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Quick reference guide

Curated Resources for Implementing Blue-Green Infrastructure and Nature-based Solutions.

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Colophon

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Introduction

This deliverable is part of Work Package 8 of ARCADIA (Arcadia adaptation) and presents an interactive PDF (iPDF) designed as a ‘guide to the guidelines’ for Nature-Based Solutions (NBS) and Blue-Green Infrastructure (BGI).

The document offers a curated selection of practical guidelines, serving as a quick reference guide to help regions navigate extensive information on project needs or climate hazards by highlighting the most practical and relevant resources.

Additionally, this iPDF functions as a working document for partner regions to test in local living labs. By exploring the recommended guidelines, regions can identify the most promising approaches and determine any additional steps needed for their local contexts.

Instruction for Use

On the following page, you can click on a specific need or climate hazard to access the corresponding guidelines directly. While this guide does not aim to be exhaustive, it strives to provide valuable insights derived from existing resources, facilitating practical application and further adaptation efforts.

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Climate hazards

- Heavy rainfal
- Flooding
- Drought
- Heat waves
- Landslides
- Sea level rise

How-to

- Select and design NbS/BG
- Asses and value benefits
- Determine costs of measures
- Approach spatial planning
- Execute management and maintenance
- Conduct monitoring, evaluation and impact assements
- Engage the public
- Learn from practical examples

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Heavy rainfall *Climate hazard*

Relevant guidelines:

CO-IMPACT

2021 Rather than addressing hazards directly, the tool asks you to select desired environmental (and social, economic and health) benefits and then offers suitable indicators and methodologies to plan monitoring and evaluation processes. Pertaining heavy rainfall, it provides suggestions on rainfall storage, rainfall infiltration, and water management.

Evaluating the impact of NbS: A handbook for practitioners

2021 This handbook offers a step-by step approach to developing and executing robust monitoring and evaluation plans for the assessment of NbS impacts. Case study 2 highlights a potential solution to address extreme rainfall, describing co-benefits and suggesting environmental, social, and economic indicators to monitor such NbS

Green Stormwater Infrastructure Planning & Design Manual

2021 The manual addresses heavy rainfall hazards by guiding the implementation of Green Stormwater Infrastructure (GSI) from a technical perspective. Section 2.3.3 outlines methods for drainage area delineation, optimizing stormwater capture and runoff management. Section 3.3 provides technical requirements for designing GSI systems to manage rainfall effectively, emphasizing infiltration, storage, and controlled discharge.

Sustainable drainage systems (Susdrain)

1993-2024 This portal, developed by CIRIA, offers a comprehensive collection of guidance documents addressing heavy rainfall hazard from general principles to specific SuDS components. Notable resources include the CIRIA C753 SuDS Manual, which provides detailed advice on designing systems for surface water management, infiltration enhancement, and flood risk mitigation. Note: Registration is required to access most documents.

Urban Nature Labs: Nature-based Solutions - Technical Handbook Factsheets

2019 This handbook addresses rainfall by showcasing various NbS solutions. Each solution is introduced with an explanation of its role in nature, its technical and design parameters, and the conditions required for its implementation.Tailored to urban resilience, these solutions can manage stormwater effectively, reduce runoff, and enhance infiltration.

Urban Green-Blue Grids

Living portal An interactive online portal helps users tackle heavy rainfall hazards by exploring water management challenges through a comprehensive story map. With 169 measures and 75 projects, users can identify effective strategies for reducing runoff and mitigating flood risks. Filters such as goal, scale, cost, and soil type streamline the search for specific solutions.

The Nature-based Solutions Opportunity Scan (NBSOS)

2024 The document addresses rainfall hazards by leveraging geospatial data to identify opportunities for pluvial flood reduction. It maps flood-prone areas, models benefits of NbS like bioretention and green spaces, and provides tailored recommendations for urban resilience. This tool aids strategic planning to mitigate flood risks effectively.

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Flooding *Climate hazard*

Relevant guidelines:

Building with Nature & Beyond: Principles for Designing Nature Based Engineering Solutions

2021 This book explains how engineering, ecological and social design principles can support the realization of effective and sustainable hydraulic infrastructure designs. Section 4.3 and cases ‘Climate-proof Noordwaard’, ‘City with Nature’, ‘Coastal Protection’ and ‘Flood-proof Indonesia’ are especially interesting in terms of flood-related measures.

Engineering with Nature: An Atlas

2018 The atlas provides an overview of projects that integrate natural processes into engineering strategies that support flood risk mitigation and ecosystem restoration. Descriptions detail the use of natural and nature-based features (for instance, floodplains, riverine systems, wetlands, etc.) and highlight additional social, economic and engineering benefits.

Evaluating the impact of NbS: A handbook for practitioners

2021 This handbook offers a step-by step approach to developing and executing robust monitoring and evaluation plans for the assessment of NbS impacts. Section 5.2.2 and case studies 1, 2, and 4 highlight potential NbS to reduce flooding risks, describing co-benefits and suggesting environmental, social and economic indicators to monitor such solutions.

Implementing nature-based flood protection: Principles and implementation guidance

2017 The document presents five principles and implementation guidance for the planning, assessment, design, implementation, monitoring, management, and evaluation of NbS for flood risk management. Example projects illustrate how these steps work in real life cases and direct you to additional resources.

Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide

2019 This guide is designed to enhance understanding on how and where nature-based and hybrid solutions can improve the resilience of coastal roads and bridges, summarizing potential flood-reduction benefits as well as additional advantages. It also includes site characterization tools, decision support for selecting NbS, and suggested performance metrics.

Urban Green-Blue Grids

Living portal An interactive online portal helps users address flooding by exploring water management challenges through a comprehensive story map. Offering 169 measures and 75 projects, users can identify effective strategies including enhancing water retention, managing excess runoff, etc,. Filters such as goal, scale, cost, and soil type simplify the search for flood-specific solutions.

The Nature-based Solutions Opportunity Scan (NBSOS)

2024 The document addresses flooding hazards by leveraging geospatial data to identify opportunities for pluvial flood reduction. It maps flood-prone areas, models benefits of NbS like bioretention and green spaces, and provides tailored recommendations for urban resilience. This tool aids strategic planning to mitigate flood risks effectively.

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Drought *Climate hazard*

Relevant guidelines:

CO-IMPACT

2021 Rather than addressing hazards directly, the tool asks you to select desired environmental (and social, economic and health) benefits and then offers suitable indicators and methodologies to plan monitoring and evaluation processes. As it relates to drought, it provides suggestions on water security, rainfall storage and water management.

Urban GreenUP: NbS Catalogue

2018 The catalogue begins with 46 NbS organized into 14 categories, including Horizontal GI, water treatment, Sustainable Urban Drainage systems (SUDs), etc,. It details NbS with technical specifications, ecosystem benefits, and maintenance needs. For instance, rain gardens (Section 3.2) and green filter areas (Section 4.3) focus on water retention, reuse, and conservation, addressing drought hazards.

Urban Nature Labs: Nature-Based Solutions Implementation Handbook

2022 The handbook provides a comprehensive guide for implementing NbS in urban areas, offering technical specifications and monitoring frameworks. Chapter 4.6 specifically details NbS technical specifications, including strategies like constructed wetlands and retention ponds for water storage and reuse. Appendix I also provides updated indicators to evaluate water availability and drought resilience.

Sustainable drainage systems (Susdrain)

2019-2024 This portal, developed by CIRIA, offers a range of guidance documents that address drought resilience through sustainable water management strategies. Notable resources include guidance on rainwater harvesting and SuDS design, which emphasize water retention and reuse to reduce reliance on traditional water sources. Registration is required to access most documents.

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Heat waves *Climate hazard*

Relevant guidelines:

CO-IMPACT

2021 Rather than addressing hazards directly, the tool asks you to select desired environmental (and social, economic and health) benefits and then offers suitable indicators and methodologies to plan monitoring and evaluation processes. Regarding heatwaves, it provides suggestions on reducing urban heat island effects, heat stress and air temperatures, and realizing thermal comfort zones.

Evaluating the impact of NbS: A handbook for practitioners

2021 This handbook offers a step-by step approach to developing and executing robust monitoring and evaluation plans for the assessment of NbS impacts. Section 5.2.1 describes a case on urban heat island incidence; tables 4.1 and 4.3 suggest indicators to measure effects of NbS on heat-related hazard and disaster risks.

Urban Nature Labs: Nature-based Solutions - Technical Handbook Factsheets

2019 The UNaLab NbS Technical Handbook provides insights into mitigating heat waves through NbS. Specifically, chapter 2.1 details the role of single-line street trees in reducing urban heat islands, emphasizing their shading and cooling effects. Additionally, Chapter 4.1 outlines the use of green roofs as a strategy to lower ambient temperatures and enhance urban microclimates.

Urban Green-Blue Grids

Living portal An interactive online portal helps users tackle heat challenges by providing strategies to mitigate urban heat islands and improve cooling. Users can explore various solutions like shading, green infrastructure, and cooling systems, using filters such as goal, scale, cost, and soil type.

The Nature-based Solutions Opportunity Scan (NBSOS)

2024 The document addresses heat waves by identifying urban heat islands and modeling cooling benefits of solutions like tree canopies and green roofs. It provides tailored recommendations to reduce surface temperatures, enhance shading, and improve urban microclimates, promoting heat resilience in regional planning and development.

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Landslides *Climate hazard*

Relevant guidelines:

Evaluating the impact of NBS: A handbook for practitioners

2021 This handbook offers a step-by step approach to developing and executing robust monitoring and evaluation plans for the assessment of NbS impacts. Case study 3 describes an NbS practice on landslides and debris flows; table 4.3 provides some indicators to measure effects of NbS on risks of landslides.

Sea level rise *Climate hazard*

Relevant guidelines:

Building with Nature & Beyond: Principles for Designing Nature Based Engineering Solutions

2021 This book explains how engineering, ecological and social design principles can support the realization of effective and sustainable hydraulic infrastructure designs. Videos on ‘storm surge barriers’ and ‘ designing dikes’, the Sand Engine Delfland case study and cases 4 (Coastal Protection) and 6 (Flood-proof Indonesia) are particularly relevant.

Engineering With Nature: An Atlas

2018 The atlas provides an overview of projects that integrate natural processes into engineering strategies that support flood risk mitigation and ecosystem restoration. Descriptions detail the use of natural and nature-based features (for instance, floodplains, riverine systems, wetlands, etc.) and highlight additional social, economic and engineering benefits.

Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide

2019 This guide is designed to enhance understanding on how NbS can be implemented to improve resilience of coastal roads and bridges under conditions of sea level rise and extreme weather events. It also includes site characterization tools, decision support for selecting NbS, and suggested performance metrics.

Select and design NbS/BGI *How-to*

Relevant guidelines:

Building with Nature & Beyond: Principles for Designing Nature Based Engineering Solutions

2021 The handbook offers a comprehensive engineering approach that focuses on the use of natural materials and ecological processes to achieve sustainable hydraulic infrastructural designs. It explains the BwN concept, supplementing with cases and Chapter 3 offers guidelines to implement the ecological design.

Catalogue of NBS for urban resilience

2021 This catalogue describes five important principles for the integration of NBS in cities. It categorizes various NbS 'families', indicating types of city the NbS can be applied to, suitability of the location, spatial and technical characteristics, and environmental qualities.

Green Stormwater Infrastructure Planning & Design Manual

2021 This manual provides guidance for planners and designers on creating green stormwater infrastructure (GSI) in the city. It uses Philadelphia as the case city to introduce the step-by-step planning and design strategy, technical requirements, and workflows for GSI projects.

Implementing nature-based flood protection: Principles and implementation guidance

2017 The guideline offers key principles to consider when planning NbS, summarizes the steps needed for planning, assessment and design, and what outputs facilitate the process. Example projects illustrate how these steps work in practice and direct you to additional resources.

ProGIreg: Methodology on spatial analysis in front-runner and follower cities

2018 This document supports users in selecting and designing NbS and BGI by offering practical methodologies, tools, and criteria to tailor solutions to local social, ecological, and spatial contexts.

URBiNAT NBS Catalogue

2018-2024 The catalogue allows you to select NbS according to your needs, aspirations, and local environmental conditions. The selection tool offers options to search for key words, choose types of NbS, indicate selected impacts and highlights best practices and useful references

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Asses and value benefits *How-to*

Relevant guidelines:

EU Guidance on Integrating Ecosystems and their Services into Decision-Making

2019 The EU Guidance on Integrating Ecosystems and their Services into Decision-Making provides a framework for policymakers and industry leaders. Step 3 focuses on mapping, asesseing, and valuing ecosystem services. It offers methodologies and apporaches to incorporate these values into decison-making processes.

Implementing nature-based flood protection: Principles and implementation guidance

2017 Chapter 2 step 5 provides neccessary steps to assesses and values the benefits of nature-based flood protection (as well as cost and impacts). The focus is on evaluating the economic, environmental, and social outcomes. It uses methodologies such as cost-benefit analysis, ecosystem service valuation, and stakeholder-driven assessments to quantify advantages like flood risk reduction, habitat restoration, and community resilience.

Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers

2023 Chapter 2 of this guideline delves into the methodologies for valuing the benefits and costs of NbS. It provides a decision framework and practical tools to help project developers quantify the economic, social, and environmental impacts of NbS projects.

URBiNAT NBS Catalogue

2023 The catalogue can help you identify suitable NBS based on your desired impact. It allows you to indicate impacts scores (ranging from 1-5) for nature, well-being, health, mobility, participation, and economy. It suggests fitting NbS according to these scores, meaning the tool is particularly useful prior to implementation.

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Determine costs of measures *How-to*

Relevant guidelines:

Catalogue of NBS for urban resilience

2021 For each urban NbS type, the catalogue outlines key cost considerations for the investment and implementation stage as well as longer-term maintenance costs. It also provides indicative examples of unit costs (which can vary significantly and are highly site- and project-specific).

Cost-Benefit Analysis and the Environment

2006 The book provides an in-depth assessment of conceptual and methodological developments in cost-benefit analysis and the environment. It does not tell you how to conduct a cost-benefit analysis, but chapter 2 does describe the relevant stages of such a practical analysis.

Implementing nature-based flood protection: Principles and implementation guidance

2017 The guideline summarizes (p. 24-25) necessary steps to estimate the costs (as well as benefits and effectiveness), describing what aspects you need to measure without explicitly detailing how to perform this analysis. It does, however, reference example projects that describe how calculation methods are applied in practice.

A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction

2015 The guide helps users estimate costs of GI for flood reduction through a six-step process: defining flooding problems, modeling scenarios, setting targets, evaluating GI effectiveness, calculating costs/benefits, and communicating strategies. It balances costs with long-term benefits, highlighting GI's economic, environmental, and social advantages for informed decision-making.

World Bank. Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers

2023 This publication offers an overview of valuation methods for estimating costs (and benefits) associated with NbS, along with a decision framework to guide the design of such assessments. Case study examples demonstrate how valuation methods are applied during different phases of the project cycle.

UNALAB: NBS Value Model

2019 The document provides a comprehensive approach to assessing costs of implementing NbS. Chapter 2.3 links specific NBS clusters with financial options, outlining investment and operational costs. Tables 3 and 4 further categorize costs for diverse interventions, offering tailored insights for urban planners to determine funding requirements.

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Approach spatial planning *How-to*

Relevant guidelines:

EU Guidance on Integrating Ecosystems and their Services into Decision-Making

2023 Part 2 chapter 5 of this document provides practical guidance for integrating ecosystem services into spatial planning, offering tools, methodologies, and examples to enhance sustainability and address trade-offs in land-use and development decisions.

ProGIreg: Methodology on spatial analysis in front-runner and follower cities

2018 This document provides a comprehensive methodology for spatial analysis in urban planning, guiding users to integrate NbS into sustainable spatial strategies while addressing social, ecological, and economic challenges effectively.

Green Stormwater Infrastructure Planning & Design Manual

2021 The manual guides users in spatial planning by providing a set of standards, strategies and tools for integrating Green Stormwater Infrastructure into urban landscapes, optimising sustainabilities and water management practices.

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Execute management and maintenance *How-to*

Relevant guidelines:

Catalogue of NBS for urban resilience

2021 "For each NbS typology, the catalogue provides basic guidance on maintenance requirements such as intensity of labor, frequency, or special care in the initial stages of development.

Guidelines for design, construction and maintenance of large scale NBS

2024 This guideline provides insights for managing and maintaining NbS projects, drawing from three European case studies. Chapter 4 outlines detailed strategies on monitoring and evaluating the performance of NbS, including key indicators and metrics for success.

NBS for coastal highway

2019 Chapter 8 focuses on monitoring, maintenance, and adaptive management for NbS supporting coastal highway resilience. However, its principles, like routine inspections, addressing erosion, debris removal, and adaptive adjustments, can apply broadly to NbS management in other contexts, ensuring long-term performance and climate change adaptability.

Planning Management for Ecosystem Services: An Operations Manual

2017 This manual provides in chapter 3 a structured six step approach to integrating ecosystem management, which can be helpful for creating a management plan for NbS projects. The six outlined steps include: identifying and engaging stakeholders, addssing ecosystem services, setting objectives, developing management actions, implementing management actions, monitoring and adapting.

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Conduct monitoring, evaluation and impact assessments *How-to*

Relevant guidelines:

CO-IMPACT Tool

2021 CO-IMPACT is a decision-support tool set up a baseline for and measure success of NbS. You select environmental, health, social, and economic targets, after which the tool translates these into measurable indicators and develops a personalized impact assessment plan.

Evaluating the impact of nature-based solutions: A handbook for practitioners

2021 This handbook offers a step-by step approach to developing and executing robust monitoring and evaluation plans for the assessment of NbS impacts. It includes descriptions on the selection and application of suitable indicators and identifies main data types, data sources and data generation techniques.

GrowGreen nature-based solutions co-design guide

2022 The document explains the necessity of impact assessments in the planning phase and provides a list of tools for the calculation of impacts. The document also provides reference links on how to develop a monitoring and evaluating system.

Implementing nature-based flood protection: Principles and implementation guidance

2017 The guideline (p. 29-30) summarizes necessary steps to monitor and inform future actions, describing what aspects you need to take into account without detailing explicit steps. It complements with example projects that illustrate how monitoring was conducted and useful links for further reading.

URBiNAT NBS Catalogue

2018-2024 The catalogue can help you identify suitable NbS based on your desired impact. It allows you to indicate impacts scores (ranging from 1-5) for nature, well-being, health, mobility, participation, and economy. It suggests fitting NbS according to these scores, meaning the tool is particularly useful prior to implementation.

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Engage the public *How-to*

Relevant guidelines:

Building with Nature & Beyond: Principles for Designing Nature Based Engineering Solutions

2021 Part II of this handbook (chapter 6-10) offers information on how to build a coalition of stakeholders to support the design and implementation of ecosystem-based hydraulic infrastructures. It describes stakeholder mapping and game theory techniques and provides stakeholder-inclusive social design principles.

GrowGreen nature-based solutions co-design guide

2022 The guide is a comprehensive guidance tool that explains what a collaborative design process for NbS entails. It provides reading materials, concrete tools and case studies that illustrate how co-design processes – including planning, mobilization and evaluation stages – have been implemented in other NbS projects.

Guidelines for co-creation and co-governance of nature-based solutions: Insights from EU-funded projects

2021 This publication delves into co-creation and co-governance approaches, presenting various ways of co-designing, co-developing, co-implementing and co-monitoring NbS. Drawing upon real life cases in Europe, It illustrates best practices regarding the co-creation of NBS at its different stages, phases and scales. .

LIFE MEDACC - After LIFE MEDACC Communication Plan

2013-2018 This communication plan highlights the importance of implementing communication and dissemination efforts after the project has finished. It offers practical examples to inform and enthuse the public about NbS and inspire other watersheds.

ProGIreg - Guidelines for co-designing and co-implementing green infrastructure in urban regeneration processes

This document offers practical guidance on how to initiate, steer and organize collaborative design processes for the planning and implementation of NbS with stakeholders and the wider public. It provides 6 co-design principles with practical illustrations of their application through ‘stories’ and detailed instructions and templates for tools and instruments.

URBiNAT NBS Catalogue

2023 The catalogue allows governmental authorities and citizens to co-select and co-create NbS according to their specific needs, ambitions and realities on the ground. It offers suggestions on ways and methods to ensure a participatory approach throughout, from co-diagnostic to co-monitoring stages.

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Learn from practical examples *How-to*

Relevant guidelines:

Catalogue of NBS for urban resilience

2021 The Catalogue by the World Bank emphasizes practical examples by categorizing solutions into fourteen urban NbS families. Each family includes multiple examples showcasing successful implementations in urban settings.

GrowGreen nature-based solutions co-design guide

2022 The guide is intended for practitioners responsible for the design and implementation of NbS projects. The guide elaborates on three phases: Planning, Mobilising, and Evaluating. In each phase, guiding questions are formulated, and for each question, different case study examples are provided.

Urban Nature Atlas

2024 In this atlas, you can find practical examples of urban NbS, featuring over 1,000 case studies worldwide. It offers detailed insights into various urban projects. The website provides a filter options to refine searches by criteria such as challenges addressed, NbS, and environmental impact.

NBS Best Practice Guidelines

unknown The Nature-Based Solutions Initiative's case study platform offers a collection of best-practice examples from around the globe. You can explore cases by filtering criteria such as country, ecosystem type, and climate impact addressed, providing valuable insights into effective NbS implementations.

ProGIreg - Nature-based solutions and green infrastructure

2023 This website provides practical examples of 8 types of NbS; each example includes an explanation, links, and/or clip. Types of NbS include leisure activities and clean energy, regenerated soil, community-based urban farms and gardens, aquaponics, green walls and roofs, accessible green corridors, local environmental compensation processes, and pollinator biodiversity.

Guidelines for co-creation and co-governance of nature-based solutions: Insights from EU-funded projects

2023 This document is based on four EU projects: CLEVER Cities, URBiNAT, ProGIreg, and Connecting Nature. Each section includes a box with a practical example of how co-creation and co-governance were implemented in one of these projects.

Implementing nature-based flood protection: Principles and implementation guidance

2017 This World Bank document focuses on principles and implementation guidance for nature-based flood protection. It includes best practice examples for each of the eight defined process steps in the document.

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