MULTISOURCE

Recommendations for the use of MULTISOURCE business models and tools in Brazil, USA and Vietnam

Deliverable 6.7

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TABLE OF CONTENTS

EXECUTIVE SUMMARY **7**

1. INTRODUCTION **8**

2. MULTISOURCE DIGITAL TOOLS & RECOMMENDATIONS **9**

2.1. The MULTISOURCE Planning Platform 9
2.1.1. Description *9*
2.1.2. Targeted Users *9*
2.1.3. Expected outcomes *9*
2.1.4. How MSU, HCMUT, UFSC, and related organisations can use it? *10*
2.1.5. General recommendations *10*
2.1.6. Key links or templates *11*
2.1.7. Available Tools and Resources *11*
2.2. Nat4Wat: Online decision-support tool 11
2.2.1. Description *11*
2.2.2. Targeted users *12*
2.2.3. Expected outcomes *12*
2.2.4. How MSU, HCMUT, UFSC, and related case studies can use it? *12*
2.2.5. General recommendations *13*
2.2.6. Key links or templates *14*
2.3. Business Models for Nature-based Solutions for Water Treatment (NbSWT) 14
2.3.1. Description *14*
2.3.2. How MSU, HCMUT, UFSC, and related organisations can use them? *15*
2.3.3. General Recommendations *16*

3. INTERNATIONAL WORKSHOPS: A DETAILED ANALYSIS **17**

3.1. Purpose of Multisource International Workshops 17
3.2. Workshop in Vietnam 17
3.2.1. Key Objectives and Outcomes *17*
3.2.2. Agenda of the Workshop in Vietnam *18*
3.2.3. Opening ceremony – welcome *20*
3.2.4. Session: Panel discussion on the water treatment with ENTS *21*
3.2.5. Session: The role of the cities to achieve water resilience *22*
3.2.6. Session: Project presentations from EU and Vietnam *23*
3.2.7. Workshop 1: Stakeholder Mapping and Engagement *25*
3.2.8. Workshop 2: Planning platform tools to support NbS for urban water management *26*
3.2.9. Workshop 3: Nat4Wat: an online tool to select, compare and explore nature-based solutions for water management. *27*
3.2.10. Workshop 4: Transferring MULTISOURCE ENTS into Vietnam *28*
3.2.11. Market Place *29*
3.2.12. Field Trip *30*
3.3. Workshop in Brazil 32
3.3.1. Key Objectives and Outcomes *32*
3.3.2. Agenda the Workshop in Brazil *33*
3.3.3. Workshop Key Outcomes *35*
3.3.4. Opening ceremony – welcome *36*
3.3.5. Session: Multisource Project - ModULar tools for integrating enhanced natural treatment Solutions in Urban water CyclEs' *37*
3.3.6. Session: INCT-SnN – National Institute of Science and Technology - Nature-based Solutions and the Role of the UFSC Hub – GESAD and RReSSa Research Groups *38*
3.3.7. Session: Multifunctionally and co-benefits of NbS for wastewater and stormwater management in the context of climate change *41*
3.3.8. Session: Closing the urban cycle of water – risks, opportunities and the NbS role *42*
3.3.9. Workshop 1: Problem-Solving for NbS: Defining Actor Roles for Implementation *48*

3.3.10. Workshop 2: Multisource tools for NbS dissemination – decision-making for technology 49
3.3.11. NbS business cases: design, technologies and engagement 50
3.3.12. Market Place 52
3.3.13. Field Trip 52

4. STRENGTHENING INTERNATIONAL COOPERATION: BIOFILMS AND MICROBIAL METHODS WORKSHOP WITH MONTANA STATE UNIVERSITY 56

5. CLOSING REFLECTIONS 56

6. ACKNOWLEDGEMENTS.....57

7. REFERENCES 58

8. ANNEX.....58

8.1. ANNEX 1 – VIETNAM WORKSHOP (HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY, HCMUT) 58
8.2. ANNEX 2 – BRAZIL WORKSHOP (FEDERAL UNIVERSITY OF SANTA CATARINA, UFSC) 58

List of figures

Figure 1 Nat4Wat Tool home page – website 14
Figure 2 Five dimensions of a full business case (Altamirano et al. 2021. NAIAD project D7.3) 14
Figure 3 Workshop 1: Stakeholder engagement 25
Figure 4 Workshop 2: Planning platform tools to support NbS for urban water management 26
Figure 5 Workshop 3: Nat4Wat: an online tool to select, compare and explore nature-based solutions for water management 28
Figure 6 Market place indoors 29
Figure 7 NbS pilots from the Ho Chi Minh City University of Technology 30
Figure 8 Site visit: Floating Treatment System - HCMC canals 31
Figure 9 Pedestrian Street in Crescent Lake, District 7, HCMC 31
Figure 10 Site visit: Rừng Sác tourism- Cần Giờ District 31
Figure 11. Workshop 1 Brazil: Business models and stakeholder engagement 48
Figure 12 Workshop 2 Brazil: Digital tools 50
Figure 13 Pannel of discussion: NbS business cases. 51
Figure 14 interactive coffee break 52
Figure 15 Field trip - Site 1 53
Figure 16 Field trip – Site 2 54
Figure 17 Field trip- Site 3 55

List of Abbreviations

ABES	Brazilian Association of Sanitary and Environmental Engineering
ADB	The Asian Development Bank
ARIS	Intermunicipal Sanitation Regulatory Agency
AU	Aarhus University
CASAN	Santa Catarina Water and Wastewater State Company
CCB	Center for Biological Sciences
CSO	combined sewer overflow
ENTS	Enhanced Natural Treatment Solutions
GESAD	Decentralized Sanitation Research Group
HCMC	Ho Chi Minh City
HCMUT	Ho Chi Minh City University of Technology
ICRA	Catalan Water Research Institute - Spain
INCT-SbN	National Institute of Science and Technology - Brazil
INRAE	National Research Institute for Agriculture, Food and Environment - France
LCA	Life cycle analysis
MSU	Montana State University
NbS	Nature-based solutions
NbSWT	NbS for Water Treatment
RReSSa	Research Group on Resource Recovery in Sanitation Systems - Florianopolis, Brazil
SSMU	Septage Sludge Management Unit
UFSC	Federal University of Santa Catarina
UFZ	Helmholtz Centre for Environmental Research - Germany
VNU-HCM	Key Laboratory of Advanced Waste Treatment Technology Ho Chi Minh City
WSUD	Water-Sensitive Urban Design
WWTP	Wastewater Treatment Plant

Executive Summary

This report provides a set of targeted recommendations for the international application of digital tools and collaborative business models developed under the MULTISOURCE project, with a focus on their relevance in Vietnam, Brazil, and the United States. The main emphasis is placed on the Nat4Wat tool—a digital platform designed to support the selection and preliminary evaluation of nature-based solutions (NbS) for wastewater and stormwater treatment in urban environments.

The insights presented in this report stem from two international workshops hosted by MULTISOURCE international partners of Ho Chi Minh City University of Technology (HCMUT) in Vietnam and the Federal University of Santa Catarina (UFSC) in Brazil. These workshops brought together a wide array of local stakeholders, including municipal and national authorities, researchers, practitioners, and private sector representatives. Through presentations, hands-on sessions, and field visits, the workshops served as key opportunities to test the Nat4Wat tool, discuss its practical applications, and co-reflect on the conditions needed for successful NbS implementation.

While MULTISOURCE offers several tools to support urban water resilience, this report centers on the use, adaptation, and implementation of the MULTISOURCE planning tool and decision-making tool Nat4Wat across varied international contexts. It includes a set of structured recommendations to guide new users, with emphasis on required technical knowledge, best practices for onboarding, strategies for incremental learning, and guidance for continuous feedback and knowledge contribution. In doing so, the report aims to facilitate the integration of Nat4Wat into both training settings and early-stage planning processes, particularly in contexts where nature-based solutions are emerging as alternatives to conventional water infrastructure.

In addition, the report outlines lessons learned from the co-creation of business models for NbS for Water Treatment (NbSWT), highlighting the value of structured stakeholder engagement, locally tailored strategies, and public-private collaboration. These experiences complement the use of tools like Nat4Wat by supporting the policy and financial frameworks necessary for the real-world implementation of NbS.

The final chapter consolidates the main reflections from both workshops, stressing how cross-continental dialogue contributes to innovation and local empowerment. The report concludes by encouraging further international cooperation. Countries such as the United States, which face similar urban water challenges, can benefit greatly from adopting the shared insights, participatory methods, and technical guidance developed through this process. In doing so, they can enhance their own efforts toward sustainable and climate-resilient urban water systems.

1. Introduction

The MULTISOURCE Project aims to advance the global adoption of Nature-Based Solutions for Water Treatment (NbSWT) and stormwater management by sharing valuable knowledge, experiences, and lessons learned from pilot projects implemented across various countries. In collaboration with local and international stakeholders, the project organized workshops in Florianopolis, Brazil and Ho Chi Minh, Vietnam to disseminate findings and spark discussions on adapting NbSWT to local contexts. The project also sought to introduce **methodologies, tools and business models for NbSWT**, providing a framework to guide the implementation and scaling of such solutions globally.

ICLEI led the organization of these workshops, working closely with relevant local institutions (UFSC and HCMUT) and programs to promote knowledge exchange between European partners and local experts. The workshops aimed to highlight the technological, environmental, social, and economic dimensions of NbSWT, while also identifying potential opportunities for partnership development and funding to replicate successful solutions in global settings. In this context, the tools and business models developed by the project were essential to the discussions, as they provided a structured approach for stakeholders to assess, implement, and scale NbSWT solutions effectively.

The MULTISOURCE partners who participated in the different interactions, preparations for the workshops, and other activities with the international partners (UFSC, HCMUT and MSU) of Brazil, Vietnam and USA were of great help and support. Their contributions ensured the success of the workshops, enhancing the exchange of ideas and fostering meaningful dialogue between local and international stakeholders.

The events in Brazil and Vietnam provided a platform for stakeholders from diverse sectors, academia, private companies, NGOs, local authorities, and citizens to actively engage in discussions and activities. These interactive sessions allowed participants to explore suitable technologies, identify local challenges, and discuss practical strategies for implementing NbSWT. Additionally, the workshops provided an opportunity for reflecting on gender mainstreaming and social inclusion, recognizing that gender related, and social equity issues can differ significantly across regions.

The insights and recommendations gathered during these workshops have been valuable for informing the work of international partners, including Montana State University (MSU) in the USA, where efforts were also underway to monitor local NbS pilots. Although stakeholder engagement in the USA was expected to be less extensive than in European pilots, the knowledge shared from Brazil and Vietnam has provided important guidance for future initiatives.

Through fostering collaboration and the exchange of knowledge and experiences, the MULTISOURCE Project supported the development of adaptable, resilient, and inclusive NbSWT systems worldwide. The tools and business models developed as part of the project are integral to understanding the context of the reflections and recommendations presented in this report, which aim to guide future efforts to scale NbSWT solutions in diverse settings.

2. Multisource Digital Tools & Recommendations

The MULTISOURCE Digital Tools, including the **MULTISOURCE Planning Platform** and the decision making tool **Nat4Wat tool**, were developed to advance the global adoption of Nature-Based Solutions for Water Treatment (NbSWT) and stormwater management. These tools provide a **structured framework and resources** to support users in selecting, comparing, and exploring suitable NbS for urban environments. By leveraging open data and analytical capabilities, they assist cities, planners, and engineers in **developing sustainable and cost-efficient strategies**, making NbSWT more accessible and adaptable to diverse urban contexts worldwide. The tools are integral to guiding the implementation and scaling of these solutions.

2.1. The MULTISOURCE Planning Platform

2.1.1. Description

The MULTISOURCE Planning Platform was created to help cities and regions develop sustainable and cost-efficient stormwater management strategies. Leveraging open data and a modular software framework, the platform provides a versatile solution that can be adapted to the specific characteristics and limitations of diverse urban contexts. It enables users to consider key planning factors such as spatial constraints, comparison with traditional stormwater infrastructure, and economic feasibility in their strategic decision-making.

At the core of the platform are several integrated tools that offer robust analytical and design capabilities:

- **Spatial-economic stormwater scenarios** identify optimal areas for deploying NbS, balancing environmental benefits with economic considerations.
- **Pysewer** generates cost-effective sewer network layouts, streamlining the connection of buildings to wastewater treatment facilities.
- **OCTOPUS** supports regional-scale planning by assessing the potential of consolidating smaller treatment systems into shared networks, helping reduce costs and improve operational efficiency.

Several components of the platform are already available as open-source resources in the form of codes, enabling wider use and encouraging continued innovation and collaboration within the urban water management community.

2.1.2. Targeted Users

The platform is intended to serve a diverse group of professionals and institutions involved in urban water management and planning, including:

- Municipal authorities responsible for infrastructure development and maintenance
- Urban planners seeking sustainable solutions for stormwater control
- Environmental engineers and consultants working on water system designs
- Researchers and academic institutions focused on urban sustainability and hydrology
- Policy advisors and regional planners shaping long-term urban development strategies
- Open-source developers interested in building on or integrating with existing planning tools

2.1.3. Expected outcomes

Implementation and use of the MULTISOURCE Planning Platform are expected to contribute to:

- Smarter planning processes, with tools that enable evidence-based decisions tailored to specific urban conditions
- Greater cost-effectiveness in infrastructure investments, by optimizing system designs and evaluating decentralization potential
- Wider integration of NbS, through spatial analysis that identifies suitable locations and expected impacts
- Knowledge sharing and innovation, supported by open-source availability and cross-sector collaboration

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- Increased urban resilience, by supporting cities in building adaptable systems that can respond to climate and population pressures.

2.1.4. How MSU, HCMUT, UFSC, and related organisations can use it?

Strategic Stormwater Management: The platform's core function is strategic planning for stormwater. In Ho Chi Minh City (HCMC), challenges include stormwater surges and extreme rainfall. The workshop in Vietnam discussed integrating WSUD principles for mitigating flooding and explored local challenges like tidal influence, limited space, and sewer system types. The spatial-economic stormwater scenarios tool can help HCMUT, in collaboration with local authorities, identify suitable areas for implementing NbS like green roofs or rain gardens, considering spatial constraints in dense urban areas.

UFSC and its partners in Florianopolis and Palhoça, facing their own urban water challenges, can use these tools for similar spatial analysis and scenario comparison, particularly in areas needing stormwater infiltration or combined sewer overflow (CSO) solutions.

MSU can adapt these tools to the specific conditions and data availability in relevant US cities or regions facing comparable stormwater issues.

Scenario Comparison and Design: The platform allows users to consider key planning factors such as spatial constraints and comparison with traditional stormwater infrastructure. The block-based planning methodology discussed at the Vietnam workshop provides a framework for identifying and prioritizing areas for implementation, distinguishing between decentralized and centralized interventions. This approach is directly applicable for planning in both HCMC and Florianopolis, helping to tailor solutions based on local conditions like soil type, space availability, and existing sewer infrastructure. MSU can utilize this structured approach for planning in different US urban archetypes.

Optimization of Systems: Tools like Pysewer and OCTOPUS can help engineers and planners at HCMUT and UFSC optimize sewer network layouts or assess the feasibility of consolidating treatment systems in peri-urban or rural areas discussed in Brazil. While the primary focus of the platform seems to be stormwater, the underlying modular framework and principles of optimizing infrastructure can potentially be adapted or provide insights for wastewater systems planning as well. MSU can use these optimization tools in relevant planning efforts in the US.

Knowledge Sharing and Collaboration: As an open-source platform, it facilitates knowledge sharing and encourages collaboration among users. Researchers at HCMUT, UFSC, and MSU can build upon or integrate with the existing codes, contributing to its development and adapting it for specific regional needs.

2.1.5. General recommendations

The MULTISOURCE Planning Platform offers a versatile, open-source solution to support cities, planners, and engineers in developing sustainable and cost-effective stormwater management strategies. To maximize its value, users should keep the following recommendations in mind when preparing to use the platform:

Understand the Local Context Thoroughly

Before engaging with the platform, users should analyse the specific environmental, infrastructural, and socio-economic conditions of their city or region. Factors such as land availability, urban density, soil types, flood risks, and existing sewer infrastructure will significantly shape the suitability and design of NbS. For example, cities with tidal influences or combined sewer overflows, like Ho Chi Minh City or Florianopolis, need tailored approaches to address both spatial limitations and hydrological challenges. A solid understanding of these parameters helps align the platform’s outputs with local priorities and regulatory frameworks.

Prepare relevant and high-quality data inputs and clear goals

Effective use of the platform depends on the availability and quality of spatial and technical data. Users should collect accurate input data—such as GIS layers (buildings, roads, elevation, drainage networks), land

use maps, and local cost estimates—to enable robust scenario modeling. It is equally important to define planning goals from the outset: are you identifying locations for NbS? Reducing infrastructure costs? Expanding coverage of treatment systems? Clear objectives guide tool selection within the platform (e.g., Pysewer for sewer optimization, OCTOPUS for treatment consolidation), ensuring focused and meaningful outputs.

Compare Scenarios and Use an Iterative Approach

The platform allows users to model and compare multiple development strategies, such as centralized vs. decentralized stormwater systems or grey vs. green infrastructure options. Begin with broad scenarios, then refine them based on local feasibility, stakeholder input, and environmental goals. The block-based planning approach—used in the Vietnam workshop—is a helpful method for identifying and prioritizing intervention areas at a manageable scale. Iterating through options helps cities find cost-effective, locally appropriate solutions that evolve with improved data and real-time feedback.

Engage Stakeholders Early

Multidisciplinary stakeholder engagement is crucial throughout the planning process. Municipal departments, environmental agencies, private sector actors, and community representatives all bring valuable insights into both technical feasibility and social acceptance. In both Brazil and Vietnam, early involvement of local stakeholders contributed significantly to validating planning assumptions and ensuring that the outputs reflected ground realities. The platform can be used as a facilitation tool in participatory workshops, helping to visualize options and promote collaborative decision-making.

Build Capacity and Connect to Real Implementation

To successfully integrate the platform into urban planning workflows, teams need some level of technical capacity in spatial analysis, urban water systems, and digital tools. Workshops or training may be useful for new users, and the platform's open-source design enables users to adapt it to their regional needs. Users should also ensure that outputs connect to practical implementation steps—such as budgeting, design development, or regulatory approval. This bridges the gap between analysis and action, turning digital insights into resilient infrastructure projects.

2.1.6. Key links or templates

The MULTISOURCE Planning Platform includes a suite of open-source tools designed to support cities, planners, and engineers in developing cost-effective and site-specific stormwater strategies. These tools integrate spatial, economic, and technical considerations and can be adapted for different urban contexts

2.1.7. Available Tools and Resources

- Spatial-Economic Scenario Tool
- Pysewer
- OCTOPUS

For collaboration, technical support, or to explore applications in your city or region, contact:

- Jan Friesen – jan.friesen@ufz.de
- Maria Chiara Lippera – maria-chiara.lippera@ufz.de

2.2. Nat4Wat: Online decision-support tool

2.2.1. Description

Nat4Wat is an online (web-based) decision-support tool developed to assist users in selecting, comparing, and exploring NbS for effective water management. It offers a structured framework to guide the identification of the most suitable NbS options for both wastewater treatment and stormwater management.

2.2.2. Targeted users

Nat4Wat is designed for a broad range of stakeholders involved in water management and sustainable urban planning, including:

- Municipalities and Urban Planners
- Researchers and Academics
- Policymakers
- Businesses and Technology Providers
- Consultants and Engineers
- Developers and Software Integrators
- Science and technology university students

2.2.3. Expected outcomes

The use of Nat4Wat is expected to deliver the following key outcomes:

- Enhanced Decision-Making: Users can make informed choices by comparing NbS using real-world data and multi-criteria analysis.
- Tailored Recommendations: Context-specific solutions are generated based on user inputs such as water type, rainfall, soil conditions, and desired co-benefits.
- Scalable Application: Suitable for a wide range of projects, from household-level interventions to urban and industrial water management.
- Efficient Planning: Pre-design estimations and integration via API streamline project development and implementation.
- Increased NbS Adoption: Access to technology providers, case studies, and market insights supports broader uptake of sustainable solutions.
- Sustainability Promotion: Encourages the use of green infrastructure and circular economy principles.
- Stakeholder Collaboration: Supports coordinated planning and decision-making among diverse actors.

2.2.4. How MSU, HCMUT, UFSC, and related case studies can use it?

Technology Selection and Preliminary Evaluation: The primary use of Nat4Wat is to support the selection and preliminary evaluation of NbS. During the workshops in Vietnam and Brazil, participants explored the tool to propose decentralized NbS for improving municipal water management, focusing on rainwater, wastewater, and greywater treatment. HCMUT and UFSC researchers, students, and local partners can use Nat4Wat to explore suitable NbS for specific local challenges identified, such as treating canal water, managing septic tank discharge, or addressing stormwater in different urban contexts. MSU can apply Nat4Wat to evaluate NbS options for water challenges in the US context.

Scenario-Based Planning: The workshop in Vietnam involved participants designing and pitching NbS solutions tailored to specific scenarios using the tool. This scenario-based planning capability can be utilized by planners and engineers at HCMUT and UFSC to assess how different NbS options perform under various local conditions (e.g., rainfall patterns, soil types, available space). MSU can use this feature to evaluate options for different climate zones or urban typologies in the US.

Training and Education: Nat4Wat serves as a valuable training resource, particularly for science and technology university students. All MSU, HCMUT and UFSC, as academic institutions, can integrate Nat4Wat into their curricula to train future professionals in NbS selection and preliminary design.

Exploring Co-Benefits: The tool allows users to consider desired co-benefits when generating recommendations. As highlighted in the workshops, emphasizing co-benefits like enhanced biodiversity, community engagement, and urban cooling makes NbS proposals more attractive. Users at all three institutions can explore how different NbS options provide a range of environmental and social benefits relevant to their local priorities.

Providing Feedback and Contributing Knowledge: Use the "Test Session" page to provide feedback on bugs, suggest enhancements, and comment on accuracy and user experience. During the Brazil workshop, limitations related to data availability, user experience, and contextual fit were identified. Users at MSU, HCMUT, and UFSC are encouraged to utilize this feedback mechanism. Furthermore, the tool's database can be expanded with new scientific publications and market case studies, allowing these partners to contribute their research findings and local project experiences.

Initial Planning Stage: Nat4Wat provides pre-design estimations to streamline project development in the early stages. However, it is crucial to remember that these results are preliminary and require detailed engineering design before implementation. Engineers and planners at HCMUT and UFSC can use the tool for initial assessments, but subsequent rigorous design processes are necessary. MSU partners would follow the same process.

2.2.5. General recommendations

Nat4Wat, as a digital support tool for identifying and evaluating NBS options for wastewater and stormwater treatment, proved to be highly valuable in both workshop contexts. The following overarching recommendations should guide its adoption:

Prerequisite Knowledge: While Nat4Wat serves as a valuable training resource, users are expected to possess a foundational understanding of NbS for water treatment and stormwater management. This background is essential for accurately interpreting the tool's outputs and leveraging its full potential.

Initial Orientation: Begin by watching the introductory video, *"How to Use Nat4Wat?"*, available on the tool's homepage or directly via this YouTube link. This tutorial provides a step-by-step overview to familiarize users with the platform's functionalities.

Guided Exploration: Proceed to explore the tool incrementally, referring to the comprehensive guidelines accessible through the homepage. These resources offer detailed explanations to assist users in navigating the platform and understanding specific results or outputs.

Feedback and Continuous Improvement: Should you encounter any bugs, have suggestions for enhancements, or wish to provide feedback on the tool's accuracy and user experience, please utilize the "Test Session" page. Your input is invaluable for the ongoing refinement of Nat4Wat.

Contribution to the Knowledge Base: We welcome the addition of new scientific publications and market case studies related to existing NbS technologies. Contributions will aid in updating and expanding the Nat4Wat database, fostering a richer resource for all users.

Engineering Design Considerations: Please note that the preliminary design results generated by Nat4Wat are not intended for direct implementation. A detailed engineering design process is required before commencing any construction of NbS projects.

2.2.6. Key links or templates

The Nat4Wat Tool can be access in **this link**

Figure 1 Nat4Wat Tool home page – website

For collaboration, technical support, or to explore applications in your city or region, contact:

- Joaquim Comas – jcomas@icra.cat
- Josep Pueyo – jpueyo@icra.cat

2.3. Business Models for Nature-based Solutions for Water Treatment (NbSWT)

2.3.1. Description

The development of business models for NbSWT is essential for promoting sustainable and resilient urban water management systems. In the MULTISOURCE project, the co-creation of collaborative business models focused on integrating various stakeholders from different sectors of the NbSWT and urban water management value chains. The objective is to align innovative water solutions with the interests of public authorities, private investors, and local communities while enhancing water security and climate resilience.

The business model framework applied in the project follows the structured "Five-Case Model" approach, a globally recognized methodology for developing robust public investment cases. This framework, described in detail by Wirth, De Cesare, and Menconi (2024) in MULTISOURCE Deliverable 3.3, provides a comprehensive structure for evaluating and developing business cases by addressing five critical aspects of investment planning:

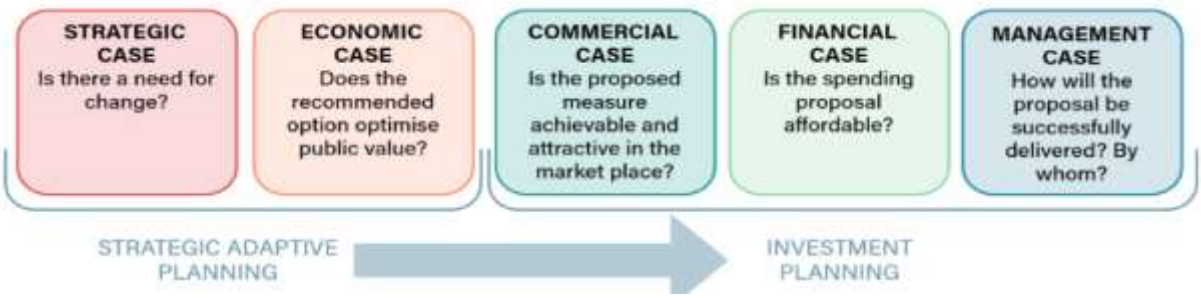

Figure 2 Five dimensions of a full business case (Altamirano et al. 2021. NAIAD project D7.3)

Strategic Case: Understanding how NbSWT fit into the specific environmental, social, and administrative contexts of each city. This includes identifying urban challenges, defining solution scopes, and establishing appropriate measures for service provision.

Economic Case: Evaluating the overall value for money, including economic, social, and environmental benefits. This dimension focuses on comparing costs and benefits and understanding the direct and societal gains of implementing NbSWT.

Commercial Case: Assessing market potential and private sector engagement by analyzing technical design guidelines, service provision capabilities, cost structures, and potential risks.

Financial Case: Examining financial feasibility, including revenue streams, available funding, financing strategies, and the economic viability of NbSWT initiatives.

Management Case: Establishing governance structures, procurement strategies, operational frameworks, and monitoring mechanisms to ensure effective implementation and service provision.

The co-creation process involved interactive workshops, consultations, and collaborative analysis sessions with MULTISOURCE partners, city authorities, and local enabling partners. This participatory approach ensured that the developed business models are context-specific, addressing the unique strategic priorities and regulatory frameworks of local and regional authorities like Milan, Oslo, Girona, Lyon, and Leipzig.

By involving stakeholders in the planning and decision-making process, the business models aim to facilitate public-private partnerships and optimize the use of resources. This collaborative approach provides a pathway to successfully implementing NbSWT in diverse urban settings while enhancing resilience and promoting sustainable urban development.

2.3.2. How MSU, HCMUT, UFSC, and related organisations can use them?

Structured Business Case Development: The Five-Case Model provides a robust framework for developing business cases for NbSWT projects. Partners at HCMUT and UFSC can use this model to evaluate the feasibility of potential projects discussed at the workshops, such as constructed wetlands for canal water treatment, septic tank wetland systems, or septage sludge management units. This involves articulating the strategic fit, evaluating economic benefits (value for money), assessing market potential and private sector engagement, examining financial feasibility (revenue streams, funding), and establishing governance structures. MSU can apply this model to develop business cases for NbSWT implementation in the US, considering different funding mechanisms and regulatory landscapes.

Stakeholder Engagement and Collaboration: A central theme of the business model approach is stakeholder engagement and co-creation which can be combined with the Co-design Framework: Engaging with the stakeholders on NBS for Water Treatment.The workshops in Vietnam and Brazil actively involved diverse stakeholders, demonstrating the value of this approach. HCMUT and UFSC, building on these experiences, can apply stakeholder mapping and engagement frameworks to identify relevant actors (municipalities, utilities, private companies like Rotaria do Brasil, community groups, NGOs) and involve them in designing business models for specific projects. MSU can leverage these lessons for stakeholder engagement in the US, which the sources note was expected to be less extensive than in European pilots, but where knowledge from Brazil and Vietnam provides guidance.

Tailoring to Local Contexts: The importance of adapting strategies to local environmental, administrative, and socio-economic conditions was highlighted. The workshops explored specific local challenges in HCMC (e.g., tidal influence, limited space) and Florianopolis (e.g., contamination, lack of infrastructure, actor roles). The business model framework encourages tailoring solutions and governance arrangements to these unique contexts, including considering existing infrastructure and the role of local authorities and policies. MSU can use this principle to adapt business models to diverse US contexts, from dense urban cores to peri-urban areas.

Public-Private Partnerships: Engaging public and private sectors early is crucial for project feasibility and investment readiness. The Brazil workshop included participation from CASAN-SC (a state water company) and private companies involved in NbS implementation (Rotária do Brasil, Wetlands Construídos, Emboa Ecosan, Ecocell, Phytorestore). This highlights the potential for developing public-private partnerships (PPPs). UFSC and its partners can leverage the business model framework to structure potential PPPs for projects

like the Septage Sludge Management Unit (SSMU) or decentralized residential/commercial systems. HCMUT and MSU can explore similar partnership models relevant to their contexts, using the framework to clarify roles, risks, and financial structures.

Addressing Barriers and Ensuring Sustainability: The workshops identified various barriers to implementation, including policy gaps, limited human resources, lack of guidelines, technical challenges (space, sludge), financial issues (long-term OPEX funding), and cultural reluctance. The Management Case in the Five-Case Model helps address operational frameworks and monitoring, which are crucial for long-term sustainability. By applying the business model framework, partners can proactively identify and plan strategies to overcome these barriers, secure funding, and ensure the ongoing management and operation of NbS, such as the maintenance responsibilities observed at the Brazilian site. Policy advisors and researchers at all three institutions can use the framework to inform policy recommendations and advocate for supportive regulatory environments.

2.3.3. General Recommendations

The co-creation process for developing collaborative business models for NbSWT involved multi-stakeholder engagement across seven MULTISOURCE pilot sites. Key recommendations for international partners applying NbSWT include:

Stakeholder-Centered Design: Successful business models require collaboration between local authorities, technical partners, private sector actors, and researchers. Co-creation workshops involving all relevant stakeholders are essential for aligning objectives and designing context-specific solutions.

Structured Decision-Making with the Five-Case Model: Adopting a structured framework based on the Five-Case Model (Strategic, Economic, Commercial, Financial, and Management) is crucial for building strong business cases. This approach helps articulate value for money, clarify investment feasibility, and structure governance and procurement strategies effectively.

Tailored Strategies for Local Contexts: Each NbSWT project must be adapted to the local environmental, administrative, and socio-economic conditions. Co-creation workshops held in cities like Milan, Oslo, Girona, Lyon, and Leipzig demonstrated the importance of scenario comparison and strategic alignment for different urban challenges.

Public-Private Partnerships and Investment Readiness: Engaging both public and private sector stakeholders early in the planning process can enhance the feasibility of NbSWT projects. Identifying potential investors, project sponsors, and roles in the value chain during initial consultations helps create sustainable business models.

Ongoing Co-Creation and Validation: Continued stakeholder engagement and collaborative modeling are essential for refining business cases. The preparation and follow-up of workshops ensure that the outcomes are further developed and adjusted to meet evolving needs.

3. International Workshops: A detailed analysis

As part of the ongoing collaboration within the MULTISOURCE project, two international workshops were held in partnership with the international academic institutions—HCMUT in Vietnam and UFSC in Brazil. These workshops were a key step in fostering meaningful engagement with international partners and local stakeholders. Designed not only to introduce and apply project tools such as the MULTISOURCE Planning Platform and the Nat4Wat tool, but they also served as important arenas for mutual learning, contextual adaptation, and interdisciplinary dialogue.

3.1. Purpose of Multisource International Workshops

The primary intention behind these workshops was to strengthen international knowledge exchange around NbS for urban water management. By grounding the sessions in local realities and involving experts, decision-makers, and practitioners from diverse backgrounds, the workshops became dynamic platforms to co-explore challenges, identify context-specific opportunities, and apply planning and stakeholder engagement frameworks in real-world scenarios.

The insights gathered from these events now serve as foundational input for the recommendations presented in this report. The active participation, discussions, and outcomes from Vietnam and Brazil guided by the collaboration with HCMUT and UFSC have provided rich, comparative perspectives that are not only relevant for local contexts, but also offer transferable lessons for international partners, including stakeholders in the USA.

3.2. Workshop in Vietnam

The MULTISOURCE Workshop aimed to bring together a diverse group of experts, policymakers, researchers, and stakeholders to explore innovative solutions for urban water management. With a specific focus on Nature-based Solutions (NbS) and sustainable urban water strategies, the workshop provided an opportunity to discuss how these approaches can enhance water resilience in Vietnam and other regions globally.

The workshop was structured over two days, with participation tailored to the availability and profile of key actors. On Day 1, the event welcomed approximately 24 participants, including 5 representatives from the local government of Ho Chi Minh City, along with stakeholders from private companies, and members of the scientific and research community. This first day of workshop featured a high-level focus, with the presence of senior stakeholders, including representatives from the Ho Chi Minh City administration and various institutional bodies, creating a platform for strategic dialogue and policy-level engagement.

On Day 2, the workshop continued with around 16 participants, including a follow-up by the Ho Chi Minh City Construction Department, ensuring continuity and practical relevance. The second session emphasized technical exchange and stakeholder interaction, with dynamic engagement between the scientific community and private sector representatives, reinforcing the collaborative nature of the event.

3.2.1. Key Objectives and Outcomes

Sharing Project Results with Local Stakeholders: The workshop aimed to showcase the advancements made in water treatment technologies and sustainable urban solutions. By presenting the results of the MULTISOURCE Project, such as the digital tools, the event aimed to inform local stakeholders about the ongoing developments and their potential applications in the context of urban water management in Vietnam.

Highlighting Best Practices: The event emphasized successful case studies from both European and Vietnamese contexts. The focus was on the implementation of NbS for water treatment, demonstrating how these strategies have been applied effectively in different regions. This served as a guide for local stakeholders to learn from best practices and adapt these solutions to local needs.

Facilitating Technical Discussions: The workshop facilitated technical discussions on innovative water management solutions, encouraging local stakeholders to engage with experts and share their perspectives. These conversations provided valuable insights into the challenges and opportunities related to implementing NbS and other sustainable water management practices in urban settings.

Identifying Future Collaborations and Partnerships: One of the key outcomes of the workshop was to identify potential collaborations and partnerships for future projects focused on urban water resilience. Through discussions and networking opportunities, the workshop aimed to build connections among stakeholders that could lead to collaborative efforts in scaling NbS and other sustainable solutions for water management.

3.2.2. Agenda of the Workshop in Vietnam

Agenda Day 1

08:30 - 09:00 | Registration and Welcome Coffee

09:00 - 09:30 | Introduction to the Event

- **Opening Remarks (10')**
  - Assoc. Prof. Dr. Pham Tran Vu, HCMUT's Vice President
  - Jaime Nivala, Senior Scientist & MULTISOURCE Coordinator, INRAE
- **Slido for Q&A**
- **Introduction to the MULTISOURCE Project (10')**
  - Jaime Nivala, Senior Scientist & MULTISOURCE Coordinator, INRAE
- **Introduction of the Host Organization (10')**
  - Dr. Frédéric Cazenave, CARE's Deputy Scientific Director

09:30 - 10:30 | Panel Discussion: Water Treatment with Enhanced Natural Treatment Solutions (ENTS) (45')

- **Topics Covered:**
  - Technical overview and efficiency of ENTS technology
  - Environmental and sustainability benefits
  - Policy recommendations and implementation strategies
- **Speakers:**
  - Mr. Nguyen Ngoc Minh Phu (Dept. of Construction, HCMC)
  - Prof. Phuoc-Dan Nguyen (CARE's Scientific Director)
  - Fabio Masi (IRIDRA) - NbS for urban diffuse pollution
  - Esther Mendoza (ICRA) - Green walls for greywater recycling
- **Q&A with Audience (15')**

10:30 - 11:00 | Coffee Break

11:00 - 12:30 | The Role of Cities in Achieving Water Resilience

- **MULTISOURCE Case Studies (30')**
  - Pedro Carvalho (Aarhus University - AU)
- **Vietnam Case Studies (30')**
  - Xuan-Thanh Bui (VNU-HCM)
- **Lessons from MULTISOURCE Stakeholder Engagement (15')**
  - Elena Petsani (ICLEI)

- **Q&A with Audience (15')**

12:30 - 14:00 | Lunch Break

14:00 - 15:00 | Marketplace – Networking Time

15:00 - 16:30 | Project Presentations: EU & Vietnam

- **Session Introduction (5')**
- **Project Presentations (40')**
    - Urban forest garden solutions - My-Hanh Diep Thi (10')
    - Green Roofs & Pollution Load Reduction - Quoc-Thinh Thuong (10')
    - Business Development & Process Design - Nguyen Song Nguyen (10')
    - NbS for Circular Economy - Fabio Masi (10')
- **Q&A with Audience (15')**

16:30 - 17:00 | Reflections of the Day

- Laura Pirazan Palomar (ICLEI)
- Maria Chiara (UFZ)

Agenda Day 2

08:30 - 09:00 | Registration

09:00 - 09:15 | Introduction of Objectives & Agenda

09:15 - 10:30 | Workshop 1: Stakeholder Mapping & Engagement (ICLEI)

- Presentation (15')
- Group Work (45')
- Results Sharing (15')

10:30 - 11:00 | Coffee Break

11:00 - 11:40 | Workshop 2: Planning Platform Tools for Urban Water Management (UFZ)

- Speakers: Maria Chiara Lippera, Ganbaatar Khurelbaatar
- Presentation (15')
- Group Work (20')
- Results Sharing (5')
- Break (5')

11:45 - 12:30 | Workshop 3: Nat4Wat – Online Tool for NbS Water Management (ICRA)

- Presentation (15')
- Group Work (15')
- Results Sharing (15')

12:30 - 14:00 | Lunch Break

14:00 - 15:30 | Workshop 4: Transferring MULTISOURCE ENTS to Vietnam (AU & Iridra)

- Presentation (15') - Pedro Carvalho
- Group Work (45')
    - Discussion & Mentimeter Poll
    - Role-playing scenarios (local technician, politician, NGO, etc.)
- **Results Sharing (30')**

15:30 - 16:30 | Reflections & Closing

- **Speakers:**
    - Tuan-Duc Ho (CARE's Director)
    - Jaime Nivala (INRAE)
    - Fabio Masi (Iridra)

Agenda Day 3 -Field trip

Visit "Rừng Sác tourism- Cần Giờ District"

"Rừng Sác" Ecotourism Area, located in Cần Giờ District, Ho Chi Minh City (HCMC), is one of Vietnam's largest mangrove forests and has been recognized by UNESCO as a World Biosphere Reserve. This destination is not only a popular tourist attraction but also a symbol of the balance between sustainable development and environmental preservation. Visitors can not only admire the pristine beauty of nature but also gain deeper insights into the vital role of mangrove ecosystems in water purification, environmental protection, and sustainable development.

Boat tours through the mangrove forests offer a firsthand view of the region's rich biodiversity and the ways in which the mangroves protect water resources and land.

Diverse Mangrove Ecosystem: "Rừng Sác" boasts a rich ecosystem with typical mangrove species such as mangroves, nipa palms, and sea hibiscus. It serves as a thriving habitat for a variety of wildlife, including birds, fish, crustaceans, and reptiles, creating a vibrant and balanced ecological system.

Natural Water Treatment Capabilities: Water Purification and Pollutant Absorption: The mangrove forests act as a massive "green lung" and a natural water treatment system. The roots of mangrove trees can absorb heavy metals and filter pollutants, helping to purify water flowing through the area.

Balancing Saltwater and Freshwater: The mangroves play a crucial role in preventing saltwater intrusion into inland areas, protecting freshwater sources, and maintaining ecological balance.

Environmental Protection Functions: Erosion Control and Disaster Mitigation: The dense root systems of mangrove trees stabilize soil, prevent coastal erosion, and mitigate the impact of waves and storms.

3.2.3. Opening ceremony – welcome

Speaker and moderator

Moderator: Elena Petsani

Speakers:

Assoc. Prof. Dr. Pham Tran Vu, Vice President of HCMUT

Jaime Nivala, Senior Scientist & MULTISOURCE Coordinator, INRAE

Dr. Frédéric Cazenave, Scientific Director of CARE

Session Description

The opening session of the workshop in Ho Chi Minh City began with welcoming remarks from the host institution and the project coordinator, setting the tone for the upcoming discussions on NbS for urban water management. The session aimed to establish a common understanding of the workshop's purpose, provide an overview of the MULTISOURCE project, and introduce the host organization's ongoing work relevant to the project's objectives.

Objectives

- Welcome and Introduction: Officially welcome participants to the workshop, acknowledging the collaborative effort between local and international partners.
- Overview of the MULTISOURCE Project: Present the project's objectives, scope, and expected outcomes, emphasizing its relevance to urban water management through NbS.

- Introduction to Host Organization's Work: Highlight the work being done by CARE, HCMUT's research centre, including their ongoing research and contributions to NbS development and implementation.

Key take aways

Collaboration and Partnership: The session highlighted the importance of cooperation between academic institutions, local authorities, and international partners to advance the development and implementation of NbS.

Project Introduction: The MULTISOURCE project's scope and objectives were clearly outlined, emphasizing the project's focus on enhancing urban water management through innovative NbS solutions.

Host Organization's Role: CARE's research and practical applications were showcased, demonstrating their commitment to promoting sustainable urban water management practices in Vietnam and beyond.

Setting the Stage for Discussion: The opening remarks and presentations established a solid foundation for the workshop's upcoming sessions and field visits, aligning participants with the overall goals of the event.

3.2.4. Session: Panel discussion on the water treatment with ENTS

Speaker and moderator

Moderator: Elena Petsani

Speaker:

Mr. Nguyen Ngoc Minh Phu - Department of Construction, Ho Chi Minh City

Prof. Phuoc-Dan Nguyen - CARE's Scientific Director

Fabio Masi – IRIDRA

Esther Mendoza - ICRA

Session Description

This session focused on various approaches to urban water management through NbS and Water-Sensitive Urban Design (WSUD). Mr. Nguyen Ngoc Minh Phu from the Department of Construction of HCMC presented strategies to enhance urban green spaces by expanding public parks and integrating WSUD principles to mitigate flooding, improve water quality, and enhance public spaces through initiatives like the ADB project. Prof. Phuoc-Dan Nguyen, CARE's Scientific Director, discussed the role of natural ecosystems such as mangroves, rivers, and water channels in urban regeneration, highlighting examples like Tan Binh Riverside and Sen Pond. He also addressed the potential of bamboo crops, green walls, and green roofs as NbS for sustainable urban water management. Fabio Masi from IRIDRA introduced intensified aerated wetland systems using Forced Bed Aeration™ technology for treating combined sewer overflow (CSO-CW), enhancing urban water quality. Lastly, Esther Mendoza from ICRA presented the multifunctionality of green walls for greywater recycling, emphasizing their benefits in water treatment and urban aesthetics, while also addressing implementation challenges related to construction, financial incentives, and public perception.

Objectives

- To explore various NbS for urban water management.
- To present innovative technologies and frameworks, such as WSUD and Multi-Edge Treatment Approach, for enhancing water treatment and urban greening.
- To discuss the integration of green walls and constructed wetlands in urban settings to improve water quality and resilience.

Key take aways

Strategic Urban Greening & Water-Sensitive Urban Design (WSUD):

- Mr. Ngyen Ngoc Minh Phu from the Department of Construction, HCMC, presented ongoing strategies for enhancing urban green spaces, focusing on expanding public park areas to address community needs and diversify activities, particularly in densely populated areas.
- The integration of policy frameworks to apply WSUD principles in mitigating flooding, enhancing public spaces, and improving water quality through NbS.
- The Asian Development Bank (ADB) project aims to incorporate NbS in urban planning for better flood management and enhanced public spaces.

NbS & Multi-Edge Treatment Approach in Urban Regeneration

- Prof. Phuoc-Dan Nguyen (CARE's Scientific Director) emphasized the significance of natural spaces and ecosystems such as mangroves, water channels, and rivers in urban greening.
- He introduced the Multi-Edge Treatment Approach under the WSUD framework, showcasing projects like Tan Binh Riverside in HCMC and Sen Pond in Hue City.
- Additional NbS interventions include green walls, green roofs, and the use of local bamboo crops as potential macrophytes for sustainable urban water management.

Innovative NbS for Water Treatment & Pollution Management:

- Fabio Masi (IRIDRA) presented intensified aerated wetland systems utilizing Forced Bed Aeration™ technology for treating Combined Sewer Overflow (CSO-CW).
- This technology offers an efficient solution for urban diffuse pollution, contributing to better water quality in urban environments.

Green Walls for Greywater Recycling:

- Esther Mendoza (ICRA) highlighted the potential of green walls for greywater recycling, emphasizing their multifunctional nature in water treatment and urban landscaping.
- She showcased case studies from Spain, Tunisia, and Italy, highlighting the barriers to implementation, including construction challenges, financial incentives, public perception, and complex legal procedures.
- She stressed the importance of optimizing water management in urban settings by integrating green walls in houses, residential communities, and schools.

3.2.5. Session: The role of the cities to achieve water resilience

Speaker and moderator

Moderator: Tâm Thanh Trương Thị

Speaker:

Pedro Carvalho - AU

Xuan-Thanh Bui - VNU-HCM Key Laboratory of Advanced Waste Treatment Technology

Elena Petsani – ICLEI Europe

Session Description

The second session of the workshop focused on the critical role of cities in enhancing water resilience through NbS. Pedro Carvalho (AU) presented the findings of the MULTISOURCE case studies, highlighting different systems developed for water treatment, retention, and reuse. Xuan-Thanh Bui (VNU-HCM) shared experiences of implementing constructed wetlands and green roofs in Ho Chi Minh City to improve urban water quality. Elena Petsani (ICLEI) discussed lessons learned from stakeholder engagement within the MULTISOURCE project, emphasizing the importance of collaborative frameworks for successful NbS adoption.

Objectives

- To present the progress and findings from the seven MULTISOURCE project pilots, emphasizing NbS application for water treatment, water retention, and reuse.
- To showcase Vietnamese case studies on constructed wetlands and green roofs, providing insights into their effectiveness and challenges.
- To discuss lessons learned from stakeholder engagement processes within the MULTISOURCE project, emphasizing the importance of multi-sectoral collaboration.
- To foster dialogue on how cities can enhance water resilience through integrated NbS approaches.

Key take aways

MULTISOURCE Case Studies (Pedro Carvalho, AU)

- Presented an overview of the seven pilot projects developed under the MULTISOURCE project.
- Described various NbS systems applied for water treatment, water retention, and reuse across different sites.
- Discussed general characteristics, types of water treated, performance results, and reuse purposes observed over three years.
- Addressed challenges faced in collaboration with stakeholders and the importance of their involvement for successful implementation.

Case Studies from Vietnam (Xuan-Thanh Bui, VNU-HCM)

- Described experiences of constructed wetlands implemented in Ho Chi Minh City's urban canals.
- Compared aerated and non-aerated systems, focusing on plant growth rates and nitrogen removal efficiency.
- Highlighted positive community engagement, with citizens actively monitoring and reporting changes in the systems.
- Presented green roof systems designed for pollutant removal from wastewater, experimenting with two types of plants and evaluating different removal systems.

Stakeholder Engagement in NbS (Elena Petsani, ICLEI)

- Emphasized the need for multi-sectoral collaboration, integrating climate adaptation, water management, and public health.
- Introduced a framework for effective stakeholder engagement in NbS for water treatment, focusing on identifying relevant actors, establishing partnerships, and developing actionable work plans.
- Discussed strategies and activities used to enhance stakeholder involvement and ensure the sustainability of implemented systems.
- Highlighted the importance of local governments and institutions in promoting urban water resilience.

3.2.6. Session: Project presentations from EU and Vietnam

Speaker and moderator

Moderator: Elena Petsani

Speaker:

My-Hanh Diep Thi - Phu An Bamboo Village

Quoc-Thinh Thuong - Urban Environment and Infrastructure Office of District 11

Nguyen Song Nguyen – HaskoningDHV Vietnam Ltd

Fabio Masi - IRIDRA

Session Description

The third session focused on innovative approaches to creating green urban spaces, protecting riverbanks, reducing flooding, and promoting circular economy principles through NbS. Presentations covered the benefits of urban forest gardens, green roofs, sustainable sludge treatment technologies, and projects integrating NbS for water treatment and reuse

Objectives

- Present various NbS approaches for urban resilience, including urban forest gardens, green roofs, and wastewater treatment.
- Highlight the importance of coordinated approaches involving policy, science, technology, and community engagement.
- Showcase real-world applications of NbS for circular economy and climate adaptation.
- Discuss challenges and opportunities in implementing NbS in urban areas.

Key take aways

Urban Forest Gardens & Community Engagement (My-Hanh Diep Thi, Phu An Bamboo Village)

- Discussed the importance of urban forests, focusing on the Phu An Bamboo Village as a model for planting bamboo along riversides.
- Highlighted ecosystem services provided by urban forests, such as erosion control and flood protection.
- Emphasized the need for coordinated approaches involving government policies, scientific and technical contributions, and implementation by authorities.
- Promoted community engagement through education and awareness programs, especially targeting children.

Green Roofs & Pollution Load Mitigation (Quoc-Thinh Thuong, Urban Environment & Infrastructure Office of District 11)

- Presented the use of F28 modelling to evaluate the effectiveness of green roofs in reducing pollutant loads and mitigating flooding.
- Discussed various scenarios under rainy and non-rainy conditions, showing positive impacts on water management.
- Emphasized the potential of green roofs as a viable NbS for enhancing urban resilience.

Biotechnology & Sustainable Sludge Treatment (Nguyen Song Nguyen, HaskoningDHV Vietnam Ltd.)

- Introduced HaskoningDHV's expertise in biotechnology and sustainable sludge treatment for renewable energy production.
- Discussed completed projects in Vietnam, focusing on efficient sludge management technologies.
- Presented the **Nereda® Technology**, which uses aerobic granular sludge as an alternative to conventional activated sludge.
- Highlighted benefits such as reduced area requirements, infrastructure, maintenance, and energy consumption.
- Noted successful applications of this technology in countries like the Netherlands and Belgium.

NbS for Circular Economy (Fabio Masi, IRIDRA)

- Presented examples from the **Hydrousa Project** in Lesvos, Greece, focusing on the Food-Energy-Nexus using NbS.
- Shared insights from the **Tavitr Project** in Aligarh, India, where a French Reed Bed (FRB) system was applied for raw wastewater treatment and reuse.
- Highlighted how these NbS initiatives contribute to circular economy principles by promoting water reuse, energy recovery, and ecosystem services.

3.2.7. Workshop 1: Stakeholder Mapping and Engagement

Moderator

Elena Petsani – ICLEI Europe

Session Description

This workshop introduced participants to the MULTISOURCE stakeholder engagement framework through a hands-on activity where attendees formed four groups to apply the framework to different case studies. The cases included improving septic tank systems, using floating wetlands for canal water treatment in Ho Chi Minh City, private company wastewater treatment, and community-driven canal revitalization. Each group applied the framework templates used in MULTISOURCE pilots to identify stakeholders, activities, and appropriate engagement methods, highlighting the importance of context-specific approaches.

Figure 3 Workshop 1: Stakeholder engagement

Objectives

- Explain the main idea of the co-design framework for the monitoring of ENTS Pilots in the MULTISOURCE Project
- Outline the Stakeholder Engagement Process and the respective stages
- Analyse the outputs of Stakeholder Engagement Process for one ENTS Pilots in MULTISOURCE as a case study
- Apply the process for the stakeholder engagement in a test case study

Key take aways

Context-Specific Stakeholder Mapping: Participants identified the importance of accurately mapping stakeholders considering social, environmental, and economic contexts. Effective engagement requires understanding the diversity of actors involved and tailoring approaches to suit local conditions.

Collaborative Framework Application: Applying the stakeholder framework to diverse case studies demonstrated the flexibility of the approach and the need for tailored strategies for different scales of interventions, from private companies to community-driven projects.

Integrating Gender & Social Equality: The activity raised awareness of the need for inclusivity in stakeholder engagement. Many participants recognized that gender mainstreaming and social equality considerations had been overlooked in their contexts and require deliberate incorporation into future planning.

Enhanced Awareness & Skill Building: Participants gained practical insights into the application of the framework, emphasizing the need for structured methodologies to improve stakeholder involvement and project outcomes.

3.2.8. Workshop 2: Planning platform tools to support NbS for urban water management

Speaker and moderators

Maria Chiara Lippera - UFZ

Ganbaatar Khurelbaatar - UFZ

Session Description

This workshop introduced the use of planning tools to assess and support NbS for stormwater and wastewater management in Ho Chi Minh City. Dr. Ganbaatar Khurelbaatar presented the MULTISOURCE Planning Platform and its block-based scenario approach, while Dr. Maria Chiara Lippera shared insights from case studies in Écully and Leipzig, focusing on integrated grey and green infrastructure for urban water resilience.

During the hands-on session, participants analyzed local challenges—such as tidal influence, stormwater surges, limited space, and sewer system types—and proposed suitable NbS technologies, including green roofs, rain gardens, infiltration swales, constructed wetlands, and managed aquifer recharge. The session highlighted how structured planning tools can guide context-sensitive, practical NbS implementation in dense urban environments.

Figure 4 Workshop 2: Planning platform tools to support NbS for urban water management

Objectives

- Introduce the MULTISOURCE Planning Platform's block-based planning tools for urban stormwater management.
- Demonstrate the application of planning tools through case studies from Ecully Catchment and Leipzig.
- Apply block-mapping methods to identify suitable areas and technologies for stormwater management in Ho Chi Minh City.

- Encourage discussion on combining grey infrastructure with NbS to achieve optimal results.

Key take aways

Context-Sensitive NbS Planning: Participants explored complex urban water challenges in Ho Chi Minh City, including tidal influence, land subsidence, limited space, and extreme rainfall. The exercise emphasized the need for site-specific approaches based on available space, soil characteristics, and existing infrastructure.

Scalable and Structured Tools: The block-based planning methodology provided a useful framework for identifying and prioritizing areas for NbS implementation, distinguishing between areas suitable for decentralized and centralized interventions.

Technology Recommendations by Urban Context:

- In dense urban areas with narrow plots and courtyards, green roofs were identified as viable NbS.
- Where more space is available (e.g., parks, peri-urban zones), solutions such as swales, rain gardens, constructed wetlands, and infiltration buffers were considered appropriate.
- In areas with septic tanks discharging into canals, constructed wetlands were proposed to improve effluent quality before discharge.
- Managed aquifer recharge was suggested as a critical strategy for stormwater infiltration in specific zones.

Soil Conditions and Sewer Infrastructure Matter:

- Participants noted that high-infiltration zones are promising for NbS implementation, while canal areas with compacted soils may require alternative technologies.
- In city centers with combined sewer systems, decentralized NbS can help reduce pressure during peak flows.
- New urban developments with separate sewer systems were flagged as suitable for centralized stormwater NbS, while rural or peri-urban areas may benefit from hybrid approaches combining network expansion and localized systems.

Learning from Case Studies: Insights from the Leipzig and Écully case studies demonstrated how combining grey and green infrastructure—guided by scenario planning—can enhance resilience and inform investment decisions.

Resilience through Integration: The session concluded that the integration of technical, social, and spatial knowledge—supported by dynamic planning tools—can significantly improve the design and acceptance of nature-based and hybrid solutions for urban water management in Vietnam.

3.2.9. Workshop 3: Nat4Wat: an online tool to select, compare and explore nature-based solutions for water management.

Speaker and moderator

Esther Mendoza -ICRA

Session Description

This workshop introduced participants to the Nat4Wat tool to propose decentralized NbS for improving municipal water management, focusing on rainwater and wastewater/greywater treatment. Participants, acting as companies, were tasked with designing and pitching NbS solutions tailored to specific scenarios. The exercise aimed to demonstrate the tool's practical application and promote creativity in finding effective, versatile, and low-cost solutions that offer multiple co-benefits.

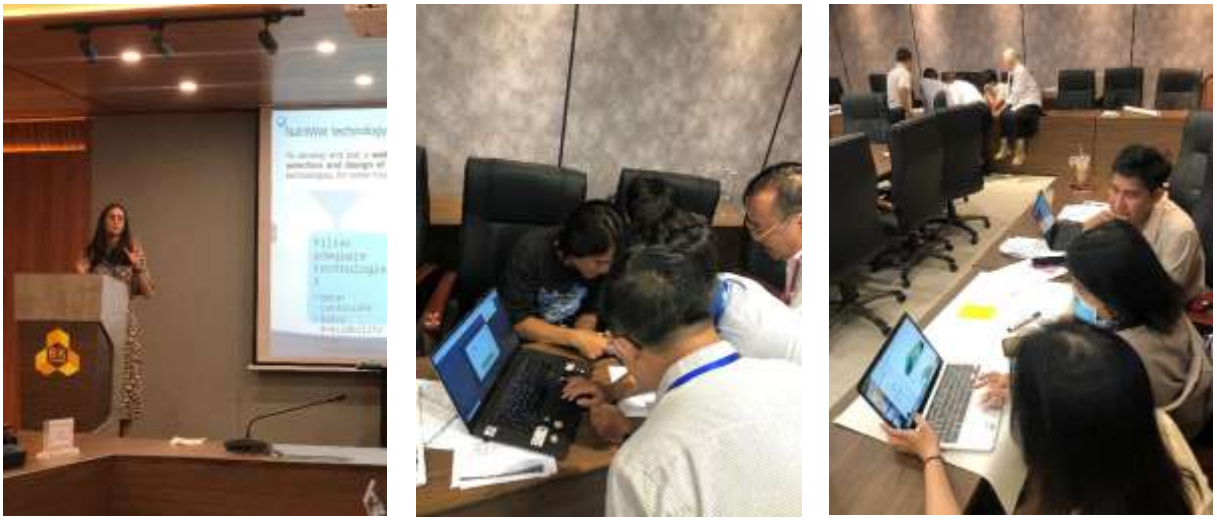

Figure 5 Workshop 3: Nat4Wat: an online tool to select, compare and explore nature-based solutions for water management

Objectives

- Introduce the Nat4Wat tool as a planning resource for decentralized NbS in urban water management.
- Enable participants to design tailored solutions for water treatment and reuse based on different scenarios.
- Highlight the importance of co-benefits in promoting NbS for city planning.
- Encourage collaborative problem-solving and practical application of NbS concepts.

Key take aways

Scenario-Based Planning: The exercise effectively demonstrated the practical application of the Nat4Wat tool for designing context-specific, decentralized NbS.

Multifunctionality of NbS: Proposals highlighted the versatility of NbS in providing solutions for rainwater collection, greywater treatment, and promoting water reuse in both dry and wet climates.

Co-Benefits as Key Selling Points: Emphasizing co-benefits such as enhanced biodiversity, community engagement, and urban cooling made proposals more attractive and feasible for city councils.

Adaptation and Innovation: Participants recognized the importance of tailoring solutions to local conditions and presenting them effectively to stakeholders for funding approval.

Tool Improvement Through Feedback: During the workshop, several limitations of the Nat4Wat tool were identified, particularly related to data availability, user experience, and contextual fit. These insights proved valuable for guiding ongoing improvements. As a dynamic and evolving tool, Nat4Wat continues to benefit from user feedback, which contributes to enhancing its functionality and relevance across diverse urban contexts.

3.2.10. Workshop 4: Transferring MULTISOURCE ENTS into Vietnam

Speaker and moderator

Pedro Carvalho - Aarhus University

Session Description

This workshop encouraged participants to openly discuss local challenges related to water management and explore relevant ENTS solutions from the MULTISOURCE project. Through group discussions and a Mentimeter poll, participants identified the most pressing water-related issues and the most promising ENTS technologies for their local contexts. Role-playing exercises helped participants approach the challenges from various perspectives, such as local authorities, researchers, NGOs, and investors.

Objectives

- Identify the most relevant water management challenges for local contexts (e.g., raw wastewater, stormwater, greywater, CSO).
- Discuss suitable ENTS solutions applicable to local conditions.
- Highlight essential topics for future MULTISOURCE initiatives.
- Identify local barriers to implementation and suggest ways to overcome them.

Key take aways

Challenges: Stormwater and rainwater were identified as the most relevant issues for the local context.

Preferred ENTS Solutions: The ICRA green wall and the UFZ green roof were highlighted as the most promising technologies for local application.

Future Priorities: The main topics suggested for future initiatives included solid waste management, use of local materials, river water (canal) treatment, and installation costs.

Barriers: The most critical local barriers identified were policy gaps, limited human resources, and a lack of guidelines. Addressing these barriers will be essential for effective implementation of NbS.

3.2.11. Market Place

As part of the workshop, a dedicated marketplace session was organized to foster interaction among participants and promote the exchange of knowledge and experiences. This session brought together a diverse group of stakeholders, including representatives from Ho Chi Minh City government agencies, private sector actors, and members of the academic community.

Participants showcased their work and ongoing initiatives related to water resilience and NbS for water treatment. These were presented through visual materials such as posters and project displays, creating an engaging and informative environment.

The format of the session was designed to encourage networking and dialogue, enabling participants to learn from each other and explore potential areas for collaboration. This interactive space highlighted both local and national efforts in advancing sustainable urban water management in Vietnam.

Figure 6 Market place indoors

Additionally, the host institution, Ho Chi Minh City University of Technology, provided participants with an overview of their water treatment pilot systems. These pilots were initially developed and tested within the university's facilities, and, following successful results, were subsequently implemented in the city's urban canal network. This visit offered valuable insights into the research-to-practice pathway and demonstrated how locally developed NbS technologies can be effectively applied in real urban settings.


Figure 7 NbS pilots from the Ho Chi Minh City University of Technology

3.2.12. Field Trip

On the third day of the workshop in Ho Chi Minh City, participants embarked on a field trip to the "Rừng Sác" Ecotourism Area, located in Cần Giờ District. This region is renowned for being one of Vietnam's largest mangrove forests and has been recognized by UNESCO as a World Biosphere Reserve. The area serves as a prime example of the delicate balance between sustainable development and environmental preservation, attracting both tourists and researchers interested in conservation efforts.

The field trip included two main stops. The first stop was a visit to one of the pilot projects of the Floating Treatment System developed by the Key Laboratory of Advanced Waste Treatment Technology from. This pilot, previously presented during the workshop's first day, is located in one of the city's canals, between District 14 and District 1. The Floating Treatment System aims to enhance water quality through the use of floating vegetation beds, which promote natural treatment processes (see Figure 8). The system demonstrates an innovative approach to addressing urban water pollution while simultaneously enhancing the aesthetic and ecological value of the waterways.

The second stop took place at the pedestrian streets surrounding Crescent Lake, situated in one of Ho Chi Minh City's urban districts (see Figure 9). This area is part of a broader initiative to promote the city's nighttime economic growth program, leveraging natural spaces to enhance tourism while also benefiting and protecting the environment. The pedestrian streets and green spaces contribute to urban biodiversity, creating ecological corridors that support local wildlife and provide recreational areas for residents and visitors alike.

Figure 8 Site visit: Floating Treatment System - HCMC canals

Figure 9 Pedestrian Street in Crescent Lake, District 7, HCMC

Finally, participants had the opportunity to take a boat tour within the Rừng Sác Ecotourism Area, allowing them to experience the mangrove ecosystem firsthand. The tour provided insights into the extensive restoration process that the area has undergone after being severely impacted by the use of herbicides, particularly Agent Orange, during the Vietnam War. This harmful chemical devastated much of the mangrove forest, but concerted efforts in restoration and conservation have successfully revived the ecosystem.

Today, the area stands as a World Biosphere Reserve, showcasing the effectiveness of ecosystem restoration in promoting biodiversity and providing critical ecosystem services. These services include disaster risk reduction by acting as a natural barrier against flooding and storm surges, preventing saltwater intrusion into freshwater sources, and maintaining ecological balance. Additionally, the restored mangrove forest supports the livelihoods of local communities through tourism and sustainable resource use, further highlighting the importance of NbS for environmental resilience and socio-economic development.

Figure 10 Site visit: Rừng Sác tourism- Cần Giờ District

3.3. Workshop in Brazil

The "Multisource Project – ModULar tools for integrating enhanced natural treatment Solutions in Urban water CyclEs" workshop, hosted at the Centre for Biological Sciences (CCB) at UFSC, successfully brought together experts, policymakers, researchers, and practitioners to explore NbS for wastewater and stormwater management. This event served as a platform for discussing cutting-edge research, innovative case studies, and practical tools to enhance sustainable urban water cycles. With contributions from both international and national experts, the workshop fostered interdisciplinary collaboration and knowledge exchange on NbS, addressing critical environmental challenges in the context of climate change.

Over the course of three days, participants engaged in insightful presentations, interactive discussions, and hands-on workshops, culminating in a field trip to observe NbS applications in real-world settings. Importantly, the workshop maintained a consistently diverse stakeholder presence, with participants including members of the scientific community, 8 representatives of civil society, 17 individuals from policymaking institutions, and 18 members of the private sector. This diversity ensured that dialogue and learning were inclusive and reflective of multiple perspectives throughout the entire event. The workshop highlighted key projects, methodologies, and tools designed to optimize wastewater treatment, improve stormwater management, and strengthen urban resilience through sustainable and multifunctional approaches.

3.3.1. Key Objectives and Outcomes

Understanding the Role of NbS

- Explored the multifunctionality and co-benefits of NbS for wastewater and stormwater management.
- Discussed the role of NbS in mitigating climate change impacts on urban water systems.

Showcasing Research and Case Studies

- Presented international and national NbS projects and best practices.
- Highlighted the work of the host organization, UFSC, and its partners in advancing NbS research.

Knowledge Exchange and Capacity Building

- Facilitated discussions through panel sessions and Q&A interactions.
- Provided hands-on workshops on stakeholder engagement, decision-making tools, and business case development for NbS.

Technology and Decision-Making Tools

- Introduced and demonstrated MULTISOURCE tools (OCTOPUS, ALLOWS, Nat4Wat) for NbS dissemination and urban water management.
- Trained participants on selecting appropriate NbS technologies based on urban water cycle needs.

Stakeholder Engagement and Policy Integration

- Mapped and engaged key stakeholders in the development and implementation of NbS projects.
- Discussed policy recommendations and strategies for integrating NbS into urban planning.

Field Observations and Practical Applications

- Conducted site visits to real-world NbS implementations in Florianopolis and Palhoça.
- Analysed operational wastewater treatment and stormwater management systems.

The workshop successfully achieved its objectives, providing valuable insights and practical tools to enhance NbS implementation. Participants left with a deeper understanding of NbS applications,

This project has received funding from the European Union's Horizon H2020 innovation action programme under grant agreement 101003527.

strengthened professional networks, and actionable strategies to integrate NbS into urban water management. Moving forward, the discussions and collaborations initiated in this event are expected to contribute to further advancements in sustainable water solution

3.3.2. Agenda the Workshop in Brazil

Agenda Day 1

08:30- 09:00 Registration

09:00- 09:30 Opening (Introduction to the Event)

- Opening Remarks from the host partner and the project coordinator
  - Rodrigo de Almeida Mohedano – ENS/UFSC
  - Jaime Nivala – INRAE/France (English)
  - Alexandre Bach Trevisan – CASAN-SC
  - Willian Goetten – ABES-SC
  - Marcos José de Abreu (Marquito) – State Deputy-SC

09:30- 10:00 Multisource Project - ModULar tools for integrating enhanced natural treatment Solutions in Urban water CyclEs'

- Introduction of MULTISOURCE work, 30´
  - Jaime Nivala, INRAE

10:00- 10:45 INCT-SbN – National Institute of Science and Technology - Nature-based Solutions and the Role of the UFSC Hub – GESAD and – Research Group on Resource Recovery in Sanitation Systems - RReSSa: Research Groups

- Introduction of the work of the host organization, 35'
  - David da Motta Marques – INCT-NbS/Brazil
  - Pablo Heleno Sezerino – GESAD/UFSC
  - Maria Elisa Magri – RReSSa/UFSC
- Q&A, 5´

10:45 – 11:15 Interactive coffee break – networking, 30´

11:15 – 12:30 Panel discussion: Multifunctionally and co-benefits of NbS for wastewater and stormwater management in the context of climate change

Moderator: Laura Pirazán-Palomar – ICLEI

- Share the recommendations from the Policy Briefs, 40'
  - Fernando Magalhães –INCT-SbN/Brasil - Núcleo IPH/UFRGS
  - Jan Friesen – UFZ
  - Anacleto Rizzo – IRIDRA
- Q&A session with the Audience, 15'

12:30 – 14:30 Lunch break

14:30 – 15:30 Closing the urban cycle of water – risks, opportunities and the NbS role.

- Presentation of the Multisource case studies, 20'
  - Pedro Carvalho, AU
- Presentation of other Case studies from Brazil, 20'
  - Maria Elisa Magri, UFSC
- Q&A session with the Audience 20'

15:30 – 16:00 Networking coffee.

16:00 – 17:15 Presentation of NbS projects for wastewater and stormwater management in Europe and Brazil

- Presentation of 4 projects, 40 ‘
  - Anacleto Rizzo -15´
  - Massimiliano Riva -15´
  - Maria Wirth 15´
  - Alexandre Bach Trevisan – CASAN-SC 15´
- Q&A session with the Audience, 15’

16:30 – 17:00 Reflections of the day.

Elena Petsani, ICLEI
Pablo Heleno Sezerino, UFSC

Agenda Day 2

08:30 – 09:00 Registration

09:00 – 09:05 Introduction of the Objectives and the agenda

09:05 – 10:30 Workshop 1: Stakeholder Mapping and Engagement, ICLEI and Maria Wirth featuring Alexandre Bach Trevisan – CASAN-SC

- Speakers: Laura Pirazan-Palomar, Maria Wirth featuring
- Presentation 15’
- Group Work 45’
- Sharing results 20’

10:30 – 11:00 Interactive coffee break – networking

11:00 – 12:30 Workshop 2: Multisource tools for NbS dissemination – decision-making for technology selection and urban water management

MULTISOURCE's tools: OCTOPUS, ALLOWS, and Nat4Wat. Jan Friesen – UFZ/Germany (English) & Massimiliano Riva – ICRA/Spain (English)

- Presentation 15’
- Group Work 50’
- Sharing results 20’

12:30 – 14:30 Lunch Break

14:30 – 16:00 Workshop 3, NbS business cases: Design, Technologies and Engagement

- Caio Voltolini -Rotária do Brasil, Florianopolis/SC
- André Baxter Barreto - Wetlands Construídos, Belo Horizonte/MG
- João Victor Cipriano & Rodrigo Franco Emboa Ecosan – Florianpolis/SC
- Wagner Gerber - Ecocell, Pelotas/RS
- Vitor Hugo Terres - Phytorestore

16:00 – 16:30 Reflections of the day and Closing of the Event

Maria Wirth
Jaime Nivala, INRAE
Pablo Heleno Sezerino & Maria Elisa Magri, UFSC

Agenda Day 3 -Field trip

09:00 – Meet at UFSC

09:30 – 16:00 Visit NbS around Florianopolis city

- Site 1 – Multifamily Residential Building in Palhoça city. Wastewater Treatment Plant - WWTP composed by Anaerobic Baffled Reactor (ABR – 50m^3) followed by Partially Saturated Vertical Wetland (PSVW – 3,400 m^2)

- Site 2 – Commercial Building in Florianopolis city. WWTP composed by Septic Tank (ST – 7 m^3) followed by Aerated Vertical Wetland (AVW – 80m^2)

- Site 3 – Septage Sludge Management Unit (SSMU) in Florianopolis city. Pilot Plant composed by Vertical Wetland (2 modules of 60 m^2 each)

16:00 Return to UFSC

3.3.3. Workshop Key Outcomes

The first two days of the Brazilian workshop, as outlined in the agenda, featured a range of activities, including presentations, interactive workshops, and panel discussions. These sessions facilitated valuable interactions and discussions among participants. The key outcomes of the MULTISOURCE workshop held in Brazil included:

- **Emphasis on multi-sector collaboration** among academia, public policy, and professional practice as crucial for advancing Nature-based Solutions (NbS). Institutional support for NbS is growing.
- Demonstration of the **effectiveness of Enhanced NbS (ENTS)** in removing pollutants and their adaptability across climates. The project introduced global knowledge resources, including an open-access guidance document (upcoming 2025) and digital tools like Nat4Wat.
- Focus on the application of **NbS for wastewater treatment in small communities**, highlighting their effectiveness and adaptability. The need for appropriate **governance mechanisms, regulations, and fostering programs** was stressed for scaling these solutions.
- Discussion of the initiative to establish a **national NbS hub in Brazil** for research, training, and collaboration. Key priorities include strengthening networks, training qualified personnel, and conducting applied research for local contexts, especially in Santa Catarina.
- Exploration of the **multifunctionality and co-benefits of NbS**, recognizing their potential to address multiple urban challenges and contribute to climate adaptation and urban resilience.
- Insights from pilot projects and case studies showcased high pollutant removal rates, effectiveness in stormwater management, environmental and socio-economic co-benefits, and often **lower CAPEX/OPEX compared to conventional infrastructure**. A notable discussion point was the priority for **simplification in NbS design in Brazil** to better match local needs, contrasted with high-tech drivers in Europe.
- Participants engaged in practical application of **stakeholder engagement and business model frameworks**, identifying actor roles and context-specific solutions for areas in Florianopolis.
- Digital tools like Nat4Wat were introduced and received positive feedback, though the need for **clearer guidance and more realistic performance information** was identified to improve user experience.
- Presentations from Brazilian SMEs highlighted how NbS are tailored to diverse local needs, the importance of integrating social and cultural context, operational challenges, and the need for **deeper academia-SME collaboration and stronger policy support** for climate adaptation and infrastructure resilience.
- Field visits provided practical insights into implemented constructed wetlands for wastewater and septage sludge treatment, illustrating operational challenges and the potential of low-cost decentralized solutions.

3.3.4. Opening ceremony – welcome

Speaker and moderator

Moderator: **Laura Pirazán Palomar**

Rodrigo de Almeida Mohedano – ENS/UFSC

Jaime Nivala – INRAE/France

Alexandre Bach Trevisan – CASAN-SC

Willian Goetten – ABES-SC

Marcos José de Abreu (Marquito) – Politician-SC

Session Description

The Opening Ceremony – Welcome successfully set the stage for the workshop by bringing together a diverse panel of experts from academia, industry, and public policy. The session introduced the main themes of the event, outlined the structure and goals of the workshop, and encouraged active participation and collaboration among attendees from different sectors.

Objectives

- Welcome participants and set a collaborative and engaging atmosphere.
- Introduce key themes of the event, highlighting its relevance to academia, industry, and public policy.
- Provide an overview of the event structure, sessions, and expected outcomes.
- Encourage networking and interdisciplinary collaboration among attendees.

Key take aways

The session highlighted the importance of multi-sector collaboration in advancing NbS, with speakers emphasizing synergies between academia, public policy, and professional practice.

Rodrigo de Almeida Mohedano (ENS/UFSC) underscored UFSC's commitment to research and partnerships that bridge science and real-world NbS implementation.

Jaime Nivala (INRAE, France) offered an international perspective, stressing the value of European experiences and cooperation in driving innovation in NbS technologies.

Alexandre Bach Trevisan (CASAN-SC) illustrated how regional utilities are incorporating sustainable solutions into water treatment practices, reflecting the growing institutional support for NbS.

Willian Goetten (ABES-SC) emphasized the pivotal role of professional associations in promoting policy development and knowledge exchange within Brazil's water sector.

Marcos José de Abreu (Marquito) highlighted the importance of policy frameworks and legislative action to enable and scale up the adoption of NbS across different levels of government.

3.3.5. Session: Multisource Project - ModULar tools for integrating enhanced natural treatment Solutions in Urban water CyclEs'

Speaker and moderator

Moderator: **Laura Pirazán Palomar**

Speaker: Jaime Nivala – INRAE/France (English)

Objectives

- Introduce the Multisource Project and its role in sustainable urban water management.
- Explain enhanced nature-based solutions and their benefits for urban water cycles.
- Highlight case studies and applications from MULTISOURCE demonstrating the effectiveness of enhanced nature-based treatment systems.
- Discuss challenges and opportunities in integrating these solutions into existing urban infrastructure.
- Encourage collaboration among researchers, policymakers, and industry professionals to advance sustainable water treatment practices.

Key take aways

This session underscored the potential of NbS in transforming urban water management, highlighting practical tools, global collaboration, and open-access resources to drive widespread adoption.

- **Demonstrating the Effectiveness of Enhanced NbS**
  - Enhanced NbS can effectively remove pathogens, micropollutants, and microplastics from various polluted urban water sources.
  - These solutions have been tested in different climate conditions, showcasing their adaptability and efficiency.
- **Risk Assessment and Suitability for Water Reuse**
  - Comprehensive risk assessments are being conducted on treated effluent.
  - Evaluation includes environmental risks (impact on ecosystems) and microbiological risks (public health concerns).
- **Building a Global Knowledge Base on NbS for Water Treatment**

  - Compilation of successful NbS case studies worldwide.
  - Development of an open-access technology selection tool to guide decision-makers.
- **Comprehensive Catalogues for Practitioners and Researchers**
  - A catalogue of nature-based solutions for wastewater treatment and stormwater management.
  - A technology provider database, featuring available solutions and their portfolios.
  - A repository of scientific publications, consolidating research findings.
- **Strengthening International Collaboration**
  - Expansion of partnerships through new projects and dissemination activities.
  - Target collaboration with Vietnam, Brazil, and the United States.
- **Development of Open-Source Assessment Tools**
  - A hydraulic assessment tool to identify stormwater overflow locations and quantities, helping pinpoint optimal NbS installation sites.
  - A decision support tool to assist in preliminary NbS design, providing estimates on area requirements, costs, and life cycle analysis.
- **Upcoming Open-Access Guidance on NbS (2025 Release)**
  - A comprehensive publication covering fundamental principles, process design, implementation, management, and operation of NbS for water treatment.
  - The guide will include 28 chapters, full-colour illustrations, and over 1,600 pages of new insights on seven common treatment wetland types.

The document is structured into four key parts:

  - **Part I: Fundamental Concepts** – Covers hydrology, hydraulics, vegetation, biomass cycling, energy flows, air, water & soil chemistry, solids accumulation, and microbiology.
  - **Part II: Data Analysis** – Focuses on wetlands as biological reactors, treatment performance assessment, statistical data interpretation, and scaling from pilot to full-scale applications.
  - **Part III: Pollutant Removal** – Explores removal processes for carbon, nitrogen, phosphorus, pathogens, micropollutants, metals, and organic chemicals.
  - **Part IV: Design, Implementation, and Management** – Provides guidance on general design principles and specific NbS types, including horizontal and vertical flow wetlands, aerated wetlands, reactive media wetlands, sludge treatment wetlands, and combined sewer overflow wetlands.

3.3.6. Session: INCT-SnN – National Institute of Science and Technology - Nature-based Solutions and the Role of the UFSC Hub – GESAD and RReSSa Research Groups

Speaker and moderator

Moderator: Laura Pirazán Palomar

Speakers

David da Motta Marques – INCT-SbN/Brazil

Pablo Heleno Sezerino – GESAD/UFSC

Maria Elisa Magri – RReSSa/UFSC

Session Description

This session focuses on NbS for wastewater treatment in small communities and decentralized systems. The presentation will explore NbS applications, including constructed wetlands and septic tank wetlands, which offer sustainable, affordable, and adaptable solutions for domestic and peri-urban wastewater treatment. Governance mechanisms, such as regulations and fostering programs, will be discussed to scale these solutions effectively. The session will also introduce the creation of a national NbS hub in Brazil, which will serve as a reference center for research, training, and international collaboration.

Finally, the session will address knowledge transfer strategies to engage government, private sectors, and civil society in adopting NbS for wastewater management.

Objectives

- Explore the application of NbS in small communities for wastewater treatment.
- Discuss governance frameworks necessary to scale NbS solutions for wastewater management.
- Introduce the development of a national NbS hub in Brazil for research, training, and international collaboration.
- Promote knowledge transfer strategies to engage governments, private sectors, and society in adopting NbS technologies.

Key take aways

This session highlighted the importance of NbS in improving sanitation in small communities, the need for appropriate governance structures, and the crucial role that higher education institutions play in fostering innovation and professional development.

- **Nature-Based Solutions for Wastewater Treatment in Small Communities**
    - Nature-Based Solutions are highly effective for treating sanitary effluent in small communities and multifamily residential buildings. Solutions such as constructed wetlands and septic tank wetlands (UGL tanque Séptico Wetland) are adaptable for peri-urban and domestic wastewater treatment.
    - These solutions are especially relevant in addressing the wastewater challenges in smaller, decentralized systems, providing a cost-effective and environmentally sustainable alternative to conventional treatment methods.
- **Governance Instruments for NbS Implementation**
    - Governance mechanisms such as regulations, normative standards, and guidelines are critical for the successful deployment of NbS.
    - The establishment of governance frameworks at local, regional, and national levels is necessary for integrating NbS into broader sanitation and water management policies.
    - Programmatic support and fostering initiatives are essential to scale NbS across different sectors, with a focus on creating supportive policies and regulations to guide implementation.
- **Establishing a National and International NbS Hub**
    - The initiative seeks to establish Brazil as a national reference centre with international reach for NbS.
    - This hub will leverage a network of scientists, researchers, and professionals to develop and scale NbS, focusing on success stories and ongoing projects.
    - The hub will train multipliers, develop new products and processes, and adapt NbS to local realities across various sectors (government, business, and society).
- **Strengthening Networks and International Collaboration**
    - The session emphasized the importance of strengthening and expanding networks among research institutions, government entities, and the private sector both nationally and internationally.
    - Fostering international collaboration will allow Brazil to share its expertise and learn from global best practices, enhancing the impact and scalability of NbS.
- **Training Qualified Human Resources**

- A key component of the initiative is the training and development of qualified professionals in NbS at all levels, from secondary education to post-graduate studies.
- Programs will prepare technicians, scientists, and managers to implement and manage NbS solutions across different sectors, including public, private, NGOs, and civil society.
- These human resources development will help create an attractive environment for education and innovation in the field of sustainable water management.

- **Applied Research for Local Contexts**
  - Applied scientific research is focused on developing new solutions and improving existing NBS technologies to meet the local realities and challenges of Brazil, particularly in Santa Catarina (SC).
  - Research efforts will focus on optimizing treatment performance, assessing economic viability, and ensuring community acceptance of NBS.
  - Topics include monitoring (chemical, physical, microbiological, and emerging contaminants), pre- and post-treatment processes, synergies with existing infrastructure, and hydrological modelling.
- **Knowledge Transfer to Government, Business, and Society**
  - The creation of digital and audiovisual content (such as books, technical articles, guides, and educational materials) will facilitate the transfer of knowledge to the government and private sector.
  - There will be a focus on public outreach, with easy-to-understand audiovisual materials aimed at educating NGOs, community organizations, and the broader public about the benefits of NbS.
  - Scientific dissemination and the popularization of science will be achieved through social media, scientific events, and publications in both technical and scientific outlets.
- **Promoting Collaboration and Integration**
  - Opportunities for collaboration were emphasized, including integration of new researchers and research groups, and fostering public-private partnerships.
  - By welcoming students and faculty from other institutions, the initiative will facilitate knowledge exchange and capacity building, enhancing the overall impact of NbS research and implementation.
- **Monitoring, Performance Metrics, and Integration**
  - The session highlighted the importance of monitoring and performance analysis for NbS systems, assessing physical, chemical, microbiological, and emerging contaminants.
  - Integrating existing grey infrastructure with NbS solutions is crucial for optimizing their performance and ensuring synergies with other urban systems.
  - Life cycle analysis (LCA), risk assessments, and decision-making tools will be developed to ensure the economic viability and long-term sustainability of NbS.
- **Research and Innovation for Economic and Environmental Viability**
  - Research will focus on the development of new materials and processes to improve the economic viability of NbS, particularly in areas such as nutrient recovery, biomass reuse, and value-added products.
  - Statistical analysis and the use of databases will support data-driven decision-making, enabling more effective design, deployment, and scaling of NbS.

3.3.7. Session: Multifunctionally and co-benefits of NbS for wastewater and stormwater management in the context of climate change

Speaker and moderator

Moderator: Laura Pirazán Palomar

Speakers

Jan Friesen – UFZ/Germany (English)

Anacleto Rizzo – IRIDRA/Italy (English)

Fernando Magalhães –INCT-SbN/Brazil - IPH/UFRGS Hub

Session Description

This session explored the multifunctionality and co-benefits of NbS for wastewater and stormwater management, particularly in the context of climate change adaptation. Global experts shared insights on how NbS can be designed to provide multiple functions, such as water treatment, biodiversity enhancement, climate regulation, and even food production. Emphasis was placed on the challenges and opportunities of implementing these solutions, with a focus on scaling and managing expectations. Case studies from Europe, Brazil, and beyond were presented, demonstrating how NbS can deliver significant co-benefits while addressing the urgent need for innovative, sustainable infrastructure solutions.

Objectives

- To understand the concepts of multifunctionality and co-benefits within NbS and their relevance to stormwater and wastewater management.
- To explore the challenges and opportunities of integrating NbS into urban planning, particularly in the context of climate change adaptation.
- To discuss how NbS were implemented effectively in vulnerable communities, ensuring social and environmental justice.
- To highlight practical case studies and innovations in NbS that demonstrated their potential for multifunctional impact.

Key take aways

Multifunctionality and Co-Benefits of NbS: NbS can be intentionally designed to address multiple urban challenges simultaneously. For example, a rain garden not only captures runoff but also enhances biodiversity, improves urban aesthetics, and serves as recreational space.

In addition to their intended functions, NbS often provide co-benefits such as improved air quality, reduced noise pollution, mental health benefits, and urban cooling. A wetland designed for wastewater treatment, for instance, may also function as a recreational area, wildlife habitat, and a tool for flood reduction.

Managing Expectations and Scaling Challenges: It is essential to manage expectations regarding the performance and visibility of NbS, especially in small-scale or isolated projects. Their full impact often depends on integration with other systems and broader urban planning strategies.

Scaling NbS effectively requires overcoming challenges linked to limited space and resources in dense urban environments. While promising, NbS are not one-size-fits-all solutions and must be evaluated in relation to their specific context and limitations.

Innovative Design and Interdisciplinary Implementation: The successful implementation of multifunctional NbS demands collaboration between designers, engineers, urban planners, and community stakeholders.

Hybrid systems that integrate green infrastructure with traditional grey infrastructure can offer effective solutions but may face barriers such as limited financing, technical complexity, and institutional resistance. New financial instruments and supportive policies are needed to promote broader adoption.

NbS for Vulnerable Communities: Implementing NbS in informal or underserved communities requires careful attention to local realities. Community participation from the planning stage is crucial to ensure that the solutions meet their needs and promote social equity.

NbS can improve public health, strengthen community ties, and increase safety. Co-developing solutions with residents helps prevent negative outcomes like gentrification and inequity between urban districts. Hybrid solutions can be particularly useful in these contexts by respecting existing infrastructure while introducing new ecological functions.

Managing System Complexity and Stakeholder Responsibilities: The success of NbS depends not only on their multifunctionality but also on how well the complexity of their systems is managed. Clear allocation of responsibilities among local authorities, utilities, and communities is vital.

Cross-departmental coordination enhances project impact and avoids fragmented implementation. Urban planners must consider the full range of effects across sectors like health, environment, and infrastructure, and set up governance structures that support collaboration.

Contextual and Geographic Relevance: The design and placement of NbS must account for local geomorphological and environmental conditions—such as topography, soil, and water flow.

Each NbS must be tailored to its specific setting to be effective, particularly in areas facing unique challenges like drought, flooding, or heat islands.

Climate Adaptation Role:

NbS are powerful tools for climate adaptation, mitigating the effects of extreme weather events and increasing urban resilience.

Floodplains, wetlands, and green spaces act as buffers, helping to regulate flood peaks and store water. NbS also contribute to climate change mitigation through carbon capture and cooling effects in urban areas.

Monitoring and Evaluation: Ongoing monitoring is essential to assess the performance of NbS over time. Data-driven approaches should measure not only physical and chemical outcomes but also biological and social indicators.

Tools like Environmental Nature-Based Technologies (ENTS) can quantify both multifunctionality and co-benefits, helping to track progress in biodiversity, air quality, community health, and more. Capturing both intended and unintended benefits is key to long-term success and learning.

3.3.8. Session: Closing the urban cycle of water – risks, opportunities and the NbS role

Speaker and moderator

Moderator: Elena Petsani, ICLEI Europe

Speakers

Pedro Carvalho – AU/Denmark

Maria Elisa Magri – RReSSa/UFSC

Session Description

During this session the pilots discussed across various countries emphasize different applications of blue-green infrastructure to address urban challenges like climate adaptation, stormwater management, pollution control, and biodiversity promotion. Each of these pilots contributes to understanding the

multifunctionality of NbS in urban settings and provides important insights into optimizing design, implementation, and monitoring of these systems

Objectives

- Evaluate the Performance of NbS: Assess the effectiveness of various NbS pilots in urban water management, focusing on stormwater management, pollutant removal, and climate resilience.
- Explore Co-Benefits of NbS: Analyze the additional benefits of NbS, including biodiversity enhancement, cost savings, public awareness, and their contribution to environmental sustainability and urban livability.
- Discuss Operational and Design Best Practices: Examine key operational considerations, challenges, and design strategies for successfully implementing and maintaining NbS in urban settings.

Key take aways

Pilot 3 – Belgium: RIETLAND Phytoparking for Wastewater Treatment

- **Focus**: A full-scale Phytoparking system treating pre-treated wastewater from 105 PE at an off-grid campsite.
- **Key Features**:
    - Aerated hybrid wetland with distinct treatment zones for grey and black water.
    - Robust design with a 1.3m deep liner basin, expanded clay aggregates, and automated control systems.
- **Performance & Co-Benefits**:
    - High removal rates for TSS, COD, BOD5, and efficient removal of micropollutants and pathogens.
    - Cost-effective with lower CAPEX and OPEX; offers flood mitigation, low energy consumption, and aesthetic green landscaping.

Pilot 4 – Italy: IRIDRA Hybrid Treatment Wetland for CSOs

- **Focus**: A full-scale, aerated hybrid treatment wetland in Merone designed to manage combined sewer overflows (CSOs).
- **Key Features**:
    - Four aerated wetland beds (4,000 m^2) plus a 1,500 m^2 surface flow wetland for final polishing.
    - Incorporates subsurface gravel layers, throttling valves, and an automated aeration system.
- **Performance & Co-Benefits**:
    - High removal rates for conventional pollutants (TSS, COD, BOD5) and effective reduction of heavy metals, microplastics, and pathogens.
    - Reduces flood risk, offers significant cost savings (up to 5× lower CAPEX & OPEX), enhances urban biodiversity, and provides educational outreach.

Pilot 5 – Spain: ICRA Green Wall Treating Greywater

- **Focus**: A full-scale horizontal flow green wall in Sant Quirze del Vallès treating greywater from residential sources combined with roof-collected rainwater.
- **Key Features**:

  - Composed of 16 modules with 9 plant pods each; includes an ozonation step for enhanced pollutant and pathogen removal.
  - Designed to treat up to 220 L/day and pump reclaimed water back for toilet flushing.
- **Performance & Co-Benefits**:
  - High removal efficiencies for ammonia, BOD5, TSS, COD, and organic micropollutants; strong pathogen reduction.
  - Provides co-benefits such as enhanced urban aesthetics, increased biodiversity, cost savings, and educational value.

Pilot 6 – Norway: Raingarden Treating Road Runoff

- **Focus**: A raingarden along Tåsenveien in Oslo designed to treat urban road runoff from roads, bike lanes, and green areas.
- **Key Features**:
  - Covers 60 m^2 with a potential surface storage volume of 19.6 m^3.
  - Equipped with automatic samplers to monitor influent and effluent water quality.
- **Performance & Co-Benefits**:
  - Effective retention of TSS, metals (e.g., Al, Cr, Fe, Pb), and microplastics (up to 81% reduction in tire wear particles).
  - Enhances urban biodiversity, reduces flood risk, improves traffic safety, and contributes to improved public health.
  - Some design challenges (e.g., inlet design flaws) highlight opportunities for further optimization.

Pilot 7 – Germany: UFZ Research Green Roof Platform

- **Focus**: A research platform in Leipzig exploring the multifunctionality of green roofs and tree swales for urban climate adaptation and stormwater management.
- **Key Features**:
  - Incorporates various green roof systems with different vegetation mixes, soil depths, and management strategies.
  - Focuses on evaluating stormwater retention, temperature regulation, CO_2 sequestration, pollutant absorption, and biodiversity enhancement.
- **Performance & Co-Benefits**:
  - Demonstrates significant cooling effects, improved urban microclimates, and efficient water retention.
  - Acts as a pollution sink by absorbing airborne contaminants.
  - Provides numerous ecosystem services, including enhanced urban biodiversity, energy savings, and building protection.
  - Serves as a research and demonstration platform for developing novel monitoring and modelling approaches.

Key Cross-Cutting Insights

1. **Nature-Based Solutions (NbS) Integration**: All pilots showcase how NbS (green walls, raingardens, green roofs, and hybrid wetlands) effectively manage urban water challenges, improve water quality, and support sustainable urban development.
2. **Pollutant Removal & Stormwater Management**: The systems significantly reduce pollutants—from suspended solids to organic micropollutants and heavy metals, both for wastewater and stormwater related pilots. Moreover, pilots dedicated to stormwater management, efficiently reduce flood risks.
3. **Biodiversity, Climate Adaptation, and Urban Resilience**: Green infrastructure enhances urban biodiversity and helps mitigate urban heat islands, contributing to climate adaptation and improved resilience against extreme weather events.
4. **Cost-Effectiveness and Socio-Economic Benefits**: Many pilots report lower CAPEX and OPEX compared to conventional grey infrastructure. Additionally, these systems offer co-benefits like improved aesthetics, enhanced public health, and community engagement through educational initiatives.
5. **Monitoring and Continuous Improvement**: Robust monitoring systems across pilots enable data-driven optimizations, ensuring that the performance and multifunctionality of these systems are continuously improved over time.
6. **High tech in Europe vs more simple systems for the Global South:** The session concluded with an interesting discussing around the drivers for NbS development (intensification) in Europe, the principles and future expectations in the field. Also, how the developments are very important as a lighthouse for the global south, but the priorities for Brazil rely on simplification of the systems to better match the local priorities.

Session: Presentation of NbS projects for wastewater and stormwater management in Europe and Brazil

Speaker and moderator

Moderator: Elena Petsani, ICLEI Europe

Speakers

Anacleto Rizzo – IRIDRA/Italy (English)

Massimiliano Riva – ICRA/Sapin (English)

Alexandre Bach Trevisan – CASAN-SC

Session Description

This session explores the integration of NbS with grey technologies to enhance water management practices. The discussion covers how combining these approaches can optimize treatment processes, generate reuse-quality effluents, and deliver additional ecosystem services across diverse scenarios. Participants will examine a range of global projects—from constructed wetlands in circular economy models to innovative façade and agroforestry solutions—that illustrate the versatility and effectiveness of NbS in urban stormwater management, greywater treatment, and wastewater reuse.

Objectives

- **Integrate NbS and Grey Technologies:** Understand how the synergy between natural and engineered systems can optimize water management.
- **Showcase Diverse Case Studies:** Explore various projects and implementation models from different regions that demonstrate practical applications.
- **Promote Circular Economy Principles:** Discuss how NbS contribute to a resource-oriented, sustainable paradigm while delivering ecosystem benefits.
- **Examine Business Models:** Review tailored business models and governance arrangements that ensure long-term sustainability of these solutions.

- **Identify Co-benefits:** Highlight additional social, environmental, and economic benefits resulting from effective water reuse and management.

Key take aways

The projects presented underscore a transformative approach to water management where NbS are integrated with grey technologies. This comprehensive strategy not only optimizes water treatment and generates reuse-quality effluents but also delivers a range of co-benefits across various settings. By embedding NbS within a circular economy and ecosystem services framework, these projects highlight the potential to shift traditional water management paradigms. From urban stormwater management initiatives—such as constructed wetlands, sponge cities, swales, and bioretention cells—to innovative façade-based solutions and wastewater treatment systems, the diverse case studies illustrate how different business models and implementation arrangements are being employed worldwide. This integrated approach demonstrates how resource efficiency and sustainable practices can drive significant environmental, social, and economic benefits.

New service provision through faecal sludge management for non-sewered sanitation applied to small cities and peri urban areas, Alexandre Bach Trevisan – CASAN-SC

- New Sanitation Model: Designed for small towns and peri-urban areas using scheduled desludging from septic tanks.
- Collaborative Approach: Partners with operators and updates regulations to expand services in Santa Catarina.
- Cost Efficiency: A low-cost, low-CAPEX solution that manages cash flow while ensuring legal compliance.
- Coverage Gap: CASAN currently covers 66% of municipalities but only 39% of the population.
- Evolving Onsite Systems: Once seen as temporary, these systems now play a key role in a master plan across 147 municipalities.
- Challenges: Include internal resistance, limited funds, and slow project execution.
- Future Expansion: Plans to build 11 new treatment plants to serve 36 additional municipalities.

Project Overview: Advancing Solutions: Updates from MULTISOURCE & NICE Pilots, Massimiliano Riva – ICRA/Sapin

ICRA is hosting a MULTISOURCE pilot project featuring a newly built green wall to treat greywater from ICRA, which is then used to irrigate surrounding green areas.

System Design & Capacity:

- Innovative design combining vertical and horizontal water flow.
- Treatment capacity of up to 250 L/day, depending on water contamination.

Experimental Setup:

- Two identical setups tested different substrates: Perlite–Coco fiber vs. Perlite–LECA.
- Experiment ran for 2 months, using 10 L/day of real greywater (from Samba Hotel, Lloret de Mar) and mint as the test plant.
- Weekly sampling at inlet and outlet tanks; analysed COD, BOD, TSS, and TN levels.

Results & Comparisons:

- Perlite–LECA showed slightly better COD and TN removal; Coco-Perlite excelled in TSS removal.
- Setup performance compared favourably with the NICE project, especially for BOD and TSS.
- Plant growth was significantly better in the setup using Perlite–LECA.

Final Decision:

- Adopt a 50% Perlite – 50% LECA inorganic substrate mix for optimal performance, robust plant growth, reduced clogging, and longer lifespan.
- Selected plants include Lavandula, Nephrolepis, Rosmarinus, Hedera, Mentha, Lactuca, and Carex.

Realising Decentralised NbS for Stormwater Management: Diverse Examples of Business Models & Implementation Arrangements, Maria Wirth

Innovative NbS & Business Models:

- NbS for stormwater management offer multiple benefits and require innovative, tailored business models for long-term sustainability.
- NbS are unique assets providing ecosystem services that demand collaboration across different sectors.

Implementation Arrangements. Four main categories based on property rights drive governance and business models:

- **Public-Public Partnerships:** Municipal agencies collaborate on projects like SuDS and treatment wetlands on public property.
- **Public-Private Partnerships (PPP):** Projects financed jointly by public sponsors and private financiers for city-wide stormwater solutions.
- **Public Service on Private Property:** Private developers install systems (e.g., green walls, raingardens) with public support such as rebates or grants.
- **Purely Private Models:** Private funds drive installations, for example, hotels adopting treatment systems to meet discharge limits.

Case Studies & Outcomes:

- **Oslo:** Developed a collaborative program to improve stormwater management and water quality in the Oslo Fjord through cross-sector stakeholder engagement.
- **Milan:** The Sponge City project aims to scale up interventions in parks and parking lots by mid-2026.

Key Conclusions:

- Combining large-scale strategies with site-specific solutions and functionality-focused policies maximizes NbS benefits.
- Increased financial resources and stakeholder payments are driving the adoption of NbS.
- Early and ongoing engagement of local communities, public agencies, and private partners is essential.
- NbS, particularly for stormwater retention, offer cost-effective alternatives to traditional sewer expansion, though more cost-benefit assessments are needed.
- Overcoming mindset barriers in citizen involvement remains a key challenge.

Closing urban water cycles with nature-based solutions: an overview of some of IRIDRA's European-World exchange R&D projects, Anacleto Rizzo, IRIDRA

- **Integrated Approach:** Combining NbS with grey technologies can optimize water management, producing reuse-quality effluents while offering multiple co-benefits.

- **Circular Economy & Ecosystem Services:** Constructed wetlands and other NbS are highlighted within a resource-oriented and ecosystem services framework.
- **Urban Stormwater & Greywater Projects:**
  - **CARDIMED:** In Catania (Italy), implements SuDS, sponge cities, swales, bioretention cells, and infiltration shafts.
  - **Greywater Treatment:** Projects like Nawatech, Nawamed, and NICE focus on NbS for greywater treatment and reuse.
- **Global Case Studies:**
  - **Treatment Wetland:** Pune (India).
  - **Façade Solutions:** Pot-based façades in Beirut (Lebanon), Tunis (Tunisia), Ferla and Turin (Italy); Ground-based façades in Beirut and Amman (Jordan).
- **Wastewater Treatment & Reuse:**
  - **Nawatech:** Sewer mining and irrigation.
  - **PAVITR:** Wastewater treatment coupled with short rotation forestry.
  - **HYDROUSA:** Integrates wastewater treatment with agroforestry for reuse.

3.3.9. Workshop 1: Problem-Solving for NbS: Defining Actor Roles for Implementation

Participants and moderator

Moderators:

Laura Pirazan-Palomar – ICLEI Europe

Maria Wirth

Participants

Brazilian stakeholders

Session Description

This workshop introduced participants to the MULTISOURCE stakeholder engagement and business model frameworks, adapted to the local context of Florianopolis, Brazil. With support from special guest Alexandre Bach Trevisan (CASAN-SC), participants explored the water management challenges in three specific areas of the island: Lagoa da Conceição, Downtown, and the Northern region. Using open-source balneability data and local knowledge, attendees worked in groups to identify suitable NbS tailored to each scenario. The exercise emphasized defining relevant stakeholders, property managers, and institutional roles necessary for the successful implementation, maintenance, and monitoring of selected NbS interventions.

Figure 11. Workshop 1 Brazil: Business models and stakeholder engagement

Objectives

- To apply the MULTISOURCE stakeholder engagement and business model frameworks in a real-world context.
- To identify locally appropriate NbS solutions for diverse urban water challenges in Florianopolis.

- To define the key actors and their roles in the implementation, governance, and operation of NbS.
- To foster dialogue on feasibility, co-benefits, and stakeholder engagement for sustainable NbS planning.

Key take aways

Contextual NbS Planning: Participants collaboratively selected three areas—Lagoa da Conceição, Downtown, and the Northern part of the island—to analyze NbS implementation scenarios, taking into account local water issues, such as overflow, contamination, and lack of infrastructure.

Scenario-Based Solutions:

- Northern area of the Island: Proposed green corridors and retention/infiltration lagoons, with a strong emphasis on engaging tourism and health sectors, as well as local communities through social media and grassroots leaders.
- Lagoa da Conceição: Focused on river water treatment through high-standard NbS along the Vermelho River, aligned with environmental education and cooperation with traditional communities and protected area guidelines.
- Downtown: Combined Sewer Overflow (CSO) solutions were identified as most suitable, with a call for feasibility studies and clear mapping of technical, financial, and social dimensions.

Stakeholder Mapping & Roles: Each group identified relevant actors—such as environmental agencies, tourism boards, health departments, and landowners—outlining their roles in financing, implementation, and long-term operation.

Real-World Application: The exercise grounded theoretical frameworks in practical application, enabling participants to consider NbS through the lens of ownership, governance, and stakeholder engagement.

Pathway to Business Models: The workshop served as an entry point for participants to develop future NbS projects supported by realistic stakeholder collaboration and adaptable business model strategies.

3.3.10. Workshop 2: Multisource tools for NbS dissemination – decision-making for technology

Participants and moderator

Moderators:

Jan Friesen – UFZ/Germany (English)

Massimiliano Riva – ICRA/Spain (English)

Participants

Brazilian stakeholders

Session Description

In this session, the two platforms developed within the MULTISOURCE project, OCTOPUS (UFZ) and Nat4Wat (ICRA), were first introduced. During the second part of the workshop, participants registered and explored the Nat4Wat web tool by proposing a potential scenario, for water treatment or water management, and discovering which NbS best matched their inputs.

Figure 12 Workshop 2 Brazil: Digital tools

Objectives

The primary objective of the session was to introduce and promote awareness of these two freely accessible tools, which are specifically designed to support decision-making and provide essential resources for more effective planning of the location and type of NbS for water treatment and water management. By making these tools widely known, the aim was to encourage their adoption among professionals, researchers, and stakeholders in the water sector.

The secondary objective was to assess the user experience of the Nat4Wat platform, evaluating its ease of use and functionality. Participants were encouraged to explore the tool, test its features, and provide feedback on its usability. This feedback would help identify potential improvements and refinements that could be implemented to enhance the platform's accessibility, efficiency, and overall user-friendliness, ensuring that it meets the needs of a diverse range of users effectively.

Key take aways

Both platforms received highly positive feedback, demonstrating their relevance and potential impact. Nat4Wat garnered strong interest, with over 40 new registrations, highlighting a growing demand for accessible tools that support effective water treatment and management planning.

During the workshop simulations, an in-depth discussion emerged about potential enhancements to improve the platform's usability and overall user experience. One of the key areas identified for improvement was the need for clearer guidance on the step-by-step process and the treatment limitations of different NbS. A common challenge observed was that participants frequently inputted treatment and contaminant reduction values that were unrealistically high for NbS capabilities. Consequently, the platform was unable to generate suitable recommendations, leading to confusion among users.

To address this, participants suggested incorporating more detailed instructional content, including an enhanced explanation of how the tool works, realistic performance expectations for various NbS, and the constraints of different treatment approaches. By improving clarity and providing more structured guidance, Nat4Wat could become more intuitive and user friendly, ensuring that users receive accurate, actionable insights tailored to their specific needs.

3.3.11. NbS business cases: design, technologies and engagement

Speaker and moderator

Moderator

Pablo Sezerino – GESAD/UFSC

Speakers

Caio Voltolini – Rotária do Brasil (Florianopolis/SC)

André Baxter Barreto – Wetlands Construídos (Belo Horizonte/MG)

João Victor Cipriano & Rodrigo Franco– Emboa Ecosan (Florianopolis/SC)

Wagner Gerber – Ecocell (Pelotas/RS)

Vitor Hugo Terres – Phyto-restore (France/Brazil)

Session Description

This session brought together representatives from various Brazilian companies and institutions with experience in implementing NbS for water treatment and sanitation. Presenters shared real-world case studies, technical insights, and lessons learned from operating across diverse contexts in Brazil. The session provided a platform for knowledge exchange between academia, SMEs, and practitioners, offering both local perspectives and international relevance.

Figure 13 Pannel of discussion: NbS business cases.

Objectives

The primary goal of this session was to highlight the diversity and adaptability of NbS implementation in Brazil, focusing on:

- Practical experiences from SMEs
- Integration of social, environmental, and technical considerations
- Challenges in scaling and sustaining NbS approaches
- Opportunities for collaboration between research and practice

Key take aways

Scenario-Based Design & Adaptation: Presentations showed how NbS can be tailored to diverse contexts and needs, particularly in small-scale, decentralized settings. Flexibility and adaptation were emphasized as key to success.

Importance of Co-Benefits: Projects that emphasized ecological, social, and aesthetic co-benefits (e.g., urban cooling, biodiversity, education) were more likely to attract community and municipal support.

Integration of Social Context: Effective NbS projects considered cultural and social factors, especially in work with indigenous communities or urban parks. Inclusion helped strengthen project acceptance and impact.

Operational Challenges & Knowledge Gaps: Long-term maintenance, availability of skilled operators, and understanding of CAPEX/OPEX trade-offs were raised as major concerns during the roundtable.

Academic–SME Collaboration: There was strong consensus on the need for deeper collaboration between academia and SMEs. Universities play a critical role in bridging knowledge gaps and informing public policies but often face mismatched timelines and limited project funding for operations.

Barriers to Scale-Up: Technical (space requirements, sludge management), financial (lack of long-term OPEX funding), and cultural (decision-maker reluctance) barriers remain significant obstacles to broader implementation.

National Priorities & Future Outlook: While the sanitation agenda is gaining traction (with a 2033 national goal), stormwater management remains under-addressed. Participants called for stronger policy support for climate adaptation, disaster mitigation, and infrastructure resilience.

3.3.12. Market Place

For the Brazilian partners, the marketplace occurred during an interactive coffee break, providing a dynamic setting for knowledge exchange and networking. Various organizations showcased their work through posters and an interactive map of Florianopolis, facilitating conversations around local challenges and solutions.

The setup encouraged meaningful interactions between a diverse group of stakeholders, including students, entrepreneurs, researchers, and experts from various disciplines. These discussions fostered connections and collaborations, enhancing the understanding of different perspectives and identifying synergies for advancing NbS in urban water management.

Figure 14 interactive coffee break

3.3.13. Field Trip

Site 1 – Multifamily Residential Building in Palhoça city. WWTP composed by Anaerobic Baffled Reactor (ABR – 50m³) followed by Partially Saturated Vertical Wetland (PSVW – 3,400 m²)

The first site visit took place at a Multifamily Residential Building in Palhoça City, where participants were introduced to a constructed wetland system designed for wastewater treatment. The constructed wetland was developed and maintained by Rotaria do Brasil, the company that hosted this portion of the field trip. During the visit, participants were presented with detailed explanations of the technical aspects of the wetland, including its design, operational processes, and the specific characteristics of the site. One notable feature is the use of papyrus as part of landscape management, which integrates natural aesthetics with functionality.

Discussions during the visit highlighted several challenges associated with managing constructed wetlands in private areas. In this case, maintenance responsibilities are divided between two separate companies: one responsible for the operation and maintenance of the constructed wetland itself, and another in charge of landscape maintenance. This separation of responsibilities has led to operational complications, as damage to the wetland infrastructure can occur during landscape maintenance, potentially compromising the functionality and efficiency of the wetland.

The visit also demonstrated the practical application of nature-based solutions for wastewater treatment in residential areas. It was noted that the treated wastewater from this constructed wetland is ultimately discharged into a nearby water body, underlining the importance of proper maintenance and operational management to ensure environmental safety.

Figure 15 Field trip - Site 1

Site 2 – Commercial Building in Florianopolis city. WWTP composed by Septic Tank (ST – 7 m^3) followed by Aerated Vertical Wetland (AVW – 80m^2)

The second site visit was hosted by Rotaria do Brasil at a wastewater treatment plant located within a private commercial area in Florianopolis City. This facility is designed to treat wastewater generated by various commercial and industrial sources, including a restaurant, a bakery, and other shops. The treatment system consists of a Septic Tank (ST) with a capacity of 7 m^3, followed by an Aerated Vertical Wetland (AVW) covering an area of 80 m^2.

Participants were able to observe both the location of the septic tank and the operation of the Aerated Vertical Wetland. The wetland integrates ornamental vegetation as part of its landscape management strategy, enhancing the aesthetic appearance of the area and demonstrating the possibility of combining functionality with visual appeal in commercial settings.

The Aerated Vertical Wetland is particularly well-suited for this type of application, as it effectively treats wastewater with a high grease content, estimated at approximately 30 m^3 per week. The aeration process helps maintain aerobic conditions within the wetland, which promotes the efficient breakdown of organic matter and enhances treatment performance.

This visit highlighted the potential of implementing nature-based wastewater treatment solutions in private commercial areas. It also demonstrated how aesthetic landscaping can be incorporated into the design to create attractive, functional systems that not only provide effective wastewater treatment but also contribute positively to the surrounding environment.


Figure 16 Field trip – Site 2

Site 3 – Septage Sludge Management Unit (SSMU) in Florianopolis city. Pilot Plant composed by Vertical Wetland (2 modules of 60 m^2 each)

The third and final site visit was to the pilot plant of the Septage Sludge Management Unit (SSMU), a collaborative project developed and constructed by CASAN (Santa Catarina Water and Wastewater State Company) and GESAD (Decentralized Sanitation Research Group), from the Department of Sanitary and Environmental Engineering at the UFSC. The pilot plant is located in the northern part of the island of Florianopolis.

This facility focuses on the treatment of septage sludge through a nature-based solution involving two modules of Vertical Wetlands, each covering an area of 60 m². The process begins with sludge transported to the site by tankers, where it is then applied to the vertical wetlands for treatment.

During the visit, participants had the opportunity to observe the structural components of the wetland, including its design, materials, and selected vegetation. The vertical wetland system is designed to enhance sludge dewatering and stabilization through processes such as filtration, sedimentation, and biological treatment. The vegetation planted in the wetland also is intended to contribute to nutrient uptake improves the overall efficiency of the treatment process.

This pilot project aims to demonstrate the feasibility of using Vertical Wetlands for the effective treatment of septage sludge. It represents a promising approach for decentralized sanitation solutions, providing a sustainable and low-cost alternative for sludge management in urban areas.


Figure 17 Field trip- Site 3

4. Strengthening International Cooperation: Biofilms and Microbial Methods Workshop with Montana State University

As part of the MULTISOURCE project's commitment to advancing NbS for water treatment through interdisciplinary and international collaboration, a specialized workshop on Biofilms and Microbial Methods in NbS was held in partnership with Montana State University (MSU). Hosted by INRAE on 19 and 20 May 2025, the event featured prominent facilitators.:

- Ellen Lauchnor, Associate Professor, Montana State University
- Stephanie Ayotte, Postdoctoral Researcher, Montana State University
- Diana Le Berre, Postdoctoral Researcher, INRAE

The two-day workshop focused on advancing knowledge and capacity related to biofilms and microbial processes in water treatment contexts. Key sessions included:

- **Biofilms: Applications and Methods of Analysis**, where participants gained insights into the role of microbial communities in enhancing NbS performance.
- **Group Activity and Applied Research**: Engaging discussions and collaborative exercises enabled participants to apply microbial methods to practical case studies and ongoing research.

This workshop served as a dynamic forum for knowledge exchange, building upon the foundational research developed within the MULTISOURCE project. The participation of U.S.-based researchers and the integration of microbial analytical techniques underscored the project's growing international reach.

Moreover, this event exemplifies how international workshops can serve as strategic extensions of project-based collaboration, offering opportunities to disseminate findings, explore synergies across global research networks, and strengthen methodological approaches. It also demonstrated the added value of bringing together diverse academic and scientific perspectives to enhance the performance and understanding of NbS in urban water management.

Encouragingly, this type of cooperation lays the groundwork for sustained engagement beyond the project's lifecycle, reinforcing the importance of continued dialogue, capacity building, and shared innovation in the field of sustainable water solutions.

5. Closing Reflections

The experiences in Florianopolis and Ho Chi Minh City underscored that NbS are not only technical interventions but also governance and community engagement processes. The success of NbS implementation hinges on the integration of spatial realities, local priorities, and institutional capacities—elements that were strongly emphasized during both workshops.

By embedding stakeholder perspectives into digital planning tools and business frameworks, the MULTISOURCE project contributes to the mainstreaming of NbS as feasible, desirable, and replicable strategies for sustainable urban water management. In particular, the MULTISOURCE Planning Platform emerged as a valuable enabler of evidence-based decision-making, helping cities to explore cost-effective and context-sensitive stormwater solutions. Its modular design, capacity for scenario comparison, and open-source flexibility support both high-level strategic planning and localized interventions.

The workshops demonstrated how the Planning Platform can bridge the gap between technical planning and stakeholder dialogue—by helping visualize trade-offs, map implementation pathways, and connect proposed solutions to real-world constraints. When paired with tools like Nat4Wat and supported by active collaboration between academia, public institutions, and communities, the platform facilitates a more inclusive and adaptive approach to urban water resilience.

A particularly valuable addition to the knowledge-sharing efforts of the project was the Biofilms and Microbial Methods in NbS workshop hosted by INRAE, in collaboration with Montana State University (MSU). This international training event not only expanded the technical understanding of microbial processes in water treatment but also reflected the project's commitment to fostering cross-continental scientific exchange. The presence of experts from both the U.S. and Europe demonstrated how the MULTISOURCE initiative is part of a global research network advancing sustainable solutions for urban water challenges.

Workshops of this nature illustrate how international cooperation can extend the impact of the project beyond its core activities, encouraging continuous learning, methodological innovation, and the development of new research partnerships. The discussions and applied exercises on microbial techniques enriched the MULTISOURCE knowledge base and opened avenues for long-term collaboration and capacity-building beyond the formal project duration.

The materials presented during both workshops in Florianopolis and Ho Chi Minh City are included in the Annex chapter of this report for reference and further consultation. The following sections detail the structure, implementation, and results of these workshops, forming the basis for the strategic guidance this report aims to provide.

6. Acknowledgements

The successful implementation of the international workshops held in Florianopolis, Brazil, and Ho Chi Minh City, Vietnam, was made possible through the close collaboration of multiple partners, whose contributions were instrumental to both the preparation and execution of these events.

Recognition is extended to the two academic institutions that served as key international partners in the MULTISOURCE project:

- Universidade Federal de Santa Catarina (UFSC) in Florianopolis, Brazil
- Ho Chi Minh City University of Technology (HCMUT) in Ho Chi Minh City, Vietnam

Both universities played a central role in organizing the workshops, offering critical support in shaping the content and ensuring that the sessions were grounded in local knowledge and context. Their academic teams contributed significantly to the design, facilitation, and reflection processes that guided the workshops, helping to create an environment conducive to collaborative learning and knowledge exchange.

The support from the broader university teams—including faculty members, researchers, and students—was vital to the logistical and technical success of the sessions. Their engagement and commitment helped bring together diverse perspectives and promoted constructive dialogue among participants.

The workshops also greatly benefited from the active engagement of a wide range of local stakeholders, including municipal authorities, utility companies, private sector actors, non-governmental organizations, community representatives, and academic institutions. The diversity of these participants enriched the discussions, ensuring that proposed solutions reflected the complexity of each local context. Their openness to dialogue and co-creation transformed the workshops into not only a venue for sharing knowledge, but also a dynamic stakeholder engagement exercise.

This collaborative process exemplified the value of international knowledge exchange in the pursuit of sustainable development goals. By connecting expertise across borders and sectors, the workshops contributed to strengthening capacities and forging new partnerships toward a shared vision of urban water resilience through nature-based solutions.

The MULTISOURCE project acknowledges the dedication and generosity of all individuals and institutions involved, whose efforts laid the foundation for future collaboration and learning across global regions.

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8. Annex

This annex provides access to the supporting materials and presentations shared during the two international workshops conducted as part of the MULTISOURCE project. These resources are intended to complement the main content of the report and offer readers a deeper understanding of the tools, methodologies, and discussions explored during each event.

8.1. Annex 1 – Vietnam Workshop (Ho Chi Minh City University of Technology, HCMUT)

This section includes the agenda, speaker presentations from the sessions held in Ho Chi Minh City, Vietnam. Access the materials here.

8.2. Annex 2 – Brazil Workshop (Federal University of Santa Catarina, UFSC)

This section includes the agenda, speaker presentations from the sessions used during the Brazil workshop in Florianopolis. Access the materials here.

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

MULTISOURCE
enhanced natural treatment solutions

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