

Julia Wójcik-Madej*, Joan Garcia**, Barbara Sowińska-Świerkosz*

*Department of Hydrobiology and Ecosystems Protections, University of Life Sciences in Lublin;

** GEMMA-Group of Environmental Engineering and Microbiology Department of Civil and Environmental Engineering Universitat Politècnica de Catalunya-BarcelonaTech

1. INTRODUCTION

Nature-Based Solutions (NBS) are solutions that utilize natural processes and ecosystems to address environmental, social, and economic challenges while promoting sustainable development and enhancing resilience to climate change. These solutions encompass ecosystem-based measures such as wetland restoration, forest rehabilitation, urban greenery, and other actions that harness nature to meet human needs. One of the current research directions on Nature-Based Solutions (NBS) focuses on creating methodological frameworks for their effective implementation in urban contexts. To achieve this, it is necessary to adopt a transdisciplinary approach based on evidence, context-specific, and equitable.

2. MAIN AIM

The aim of the research is to develop methodological frameworks for selecting optimal Nature-Based Solutions (NBS) for urban areas, addressing various environmental, social, and economic challenges, particularly in the context of Lublin city (Poland). The study also involves assessing existing and new types of NBS for their effectiveness and socio-political integration.

3. METHODS

The study aimed to develop a framework for selecting an optimal array of Nature-Based Solutions (NBS) types suitable for implementation in urban settings to tackle diverse challenges. This array encompasses both proven effective solutions already in use and potential solutions ready for implementation. To achieve this, a multi-faceted evaluation method was employed, assigning equal significance to ecological, social, and managerial factors, tested within the context of a case study on Lublin city (Poland). To facilitate the selection of the optimal NBS type, an exclusionary approach was taken, whereby NBS types failing to meet criteria at a given stage were excluded from further consideration. Such an approach facilitated the identification of the most effective NBS types from the initial selection of several dozen, based on the analyzed criteria. The study was anchored in four methodological premises (MAs) and four research queries (RQs), forming the cornerstone of the methodological framework (Figure 1).

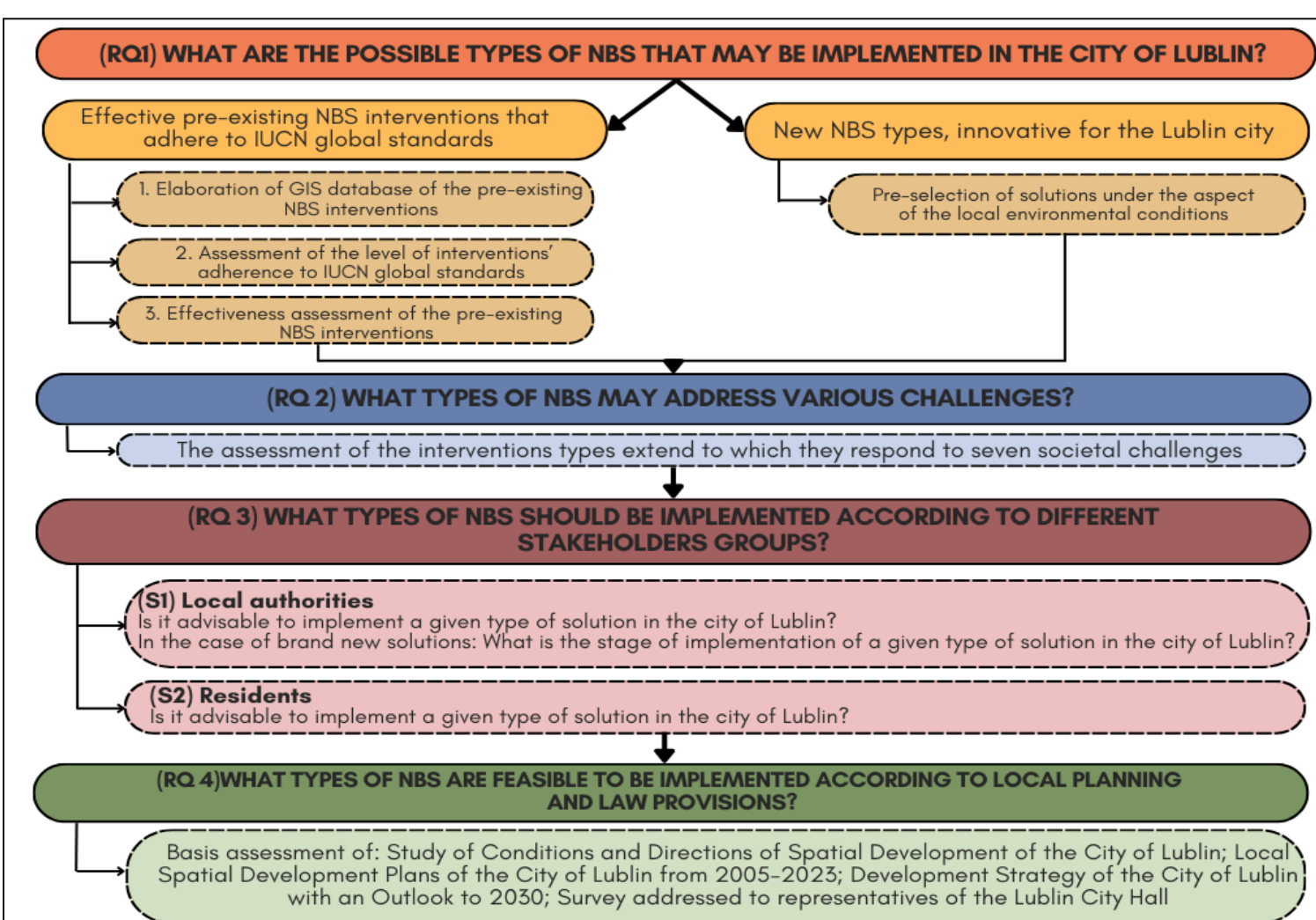


Figure 1. Methodological framework with four research queries (RQs) and two main NBS categories (existing and new for the analyzed city) for selecting optimal NBS types in Lublin, Poland
Source: Unpublished article by Wójcik-Madej, Garcia and Sowińska-Świerkosz 2024 following positive peer-review in the Journal of Environmental Management

The questionnaire is divided into two parts. Part I: 'NATURE-BASED SOLUTIONS EXISTING IN THE CITY OF LUBLIN' features 'Solution: Allotment gardens' with three photos and a rating scale. Questions include 'I enjoy the benefits of allotment gardens' and 'I would like to more allotment gardens be implemented in the Lublin city'. Part II: 'INNOVATIVE SOLUTIONS FOR THE LUBLIN CITY' features 'Solution: Hybrid wastewater treatment plants' with two photos and a rating scale. Questions include 'I would like hybrid wastewater treatment plants to be implemented in the Lublin city'. Both parts include a 'RATING SCALE' from 1 (strongly disagree) to 5 (strongly agree) and a 'DISTRICT(S) PREFERRED FOR THE ESTABLISHMENT OF...' section with a list of districts.

Figure 2. Model questionnaire on NBS implementation preferences
Source: Unpublished article by Wójcik-Madej, Garcia and Sowińska-Świerkosz 2024 following positive peer-review in the Journal of Environmental Management

4. RESULTS

(RQ1) What are the possible types of NBS that may be implemented in Lublin?

In the initial study phase, 22 NBS types were analyzed for compliance with IUCN global standards (Table 1; Column A). Results showed 11 strongly adhered, 10 were adequate, and 1 partially complied. Hence, *Maintenance of agricultural areas* was excluded, leaving 21 for further evaluation. Effectiveness assessment revealed 2 highly effective and others effective (Table 1; Column B). Lower efficacy was in social, spatial, and economic factors; higher in political and long-term. Most effective solutions minimized human intervention, e.g., *Ensuring the continuity of the ecological network* and *Restoring degraded waterbodies*. All 21 types proceeded as none were rated partially or non-effective.

(RQ 2) What types of NBS may address various challenges?

The results of the assessment indicated that 10 NBS interventions were strongly geared towards challenges, 14 were deemed adequate, and 5 were partial (Table 1; Column C). The latter pertain to *Nesting boxes for native bats*, *Insect hotels*, *Installation of apiaries*, *Rainwater collection systems* and *Temporary green installations*. This mainly stems from the nature of these solutions, as interventions must be sufficiently large to effectively address societal challenges related to disaster risk reduction and climate change adaptation and mitigation. As a result of this stage, 17 pre-existing types of NBS interventions and 7 new types were further analyzed in terms of stakeholders' preferences.

(RQ 3) What types of NBS should be implemented in Lublin according to different stakeholders groups?

Both groups of respondents expressed strong implementation preferences regarding most of the analyzed solutions (Table 1, Column D, E). However, representatives of LCO were more critical than citizens, particularly concerning existing NBS types. Weak preferences were expressed regarding two types of solutions: *Allotment gardens* by citizens and *Natural bathing ponds* by representatives of LCO. Therefore, these solutions were not included in the last stage of the assessment.

(RQ 4) What types of NBS are feasible to be implemented in Lublin according to local planning and law provisions?

According to local regulations and planning documents, all previously existing NBS and four new solutions have been identified as feasible for further implementation (Table 1, Column F). This is either due to their inclusion in local documents or the planning/implementation stage declared by representatives of the LCO.

Table 2. Possible types of pre-existing NBS interventions for implementation in the Lublin area along with their assessment in terms of IUCN global standards and overall effectiveness level. This assessment includes challenge orientation, stakeholders' opinions on implementation needs, and consideration of the analyzed set of NBS solutions in local planning and legal provisions.

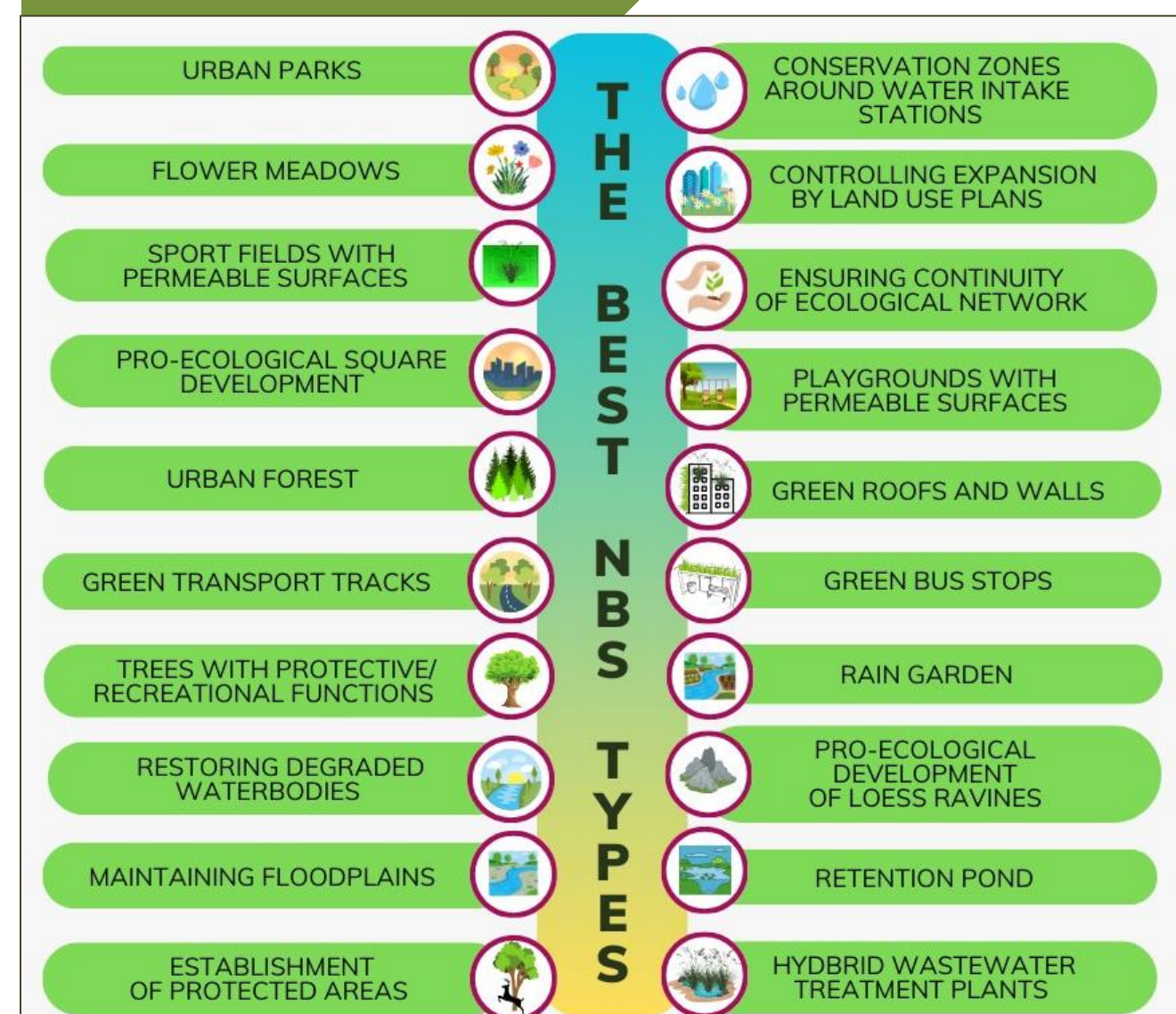
Type of intervention	PRE-EXISTING NBS SOLUTIONS					
	A. Adherence to IUCN standards	B. Total effectiveness	C. Challenge-orientation	D. Preferences of local authorities	E. Preferences of residents	F. Local planning
Urban parks	STRONG	EFFECTIVE	STRONG	STRONG	STRONG	YES
Allotment gardens	STRONG	EFFECTIVE	STRONG	STRONG	WEAK	-
Flower meadows	STRONG	EFFECTIVE	ADEQUATE	STRONG	STRONG	YES
Sport fields with permeable surfaces	STRONG	EFFECTIVE	ADEQUATE	STRONG	STRONG	YES
Pro-ecological square development	STRONG	EFFECTIVE	ADEQUATE	STRONG	STRONG	YES
Urban forest	STRONG	EFFECTIVE	ADEQUATE	STRONG	STRONG	YES
Green transport tracks	STRONG	EFFECTIVE	ADEQUATE	STRONG	STRONG	YES
Trees with protective/recreational functions	STRONG	EFFECTIVE	STRONG	STRONG	STRONG	YES
Restoring degraded waterbodies	STRONG	VERY EFFECTIVE	STRONG	STRONG	STRONG	YES
Maintaining floodplains	STRONG	EFFECTIVE	STRONG	STRONG	STRONG	YES
Establishment of protected areas	ADEQUATE	EFFECTIVE	ADEQUATE	MEDIUM	MEDIUM	YES
Conservation zones around water intake stations	ADEQUATE	EFFECTIVE	STRONG	MEDIUM	STRONG	YES
Controlling expansion by Land Use Plans	ADEQUATE	EFFECTIVE	STRONG	MEDIUM	STRONG	YES
Ensuring continuity of ecological network	ADEQUATE	VERY EFFECTIVE	STRONG	MEDIUM	STRONG	YES
Playgrounds with permeable surfaces	ADEQUATE	EFFECTIVE	STRONG	MEDIUM	STRONG	YES
Green roofs and walls	ADEQUATE	EFFECTIVE	ADEQUATE	MEDIUM	STRONG	YES
Green bus stops	ADEQUATE	EFFECTIVE	ADEQUATE	MEDIUM	STRONG	YES
Nesting boxes for native bats	STRONG	EFFECTIVE	PARTIAL	-	-	-
Insect hotels	ADEQUATE	EFFECTIVE	PARTIAL	-	-	-
Installation of apiaries	ADEQUATE	EFFECTIVE	PARTIAL	-	-	-
Rainwater collection systems	ADEQUATE	EFFECTIVE	PARTIAL	-	-	-
Maintenance of agriculture areas	PARTIAL	-	-	-	-	-
	NEW SOLUTIONS					
Rain garden	Not applicable	Not applicable	STRONG	STRONG	STRONG	YES
Pro-ecological development of loess ravines	Not applicable	Not applicable	ADEQUATE	STRONG	STRONG	YES
Temporary green installations	Not applicable	Not applicable	PARTIAL	-	-	-
Retention pond	Not applicable	Not applicable	ADEQUATE	STRONG	STRONG	YES
Biofiltration basins and ditches	Not applicable	Not applicable	ADEQUATE	STRONG	STRONG	NO
Infiltration trenches	Not applicable	Not applicable	ADEQUATE	STRONG	STRONG	NO
Hybrid wastewater treatment plants	Not applicable	Not applicable	ADEQUATE	MEDIUM	MEDIUM	YES
Natural bathing ponds	Not applicable	Not applicable	ADEQUATE	WEAK	STRONG	-

Source: Unpublished article by Wójcik-Madej, Garcia and Sowińska-Świerkosz 2024 following positive peer-review in the Journal of Environmental Management

Join our research if you are a resident of Lublin. Share your opinion and have an impact on the future of the city.



5. CONCLUSION



We would like to thank the Lublin City Office for their cooperation in the research, including participation in online surveys, interviews, and providing spatial data. We also extend our gratitude to Krzysztof Józwiakowski for sharing photographs.