A glimpse into the euPOLIS multi-dimensional Indicator System for Site Screening & NBS Assessment

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ABSTRACT

1. Introduction

Evaluating the impact of Nature-Based Solutions (NBS) via appropriate indicators and metrics has attracted, in the past few years, significant interest. In response to this, the European Commission has recently published a handbook that aims to serve as a guide towards the evaluation of NBS impacts (EC, 2021) based on current available knowledge and state-of-art technologies and practices. The evaluation process, which involves the development and estimation of pertinent metrics, is crucial across the different NBS implementation stages, i.e., from the selection and design of effective NBS interventions to the NBS efficiency evaluation and potential improvement of the deployed systems. Within this context and as part of the work that was carried out for the euPOLIS project, an integrated indicator-based methodological framework is proposed herein for assessing the multi-dimensional aspects and impacts associated with the implementation of NBS in urban environments. The proposed framework employs different types of indicators with distinct functions and purposes and aims at providing structured guidance to practitioners and urban planners throughout all the different NBS analysis, deployment, and evaluation stages.

2. euPOLIS Indicator NBS Assessment Framework

A multi-dimensional indicator-based methodology is proposed herein, focusing on aspects related to the NBS intervention effect on Public Health (PH) and Well-Being (WB), which include direct PH & WB impacts, as well as indirect ones, such as socio-cultural, environmental, and economic impacts. Since this indicator methodology aims to cover different phases associated with an NBS implementation project, it introduces two sets of indicators: (1) Contextual Indicators (CIs) that are used for the NBS planning phase, and (2) Evaluation Indicators (EIs) that are used for monitoring during the NBS deployment and exploitation phase. Both sets of indicators are developed within five (5) different categories: (a) PH & WB, (b) social, (c) business/economic, (d) environmental, and (e) urban development, as well as various identified associated Challenges and Themes, which represent the main topics and physical/social processes relevant to NBS implementation.

Figure 1 presents the overall euPOLIS NBS Assessment Framework and how this has been conceptualised for the different analysis stages. CIs are utilised during the planning phase to provide an initial site screening and site characterisation by facilitating an initial baseline assessment founded on readily available data. The baseline assessment process is anticipated to assist in gaining a better understanding of the site, the crucial issues as well as their severity and consequently the urban site's needs (Step 1). This leads to the next step (Step 2), that involves the identification of potential NBS interventions that could target the site-specific issues and needs using relevant urban planning processes; in the case of euPOLIS this is accomplished by means of the Goal Driven Planning Matrix (GDPM) methodology (Bozovic et al., 2017). The initially identified NBS interventions are then evaluated through i) the NBS preliminary selection tool (Baki et al., 2023) (Step 3) and potentially ii) more in-depth through applicable simulation and assessment methods, so as to eventually select and design the final NBS to be implemented at an urban

site of interest (Step 4). Following the final selection of NBS, a tailor-made list of EIs is produced based on the expected impacts of the implemented NBS (Step 5). The aforementioned list will be used for the performance evaluation of the implemented NBS (Step 7) following the NBS and monitoring system deployment (Step 6).
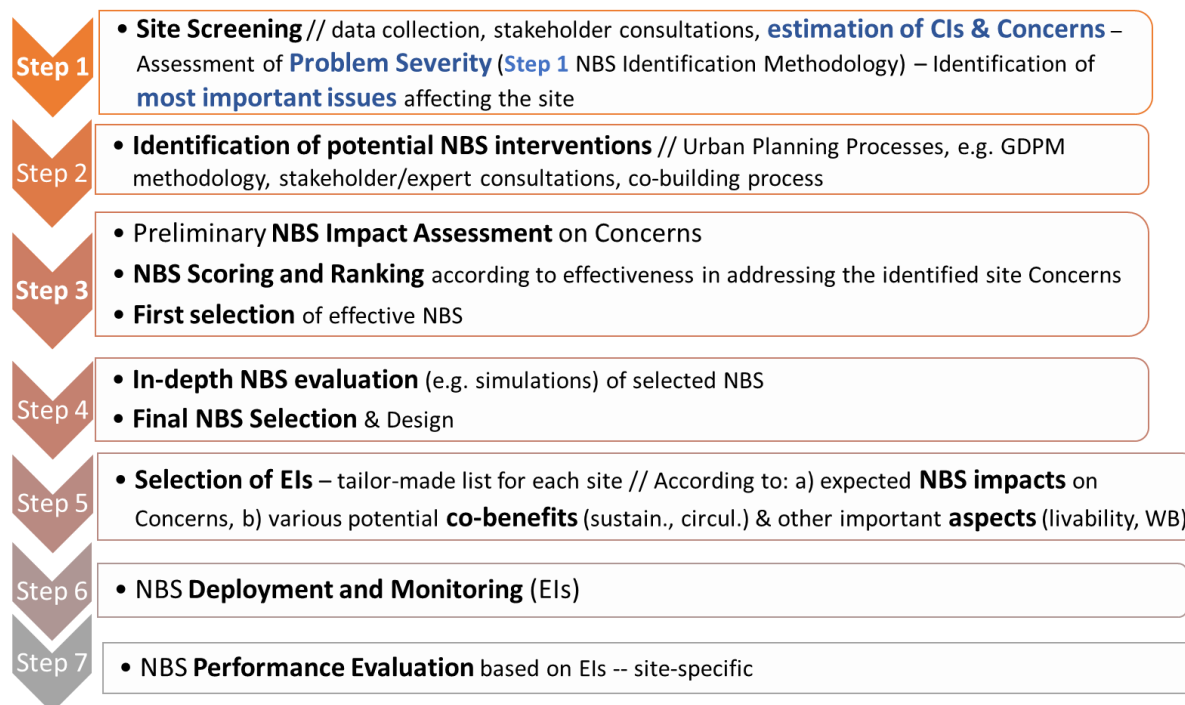
Step 1
- **Site Screening** // data collection, stakeholder consultations, **estimation of CIs & Concerns** – Assessment of **Problem Severity** (**Step 1** NBS Identification Methodology) – Identification of **most important issues** affecting the site

Step 2
- **Identification of potential NBS interventions** // Urban Planning Processes, e.g. GDPM methodology, stakeholder/expert consultations, co-building process

Step 3
- Preliminary **NBS Impact Assessment** on Concerns
- **NBS Scoring and Ranking** according to effectiveness in addressing the identified site Concerns
- **First selection** of effective NBS

Step 4
- **In-depth NBS evaluation** (e.g. simulations) of selected NBS
- **Final NBS Selection** & Design

Step 5
- **Selection of EIs** – tailor-made list for each site // According to: a) expected **NBS impacts** on Concerns, b) various potential **co-benefits** (sustain., circul.) & other important **aspects** (livability, WB)

Step 6
- NBS **Deployment and Monitoring** (EIs)

Step 7
- NBS **Performance Evaluation** based on EIs -- site-specific

**Figure 1:** Conceptualisation of the euPOLIS NBS Assessment Framework

3. CIs and Site Screening Process

The main purpose of the CIs is to facilitate a coherent quantitative site screening analysis at the beginning of an urban-upscaling project, via utilising readily available data that does not require the existence of an on-site monitoring scheme. In particular, the evaluation of CIs is based on readily available data and sources, including national and international databases, local agencies and authorities, existing reports, questionnaires, site visits, etc. The data reflect the temporal and spatial resolution level that is most appropriate (and available) for the urban site of interest.

Even though many different CIs have been identified, only a core group of these indicators is considered critical for the site screening process, since these indicators address site specific issues that could potentially be mitigated through the implementation of NBS (e.g., flooding, extreme heat, community engagement, etc.). Specifically, the evaluation of this concise list of CIs, monitors the site performance across 28 persistent Concerns associated with the aforementioned five categories, to eventually assist practitioners in identifying the more pressing problems that are being faced at a particular urban site, which could, either directly or indirectly, be mitigated by implementing specific NBS. Some of the Concerns are estimated through more than one CIs, eventually forming the so-called composite CIs. For each CI specific thresholds have been set in order to classify and score the site performance that is measured by each one of them in a standardised manner. This site screening analysis is utilised for the initial ranking and selection of candidate NBS interventions according to their anticipated effectiveness in addressing high-severity concerns in a particular site of interest, according to the NBS preliminary selection methodology and online tool presented by Baki et al. (2023).

4. EIs and NBS Performance Assessment

In total 80 EIs have been defined, within the five aforementioned euPOLIS categories, as suitable to assess the different direct and indirect impacts that NBS could have on PH & WB. EIs' function is to assess the performance and effectiveness of the implemented NBS through comparing the indicator values prior to and after the implementation of the NBS at the site of interest. The data needed to estimate the EIs at these two stages are collected either via i) monitoring through environmental sensors, questionnaires, wearables monitoring PH & WB parameters and using people as a source of data; ii) modelling/simulations using appropriate models; or iii) targeted data collection (Randelović et al., 2023) (Figure 2). This process results in a multi-dimensional impact assessment of the implemented NBS.
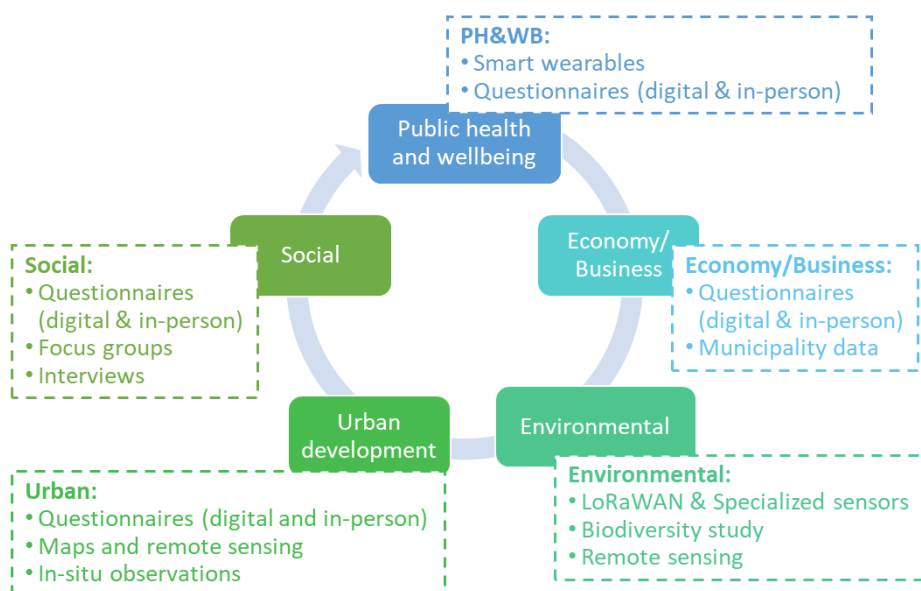
Figure 2: EI estimation means across the five indicator categories

Contrary to the list of CIs that is common across the different urban sites, aiming to provide, to the extent possible, a standardised screening process, the list of EIs is tailor-made for each site. Hence, the selected EIs should serve the need of quantifying the expected impacts of the implemented NBS, or, to put it otherwise, to evaluate how effectively an NBS that was selected to upgrade a certain urban site addresses the main site Concerns for the remediation of which it has been selected. Practitioners are also recommended to select EIs that evaluate the co-benefits resulting from NBS implementation, even though these impacts might not be linked to high severity Concerns. Additionally, there might be a need to assess other important aspects, such as "Sustainability", "Circularity", "Livability" and "Wellbeing", and in this case it is recommended to select corresponding EIs from the developed indicator clusters.

5. Conclusions & Future work

The site screening methodology, that involves the evaluation of the core CIs and related Concerns, has been applied in all euPOLIS Front-Runner (FR) cities demonstration sites. Figure 3 presents indicative results for Akti Dilaveri, one of the demonstration sites in the euPOLIS FR city of Piraeus, Greece. This process has significantly assisted in identifying the most pressing issues in each demo site, as well as the most appropriate/efficient NBS interventions following a scoring and ranking process. It has also facilitated a comparative overview and has highlighted the peculiarities and uniqueness of each city/area.

In terms of the EIs, the related indicator methodology has not been validated with field data since the monitoring systems and NBS have not yet been deployed in the demonstration sites. Once the necessary data is obtained, the EI methodology, as well as the indicator definitions and estimation methods are going to be critically assessed and adjustments and modifications are going to be applied where necessary.

Figure 3: Indicative site screening results for the euPOLIS demonstration site of Akti Dilaveri, in the city of Piraeus

Overall, the proposed indicator-based methodological framework is considered innovative in view that it attempts to monitor multiple societal challenges that could simultaneously be addressed by the implemented NBS and consequently provide evidence for their multi-functional role with particular emphasis on citizens' PH & WB. Furthermore, this framework provides the methodological foundation upon which all the activities related to NBS implementation can be based on, including quantitative demo site screening and needs assessment, NBS and indicator (EIs) selection, and NBS assessment, thus offering an integrated assessment methodology and providing guidance to practitioners on NBS analysis and deployment in a structured manner from start to finish.

Acknowledgements

References:

Baki, S., Kazantzi, A., and Makropoulos, C., 2023. NBS efficiency-informed urban upscaling methodology: the euPOLIS approach, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-17125, https://doi.org/10.5194/egusphere-egu23-17125.

European Commission, 2021. Evaluating the impact of nature-based solutions: A handbook for practitioners. European Commission, Directorate-General for Research and Innovation, European Union. https://doi.org/10.2777/244577.

Randelović, A., Figueras, A., Seidelin, F., Briggs, L., and Stanić, F., 2023. Nature-based Solutions (NBS) at work and monitoring their performance – the innovative research case of the EU-funded project euPOLIS, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-17063, https://doi.org/10.5194/egusphere-egu23-17063.

Bozovic, R., Maksimovic, C., Mijic, A., Smith, K.M., Suter, I., and van Reeuwijk, M., 2017. Blue Green Solutions: A Systems Approach to Sustainable, Resilient and Cost-Efficient Urban Development, Technical report, Imperial College London, doi: 10.13140/RG.2.2.30628.07046.