. Support of competent authorities in the development of cities
2. Home street familiarity
3. User ownership
4. Enabling design possibilities, community awareness and political authorities
5. Stakeholders feedback
6. Simple visualisation tool to express ideas
7. It would be interesting to know the contributions to nature, climate, etc of the options to choose from
8. Instant visibility/results
9. Allows to reach out to various stakeholders

10. Co-creation: Integration of diverse values about the space
11. Include groups that have less access
12. Simple, visual, inclusive
13. General ideas from the community
14. Would be made visible to the community to visualise future scenarios in an easy way
15. Great visualisation of ideas
16. It is a tool that allows inclusiveness
17. Interactions among users
18. Inclusive approach
19. Allows one to get in contact with different people/target groups. It helps to visualise NbS and hence increases understanding for their necessity
20. More street design than NbS, but very nice anyway – it's low threshold, and especially the interaction option with users in the space is a big plus
21. Need for internet connection
22. Contribution to urban sustainability

- **What are its weaknesses?**

1. Editing functions
2. Need to familiarise yourself with the platform
3. Bugs: not possible to select other features beyond the first one
4. Needs good internet, access to electronic equipment, care of equipment
5. Tool is as good as the options
6. No variety of options
7. Time consuming
8. Limited design options
9. Needs local adaptation
10. You need an internet connection
11. You need to adapt it to the reality of each city and the possibility of photographic elements
12. Creating wrong expectations, if not properly managed
13. Cannot remove the actual objects in the picture (e.g., a car)
14. Expectations are created? Follow up plan should be clear
15. Unlimited budget for street modification
16. Internet connection
17. Need for devices
18. Internet connection
19. Perspective of the photo
20. You wake the expectations that the respective place will be actually transformed the way the user suggested
21. Information about available budget and the real costs of available products (trees, skate park, etc)
22. Expectation to the population

- **What should be integrated into the tool so that you can use it?**

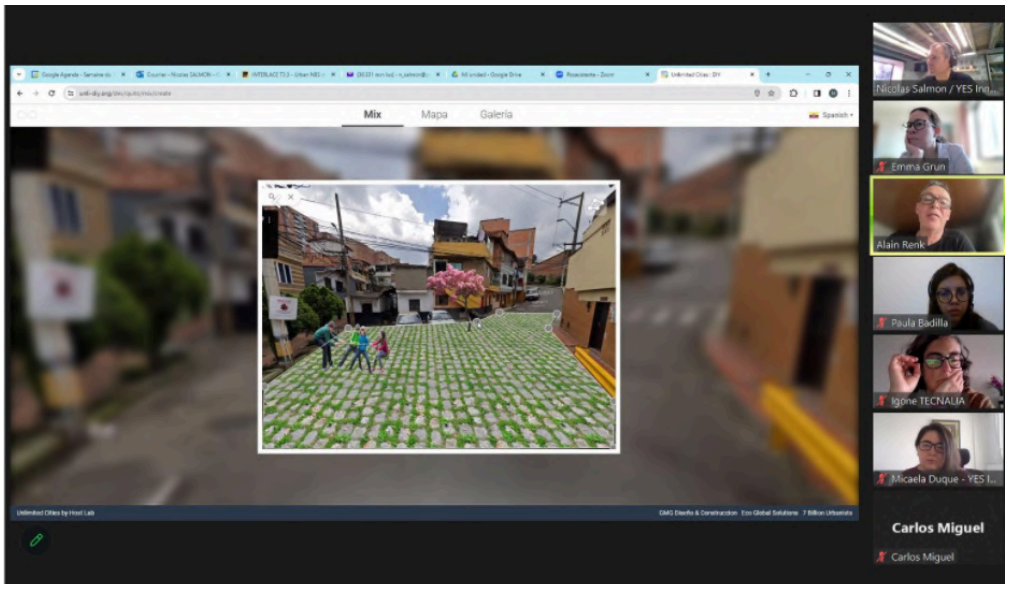
1. More options to renature the place
2. Something to challenge the user, to feed creativity
3. Street furniture and local plants
4. More variety of citizens
5. More explanation (introduction, etc.)
6. Community budget limit and cost of each structure, collective priority setting exercise
7. Information on each tree species and its benefits
8. Rough impact assessment

9. Benefits and weaknesses of each object
10. Include Spanish language for LatAm
11. A video tutorial to get the maximum potential, the possibility of photo pasting depending on the size of the area.
12. Available in app
13. ☺
14. Inform that this is an experimental workshop
15. Blue elements
16. A magnifier option for people with bad eyes (perhaps it's there already)

- **In one word, how would you define the tool?**
    - effective
    - nice
    - greening
    - useful
    - easy
    - time consuming
    - intuitive
    - visual
    - interactive
    - local
    - good
    - pre-design
    - inclusivity
    - helpful
    - can be improved
    - depictive
    - ☺
    - landscaping
    - territory

Workshop to design new functionalities

Participation of Gensler and Tecnalia

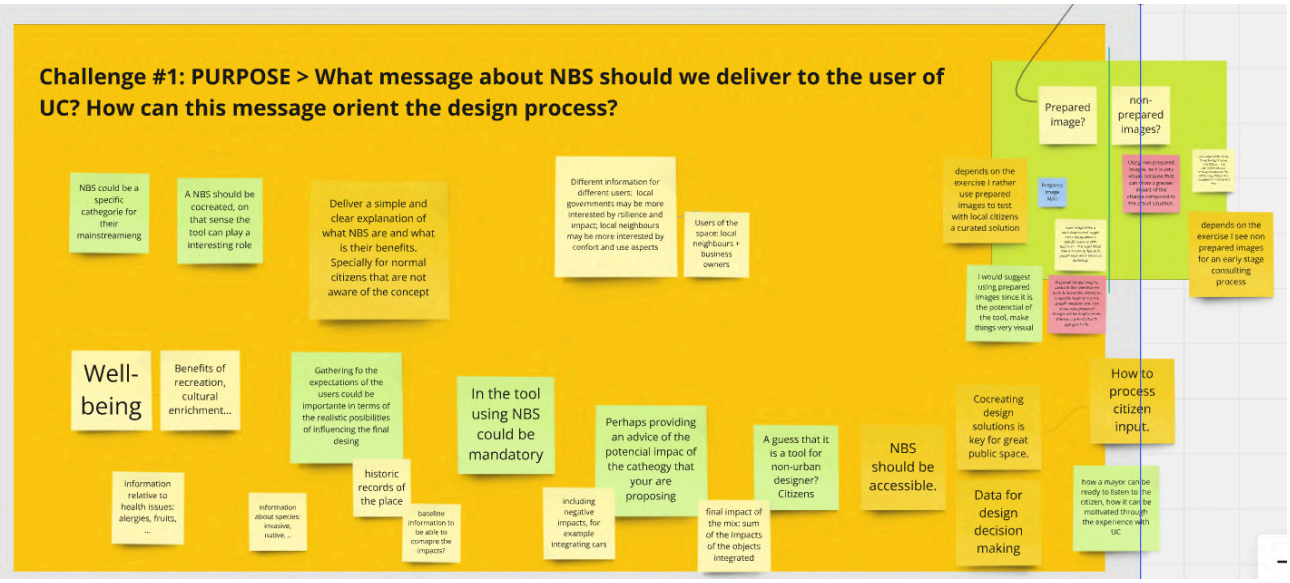


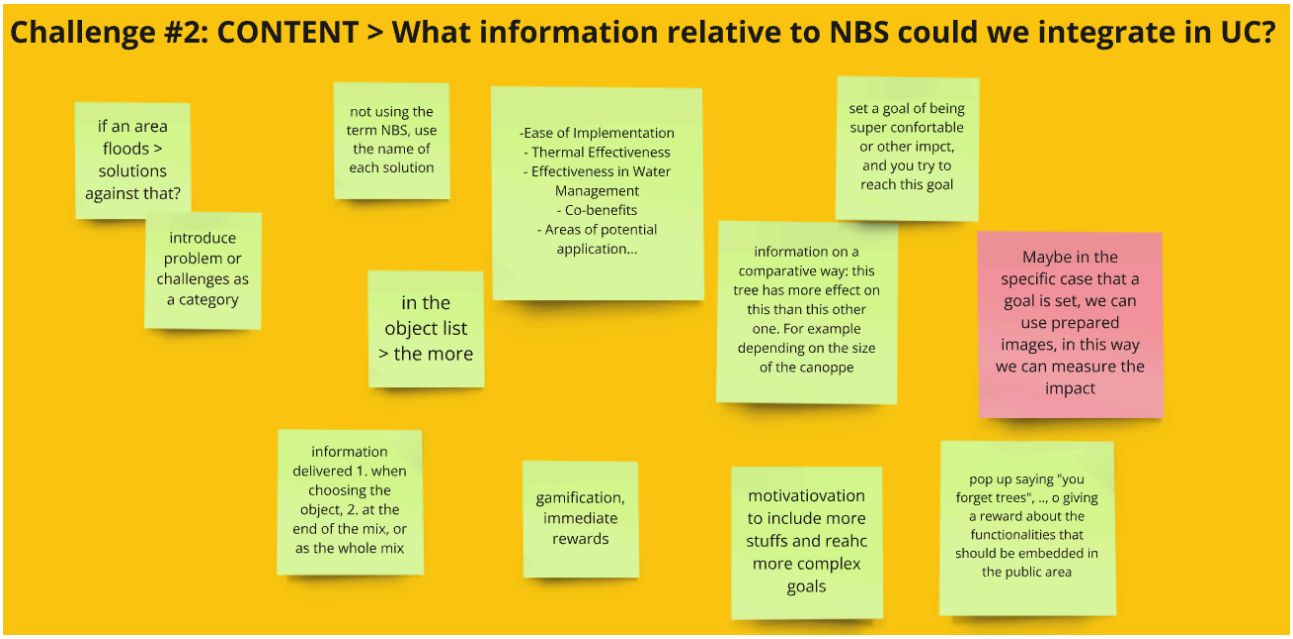
Agenda of the meeting:

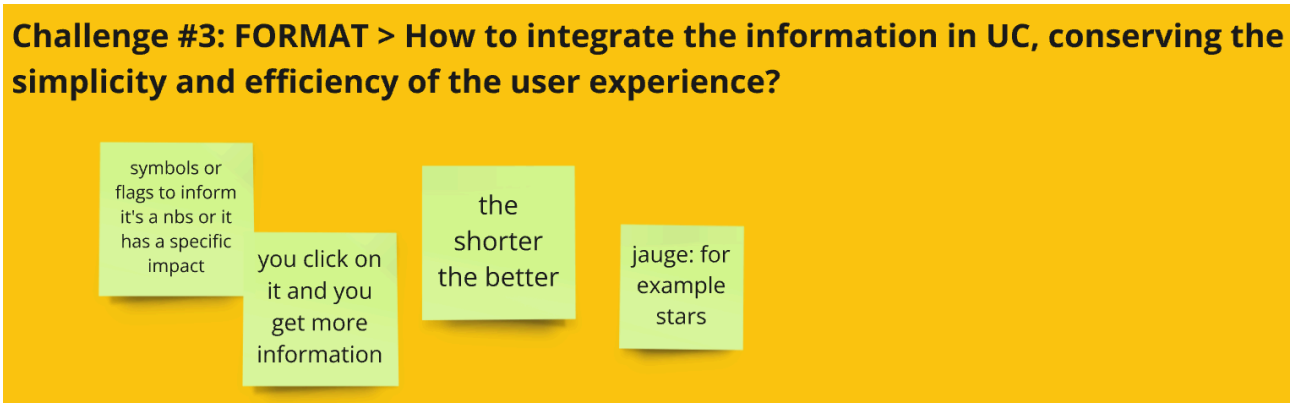
- Welcome, objectives for the workshop and roundtable presentation
- Presentation of Unlimited Cities: purpose, how it works, previous experiences
- Challenge #1: PURPOSE > What message about NbS should we deliver to the user of UC? How can this message orient the design process?
- Challenge #2: CONTENT > What information relative to NbS could we integrate in UC?
- Challenge #3: FORMAT > How to integrate the information in UC, conserving the simplicity and efficiency of the user experience?

Questions/topics

- OBJECTS
    - Which objects should we integrate?
    - How do we present them?
        - by function? by typology?
- INFORMATION/TAGS
    - What information should we present?
    - What language should we use (impact vs. gain)?
    - Should we integrate reference or baseline?
    - How do we present the information?
- PROCESS
    - How can the tool and the information guide the dialogue towards understanding people's priorities?
    - Should UC on NbS be a tool focused only on NbS projects or should it also integrate the "common" functions and objects?


Challenge #1: PURPOSE > What message about NBS should we deliver to the user of UC? How can this message orient the design process?
NBS could be a specific cathegorie for their mainstreamieng
A NBS should be cocreated, on that sense the tool can play a interesting role
Deliver a simple and clear explanation of what NBS are and what is their benefits. Specially for normal citizens that are not aware of the concept
Different information for different users: local governments may be more interested by rsilience and impact; local neighbours may be more interested by confort and use aspects
Users of the space: local neighbours + business owners
Prepared image?
non-prepared images?
depends on the exercise I rather use prepared images to test with local citizens a curated solution
depends on the exercise I see non prepared images for an early stage consulting process.
I would suggest using prepared images since it is the potencial of the tool, make things very visual
Well-being
Benefits of recreation, cultural enrichment...
Gathering fo the expectations of the users could be importante in terms of the realistic posibilities of influencing the final desing
In the tool using NBS could be mandatory
Perhaps providing an advice of the potencial impac of the catheogy that your are proposing
A guess that it is a tool for non-urban designer? Citizens
NBS should be accessible.
How to process citizen input.
Cocreating design solutions is key for great public space.
Data for design decision making
how a mayor can be ready to listen to the citizen, how it can be motivated through the experience with UC
Information relative to health issues: alergies, fruits, ...
information about species: invasive, native, ..
historic records of the place
baseline information to be able to comapre the impacts?
including negative impacts, for example integrating cars
final impact of the mix: sum of the impacts of the objects integrated


Challenge #2: CONTENT > What information relative to NBS could we integrate in UC?
if an area floods > solutions against that?
introduce problem or challenges as a category
not using the term NBS, use the name of each solution
-Ease of Implementation
- Thermal Effectiveness
- Effectiveness in Water Management
- Co-benefits
- Areas of potential application...
in the object list > the more
set a goal of being super confortable or other impct, and you try to reach this goal
information on a comparative way: this tree has more effect on this than this other one. For example depending on the size of the canoppe
Maybe in the specific case that a goal is set, we can use prepared images, in this way we can measure the impact
information delivered 1. when choosing the object, 2. at the end of the mix, or as the whole mix
gamification, immediate rewards
motivatiovation to include more stuffs and reahc more complex goals
pop up saying "you forget trees", .., o giving a reward about the functionalities that should be embedded in the public area


Challenge #3: FORMAT > How to integrate the information in UC, conserving the simplicity and efficiency of the user experience?
symbols or flags to inform it's a nbs or it has a specific impact
you click on it and you get more information
the shorter the better
jauge: for example stars

INTERLACE
RESTORING URBAN ECOSYSTEMS
RECUPERANDO ECOSISTEMAS URBANOS

INTERLACE is a four year project that will empower and equip European and Latin American cities to restore urban ecosystems, resulting in more liveable, resilient and inclusive cities that benefit people and nature.

interlace-project.eu

INTERLACE es un proyecto de cuatro años que busca empoderar y apoyar ciudades de Europa y América Latina en la restauración de ecosistemas urbanos, resultando en ciudades más vivibles, inclusivas y resilientes para el beneficio de la gente y la naturaleza.

Project Partners

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