EVALUATING NATURE-BASED SOLUTIONS: BUILDING THE NBS EFFECTIVENESS DATA EXCHANGE

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WHAT ARE NATURE-BASED SOLUTIONS?

Nature-based solutions (NBS) are actions that protect, conserve, restore, sustainably use, and manage natural or modified ecosystems to address socioeconomic challenges. They are increasingly being considered as a complement or replacement to traditional gray infrastructure approaches.

WHY DO WE NEED TO COLLECT DATA TO EVALUATE EFFECTIVENESS?

Evidence on the effectiveness (performance and reliability) of NBS in achieving benefits for both people and nature is often identified as insufficient to inform project planning, support development of design and engineering standards, and conduct benefit-cost and return on investment analyses. Evaluation of NBS requires consistent, comprehensive data on NBS projects and their outcomes, including data on baseline conditions (before project) or at a reference site (similar site without intervention) which is currently not available for most types of NBS.

For example, recent attempts at systematic review of the effectiveness of NBS for coastal protection (hazard attenuation) found heterogeneity in metric reporting, a lack of information on critical metrics, and insufficient detail about NBS type and design, making it impossible to assess NBS effectiveness at the level of detail needed for engineering guidance (Bredes et al. 2024, Huynh et al. 2024). Similarly, a systematic review of studies on ecological outcomes from NBS projects found heterogeneity in assessment metrics, with more holistic assessments significantly more likely to show negative or mixed outcomes than solely positive outcomes or no effect (Key et al. 2022). Project-level data collected by funders are insufficient for many of the same reasons (Warnell and Olander 2024).
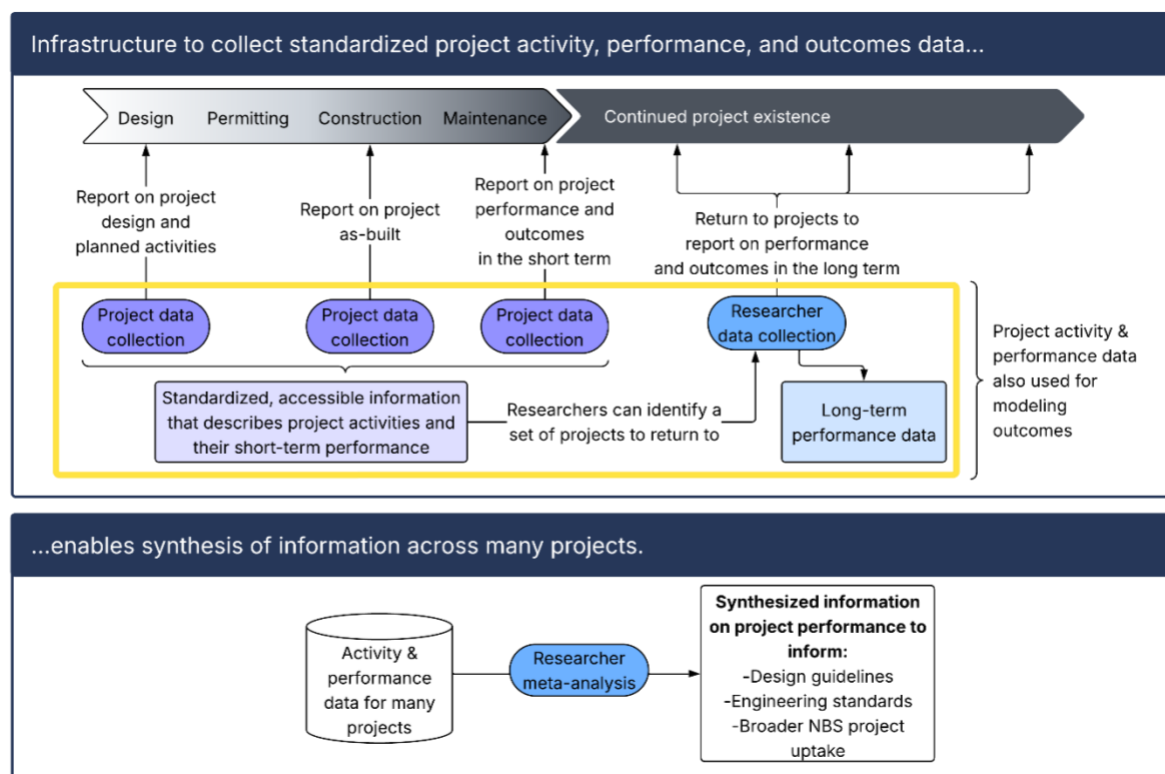
WHAT IS THE NBS EFFECTIVENESS DATA EXCHANGE?

The NBS Effectiveness Data Exchange (NEDE) is envisioned as a network of funders, practitioners, researchers, and data users that aims to promote consistent collection, sharing, and use of relevant data on NBS effectiveness. Its primary activities will be:

- To lay a foundation for robust NBS effectiveness assessment by providing the infrastructure for collating data on a consistent set of key metrics essential for evaluating project effectiveness.
- To host a database (the NBS Effectiveness Database) accessible to funders, developers, and researchers that will contain baseline, reference site, project and outcomes data, enabling more refined effectiveness evaluation.

The NEDE will provide metrics recommendations and a data sharing system to make it simpler for projects to contribute consistent baseline and as-built project data to the NBS Effectiveness Database. Once built, this database will help researchers identify projects with relevant information available for assessment years after implementation. We envision a collaborative process of data collection, sharing, and evaluation by project teams and researchers, culminating in large-scale effectiveness evaluation across multiple NBS projects.

Figure 1. The NEDE data collection process.

Note: This diagram shows how coordinated data collection at different points in the NBS project life cycle, across many different projects, could ultimately enable synthesis of information on NBS effectiveness. The yellow box indicates NEDE data collection steps.

WHO IS THE NEDE FOR?

Funders and Project Developers. The NEDE would provide a standard way to describe projects and consistent metrics for collecting baseline, as-built, and short-term (~1 year post project) data. It would provide a user-friendly data entry platform that would feed directly into funder monitoring and reporting requirements. Having robust baseline data will enable future research on projects to evaluate their impact, tell their story, and raise awareness.

Researchers. The NEDE would enable researchers to measure performance and reliability of NBS projects in achieving benefits for both people and nature. It would (1) help researchers find projects with baseline data to evaluate, (2) provide guidance on what metrics to measure and a way to report data that are consistent with existing commonly used frameworks and quantification models, (3) provide a platform for data-sharing to enhance knowledge and understanding, and (4) serve as a source of data for systematic reviews and meta-analysis, which could inform engineering guidance and new tools for project selection, siting, and benefits calculation.

Engineers. The NEDE and the research it supports could feed directly into the development and continued updating of engineering guidance for NBS.

WHAT TYPE OF DATA WILL BE COLLECTED?

Data about NBS projects, their outcomes, and the context in which they are located are needed to evaluate their effectiveness and inform project planning and design. Collecting information at baseline, after construction, and years after project completion, and at reference sites as well as project sites, strengthens the usefulness of evaluations. Our metrics are grouped into four categories reflecting the different roles they play in the evaluation process:

1. *Project description metrics* provide details about the NBS project and its design. These are used as explanatory variables in effectiveness evaluation, allowing better differentiation between different types and designs of NBS to inform engineering and design guidance for future projects.
2. *Local context and condition metrics* provide information about the environmental conditions in which the project is located, which can influence its establishment and ability to create desired outcomes. This context is useful for project planning and siting. Many of these metrics are also used to calibrate and validate quantitative models of outcomes, such as coastal hazards.
3. *Ecological performance metrics* give insight into how a project is functioning ecologically, especially related to vegetation establishment and growth, which enables many target outcomes. These metrics are particularly useful to collect both soon after a project is implemented and during longer-term monitoring to allow evaluation of the project's trajectory over time. Many ecological performance metrics are also inputs to quantitative models of outcomes.
4. *Outcome metrics* (e.g., for hazard attenuation or biodiversity) directly measure how the project is creating target outcomes, supporting effectiveness evaluation without

the need for complex modeling. These metrics can also facilitate evaluation and improvement of quantitative models.

WHAT TYPES OF RESEARCH QUESTIONS WILL THIS DATA COLLECTION HELP ANSWER?

Consistent data collection across multiple NBS projects over time will provide the information needed for analysis to answer research questions such as:

- How do variations in NBS project design influence coastal hazard attenuation and biodiversity outcomes of those projects?
- How quickly do new NBS projects develop the functionality needed to provide desired outcomes?
- How do different environmental settings and conditions influence NBS performance?
- How well do NBS with different designs and in different settings recover after disturbances such as storms, and how long does recovery take?

WHAT RESOURCES ARE AVAILABLE NOW?

In the first phase of NEDE development, recommended metrics were developed for quantifying the hazard attenuation and biodiversity benefits of coastal NBS. The recommended metrics spreadsheet (available on request) includes a list of relevant metrics with information on how the data should be reported (e.g., units, uploaded files, etc.), as well as references with guidance or examples on how to measure the metrics.

While the metrics list looks extensive, obtaining and sharing relevant information is not as complicated as it may seem. Many of the metrics recommended for reporting by NBS project teams are characteristics of the project itself and can be sourced from project design documents. We envision that online forms will streamline the data-sharing process for NEDE members. For example, the form uses basic information provided about the project to identify which metric fields are relevant and should be displayed, while hiding extraneous fields. The form also provides standard response options for many metrics. An example form based on our coastal NBS metrics list is available here.

The recommended coastal NBS metrics will be pilot tested over the next year. In addition, a second metrics list for inland flood reduction−related NBS is underway.

We anticipate that as the NEDE matures, additional metrics will be developed for more NBS types (beyond coastal NBS and inland flood reduction NBS) and outcomes (beyond hazard attenuation and biodiversity benefits).

HOW CAN YOU CONTRIBUTE?

Give feedback on our recommended metrics. Let us know how our metrics list aligns with your experience monitoring or evaluating NBS projects. Are any metrics particularly useful or less valuable? Do you have suggested updates to how metrics are described or categorized?

Share knowledge about other metrics frameworks or measurement standards. We want to build on existing useful frameworks where they exist and point to measurement standards for recommended metrics.

Collaborate on piloting the recommended metrics. We are looking for data on NBS project implementation and effectiveness to test how well it aligns with our recommended metrics. Tell us if you have data to share or would like to try out the metrics for yourself.

Help build the NEDE. This network of funders, NBS practitioners, researchers, and data users is just getting started. We are looking for partners to contribute their insight or funding to developing and maintaining the NEDE. NEDE development will include not only discussions of what metrics to include and the design of a data sharing platform, but also important considerations such as how to maintain data confidentiality and what a sustainable funding model for the NEDE could look like. If you'd like to learn more, contact lydia.olander@duke.edu.

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