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Guidelines on

Canal Restoration using Nature-based Solutions

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Abbreviations

DRR	Disaster Risk Reduction
EbA	Ecosystem-based Adaptation
Eco-DRR	Ecosystem-based Disaster Risk Reduction
Eds.	Editors
ESG	Environmental, Social and Governance
Etc.	Etcetera
IUCN	International Union for Conservation of Nature
NbS	Nature based Solutions
PRA	Participatory Rural Appraisal
SSG	Species Specialist Group
UNDRO	United Nations Disaster Relief Coordinator

Foreword

Canals play an important role in water management, habitat conservation, and improving the lives of people living around them. However, as our cities face increasing pressure from urbanisation, extreme weather and climate risks, it is becoming necessary to complement traditional engineering methods with nature-based solutions (NbS) to prevent erosion, improve water security and quality, and mitigate urban flooding and improve long-term climate resilience.

These Guidelines draw on a wealth of evidence on canal resoration using NbS. Please refer to Compendium on Waterbody Restoration Using NbS (https://southasia.iclei.org/wp-content/uploads/2026/05/NbS-for-Waterbody-Restoration.pdf).

The Guidelines on Canal Restoration using Nature-based Solutions were developed in response to the request from Kochi city for practical guidance on restoring urban canals using NbS. While the city has used green infrastructure, these guidelines will help to mainstream NbS into the regular process of canal rejuvenation and revitalisation. Prepared through a consultative process with city stakeholders and shaped by their priorities and needs, it outlines a practical step-by-step approach covering the lifecycle of a restoration project: from picking the right locations and securing innovative funding to engaging stakeholders, selecting native species, monitoring construction and implementation, and ensuring long-term maintenance.

It also provides concrete tools for mapping climate vulnerability, working alongside communities, and tracking project success over time.

This document is intended as a go-to guide for local governments, urban planners, and engineers. These guidelines will help the city to establish a model that will promote biodiversity conservation and improve the climate resilience of the city, through improved floods management in the canals.

We hope that it provides neighbouring cities with the guidance needed to deliver projects that protect our canals, enhance local biodiversity, and serve our communities and enhance their climate resilience for years to come.

What is a Nature-based Solution?

Nature-based solutions (NbS) are defined by the International Union for Conservation of Nature (IUCN) as actions to protect, sustainably manage, and restore natural or modified ecosystems that effectively and adaptively address societal challenges, while simultaneously delivering benefits for human well-being and biodiversity.[1] As an umbrella term, NbS encompasses approaches that work with nature, such as ecosystem-based adaptation (EbA) and ecosystem-based disaster risk reduction (Eco-DRR). Operational approaches such as EbA and Eco-DRR demonstrate the application of NbS to address specific societal challenges, particularly climate adaptation and disaster risk reduction.

Benefits of Using Nature-based Solutions for Canal Restoration

Nature-based solutions provide a wide array of benefits by improving the capacity of the ecosystems to provide all four types of ecosystem services. Some of the key benefits of using NbS for canal restoration include:

1. Addressing climate change
2. Disaster risk reduction
3. Erosion reduction
4. Improved water security
5. Biodiversity conservation
6. Flood management
7. Food security
8. Creation of green jobs
9. Enhanced opportunities for local livelihoods
10. Carbon sequestration
11. Reduction of urban heat island impacts
12. Improved community health
13. Improved water quality

The guidelines presented hereafter refer to any project that can be classified as an NbS for canal restoration. The key steps include:

Types of Nature-based Solutions for Canal Restoration

Constructed Wetlands: Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality. They are designed to take the advantage of many of the same processes that occur in natural wetlands, but do so within a more controlled environment. Some of these systems have been designed and operated with the sole purpose of treating wastewater, while others have been implemented with multiple-use objectives in mind, such as using treated wastewater effluent as a water source for the creation and restoration of wetland habitat for wildlife use, for reuse in agriculture or environmental enhancement. The key benefits of constructed wetlands include:

- **Low Operating Costs:** They require significantly lower energy and maintenance compared to traditional wastewater infrastructure.
- **Versatility:** Used globally to treat municipal sewage, industrial wastewater, mine drainage, and farm runoff.
- **Environmental Value:** They act as green spaces that create habitats for wildlife, restore local ecosystems, and improve aesthetic value.

1. IUCN (2020). IUCN Global Standard for Nature-based Solutions. https://doi.org/10.2305/IUCN.CH. 2020.08.

Floating Wetlands: Floating wetland treatment (FWT) is an emerging natural method for treating surface water bodies and restoring their ecological processes. These wetlands are man-made platforms planted with native vegetation that float on water bodies. Their roots dangle into the water, acting as natural biological filters that absorb excess nutrients, heavy metals, and pollutants while creating thriving habitats for aquatic life. These nature-based systems are highly effective at cleaning polluted water without the need for additional land. The key benefits include:

- **Cost-Effective:** They are often cheaper to install and maintain than traditional land-based wastewater or stormwater treatment facilities.
- **Biodiversity:** They create safe nesting areas for birds and shelter for fish, insects, and amphibians.
- **Urban Aesthetics:** By replacing grey concrete shorelines with lush, green islands, they naturally improve the visual appeal of urban lakes and ponds.

Wetland Bank Stabilisation: Wetland bank stabilization with plantation, commonly known as biostabilization or bioengineering, utilizes native vegetation alongside biodegradable materials to prevent soil erosion, absorb wave energy, and secure shorelines. It is a sustainable, cost-effective alternative to rigid structures like concrete or rip-rap. The implementation techniques include:

- **Coir Logs & Geotextiles:** Biodegradable cylinders made of coconut fiber (coir) are pegged into the bank's edge. They act as a temporary wave break while marsh plants take root behind them.
- **Brush Layering / Live Staking:** Dormant cuttings (e.g., willow branches) are driven deep into the soil. They sprout into a dense root network that anchors the soil mass.
- **Soil Bidding / Terracing:** Slopes are regraded to a gentler angle (e.g., 1:3 or 1:2) before planting to reduce runoff velocity and prevent slope failure.

The key benefits include:

- **Erosion Control:** Root systems mechanically reinforce the soil.
- **Water Quality:** Wetland plants filter excess nutrients and trap sediments before they enter the waterbody.
- **Habitat Creation:** Creates natural microhabitats for local birds, fish, and aquatic invertebrates

Removal of invasives: The most effective natural methods for removing invasive aquatic plants include manual extraction, biological controls like introducing natural predators, and environmental adjustments like shading. These methods prevent chemical pollution and restore ecological balance. A hydro-rake is a powerful tool designed to remove lake weeds like water lilies and emergent vegetation like cattails and phragmites by manual method. Biological control methods include use of grass carps and beneficial microbes. Grass carp have a voracious appetite for aquatic plants, making them an effective biological control solution for submersed, floating, and emergent weeds in some waterbodies.

For more details on each of these methods and understanding their actual implementation in cities, please refer to https://southasia.iclei.org/wp-content/uploads/2026/05/NbS-for-Waterbody-Restoration.pdf

Site Selection

Site selection is a critical step for undertaking canal restoration. For maximum impact, it is essential to:

1. Identify potentially high-risk areas using hazard mapping.
2. Identify vulnerable communities from climate and disaster risk perspectives.
3. Carry out participatory mapping to understand local challenges and context.

Identification of high-risk areas using hazard mapping

Hazards may be natural and man-made. Their interactions with vulnerable populations often result in disasters that may be further exacerbated by climate change. Risk is a function of hazard, exposure, and vulnerability.

Hazard mapping identifies areas that may be affected by hazards such as floods, drought, and landslides. According to the United Nations Disaster Relief Coordinator (UNDRO), hazard mapping is the process of determining where and to what extent a particular phenomenon may pose a threat to people, property, infrastructure, and economic activities. Its main objective is to inform residents about potential risks and disaster prevention activities. While hazard mapping cannot prevent disasters, its effective use can reduce their impacts.[2] Flood maps, landslide maps, and seismic maps are specific types of hazard maps.

There are two types of hazard maps:

(a) Resident–Educating Type: to inform residents about risks in their area.

(b) Administrative Information Type: to support the administration in planning warning and evacuation systems.

Mapping techniques and tools

Community knowledge: Local knowledge can be used to map local experiences. Tools used in rural development activities, such as Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) are cost-effective and reflect local perceptions of hazards. The resulting information can be overlaid onto local contour maps.

Surveys on historic events: Reports on past events, even if developed for other purposes, may contain useful information.

Scientific investigation and research: This usually involves multidisciplinary teams of experts. For example, landslide hazard mapping may require expertise from geologists, geo-technical engineers, geomorphologists and topographers.

Identification of vulnerable communities using spatial data on climate- and disaster-vulnerable areas

This step requires developing maps that depict climate-vulnerable areas and classify populations into low, medium, and high vulnerability categories. The maps also highlight the associated climate or extreme weather event affecting each community.

Climate vulnerability is measured by exposure, sensitivity, and adaptive capacity.

$$\text{Climate Vulnerability} = \frac{\text{Exposure} \quad X \quad \text{Sensitivity}}{\text{Adaptive Capacity}}$$

2. Hazard Mapping: Definition and Techniques (n.d.) https://hooghlywomenscollege.ac.in/ol%20doc/Hazard%20Mapping%20Techniques.pdf. Accessed on 15 January 2026

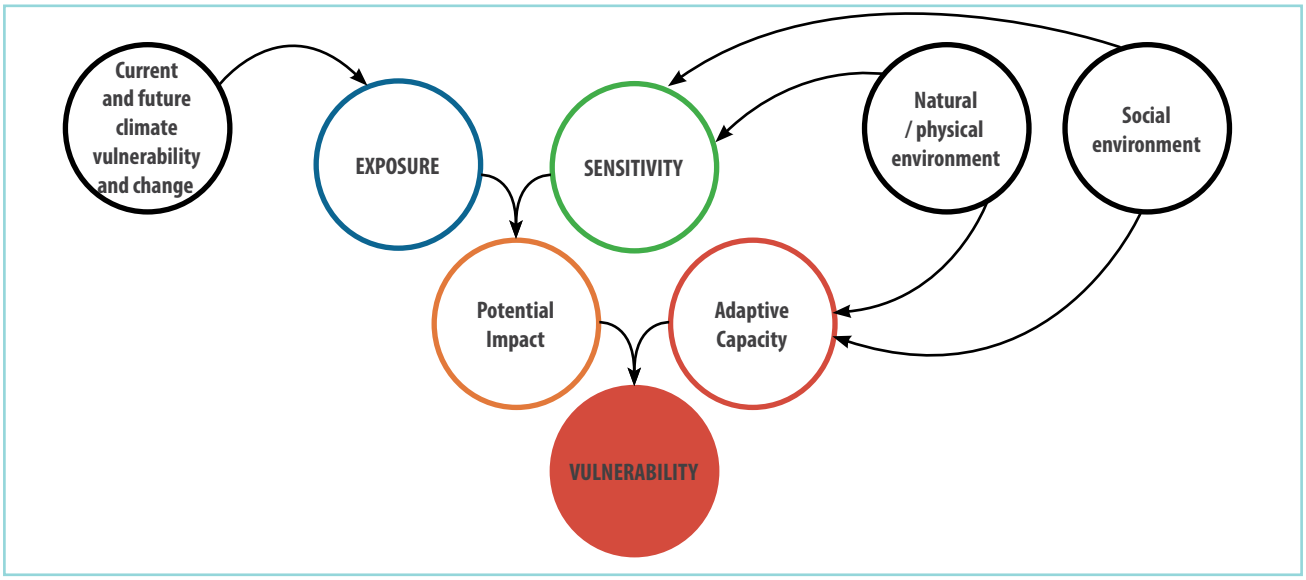

Figure1: Components of climate vulnerability[3]

The higher a community's adaptive capacity of, the less vulnerable it is to the impacts of climate events. Table 1 presents methods for assessing the components of climate vulnerability.[4]

Table 1: Assessing components of climate change vulnerability

Component	Description	Ways to Assess
Exposure	Changes in climate or weather that will affect/ are affecting the target population and the region	• Historical records of climate data • Modelling temperature and rainfall impacts, or undertaking studies/ interviews to understand people's perception of climate change • Data from sources such as Climate Wizard (https://climatewizard.clat.cgiar.org/)
Sensitivity of the system or ecosystem services	Impacts that climate change has on livelihoods (e.g., agriculture, fisheries) and on ecosystem services they rely on	• Modelling the impact of temperature and rainfall changes on crop productivity and availability of water • Stakeholder interviews to understand their perceptions on how extreme weather events have changed crop productivity, availability of water, etc., which, consequently, impact their livelihoods • Data from sources such as Intergovernmental Panel on Climate Change reports, National Adaptation Plans, etc.
Adaptive capacity of the target population	The ability of the target population to adjust to climate change impacts on human, social, financial, physical and natural capital	• Census data (literacy, income, ownership of assets) that contribute to adaptive capacity • Interviews with local communities and experts on adaptive capacity aspects • Data from sources such as Living Standards Measurement Study; Resilience Atlas, etc.

3. Fritzsche, K., Schneiderbauer, S., Bubeck, P., Kienberger, S., Buth, M., Zebisch, M., and Kahlenborn, W. (2014). The Vulnerability Sourcebook, Concepts and guidelines for standardized vulnerability assessments. Boon and Eschborn, Germany: Deutsche Gesellschaft fur Inetrnationale Zusammenarbeit (GIZ) GmbH. 177 pp.

4. Donatti, C.I., Martinez-Rodrigo, M.R., Fedel, G., Harvey, C.A., Andrade, A., Scorgie, S., Rose, C., and Alam, M. (2019). Guidelines for designing, implementing and monitoring ecosystem-based adaptation intentions. Virginia, UAS. Conservation International. 40 pp.

Vulnerability assessment tools, when applied in a participatory manner, enable a comparative evaluation of potential climate impacts and adaptive capacity. Information from vulnerability assessments can inform site selection and concept design for NbS for canal restoration.

Carrying out participatory mapping to understand local challenges and context

Participatory mapping is an important step in hazard mapping and disaster risk reduction. This methodology empowers local communities by recognising their observational capacity and place-based knowledge. For example, community members can identify areas prone to flooding and suggest locally appropriate response measures. Participatory mapping also strengthens community ownership and opens the path for further engagement throughout project planning and implementation.

Information to collect while evaluating a potential NbS site

Interviews

The site assessment begins with initial meetings with local government officials and community members. These meetings help identify local priorities and contextualise NbS implementation through:

- Understanding community interactions with the natural environment and how the environment connects to local socio-economic conditions
- Gathering contextual information on climate vulnerabilities, hazards, and risks
- Undertaking rapid biodiversity and environmental impact assessments
- Defining the scale of the potential project
- Introducing locally relevant NbS options based on initial opportunity assessments
- Identifying potential sites within the area of interest

Existing data collection

Existing data needs to be collected simultaneously. This includes:

- Disaster Risk Reduction Plans
- Local Climate Change Adaptation Plans
- Municipal Development Plans
- Relevant maps, including
  - Water and land use
  - Resource maps
  - Topography
  - Floodplains

Field Evaluation

After initial consultations and data collection are completed, a multi-disciplinary design team conducts site visits to evaluate existing conditions and NbS opportunities and constraints. The goal of the site visits is to systematically analyse links between ecosystems, livelihoods, and hazards to better understand climate vulnerability and the role of ecosystems and engineering solutions in adaptation. Table 2 summarises the information collected during field evaluation.

Table 2: Information collected during field evaluation

Required Information	Examples
Site Location	Proximity to basic services such as water and wastewater treatment, electricity, and transportation hubs
Economic characteristics	Land use, infrastructure, transport
Physical characteristics	Wind patterns, rainfall, geology, topography, water sources, wastewater treatment, built infrastructure
Environmental characteristics	Location, extent, condition, ecosystem services, threats, existing management, historic ecosystem information
Social characteristics	Demographics, livelihoods, existing social organisations, gender, access to basic services, disaster risk reduction plans, climate change adaptation plans, evacuation plans, natural resource management plans
Institutional characteristics	Land tenure, land ownership, regulatory policies for land management, zoning
Climate change impacts addressed by NbS	Exposure, sensitivity, vulnerability, adaptive capacity
Description and sketch of potential NbS	Initial sketch with details
Photos and videos of the site	For baseline and post-implementation comparison

Site selection criteria for NbS implementation

Three basic criteria guide the site selection process:

- Climate vulnerability
- Community commitment
- NbS applicability

Climate vulnerability: Vulnerability is defined as a function of sensitivity, exposure, and adaptive capacity of ecosystems and human communities therein.[5] A climate vulnerability assessment comprises:

a. Human/social dimension
b. Climate-related hazard/risk exposure
c. Economic safeguards/ ecosystem quality (adaptive capacity)

a. Human/social dimension: Questions should evaluate specific conditions that make a community more sensitive to specific climate hazards. For example:
    i. How many houses are constructed with light materials
    ii. How many houses are likely to experience less water availability during droughts
    iii. How many houses are without backup or alternative water supplies

b. Climate-related hazard/risk exposure: Questions focus on understanding the scale of relative exposure to climate-related hazards at each site. For example:
    i. What is the anticipated storm surge at each site, measured in meters?

c. Economic safeguards / ecosystem quality (adaptive capacity): This section focuses on identifying physical, social, and ecosystem indicators that measure a community's resilience to a specific climate hazard. For example:
    i. What is the presence, quality and extent of ecosystems that can buffer the impacts of extreme weather events? The table below showcases examples.

Table 3: Examples of Economic Safeguards/ Ecosystem Quality (Adaptive Capacity)[6]

Are any of the following indicators present in the community			
Physical	**Yes / No**	**Ecosystem**	**Yes / No**
Evacuation centres		Mangroves	
Road networks		Coral reefs	
Alternative water supply		Groundwater recharge features	
Water treatment		River/stream connected to floodplains	
Social	**Yes / No**		
Disaster risk reduction plan			
Community has first-responder training			
Watershed management plan			

5. IPCC (2024). Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (eds.) Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D.

6. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. 32 pp.

Community commitment: This criterion evaluates the interest and long-term commitment of the stakeholders, including local government and communities, and their organisational capacities. It comprises:

a. Commitment of the local government and the community to the project
b. Project beneficiaries
c. Critical infrastructure at risk

a. Commitment of local government and community to the project: This aspect encompasses the following:

i. Is the local government willing to endorse the project and collaborate with the project lead and the local community to implement it?
ii. Is the local community committed to monitoring, maintaining and potentially constructing the project?
iii. Are the local community's socio-economic indicators (refer Table 4) favourable?

b. Project beneficiaries: This includes the following:

i. How many people will directly benefit from the project?
ii. How many people will indirectly benefit from the project?

c. Critical infrastructure at risk: This considers which critical infrastructure may be affected or damaged if the NbS project is not constructed.

Table 4: Socio-economic criteria

Would you consider the community	Yes	No	Remarks
Open-minded			
Collaborative			
Easy to work with			
Willing to provide co-funding			
Willing to undertake training			
Shares a common vision with the project			
Is a community organisation?			
Present			
Registered			
Has a constitution and bylaws			
Has a structure			
Has a complete set of officer bearers			
If no existing community organisation:			
Does the community express willingness to organise?			
Are partners (government/academia)			
Willing to provide technical or other support and guidance			
Do community members:			
Have access to financial services			
Have access to post-disaster relief			
Have insurance			

NbS applicability: This comprises the following:

a. Site conservation, sustainable management, and/or restoration potential
b. Integration of NbS
c. Climate change adaptation potential

a. Site conservation, sustainable management and/or restoration potential:

This includes:

i. Based on the environmental and biodiversity assessment of the site, are the conditions favourable for conserving or restoring ecosystems that provide climate resilience and adaptation benefits? For example, if the target ecosystem is mangroves:
    a. Can hydrology and soil conditions be feasibly modified to allow mangrove restoration?
    b. Are there nearby sources of mangrove seedlings?
    c. Are there conflicts with the proposed restoration and /or conservation and existing land ownership or land use?

ii. Estimate the area available for restoration

b. Integration of NbS: This includes:

i. Do grey infrastructure elements complement the restoration/conservation outcomes, while also building resilience?
ii. Is the NbS cost-effective in terms of its cost-benefit ratio?

c. Climate change adaptation potential: This involves assessing the long-term impact and sustainability of an intervention under changing climate conditions and should be considered at every stage of the project.

This comprises:

i. Will the proposed NbS provide climate change resilience and adaptation benefits?
ii. Has the potential for maladaptation been considered? What measures can mitigate the risk of maladaptation?
iii. How will the project account for climate change impacts on its continued functioning and benefits?
iv. Does the project qualify as a no-regret solution, offering benefits regardless of climate change impacts?

Table 5: Determining project benefits and co-benefits[7]

Benefits/co-benefits	Indicators and data needs	
	Physical measurements	Economic valuation
All provisioning services	Quantity harvested annually	Market price and shadow price
Carbon	Tonnes of carbon sequestered or emitted	Social cost of carbon
Water quality regulation	Changes in water quality parameters	Changes in water purification
Tourism	Changes in the number of tourist visits	Changes in the income and revenue of local businesses
Water provision	Amount of water supplied for sectors like irrigation and household use	Beneficiary-specific value of water such as tariffs for domestic water consumption
Erosion control	Sediment loads in irrigation channels, etc.	Dredging costs
Pollination	Changes in crop productivity	Cost of replacing natural pollination
Non-timber forest products	Total volume harvested by communities	Equivalent market price

7. Donatti, C.J., Martinez-Rodrigo, M.R., Fedele, G., Harvey, C.A., Andrade, A., Scorgie, S., Rose, C., and Alam, M. (2019). Guidelines for designing, implementing and monitoring ecosystem-based adaptation intentions. Virginia, USA: Conservation International. 40 pp.

Economic Assessment

To accelerate and scale the implementation of NbS projects, familiarity with economic and financial principles is essential. Evaluating NbS to inform the value and costs is important because:

1. It informs project design and the selection of the best or most desirable alternative to meet project goals.
2. It justifies the use of resources to investors, taxpayers, and stakeholders.

Economic analyses applicable to any project investment include:

1. Cost-benefit analysis
2. Technical economic analysis
3. Financial appraisal
4. Market/environmental valuation
5. True-cost accounting
6. Triple-bottom-line cost-benefit analysis

The last three methods are specifically used to capture ecosystem values and costs.

1. Cost-benefit analysis: This method uses welfare economics to justify an investment. It evaluates socio-economic impacts by quantifying benefits and costs in monetary terms, comparing projected investments with existing alternatives. The method requires a case-by-case evaluation of each alternative's ability to deliver the intended project outcomes.

   Cost-benefit analysis is a widely trusted decision-support tool. Multilateral financial institutions use it to allocate resources, provide insights into overall societal gains, direct financial and sustainability impacts and assess project risks.

2. Technical economic analysis: This includes measuring a project's cost-effectiveness and life-cycle costs. Cost-effectiveness measures how efficiently project alternatives deliver on the same objective. Life-cycle cost encompasses design, construction, operation and maintenance of the NbS. Life-cycle cost analysis helps to optimise capital and operating expenses.

3. Financial appraisal: It informs investment decisions by assessing a project's affordability and profitability, using data from technical-economic analysis.

4. Market/environmental valuation: This method uses the Total Economic Value approach[8] and the Millennium Ecosystem Assessment[9] for estimating the monetary value of ecosystem services. Total Economic Value is the sum of all service flows generated by an ecosystem, both now and in the future.

5. True-cost accounting: It assesses social and environmental impacts by accounting for material flows and unintended effects.

6. Triple-bottom-line cost-benefit analysis: An evidence-based economic framework that combines cost-benefit analysis and life-cycle cost analysis. The triple bottom line refers to financial, social, and environmental dimensions, weighing impacts on stakeholders.[10] Triple-bottom-line cost-benefit analysis involves a comprehensive account of project benefits and costs over the entire life cycle, along with a comparative analysis of net benefits across alternatives.

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8. The Economics of Ecosystem and Biodiversity. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan: London and Washington.
9. Millennium Ecosystem Assessment. (2005). Ecosystems and Well-being Synthesis Report. Washington DC: Island Press. v+86pp.
10. TBL-CBA leverages Boardman et al. (2011). as foundational guidance to conduct CBA and it evaluates the incremental differences between a base case and alternatives.

Funding the Initiative

Funding refers to the source(s) of finance for project execution and maintenance. These may include municipal budgets, grants, taxes, subsidies and revenue from market-based instruments and payment for ecosystem services.

Municipal budgets are an entry point for leveraging public funding, including budget allocation during preparation, approval, execution and monitoring stages.

Grants are non-repayable financial assistance provided by national or international governments, the private sector, foundations, or international organisations.

Taxes are compulsory contributions that can align with an NbS project.

Subsidies are a policy mechanism for funding projects, and are mainly economic tools for introducing transformative change.

New and Innovative Funding Mechanisms for Canal Restoration through Nature-based Solutions

To accelerate funding and implementation of NbS, project investments need to align with landscape-scale plans, policy priorities, and investor mandates. Financial stability in NbS projects can be built through:

1. Linking NbS projects within a landscape and public policy context:
    a. Resilience planning processes at river basin, coastal, or urban scales identify climate and hazard vulnerabilities and opportunities for NbS using an environmental, social, and governance (ESG) framework.
    b. Nationally Determined Contributions under the Paris Agreement can also be instruments for defining long-term adaptation ambitions, funding and the role of NbS.
    c. Integrating NbS into broader landscapes will help to accelerate funding. Canals should be looked at from a landscape perspective, including upstream catchments and downstream flows.

2. Creation of NbS project portfolios:
    a. Project portfolios can reduce the costs of a particular intervention and help mobilise funds for future investment.
    b. An equity fund manager can create a project pipeline.

3. Climate budgeting to make financial management more responsive to adaptation needs:
    a. Introducing climate budgeting as a catch-all budget component will help build long-term sustainability. This can be done through:
        i. Integrating climate considerations into public investment appraisal techniques
        ii. Including adaptation needs in annual budgets

4. Public authorities have several avenues to enable NbS projects. These include:
    a. Establishing fiscal incentives, stimuli and enabling conditions for NbS
    b. Reallocating benefits to those who are bearing the costs
    c. Establishing mandatory regulation models that create markets
    d. Developing blended finance mechanisms with the support of financial institutions

5. Designing NbS projects to unlock private financing

6. Establishing databases to systematically track costs and performance values of an NbS initiative

Guidelines of European Development Bank to structure a sustainable NbS*

1. Understand the basics of financing
2. Describe the business model and its impacts
3. Prepare historical financial accounts
4. Forecast future cash flows
5. Identify risks and mitigation methods
6. Review financial instruments
7. Assess appropriate legal structures

**European Investment Bank (2020) Investing in Nature: Financing Conservation and Nature-based Solutions. 36 pp.*

Stakeholder Engagement

Stakeholders are organisations or social groups of any size that act at various levels, have a significant and specific stake, and can affect or be affected by resource management. A successful NbS will require the support of a range of experts and stakeholders, as well as their collaboration. These stakeholders should be engaged in the design development process and will also contribute towards creating conditions for the implementation and maintenance of NbS.

Some of the important stakeholders can include:

1. Ministries and government agencies
2. Corporates
3. Community land-owners, community members
4. Non-governmental organisations
5. Civil society groups
6. Financial institutions
7. Contractors, developers, and technical experts

Various tools can be used to identify the key stakeholders. Table 6 provides an example of a stakeholder mapping worksheet.

Table 6: Stakeholder mapping worksheet

Stakeholder	Project/ Output	Impact	Influence	Interests	Role	Strategy for engagement	Contact person	Notes
		Level of impact (low, medium, high)	Level of influence on the project?	Key stakeholder concerns?	Potential to support or hinder the project?			

How to communicate NbS effectively?

Communication strategies should be designed to clearly convey the NbS narrative to key decision-makers and stakeholders and build political will. A cohesive strategy is needed for effective communication.

Key elements to address in a communication strategy include:

- Why is this necessary? What is the purpose?
- What is the message?
- Who is the audience?
- How do we reach the audience?
- Are there key dates by which messages need to be delivered?
- Where?

Using visual aids can become an integral component of the NbS narrative to capture stakeholder interest. Landscape architecture renderings can be particularly effective in generating interest in NbS and canal restoration. Posters, short videos, fact sheets, and face-to-face conversations are other effective communication measures. Refer to Table 7 for more details.

Table 7: Communication pathways[11]

Pathways	Tools and materials	Reach	Disadvantages
Media (press)	Blogs, articles, interviews, press releases, brochures, flyers, manuals	Wide outreach	Message cannot be changed once released
Media (press)	Interviews, discussions	Wide outreach	Depends on quality of the interviewer and moderator
Media (television)	Short clips and documentaries	Wide outreach	Message cannot be changed once released
Electronic media	Emails, e-newspapers, websites	Limited to those with access to internet	Message cannot be changed once released
Marketing	Advertisement, banners, billboards, light boxes	Wide outreach	Message cannot be changed once released
Social media	Blogs, hashtags, podcasts	Can become viral but limited to those with access to internet	Needs strong moderation to maintain focus
Places of religious worship	Posters, flyers	Limited reach, but effective	Message cannot be changed once released

11. Hesselink, F.J., Goldstein, W., von Kepen, P.P., Garnett, T. and Dela, J. (2007). Education and public awareness. A toolkit for the Convention on Biological Diversity. Montreal: IUCN. Commission and Education and Communication. 310 pp.

Design Development

The purpose of these initial steps is to assemble a design team that can clearly define the problems the NbS is intended to address and, with community input, develop initial design concepts to meet the project goals.

Steps involved in assembling a design team include:

- Restoration specialist with expertise in canal restoration
- Trusted community liaison
- Project manager
- Climate expert
- Engineers
- Technical advisory committee
- Financing partner

Table 8: Overview of NbS design development process (final process will be decided after field visit)

Design phase	Description
Concept	Concept sketches with potential design solutions, produced after collection of existing data, initial site evaluation and site visits
Design alternatives	Based on review of concept sketches by the community and design team, detailed designs with cost estimates are developed
Permit package	The design package includes all inputs from the community.
Final design	Refined design based on input from permit approvals, technical reviewers and community.
Construction documents	Final design prior to construction that incorporates all comments from previous design reviews

What data is needed to design an NbS-based canal restoration project?

Data needs are project- and solution-specific. Key factors to consider while designing an NbS include:

- Affordability
- Technical feasibility
- Political will
- Maintenance and associated costs
- Monitoring approach and associated costs
- Flexibility to adaptively manage the project
- Potential to maximise ecosystem restoration and conservation
- Cultural appropriateness

Species selection

Unless careful attention is paid to plant selection, the delivery of ecosystem services will be compromised.

Choosing species

For canal restoration, the focus needs to be on native species. The Global Invasive Species Database[12] should be consulted to verify the nativity of any species. To increase plant diversity, a mix of species should be used.

12. Invasive Species Specialist Group (SSG). (2015). The Global Invasive Species Database. Version 2015. https://www.iucngisd.org/gisd/

How to plant

A mix of species should be planted randomly, rather than in rows. Many mangrove restoration projects following the 2004 Indian Ocean tsunami failed due to inadequate understanding of mangrove ecology. Understanding ecological restoration is thus critical.

Where to plant

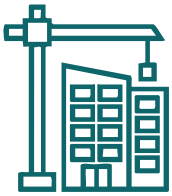
It is essential to determine which species to plant and where. For example, large areas of salt marshes are divided into low marsh (near the water) and high marsh (at higher elevation), as flooding and salinity vary from the marsh exterior to the interior. Stress-tolerant species are found in low marsh areas, and more competitive species are found in high marsh areas. Planting species in unsuitable areas will not work.

Species for urban canal restoration

In urban areas, canal restoration should also increase the aesthetic value. Horticultural species may be used, but their suitability should be verified using the Global Invasive Species Database.

In addition, a goal in urban settings is to increase urban biodiversity. The inclusion of butterfly- and bird-attracting plants and trees is recommended. Once insects appear, insect-eating birds will follow, and so on, until a complete suite of predators and prey is present in the urban area.

Construction



Three construction models are detailed below.

1. Community-Build

This model is specific to the community where the NbS-supported canal restoration project will be implemented. It emphasises a people-centred approach that provides community members with the livelihoods needed to implement, maintain, and monitor the NbS project. The immediate beneficiaries are the communities and the local government associated with it.

Engaging the local community in building, monitoring, and maintaining NbS-based canal restoration projects has several benefits:

- It promotes ownership and responsibility for the project.
- Keeps resources local
- Community members are familiar with the area and local conditions.
- Community engagement is cost-effective as there is no need to transport labour from elsewhere.
- The process builds the construction skills of the community members.
- The community can monitor and maintain the system as a result of leading the project construction.

The disadvantages or risks include:

- Risks of injury of inexperienced community workers during construction
- The community may not have enough skills to construct and maintain the structures and may need additional training.

2. Design-Build

A design contractor is hired as part of the design team. Benefits of this model include:

- There is continuity, and communication throughout the design and construction.
- This brings specialised construction experience and access to special equipment, as compared to the community-based model.

The disadvantages include:

- The issue of committing to a contractor during the design phase, when the full scope of the project is not finalised
- Reliance on people with expertise coming from outside the communities
- An outside design team may not be trusted by the community and may be unfamiliar with local conditions and culture.

3. Contractor-Build

A traditional construction model where a contractor is hired following a tender.

Benefits of this model include:

- It brings specialised construction experience and specialised equipment.
- Contractors can ensure efficiency in use of material, equipment and time, resulting in cost savings.

Disadvantages of this model include:

- It may be more appropriate for large-scale projects.
- Issue of reliance on people from outside the community
- The contractor may not be trusted by the community and may be unfamiliar with the local conditions and culture.

Activities during each phase of an NbS-based canal restoration project

Pre-construction

- Design and permits
- Develop the project maintenance plan
- Coordinate regularly with the local communities and adjacent landowners
- Resolve construction access concerns
- Mobilise equipment and materials

Construction

- Communicate regularly with the project and delivery team, contractors, and the community
- Deploy erosion control and stormwater management measures
- Upgrade site to establish design elevation and slopes
- Install project elements
- Verify all elements included in the construction document
- Clean the site and remove equipment and materials

Post-construction:

- Obtain an as-built survey of the project site that includes all project elements
- Monitor, maintain, and adaptively manage the project site, recognising that green elements may take years before achieving their full potential

Monitoring, Maintenance, and Management

Project monitoring is critical to document and assess the strengths and weaknesses of each project and to inform future NbS-based canal restoration projects. Monitoring supports essential components of any project, including evaluating the strengths and weaknesses of project measures, avoiding maladaptation, and ensuring that project outcomes are achieved.

Compared to conventional grey infrastructure, NbS-based restoration can deliver a host of co-benefits. Four steps for designing and implementing an adaptive management strategy for an NbS-based canal restoration project include:

STEP 1
Develop a monitoring and evaluation framework

STEP 2
Define indicators, baselines, and targets

STEP 3
Operationalise the monitoring and evaluation framework within a maintenance plan

STEP 4
Use and communicate results through an iterative process

How to create a monitoring and evaluation framework

Monitoring should be designed to measure and evaluate the project's intended and unintended outcomes. The framework should be based on the desired project results and measure the NbS outcomes.

When designing a project monitoring and evaluation framework, consider:

- Identifying objectives and define indicators;
- Collecting baseline data that describes conditions prior to project implementation;
- Involving local communities and stakeholders in monitoring to achieve buy-in and build local capacity;
- Developing a plan and budget for implementation, including post-project monitoring; and
- Creating a plan for analysing data and using results to inform adaptive management.

Indicators to evaluate NbS-based canal restoration projects

The indicators selected to evaluate NbS-based canal restoration projects will depend on the intended results.

The following categories can be used to evaluate project outcomes:

- Climate adaptation and disaster risk reduction benefits: Reduced vulnerability and increased adaptive capacity to manage climate and disaster risks are primary outcomes. These can be monitored by measuring people's ability to take advantage of opportunities or respond to climate risks. For example, this could include estimating reduced damage (fatalities and infrastructure loss) after flooding events in the canal.
- Ecological benefits: These may include sediment accumulation and increased biodiversity. The specific benefits will depend on the project design.
- Social benefits: Social monitoring can provide quantitative and qualitative documentation of short- and long-term impacts. Indicators may include:
  - Community perception of safety during flood events
  - Community preparedness and response on receiving notice of an impending flood event
  - Community income over time as compared to trends in comparable communities
  - Share of community income from different livelihood sources
  - Job creation and local livelihood support
  - Gender equality and women's empowerment

- Recreation and human health
- Food security
- Economic benefits (e.g., reduced infrastructure maintenance costs and flood damage)

Elements of a project maintenance plan

Project monitoring, maintenance, and adaptive management are connected in a multi-step, feedback process. This includes:

- Defining green ecosystem and grey infrastructure assets to be maintained
- Identifying each asset
- Detailing asset location, required actions, and maintenance schedules
- Applying a collaborative approach with stakeholders to help define and implement maintenance and monitoring practices
- Establishing training programmes for technical and field staff
- Monitoring asset performance
- Adapting management practices based on monitoring results to improve project functions

The NbS-based canal restoration project monitoring, maintenance, and management plan should be ecologically grounded and aligned with long-term conservation and restoration objectives.

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