CLIMATE-RESILIENT DAMS AND
HYDROPOWER INFRASTRUCTURE
INTEGRATING
ENVIRONMENTAL SUSTAINABILITY
IN PLANNING AND DEVELOPMENT

Climate Finance through Nature-based Solutions: Leveraging Carbon Markets for Climate-Resilient Water and Hydropower Infrastructure

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Who We Are

Founded in **2009**, Iora Ecological Solutions is a leading global developer of nature-based projects in India

We possess **proven expertise in finance, policy advisory, scientific research, project design, and implementation.**

Over the past 15 years, we have successfully **implemented 200+ projects aimed at promoting conservation and management of natural resources, as well as climate mitigation and adaptation.**

We provide turnkey design, development, and management of **nature-based carbon projects.**

We have a strong track record in planning and implementing the restoration, revegetation, and conservation of **forest, degraded, and agricultural land.**

Our multidisciplinary team of nearly **60 experts includes specialists in forestry and biodiversity conservation, climate science, natural resource management and carbon forests, community engagement, and remote sensing and GIS.** They excel in identifying and providing effective solutions for climate action and conservation.

What We Do?

Developing & Financing Nature-based Solutions

We develop market mechanisms like carbon credits and biodiversity offsets to support nature-based solutions for landscape restoration, conservation, and climate action. Using advanced technology and climate risk assessments, we create interventions that boost community and ecosystem resilience.

Nature Metric: Our Tech-based MRV System

We use remote sensing, GIS, and AI/ML to create platforms that track degradation, land-use, and ecological changes in Forestry, Agriculture, and Water. Our cloud-based Big Data tools enable precise modeling, from individual trees to watersheds, supporting carbon assessments and resource monitoring for better decision-making.

Corporate Nature Strategy

We help organisations in adopting a nature-positive approach by valuing ecosystem services like clean water and climate regulation. We also provide training and toolkits to help integrate nature-based solutions, benefiting stakeholders, the environment, and communities.

Policy Advisory

We develop integrated policies for ecosystem conservation and climate action, using a participatory approach that engages communities, businesses, and governments. Our policy contributions in India are driven by robust data, analytics, and multi-disciplinary expertise, ensuring diverse perspectives are integrated for effective solutions.

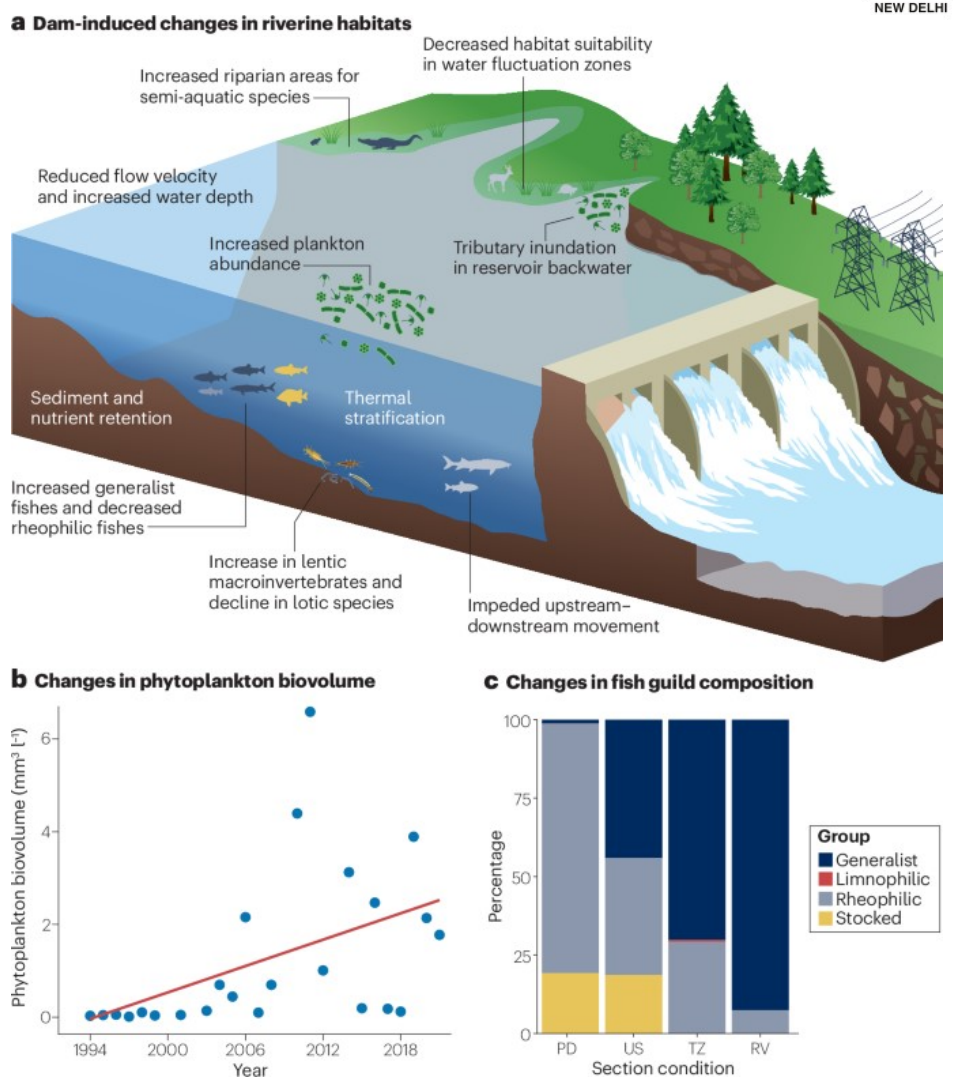
15 Years of Committed Action for Developing and Implementing Nature-based Solutions to strengthen ecosystems, economies, and communities.

The Core Argument

- Hydropower is often labeled *"clean energy"* yet its **long-term viability is increasingly threatened by nature degradation**
- Floods, siltation, catchment erosion, disrupted river ecology and biodiversity loss are **direct financial and operational risks**, not external environmental issues
- Climate change amplifies these risks, making **grey infrastructure alone insufficient**
- **Hydropower without ecosystem restoration is not climate-resilient**

Risk → Degradation → Losses

Hydropower impacts on riverine biodiversity



Source: https://www.nature.com/articles/s43017-024-00596-0

**Note: Perspective from a carbon market project developer working at the energy–nature interface*

The Transition

- **Nature-based Solutions (NbS):** watershed restoration, riparian buffers, wetlands, act as **natural risk buffers**
- When paired with **carbon markets & ecosystem finance**, restoration shifts from a *cost* to a **revenue-generating asset**
- This enables **net-positive hydropower landscapes** over the project life cycle

Nature-based Solutions – A No-Regrets Strategy for Climate Mitigation

- **>50%**

  Of global economic output is dependent on nature and its services

- **1.75**

  Number of planets humanity would need to sustain its current rate of consumption of natural resources

- **$354 Bn.**

  In annual investments in nature-based solutions needed by 2030 to meet biodiversity and land degradation targets

Source: WWF I WEF

Nature-based Solutions are 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.

-United Nations Environment Assembly (UNEA)

Categories of NbS Approaches

Ecosystem restoration approaches

- Ecological Restoration (ER)
- Ecological Engineering (EE)
- Forest Landscape Restoration (FLR)

Issue-specific ecosystem-related approaches

- Ecosystem-based Adaptation (EA)
- Ecosystem-based Mitigation (EM)
- Climate Adaptation Services (CAS)
- Ecosystem-based Disaster Risk reduction (EDRR)

Infrastructure-related approaches

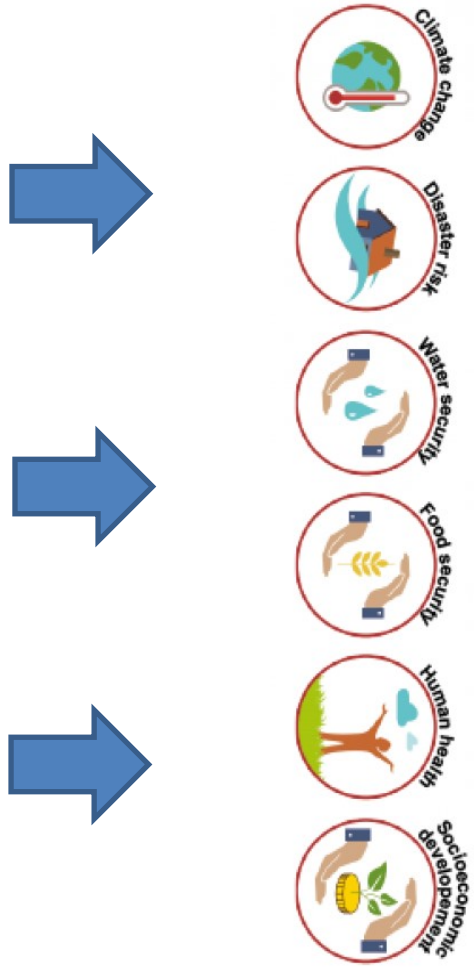
- Natural infrastructure (NI)
- Green infrastructure (GI)

Ecosystem-based management approaches

- Integrated coastal zone management
- Integrated water resources management

Ecosystem protection approaches

- Area-based conservation approaches (ABC)



NbS Funding – Global Scenario`

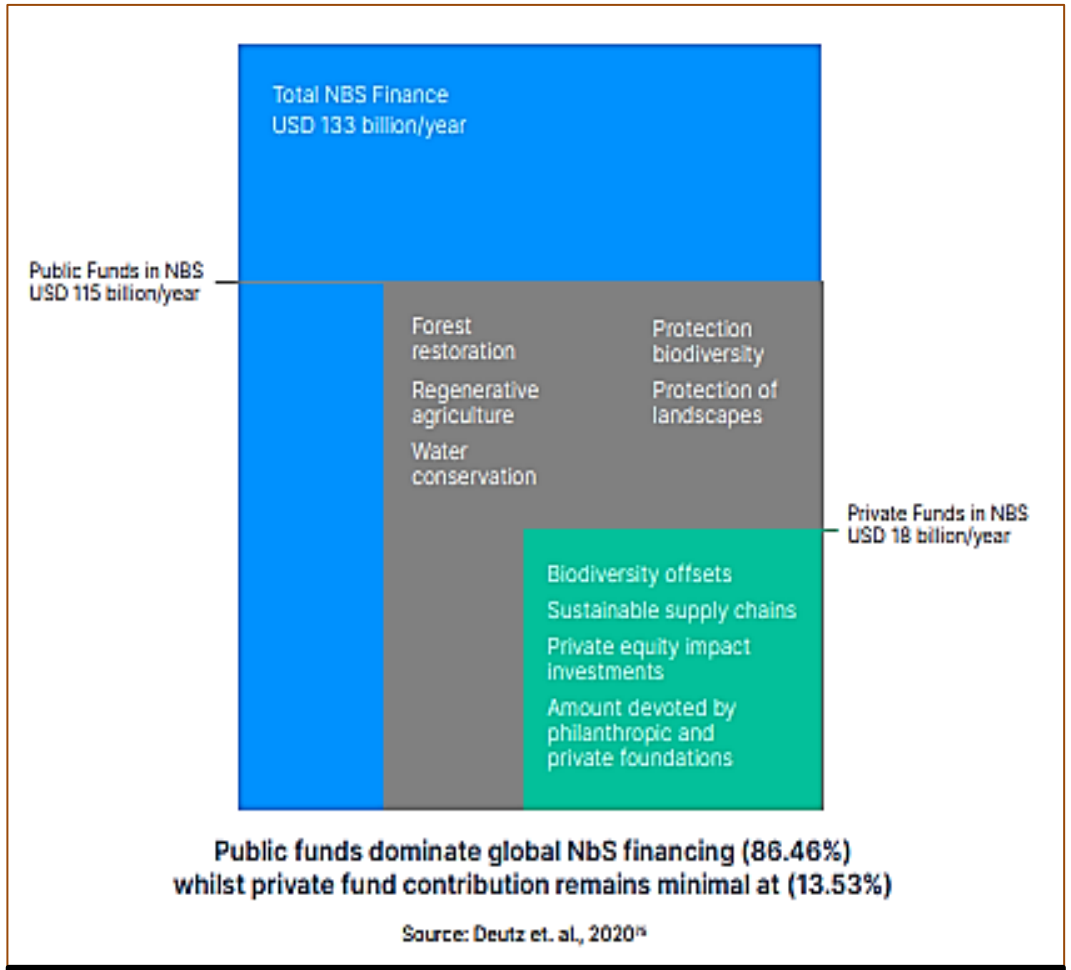


Fig: Global biodiversity conservation funding needs (in USD billion/year)

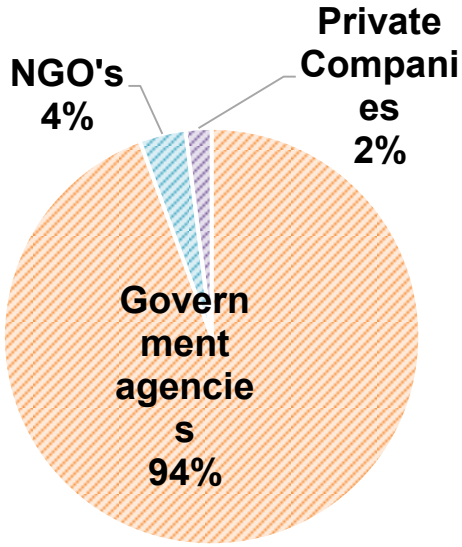
We need nature-based solutions (NbS) to provide up to a third of the mitigation required by 2030 in order to keep the goals of the Paris Agreement in reach. However, in 2022 they received roughly $200 billion a year, – up from $154 billion in 2021. While this represents an increase of 11%, it is still only a third (37%) of what's needed by 2030 to achieve global climate and biodiversity goals.(Source - UNEP State of Finance for Nature 2023 report)

"Public funds dominate global NbS financing (86.46%) whilst private fund contribution remains minimal at (13.53%)." - (Deutz et. al., 2020)

NbS Funding – Indian Scenario

Currently, **public funds make up 86% of finance-flow** into nature conservation and restoration, while the private sector finance and engagement will have to be significantly scaled up.

- The G20 countries invested $120 billion in nature-based solutions in 2020, according to the State of Finance for Nature in G20 report.
- However, **future global investment in NbS needs to triple by 2030** and **increase four-fold by 2050, namely $536 billion annually to meet net zero targets.**



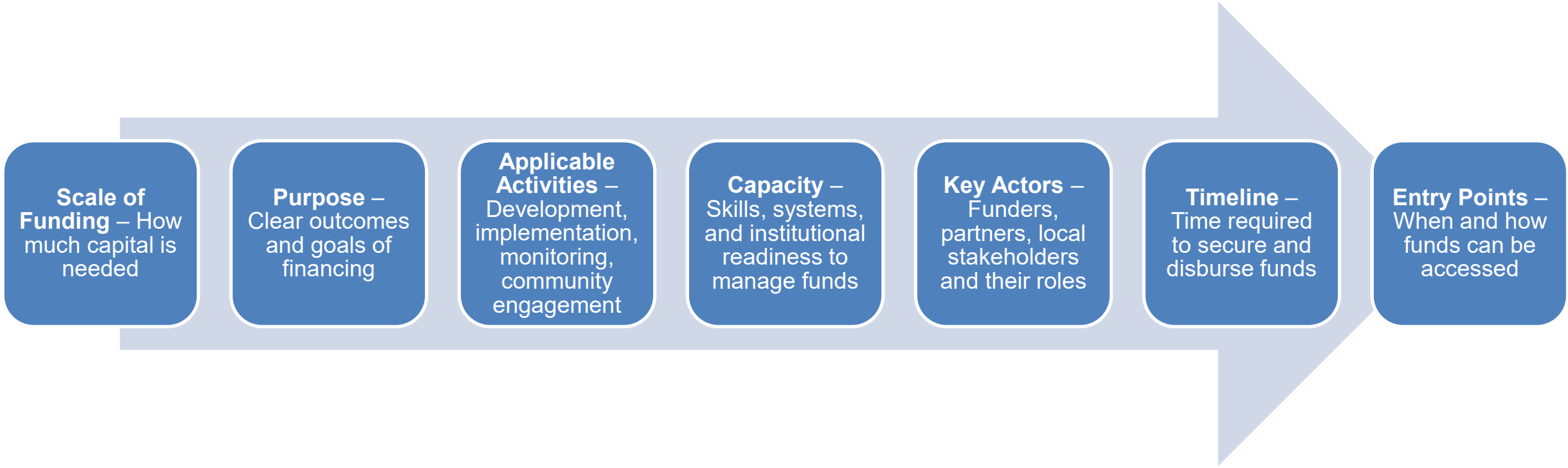
Current Indian Funding Scenario

"Given the finite nature of public resources along with their ineffective flows, these are not sufficient to meet the desired scale of funding. Therefore, such finite public sector funds must be used strategically to attract additional private sector capital and philanthropic investments to mobilize, unlock, and scale NbS"

Categories of NbS Approaches: Relevant for water and hydropower systems

Hydropower–Nature Interface	Nature Degradation / Risk	Climate & Nature Outcome	Climate Finance Opportunity	Relevant Instruments / Markets
Catchment deforestation & land degradation	Increased sedimentation, reduced reservoir life, higher O&M costs	Improved water regulation, reduced erosion, enhanced carbon sinks	Financing catchment restoration to protect hydropower assets	ARR, ALM carbon credits; watershed PES; adaptation finance
Altered river flows & habitat fragmentation	Loss of aquatic biodiversity, disrupted fish migration	Restored ecological flows, improved river connectivity	Investment in nature-based flow regulation and fish habitat restoration	Biodiversity credits; blended finance; resilience bonds
Reservoir-induced emissions & water quality decline	Methane emissions, eutrophication	Reduced GHG intensity of hydropower	Monetising emission reductions from reservoir management	Carbon credits (methane avoidance); results-based finance
Floodplain disconnection downstream	Increased flood risk, loss of natural buffers	Enhanced flood control and ecosystem services	Financing floodplain and wetland restoration as green infrastructure	Wetland restoration credits; adaptation funds
Climate-driven hydrological variability	Reduced power reliability, drought & flood exposure	Climate-resilient water availability	Nature-based adaptation to stabilise inflows	Adaptation finance; insurance-linked finance
Community dependence on degraded ecosystems	Livelihood stress, social conflicts around projects	Strengthened livelihoods and social licence	Community-led NbS linked to hydropower benefits	Article 6 mechanisms; impact investment
Sediment trapping by dams	Downstream erosion, delta subsidence	Restored sediment balance	Sediment management combined with upstream NbS	Blended finance; MDB climate funds

Viable Financing Pathways



Viable Financing Pathways

Convention Specific Funds

Adaptation Fund,
Green Climate Fund

Global Environment Facility (GEF) core & its Small Grants Fund

Ramsar
Small Grants Fund
Wetland-for-the-Future

International Funds/ Bilateral and Multilateral Mechanisms

World Bank , ADB climate finance
GEF
Adaptation Fund

UNEP
UNDP
FAO

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Kreditanstalt für Wiederaufbau (KFW)

KfW, JICA, FCDO, SECO etc.

National and Sub National Funds

National climate funds
NPCA

National Conservation/Environmental funds
Biodiversity Board Funds

Other non-Market Mechanisms

CSR and ESG Funds

Philanthropy

Debt swap/relief conversion initiatives

Crowdfunding

Market Mechanisms

Voluntary Carbon Market

Regulated Carbon Market

PES
Risk sharing and insurance
BioRights

Green Bonds

Summary of financing pathways: Blue & Teal Carbon ecosystems

Financing Pathway	Scale of Capital*	Core Purpose / Value-add	Typical Eligible Activities	Transaction Costs**	Core Capacities Needed	Key Actors***	Best Entry Point
International climate & environment funds (GCF, GEF, Adaptation Fund)	High	Deliver global climate & biodiversity gains; catalyse co-finance	Landscape mangrove/peat restoration, NbS infrastructure, policy & capacity building	High – intensive proposal, safeguards & MRV	Proposal design, fiduciary & ESMS compliance, multi-partner coordination	NDA (MoEFCC), UNDP/UNEP, NABARD, state depts.	Concept stage when national priorities are being set
Multilateral development-bank loans / results-based finance (World Bank, ADB)	Very High	Large-scale adaptation, resilient infra, coastal protection	Hybrid grey-green structures, flood dykes + wetlands, early-warning systems	High – due diligence & loan covenants	Project finance, procurement, safeguard compliance	MDBs, GoI/State line agencies	When state is drafting investment plan/masterplan
Bilateral cooperation (KfW, JICA, GIZ, FCDO)	Medium-high	Tech assistance + concessional debt/grants; pilot innovation	Community NbS pilots, capacity, eco-engineering	Moderate	Partnership management, reporting to donor	Donor agency, state dept., NGOs	During bilateral programme scoping
Domestic public schemes (NPCA, CAMPA, GIM, MISHTI, MGNREGS)	Medium-high	Meet national adaptation, livelihood & biodiversity mandates	Desilting, hydrology works, afforestation, community livelihood pilots	Low-moderate – existing govt. channels	DPR writing, state-scheme alignment, community mobilisation	MoEFCC, state wetland/forest depts., PRIs	Include works in Annual Plan of Operations / district plan
National climate funds (NAFCC; Green Credit Programme)	Medium	Pilot state-level climate solutions	Wetland NbS pilots, carbon-farming, capacity	Moderate	Alignment with SAPCC, proposal design	State climate cells, NABARD	Project concept / DPR
CSR & corporate philanthropy	Low-medium	Fast, flexible funding + brand value	Mangrove planting, lake clean-ups, eco-facilities, education	Low – simple MoUs, annual audit	Story-telling, outcome metrics, volunteer mgmt.	CSR boards, corp. foundations, NGOs	Pitch during CSR budget planning

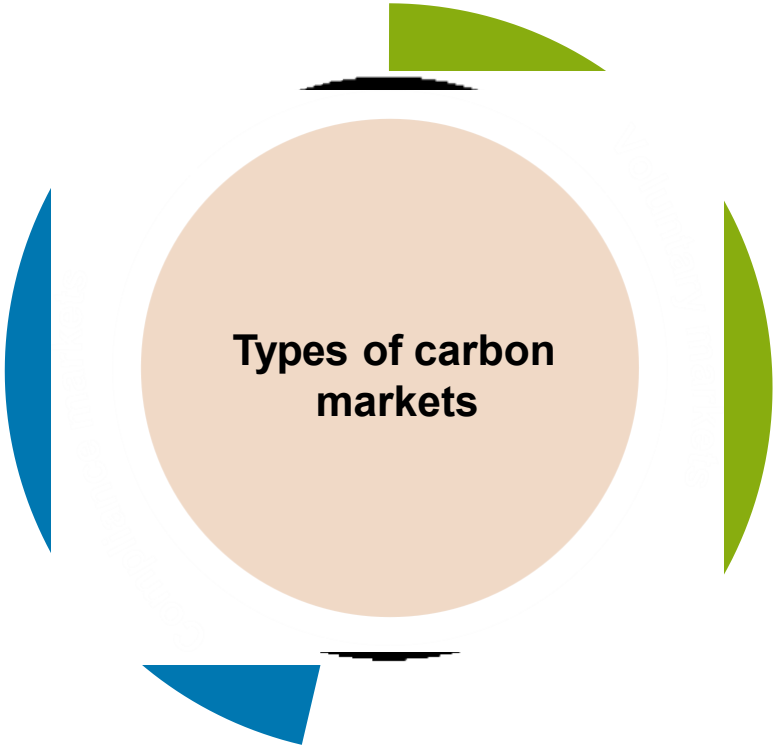
Summary of financing pathways: Blue & Teal Carbon ecosystems

Financing Pathway	Scale of Capital*	Core Purpose / Value-add	Typical Eligible Activities	Transaction Costs**	Core Capacities Needed	Key Actors***	Best Entry Point
Philanthropic grants (domestic & intl.)	Low-medium:	Support catalytic, high-impact conservation	Research, advocacy, community co-management	Low	Proposal & impact communications	Foundations, HNIs, NGOs	Concept or pilot stage
Impact-investment / private equity & debt funds	Medium	Dual returns – profit + measured impact	Eco-tourism, sustainable aquaculture, blue-carbon SPVs	Moderate-high – due diligence, IMM	Bankable business model, finance & governance	Impact funds, family offices, social enterprises	Seed / Series-A or expansion phase
Carbon markets (voluntary & emerging Article 6)	Potentially high – depends on ha & price	Monetise verified emission reductions / removals	Mangrove/peat restoration & protection, re-wetting	High – baseline, VVB audits, registry	Carbon accounting, tenure & benefit-sharing	Project SPV, Verra/GS, brokers, corporate buyers	Project design – integrate MRV from day 1
Payment for Ecosystem Services (PES)	Low-medium	Tie beneficiaries to conservation payments (water, flood risk)	Up-/down-stream watershed pacts, mangrove storm-shield PES	Moderate – contracts, basic MRV	Valuation, mediation, simple monitoring	Utilities, industries, panchayats, NGOs	Catchment planning or when buyer shows WTP
Blended finance / PPP	High	Leverage public concessional capital to crowd-in private	Wetland eco-parks, coastal protection PPP, blue bonds	High upfront structuring	Financial modelling, legal, multi-stakeholder mgmt.	Govt., MDBs/DFIs, private investors, NGOs	Feasibility stage for large integrated project
Green bonds	Medium-high	Raise debt for verified green assets	STPs feeding wetlands, urban wetland rejuvenation, hybrid infra	Moderate-high – issuance, verification	Capital-markets know-how, asset pipeline	ULBs, SOEs, banks, investors, verifiers	When cap-ex plan & revenue streams clear
Crowdfunding / citizen finance	Low	Mobilise public passion & visibility	Niche site clean-ups, boardwalks, citizen science	Low (platform 5-8 %)	Social-media outreach	NGOs, start-ups, media, donors	Ready-to-go micro projects

Carbon Markets Integration

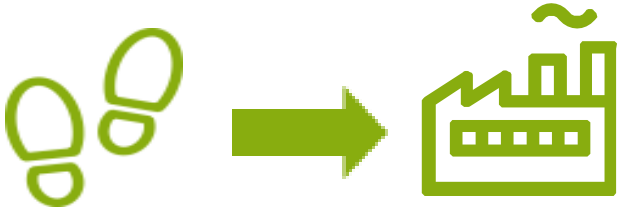
Governments oblige polluters to reduce their GHG emissions by forcing them to either:

- hold the number of permits corresponding to their GHG pollution, with the total number of permits in the market declining at regular intervals; or
- offset their emissions by, for example, financing reforestation initiatives.



Companies participate in a voluntary carbon market as a result of:

- corporate social responsibility efforts to reduce their carbon footprint; or
- preparatory initiatives for future compliance with a mandatory system.



Types of Carbon Projects

Nature-Based Solutions

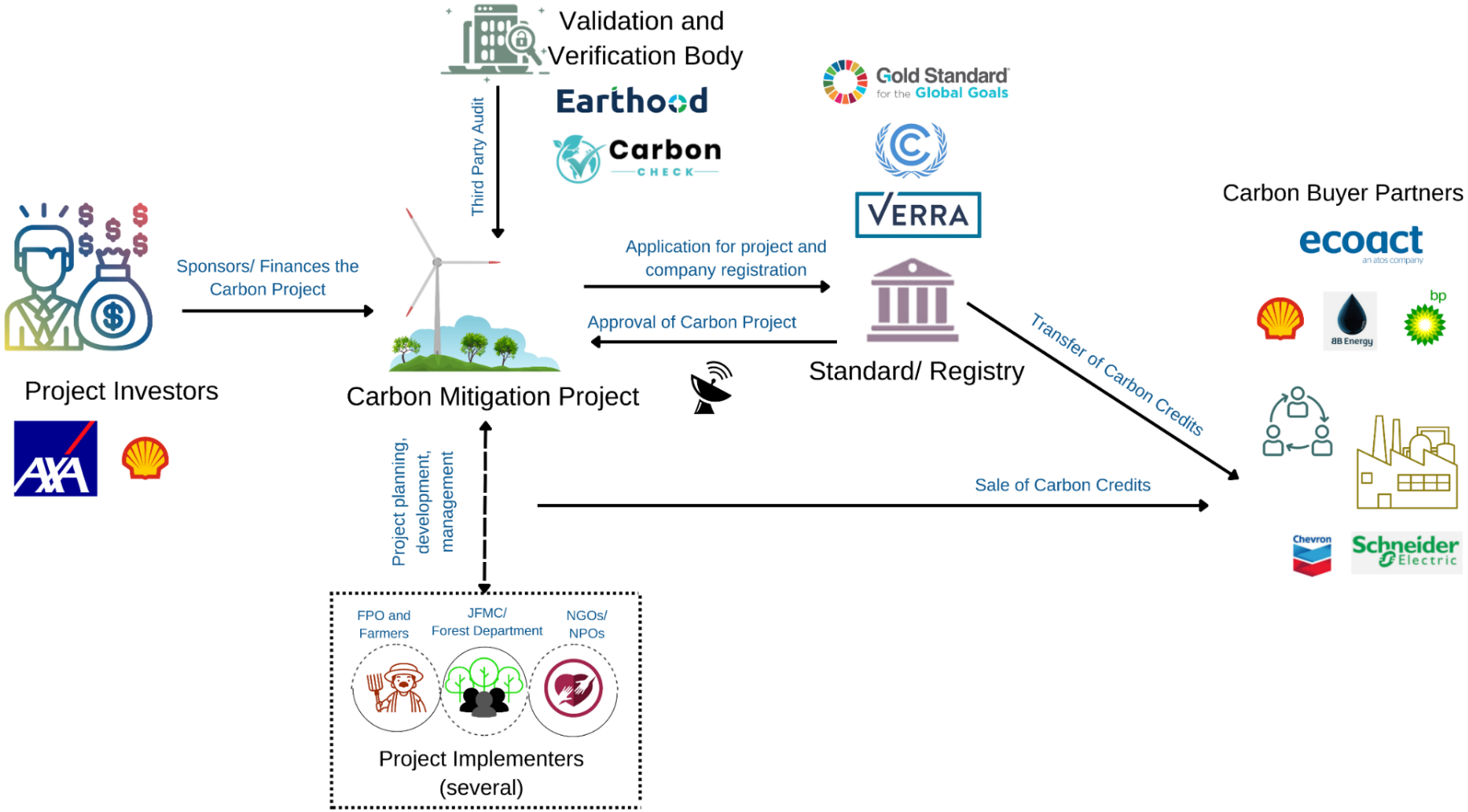
Nature-based solutions (NbS) projects produce credits based on either the carbon captured by new trees or by the carbon not released through the protection of forests.

Key Categories:

1. Renewable Energy
2. Waste Management
3. Industrial gases
4. Energy Efficiency
5. Agriculture Emission Abatement
6. Forestry

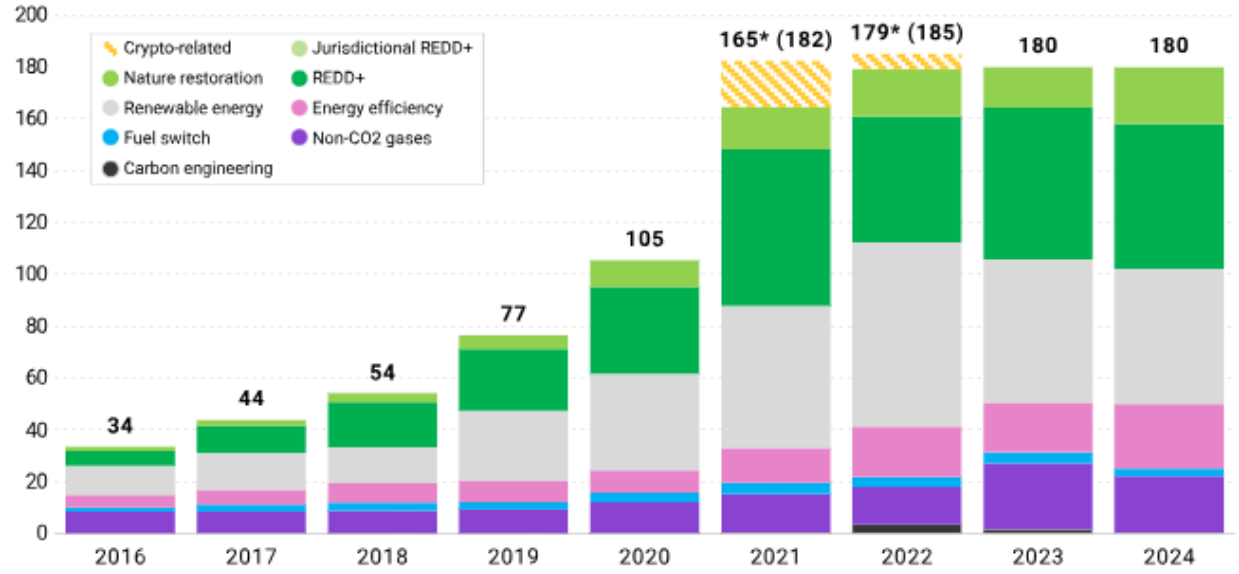
Source https://carboncredits.com/the-carbon-credit-lifecycle/

Ecosystem of a Typical Carbon Project



Voluntary Carbon Market Size

Annual Retirement by Project Type (MtCO2e)



Source: MSCI

In 2024, **around 255 million credits were issued and 162 million were retired** mostly from avoided deforestation (REDD+) and renewable energy projects. *(Source: Carbon Pulse)*

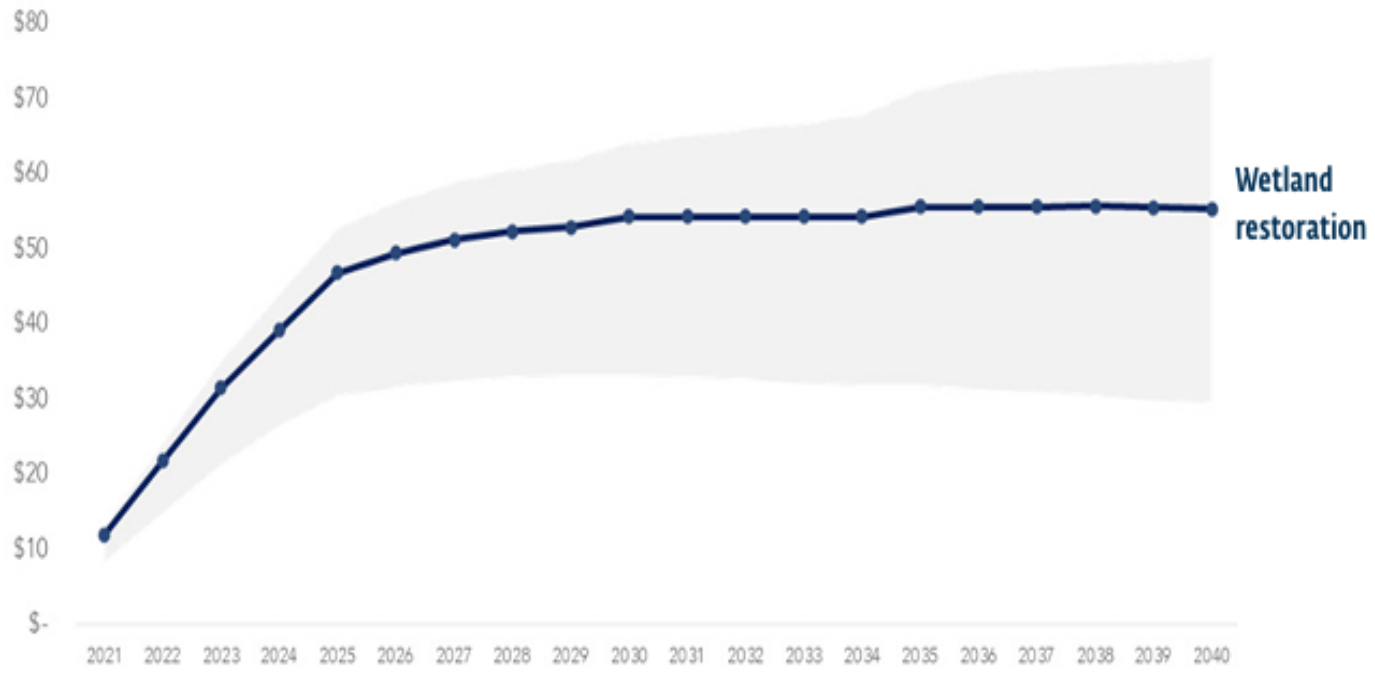
The global carbon credit market is projected to experience significant growth, potentially reaching between **$7 billion and $35 billion by 2030,** and potentially reaching **$250 billion by 2050,** according to Morgan Stanley Capital International (MSCI).

In **2023**, carbon pricing revenues reached a record **$104 billion**, according to the World Bank's annual "State and Trends of Carbon Pricing 2024" report.

Carbon Financing for Wetlands

Demand of Blue Carbon (BC)

- Many countries want to feature coastal management as part of integrated planning for sustainable development—both at the global level as guided by the Sustainable Development Goals (SDGs), and at the national level as coastal countries develop and expand their Blue Economies.
- Numerous carbon standards in the voluntary carbon market have now developed methods for BC ecosystem management.
- **In 2014, a total of 159,493 BCCs were issued**, marking their introduction to the carbon market. The issuance trend has shown a steady upward trend, with the number of issued credits surpassing 1 million by 2020 and then continuing to rise sharply, reaching about 6.96 million credits by March 2025.[1]



Pricing Corridor For Blue Carbon Voluntary Emission Reductions Until 2030 (In Nominal $ Per Ton) [2]

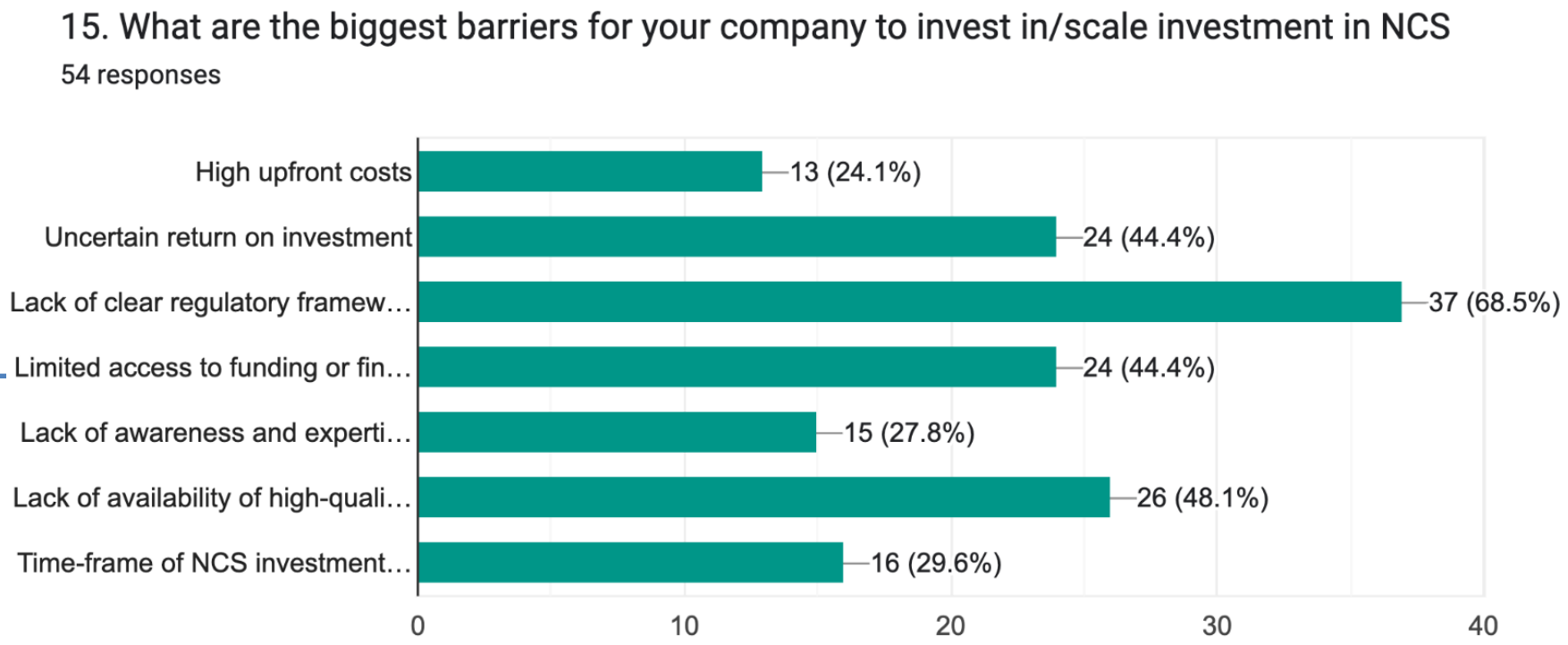
What are the Risks?

Lack of Unified Action for Grouped Projects	• Lack of methodology awareness & institutional support for decision-making, and community mobilisation
Delayed Returns on Investments	• Quantification of changes in soil carbon stock is a challenge owing to spatial variability of soil texture, landscape position, drainage, plant productivity and bulk density.
Data Management	• Disturbances caused by natural and anthropogenic risks stemming from farmers switching back to conventional emitting practices can cause rapid reversals of GHG emissions reduction in agriculture sector.
Carbon Emission Reversal	• Emissions arising from activities that aren't truly addressed or reduced, leads to leakages, which further reduces the quality of carbon offset.
Leakages	• While implementing, a carbon project may deviate from the procedures set out in methodologies in certain cases.
Methodology Deviation	• The resources required for monitoring these projects are quite high.

Barriers in Scaling NbS Project Implementation

Majority of the companies (~69 percent) indicated the lack of clear regulatory framework/Complex regulatory environment to be the biggest barriers to Scaling NCS Investments.

2nd biggest challenge is the lack of availability of high-quality NCS Project (~ 48 %)



Policy Support for Wetland Restoration in India

Wetlands of India Portal: Launched on October 2, 2021, by the Ministry of Environment, Forest, and Climate Change (MoEFCC), this portal provides comprehensive information on India's wetlands. It includes capacity-building materials, data repositories, and dashboards for each state and union territory.

Centre for Wetland Conservation and Management (CWCM): Established on World Wetland Day 2021, this center focuses on addressing research needs and knowledge gaps in wetland conservation.

Wetlands Rejuvenation Programme: Initiated by MoEFCC in 2020, this program aims to rejuvenate over 500 wetlands across India. It includes developing baseline information, rapid assessments, stakeholder engagement, and management planning.

Amrit Dharohar Scheme: Launched with the Union Budget 2023-24, the scheme is a key initiative aimed at optimizing wetland utilization over the next three years. Its goals include enhancing biodiversity, increasing carbon stock, boosting eco-tourism, and generating income for local communities, in line with the government's sustainable development vision.

Conclusion

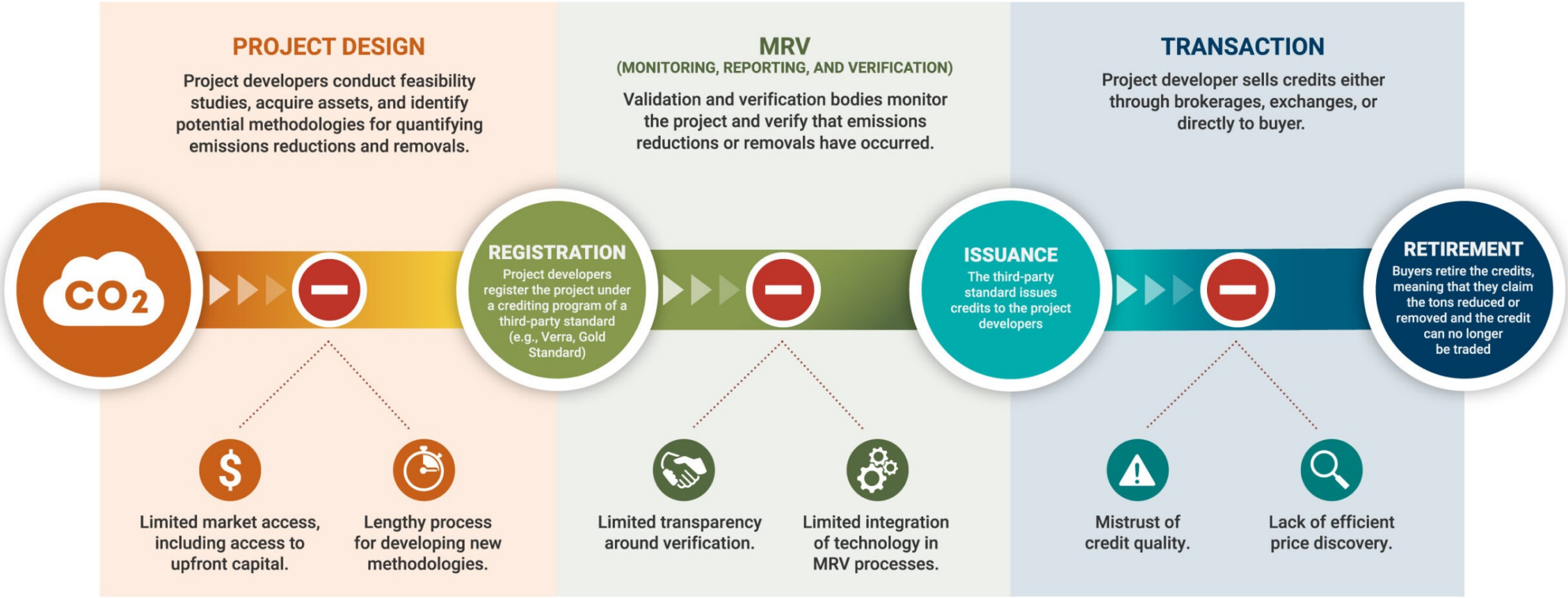
1. Climate resilience of hydropower begins beyond the dam — at the landscape level.
Long-term performance of dams and hydropower assets depends on healthy catchments, stable ecosystems, and reduced sediment and flood risks. Nature-based Solutions are therefore not optional add-ons, but essential infrastructure that protect and extend the life of our investments.

2. Carbon markets convert ecosystem restoration into a bankable financial asset.
By monetizing carbon sequestration and environmental co-benefits, carbon finance creates predictable, results-based revenue streams that enable watershed restoration, community stewardship, and long-term maintenance — making NbS financially viable for dam owners, PSUs, and financiers.

3. The future lies in integrated finance and infrastructure planning.
Combining grey infrastructure with green investments, supported by climate finance and carbon markets, allows us to build hydropower systems that are not only low-carbon, but climate-resilient, socially inclusive, and economically sustainable for decades to come.


Thank You

How do Carbon Credits Reach Carbon Markets?



Source - RMI

How to use Carbon Revenues?

- Carbon revenues can finance tax reforms to support increased economic growth.
- Carbon revenues can finance additional policies or programs aimed at reducing emissions.
- Carbon revenues provide an important source of funds for developing countries seeking to finance development objectives.
- Carbon revenues can be used to address the potentially negative impacts of carbon pricing on competitiveness for domestic industry, reducing the risk of carbon leakage.
- Carbon revenues can be used to help individuals, households, or businesses deal with the impacts of carbon pricing through direct transfers or other policies and programs.
- Carbon revenues can pay down the existing stock of debt, if not used for tax reforms or increased spending.