Global Infrastructure Resilience
Capturing the Resilience Dividend

Building with Nature – An Evidence-based Adaptive Systems Transformation (EAST) pathway for mainstreaming NbS for climate resilient infrastructure

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Building with Nature – An **E**vidence-based **A**daptive **S**ystems **T**ransformation (EAST) pathway for mainstreaming NbS for climate resilient infrastructure

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ABSTRACT

The chapter explores the potential pathway for scaling-up nature-based solutions in climate resilient infrastructure from the perspective of coastal ecosystem resilience.

While evidence from the updated NDC submissions suggest an uptick in the perceived role of Nature-based Solutions (NbS) in mitigating and adapting to climate change, normative thinking on climate resilient infrastructure still relies largely on hard-engineering solutions. This will remain to be the case unless approaches like nature-based solutions are mainstreamed into thought, decision-making and planning processes. However, it's a long road from the recognizing the opportunities and multiple dividends that NbS can mobilize to actually implementing NbS at scale. This chapter suggests the EAST (Evidence-based Adaptive Systems Transformation) Pathway for inclusion and mainstreaming of NbS for climate resilient infrastructure. The elements of the EAST pathway include:

- **E**vidence –based education and capacity building across scales
- **A**daptive management and planning
- **S**ystems thinking and approach for NbS design
- **T**ransformative regulatory and planning perspective

This approach seeks to resolve the issues of capacity, credibility and institutional barriers to up-scaling NbS which can help not only in hazard mitigation, environmental, social and economic benefits but also a wide range of co-benefits when NbS are designed at scale. This approach could also potentially contribute to bringing about a transformational shift in perspectives that is required to understand the value of short term adjustments and long term benefits of including NbS in resilient infrastructure and development planning versus short-term business-as-usual approaches which don't consider nature and ecosystem health as part of the equation.

Keywords: Nature-based Solutions, mainstreaming, design, transformation, resilience

INTRODUCTION

Infrastructure is a key element of economic as well as social development. This is pertinently demonstrated especially in this global scenario of shocks and disruptions. In 2017, the G-20 Global Infrastructure Outlook estimates the current investment trends for infrastructure to be USD 79 Trillion and the forecast for required investment in infrastructure to be USD 94 Trillion by 2040[1]. This finance gap for infrastructure has further widened post-covid. Ambitious infrastructure development plans like the 1.2 Trillion USD Infrastructure Investment and Jobs Act in the USA and the1.3 USD Gati Shakti plan in India, aiming to create jobs along with Infrastructure development in developed and developing countries alike, shifts emphasis on finance for infrastructure. Earlier this year, the G7 have launched a USD 600 Billion partnership for global infrastructure and investment. However, it is still a long road ahead to meet the finance gap.

While the finance for infrastructure poses a problem for infrastructure development, it also presents an opportunity for more integrated and resilient approaches for 'building back better'. The urban built environment is expected to double in the coming decades wherein sixty percent of the infrastructure is yet to be built[2]. It is imperative that a crucial global challenge like climate change and its impacts be factored into the design and approach to infrastructural development. With the recent IPCC report citing the high likelihood of irreversible changes with more than 1.5-degree Celsius increase in temperature[3], the need of the hour is for existing and planned infrastructure to not only to be resilient to future climate threats but also be able to contribute to improved resilience for local stakeholders.

Climate resilient infrastructure, therefore, is a key component of the solution to future challenges. This applies to not only infrastructure that is yet to be built but also existing infrastructure that need repair and restoration. In this context, nature-based solutions can be a concept, that when applied can lead to multiple dividends.

NBS – CONCEPT AND DEFINITION

While the coinage may be a fairly new addition to the climate, biodiversity and development lexicon, the concept of nature-based solutions (NbS) is not new. Similar to autonomous adaptation, examples of nature-based solutions in practice can be found in various examples where sometimes local-level and community stakeholders have sought to solve societal challenges through innovative design and traditional knowledge, often involving local natural resources and that were available to them.

Following the Paris Agreement at the UNFCCC COP in 2015, there has been increasing conversation around NbS and it had come under the spotlight for reasons both good and controversial. Prior to 2022, there were several definitions and consequently, several interpretation of what nature-based solutions actually meant. Approaches like ecosystem-based adaptation, eco-DRR, ecosystem restoration and conservation are also parts of NbS. (add)

The European Commission defined Nature-based solutions as: "Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature

[1] Global Infrastructure Outlook; https://outlook.gihub.org/
[2] TNC, Deutz et al. 2017, https://www.nature.org/en-us/what-we-do/our-insights/perspectives/the-coming-rise-of-urban-infrastructure-turning-infrastructure-green/
[3] IPCC, WG II report, 2022

and natural features and processes into cities, [4]landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions".[5]

The University of Oxford based Nature-based Solutions Initiative defines NbS as "working with nature to address societal challenges, providing benefits for both human well-being and biodiversity."[6]. The IUCN came up with a more comprehensive definition where it defined NbS as "Actions to protect, sustainably use, manage and restore natural or modified ecosystems, which address societal challenges, effectively and adaptively, providing human well-being and biodiversity benefits".[7]

Till earlier this year, the IUCN definition of NbS was the most comprehensive and widely used definition of NbS. In March 2022, Nbs was discussed for the first time in multi-lateral forum at the United Nations Environmental Assembly. The concept and definition was agreed upon by States and the UNEA resolution now defines NbS as The UNEA resolution formally adopted the definition of nature-based solution as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits.'[8]

The UNEA's adoption of NbS and defining the concept is a very welcome move as it provides a degree of credit to the concept and entry into the United Nations lexicon. Well-designed NbS are aimed at providing solutions for crucial societal challenges while maintaining and improving human well-being and biodiversity. These solutions, when designed at scale and informed by a systems approach, can provide multiple benefits. For example, an intervention like restoring a seaward mangrove belt to the protect an earthen embankment can not only improve the structural integrity and resilience of the earthen embankment and protect the coastal and inward areas from loss of life and livelihood in the case of an extreme event like a cyclone. It also leads to sediment accretion, thereby further strengthening the coast. This would lead to improved marine as well as terrestrial biodiversity and restore habitats and connectivity for important species. In due course of time, the restored mangrove ecosystem sequester carbon and could potentially provide local livelihood resources in the form of NTFPs. However, as is evident in a lot of cases, there is concern of misuse of the concept, leading to ill-designed carbon-offset projects that do not adequately seek to protect nature, biodiversity and well-being of the local communities and systems where the projects are implemented. In order to avoid this and provide a clear guidance for design of the NbS projects, the IUCN has designed the IUCN Global Standard[9] – which has a clear set of 8 criteria that need to be kept in mind when designing and assessing NbS projects. The criteria that the global standard presents are as follows:

1. NbS effectively address the societal challenges of climate change mitigation and adaptation, disaster risk reduction, economic and social development, human health, food and water security, and environmental degradation and biodiversity loss.
2. Design of NbS is informed by scale.
3. NbS result in a net gain in biodiversity and ecosystem integrity.
4. NbS are economically viable.

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5 European Commission, Knowledge for Policy, https://knowledge4policy.ec.europa.eu/biodiversity/topic/NBS_en#:~:text=The%20European%20Commission%20defines%20Nature,benefits%20and%20help%20build%20resilience.

6 Nature based Solutions Iniotiative, https://www.naturebasedsolutionsinitiative.org/what-are-nature-based-solutions/

7 IUCN, https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

8 https://wwf.panda.org/wwf_news/?5226891/nature-based-solutions-UNEA

9 IUCN Global Standard, https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

5. NbS are based on inclusive, transparent, and empowering governance processes.
6. NbS equitably balance trade-offs between the achievement of their primary goal(s) and the continued provision of multiple benefits.
7. NbS are managed adaptively, based on evidence.
8. NbS are sustainable and mainstreamed with an appropriate jurisdictional context.

NbS has not yet been included in the text of CBD or the UNFCCC but it would be under discussion in the forthcoming COPs later this year. However, in the case of infrastructure, this should not be a reason to adjourn integration of NbS into designing climate resilient infrastructure.

CASE STUDIES: NBS FOR RESILIENT INFRASTRUCTURE

This section presents two case studies as successful examples of NbS for different societal challenges from the ecological infrastructure perspective.

The first case study explores the role of participatory development of adaptation and NbS portfolio of options that is co-created with stakeholders, capacity building of communities and decision makers and regional knowledge sharing and dissemination for better future preparedness in coastal regions. Coastal and marine resources provide essential ecosystem services, sustain key economic sectors (esp. fisheries and tourism), support the livelihoods of several million people and contribute to the protection of coastal communities against adverse effects of climate change in coastal areas of the world. At the same time, these coastal areas are among the most vulnerable regions and ecologically sensitive regions bearing the continued brunt of climate change impacts. The management of these resources and ecological infrastructure, including through Marine Protected Areas (MPAs) and overarching coastal development frameworks, does not yet adequately take into account adaptation principles and options. There is a need to strengthen capacities in coastal communities and government institutions to integrate climate change scenarios and adaptation options into a participatory decision-making process that can inform MPA as well as coastal zone management and development policies.

The second case study presents the case of impacts and wildfires and how NbS for resilient infrastructure can contribute to addressing impacts.
Wildfires are on the rise across the globe and with increasing frequency of incidence and intensity due rising global air surface temperatures[10]. Extreme heat and drought like conditions coupled with reduced humidity and conducive winds can lead to large scale damage to ecosystems. The impacts are exacerbated when the vegetation type includes dense, invasive and non-native species. These impacts pose a high risk to habitats and species, while also leading to disturbance in ecosystem functions due to loss of green cover. They would also lead to sudden release of sequestered carbon into the atmosphere. This case study demonstrates how NbS approaches [11]for resilient ecological infrastructure involving restoration of riparian water bodies. Through restoration of riparian habitats and enhanced moisture in the riparian zone, riparian areas next to streams and rivers can disrupt the spread of fire within a landscape and often burn at lower severity.[12]

[10] Rosenszweig, 2016
[11] WWF Mesoamerica, Smart Coasts,
[12] Fire Science, https://www.fs.usda.gov/psw/topics/fire_science/ecosystems/riparian.shtml

1. Case Study Name: Smartcoast

Smart Coasts seeks to reduce the vulnerability to climate change of coastal communities by identifying, prioritizing and implementing ecosystem-based adaptation measures. The project was designed to bring climate change adaptation benefits to local communities from strengthening ecosystem services, not necessarily direct financial benefits. However, during the implementation phase (2022), local communities were hired to conduct ecosystem restoration activities leading generation of green jobs.

Societal Challenge Addressed: Climate change adaptation and disaster-risk reduction

Inclusive Governance: Multi-country dialogue

Balanced Trade-offs: Yes

Adaptive Management: Yes

Mainstreaming and Stability: Yes

Scale of Design: Regional- Latin America and Caribbean. Countries of Implementation: Mexico, Belize, Guatemala, Honduras

Biodiversity Net Gain: Yes, through habitat for species, pollination & seed dispersal, soil formation & protection, hazard regulation in coastal Dunes, coastal reefs and mangroves

Economic Feasibility: Yes

WWF- Mexico, SmartCoast

Contact/Source: WWF Mexico; https://www.wwfca.org/en/smartcoastsmar/

2. Case Study Name: Alvares - landscape management for rural fire prevention

Phase 1 - Restoration of water stream riparian areas as protection against fire, ~500k€. Successful in fire reduction in 60% of the area

Societal Challenge Addressed: Climate change adaptation and disaster-risk reduction, Forest fires

Scale of Design: Sub-national. Country of Implementation: Portugal

Biodiversity Net Gain: Yes, measured through population of bats

Economic Feasibility: Yes

Inclusive Governance: Yes, In partnership with Gois Municipality

Balanced Trade-offs: Yes

Adaptive Management: Yes

Mainstreaming and Stability: Yes

WWF- Portugal, Alvares

Contact/Source: https://www.alvares-fogo.com/ ; https://aigp-alvares.pt/

CHALLENGES AND BARRIERS TO MAINSTREAMING NBS

Since NbS as a term is fairly new entrant into the and though it is composed of familiar concepts, it takes time to build familiarity and credibility. However, the complexity of the nature of NbS makes it that much challenging to explain the multitude of benefits that can be accrued through this approach. Resilient infrastructure itself is a complex endeavour seeking to address assets and variable deterioration patterns, evolving nature of risks, sector regulations and by laws while maintaining optimum provision of services. To add an additional layer of nature-based interventions, that are most likely slower than engineering solutions in the delivery of outcomes and making operation and management that much more challenging, can be a daunting task. However, the merits and rewards of NbS promise to far outweigh their perceived challenges. NbS can bring about not only short-term but also medium as well as long-term benefits and has the potential capacity to catalyse transformational change thereby improving resilience and adaptive capacity of systems. For example, constructing sponge cities to stop flooding in China.[13]
A crucial requirement for NbS to be able to bring about transitional and consequently transformational change in the infrastructure space, is the need to mainstream NbS for resilient infrastructure. However, there are several challenges that need to be addressed and barriers to overcome so that NbS can be mainstreamed in the development of resilient infrastructure.
The four categories of barriers are

Institutional and regulatory barriers:

These refer to barriers related to the rules and conventions required for the effective governance of nature-based solutions

1. There are, at present, no global or regional institutional or frameworks that mandate the inclusion of NbS in the design and implementation of infrastructure projects. Most projects are either exploratory and/or voluntary in nature
2. Despite the recent UNEA resolution, NbS has not yet been in included in the Paris Agreement text. Even though NbS, in the context of resilience and infrastructure, has been mentioned by more than 66 signatories of the Paris Agreement in their NDCs, these NDCs are not legally binding and do not compel parties to implement/achieve mentioned targets.[14]
3. In a discipline like infrastructure, which has strict regulatory norms, building codes, by laws etc. – NbS can be perceived as a rather fluid concept and thereby and unrealizable concept without proper evidence to support the effectiveness of suggested solutions.
4. Lack of cross-disciplinary and trans-disciplinary engagement in operating bodies – Tendency to work in silos.
5. Lack of adequate evidence of efficacy: In several cases, decision makers as well as funding partners are designed to look for operational proof that a suggested intervention will be able to deliver the outputs that were promised- which is not always possible in the case of NbS.
6. Lack of any strong coordinated political will

[13] Sponge Cities in China. https://www.dw.com/en/china-turns-cities-into-sponges-to-stop-flooding/a-61414704
[14] UNFCCC, NDC. https://unfccc.int/ndc-information/nationally-determined-contributions-ndcs

Financial Barriers

These refer to the barriers to procuring adequate and effective funding and investor interest in NbS based resilient infrastructure projects.

1. The marker of a countries /development/ progress, the Gross Domestic Product (GDP does not account for natural capital. Not only does this lead to the perceived devaluation of natural resources but also leads to lack of measurement for the financial impact of positive and negative interactions with regard to nature and natural resources. For example, depletion vs natural sustainable flows and consumption patterns.[15]
2. NbS has to compete with other uses- more lucrative uses for the land resources and land is a very valuable resource
3. NbS also has to compete with other investment opportunities which could provide faster returns on Investment
4. Lack of replicable financial models like PPPs in this context
5. Difficult to put a price/value on nature
6. Limited direct return flows from the perspective of the investor. The NbS returns can be cascading and distributed across groups of stakeholders which might not be very attractive from the investors point of view.

Capacity, Knowledge and Skills

These pertain to the barriers in appropriate capacity to conceptualize, design and implement high-impact NbS projects

1. There is a need for clarity in the concept of NbS itself. With multiple definitions circulating, there is a lack of standardization – which can potentially lead to misinterpretation and provide scope for misuse
2. Lack of understanding cross and transdisciplinary concepts of practitioners and decision makers. While infrastructure and NbS projects are both site based, NbS approach promotes designing at scale, factoring in upstream and downstream impacts and benefits
3. NbS requires capacities that can customize approaches to suit local conditions. NbS requires more context-specific information for appropriate design and customization to suit the needs of the project site.
4. Inadequate dissemination of learnings from past experiences - Perception of Engineering-based solutions to be more effective than without looking at long-term impacts. An example of on an NbS like living shorelines amply demonstrates the merits of NbS. However, there is a need to share these examples so that others can learn.

AN EVIDENCE-BASED ADAPTIVE SYSTEMS TRANSFORMATION (EAST) PATHWAY FOR MAINSTREAMING NBS IN CLIMATE RESILIENT INFRASTRUCTURE

This section presents a pathway for initiating mainstreaming of NbS into resilient infrastructure development approaches. However, prior to proposing recommended pathways, there are several

[15] WWF, 2021, Powering Nature

aspects that need to be addressed, resolved and clarified for such a pathway to be effective in operation.

As discussed in the previous section, there exist several barriers and challenges to implementing and mainstreaming NbS. Mainstreaming NbS for resilient infrastructure needs to be prefaced by transformational change in design, thinking and planning. This requires concentrated and coordinated thought leadership and political will across scales and levels of governance. Political will can be one of the most important drivers of systemic transitional and transformative change. (add reference). It is amply demonstrated that there is immense political drive to promote infrastructural development across countries in the race for post-covid recovery. It is important that thought leadership and implementation of these plans include long-term vision and are also informed by the projected impacts of climate change. Existing infrastructure plans should incorporate tweaks in design so that NbS can proactively contribute long term resilience through the plans that have already been set in motion. Adoption of standardized definition and assessment of NbS, regulatory frameworks and policies are required so that there is clarity before NbS in put into wider practice.

The transition towards mainstreaming NbS for resilient infrastructure should be lead by

Evidence – based education and capacity building across scales

Build compendium of successful NbS case studies and best practices

Several international organizations, multilateral and bilateral organisations and funding agencies have existing databases of funded NbS projects with details. Many of these are already published in the public domain[16] or are in the process of publishing[17]. These databases should be collated to create a compendium of projects with societal challenges they are seeking to address, the intervention that are being/ have been implemented, the indicators used for measuring impact and the cumulative impacts over short, medium and long term. With continued monitoring and evaluation to demonstrate cumulative impacts and benefits, these cases can provide evidence for scale-up in other locally, other regions with similar challenges and mobilize funding and lead to creation and implementation of investment ready projects.

Enhance capacities and knowledge networks through targeted professional training courses

The emerging ESG landscape has given rise to multiple certifications for proficiency in a range of index-based assessments. Not only is this creating a cadre of qualified professions to design, assess and provide recommendations for ESG projects, they are also contributing widespread knowledge and knowledge networks and opportunities for cross-learning. For NbS professional training, while some certificate level courses exist, they are not as targeted and standardized. The IUCN Global standard has a certificate course in the early stages. NbS courses needs to be customised by level of governance. Since NbS projected require a degree of customization, Courses should have components that cater to regional and global, regional, national and local level decision makers, practitioners and finance professionals are required. Such courses, aligned by a common top-level

[16] World Bank, GFDRR, 2022, https://naturebasedsolutions.org/projects
[17] WWF, Global Map of NbS projects - Upcoming

understanding of NbS as a concept but also customised to specific thematic areas one which can be resilient infrastructure in different systems based on ecosystems like urban, coastal, grasslands, riverine areas etc. can help professionals from different disciplines build their capacities for design components, interventions and long term sustainability of NbS projects.

Handbook of knowledge resources for practitioners

In the course of envious projects that have been implemented or are being implemented, several important data emerged from supporting assessments. For example, they can be high resolution projected climate projections for specific scenarios, cost benefit analysis, benchmarks for carbon sequestration values or standardised methods for verification. Such important data are often lost in the volume of research output that is generated and oftentimes practitioners implementing other NbS projects are unable to access these resources. Therefore, a handbook that compiles specific data points based on thematic areas like carbon sequestration values or cost benefit analysis can prove to be significantly useful for future research and development in developing resilient infrastructure projects.

Establishment of communities of practices for thought leadership and partnerships

Knowledge sharing and transfer are key components that can accelerate scale-up an uptake of novel and innovative ideas, interventions and proposals. Communities of practice have proved to be useful tools in sharing ideas, leveraging resources for projects on common interests at a larger scale. It allows lik- minded stakeholders with common interests to explore specific thematic areas in more depth and provides a platform for co-development of new projects, programmes and initiatives. For example the Resilient Asian Delta's programme allows for development and mobilizing funds for new NBS projects in the Asian deltaic region through facilitation of in Asia and the Pacific with participants from India, Pakistan, Myanmar, Thailand, Viet Nam, Hong Kong and China.[18]

The established communities of practice should encourage decentralised reporting responsibilities based on regions or countries to ensure both ownership and responsibility within community partners. This can also encourage partners to work in smaller cohorts that can be specific to local regions, states or countries with common issues and work towards common goals like development of system- based information catalogues by regions or countries, depending on the strength of the community. Communities of practice can also contribute to the development of position papers and perspectives for advocacy at important global and regional events or forums.

Since communities of practice are dynamic in nature with periodic flux of participants, it would be a good practice to encourage participants to contribute to regional hubs which can act as knowledge repositories in the event of outgoing resource persons/practise members

Curriculum for transdisciplinary learning at university level

To prepare the next-generation of innovators, designers and practitioners, it is important that the foundation is strong. In order to achieve this, design and access to trans-disciplinary educational streams and material is required. Innovations in course structure can be introduces through interdisciplinary subjects like climate change, cultural ecology, finance, governance, environmental impact assessment and land-use planning. Course credit mechanisms that encourage transdisciplinary learning an application of systems thinking for design and planning for solutions to

[18] WWF, 2021, Resilient Asian Deltas. https://wwf.panda.org/discover/our_focus/freshwater_practice/freshwater_inititiaves/resilient_asian_deltas_initiative/

complex problems can contribute to the development of better prepared next generation professionals.

Adaptive management and planning

Restoration and retrofitting of existing projects, wherever its possible and adds value

A lot of NbS projects tend to be grant-based at present. In order to build a case for bankable projects and transition from grant-based to investment ready projects, evidence in practice of successful implementation is required. Infrastructure projects that are in need of restoration can provide excellent opportunities for testing and building evidence for the efficacy and resilience building capabilities of NbS. Financial resources allocate to operation and maintenance expenses, when available, can be used for such pilots. Successful interventions that are able to demonstrate effectiveness can lead to further expansion and scale-up.

Promotion of participatory local stewardship

Local stakeholders are, more often than not, excellent resources and local stewardship can provide both use and non-use values.[19] Human values associated with biodiversity and conservation of local resources cannot be easily valued. However, an assessment conducted by Roman et al. demonstrates that stewardship activities contributed almost 70% more than major activities that supported the regional economy in coastal Massachusetts in the same year (2014). Local stewardship can promote inclusive governance and aid in local level monitoring. It can also create ownership for better success of implemented interventions and creation of direct information channels that would lead to better adaptive management.

Contingency planning

Demonstrated success in implementation can play as significant role in mainstreaming. In the case of NbS for resilient infrastructure projects, lack of initial examples of success or reports of failure of interventions, even if they are due to external shocks, can discourage further uptake. Based on possible what-if scenario based analysis, it would be good practice to undertake anticipatory actions and safeguards for better preparedness under different scenarios. Such preparatory activities would not only lead to a more robust plan but also improved investor confidence in the proposed project.

Reviewing developments at regular intervals

Evolving bio-physical, ecological, political and local scenarios can present unique challenges as well as opportunities for management, scheduling and planning of projects. While issues like civil unrest, extreme events like floods, storms and forest fires can pose challenges for implementation at the local level, evolving policy and regulatory scenarios can also present opportunities for incentives, recognitions, and collaborations. Timely review of relevant developments can thus provide insight for remedial measures and course correction to avoid delays and benefit from on catalytic opportunities.

[19] Roman et al, 2018. Stranded Capital-Environmental stewardship is part of the economy, too. Front Ecol. Environ 2018; doi: 10.1002/fee.1780

Systems thinking and approach for NbS design

Systems perspective in design

Interventions that seek to improve resilience but are informed by issues of scale in their design often tend to create unanticipated problems in areas further upstream or downstream. For example, hard structures like seawalls and breakwaters were built along the coast for coastal protection in Cochin, Kerala. In Chellanam, which lies downstream Cochin, the 2018 NCESS study shows that the region south of Cochin inlet (where Chellanam lies) has been under erosion for years. While activists and fishers blame the continuous dredging of the Cochin port for the coastal erosion, scientists also say that the renovated harbour breakwater could be increasing the rate of erosion. Further downstream, in Shanghumugham, the beach is getting eroded at an unprecedented rate leading to complete damage of nearby road connecting to the city airport and in some cases loss of homes. Scientific studies have mentioned that hard structures such as breakwaters, seawalls and promenades, and activities such as dredging cause irreversible erosion of the beaches. Therefore, it is important to understand and review the nature of interaction within systems and identify the positive and negative interactions across upstream and downstream reaches.[20] upstream downstream issues review.

Climate informed long- term resilience planning and designing at scale

Climate assessments such as vulnerability and impacts assessments, loss and damage avoided assessments should inform the design of NbS for infrastructure. The interventions and solutions proposed should be win-win solutions that factor in the changing climatic and weather patterns.

Climate assessments should also inform the geographies of interventions. For example, in a coastal ecosystem, if a certain part of the coast is predicted to ne submerged below sea level due to predicted seas-level rise, then no matter how innovative the solution for coastal protection, when the coast itself is submerged, NbS or other interventions would provide little value. In such cases, the capital invested would also be lost and would be much better if put to use in an area where it can contribute to coastal protection of the new coastline.

Similarly, to achieve change in one location, several interventions needs to be put in place across scales to facilitate the adoption and uptake of NbS for resilient infrastructure. In the case of (add reference) Interventions in multiple places and levels to solve problems in one area. Creates opportunities for others follow same template resolving policy issues. Resolving competing interests across systems

Combination approach to design:

Combination approaches to green-grey infrastructure should be explored rather than isolated approached to NbS. NbS should be designed as part of the portfolio of solutions that can together combat present and future climate impacts and improve resilience. It is important to recognise the NbS alone would not be able to severity of impacts and extremes that are expected in the future climate scenarios. In coastal areas that are prone to storm surges, the surge height is an important factor to consider when designing solutions. If the surge height is much higher than proposed mangrove belt that would be restored, then the impact would still remain even if the mangrove belt was restored. There would be inundation and coastal flooding in such a scenario. In such a case a

[20] https://india.mongabay.com/2022/05/hard-constructions-continue-to-erode-keralas-coastline-leaving-communities-stranded/

combination of higher embankments and structural measures to ensure drainage after flooding would be more effective.

The goal should be to the address the societal challenge/climate impact through a combined approach that provides the best fit.

Transformative regulatory and planning perspective

Balancing trade-offs short term adjustments versus long term benefit and Long-term vision

There is a certain gestational period after the implementation of NbS before we are to observe the multi-fold outcomes of NbS. In such a scenario, where the resilience benefits are not always apparent and sometimes not even demonstrated, it is a challenge to build the case for NbS. Therefore, there is a need to balance trade-offs to make space for short term adjustments for longer term benefits.

Building constituency of like-minded stakeholder groups and Facilitate thought leadership

Building a cadre of catalytic thought leaders who are able to engage and provide leadership across scales, regional and national levels scales. To build interest and conversation for achievement of common goals, coalitions like CDRI can create platforms and engage with other institutions which in turn presents outputs such as policy briefs, campaigns and advocating for transitional and transformational change. There can also be citizen engagement to present local perspectives.

Finance and design of bankable investment ready projects

According to the UN Environment Program, there is currently roughly US$133 billion a year flowing into nature-based solutions, with an estimated annual gap of about US$536 billion per year and over US$4.1 trillion by 2050.99 While this gap clearly cannot be filled by public finance alone, it is exacerbated by public incentives and financial flows that continue to support economic activities that create challenges for nature

There is a broad spectrum of potential financial viability among nature-based solutions and, as a result, the appropriate financial mechanisms also vary from purely profitable to the purely public grant-based and philanthropic. For fully bankable nature-based solutions, there is a wide range of investors and associated instruments that can potentially support them at various scales – from debt or equity financing to loan guarantees or even green bonds that cover sectors, landscapes, or regions. The key is to select the right instruments that also recognize the value of nature

It is also important to acknowledge trade-offs between financial, social and environmental aspects. As NbS have a broader cascading group of stakeholder beneficiaries, it can make trade-off and costs and benefits that much more complex. Well-defined benefit sharing mechanisms and improved understanding of trade-offs between environmental social and financial aspects would ensure sustainable solutions.

The International Business Council of the World Economic Forum, for example, has taken up work on Stakeholder Capitalism Metrics, engaging business leaders on standardized environmental and social impact measures. Auditors are also looking more closely at measurement of sustainability. The Global Public Policy Committee of the largest accounting firms has committed the group to assuring that the financial statements they audit incorporate material climate risks, and standards setters have announced the creation of a Sustainability Standards Board, starting first with climate.

Initiatives such as these can lead to the creation of strong and clear metrics that can further create an avenue for design of bankable and future investment-ready NbS projects.

CONCLUSION

Traditionally, or more appropriately, historically, infrastructural development has come at the expense of nature. Large swathes of vibrant, lush green land, free-flowing rivers and oyster colonies and shallow water fish habitats have had to make way for railways track, industries, roads, dams, ports and many more such infrastructural developments. Given that this decade 2021-2030 has been declared by UN General Assembly as the UN decade of ecosystem restoration – let this be a starting point and opportunity for bridging the gaps and dichotomies in approaches.