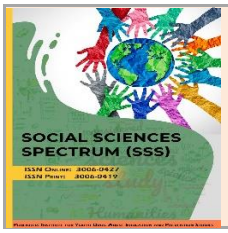

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Nature-Based Climate Adaptation in Pakistan: A Case Study of the Recharge Pakistan Project

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Abstract

This study explores nature-based solutions (NbS) and ecosystem-based adaptation (EbA) to climate resilience in Pakistan in the Indus Basin with special reference to the Recharge Pakistan Project. The aim is to evaluate the functioning of nature-based solutions NbS and ecosystem-based adaptation EbA approaches in particular through the Recharge Pakistan Project thus to minimize the climate regressions and to enhance the water management by involving large-scale ecological restoration and green infrastructure. The paper adopts a case study and mixed methodology which integrates both qualitative and quantitative data examines the project data, as well as policy reports, websites, articles and data provided by other publication houses in order to analyze the environmental and socio-economic consequences. The central concern and discussion of the paper is efficiency and scalability of NbS compared to traditional infrastructure and has emphasized challenges such as technical capability, funding and institutional impediments. The paper reveals that NbS when coupled with community and policy integration considerably reduce risks of flooding, increase ground water recharge and improve livelihoods. The paper comes to the conclusion that NbS provide a sustainable pathway of climate adaptation in Pakistan.

Keywords: Climate Adaptation, Nature-based Solutions, Ecosystem-based Adaptation, Recharge Pakistan Project, Flood management, Water resources, Community resilience, Policy Integration.

Introduction

Pakistan is at the forefront of the world climate crisis, and its geographical peculiarities along with the socio-economic structure makes this country highly exposed to climate change water-induced crises. Even highly problematic is the dependence of the country on the Indus Basin Irrigation System (IBIS) as the source of agricultural production and water supply, as due to the water resources in the system are mainly supplied by the snow and glacial melt of the Hindu Kush-Karakoram-Himalaya mountain range (Johnson & Manikandan, 2024). All these glaciers have already been melting down, and climate change has only done that at an even faster pace causing unstable rivers, unpredictable monsoons, and even more floods and droughts. These changes in climate have already revealed themselves in the form of disaster that is experienced in 2010 and 2022 super flooding that displaced millions and cost billions of economic damages. The consequences do not just end with disaster effects but they pose threat to food security, production of energy and the lives of more than 138 million people who rely on irrigated agriculture in the Indus basin (Mansoor, 2025).

Pakistan has an extensive supply of water resources; however, the imminent water insecurity crisis cannot be spared, which is catalyzed by the cluster forces of the climate crisis, exploding population, and the devastation of the ecosystem. By 2025 pure water shortage would probably be renowned in the country and the supply of water relative to population is currently on a declining scale. Even more destruction of the very ecosystems that already play a significant role in natural buffering effect on the landscape (wetlands, floodplains, forests, etc.), has minimized the natural buffering effect even more and contributed to the very impact that extreme weather events do have. These ancient modes of water management that relied heavily on grey infrastructure such as dams, levees and embankments have failed to be effective and are at the same time counterproductive. The disastrous floods of 2010 and 2022 have indicated the level of those hard-engineered interventions and revealed the need to change the paradigm toward more coupled and sustainable, flexible ways of management (Asad, 2016).

Hereafter, the nature-based solutions (NbS) and ecosystem-based adaptation (EbA) have been seen to offer an alternative or supplement to traditional infrastructure. NbS as defined are these actions which safeguard, sustainably manage and heal natural or altered ecosystems in order to meet society needs and at the same time benefit both the biodiversity and the humans (IUCN, 2023). Underlying the risk-reduction effectiveness of these approaches is the inherent resilience of natural systems which embrace processes like wetlands reclamation, planting of forests, and managing a sustainable land to mitigate risk of disaster, increase water security, and livelihoods. EbA is a type of NbS and consists of the measures taken to apply the ecosystem services and biodiversity in order to assist people to adjust to the negative impact of the climate change. NbS can have a multi-faceted, cost-effective, and scalable asset and can therefore be used to reduce floods, recharge ground water, isolate carbon to the ground as well as increase agricultural yields. NbS are also highly flexible and adaptive as compared to grey infrastructure whose solutions have the characteristic of being single purpose and inflexible, and also cannot provide co-benefits to all the sectors and populations (Seddon et al., 2020).

The socio-ecological realities of the country can also be cited as a reason why NbS and EbA should be considered mainstreamed in the strategy of climate adaptation in Pakistan. Climate variability and environmental degradation seriously affect rural populations disproportionately given that the communities form the backbone of the national economy. The in-corporation of NbS into local and national planning does not only strengthen ecological resilience but also strengthen local communities through participatory administration, diversified livelihoods as well as safeguarding

of indigenous know-how. The most significant areas in scaling up solutions are policy support, financial incentives, and capacity building, as well as aligning NbS with national climate commitments and development goals (Anderson et al., 2022).

In this backdrop, the Recharge Pakistan Project is a flagship initiative to integrate NbS and EbA in the floods and the management of water resource in the country. Recharge Pakistan is a program initiated with the help of the Ministry of Climate Change and Federal Flood Commission, WWF-Pakistan and foreign stakeholders such as Green Climate Fund and USAID, which is officially inaugurated on 10th Sep, 2024. The focus of the project is to restore more than 14,000 hectares of degraded forests and wetlands, restore key water flows pathways and carry out 127 green infrastructure interventions at key sites in the Indus Basin. They are directed at checking, soaking, and intercepting the floodwaters, which leads to decreasing the disaster susceptibility to vulnerable down slope communities as well as enhancing biodiversity, water-retention, and soil health. The project will directly and indirectly benefit more than 680,000 and 7 million people respectively and will therefore be considered a scaled nature-based climate resilience intervention in Pakistan and other regions (Recharge Pakistan, 2023).

Recharge Pakistan aims to spur a paradigmatic shift in Pakistan by integrating NbS and EbA into national and provincial planning systems, and replacing the current isolated adaptation measures with a system-based, policy-coherent concept of resilience. Not only does the project show effectiveness of ecosystem-based interventions but it also establishes a foundation of the long-term and climate-smart governance. In the process, it provides invaluable lessons to other climate-vulnerable nations that aim to develop and not endanger the environment amidst the growing climate changes (Anderson et al., 2022).

Objective of the Paper

- To assess the performance of nature-based solutions NbS and ecosystem-based adaptation EbA strategies in particular by means of the Recharge Pakistan Project.

Research Methodology

The study uses case study approach in which projects data, policy reports, and field assessments of the Recharge Pakistan Project have been combined. It is an assessment of quantitative data of ecosystem restoration, flood mitigation, and benefits to the people, plus input of qualitative information gathered from articles, think tanks, websites and other publication houses. Such a mixed methods approach promises an evaluation of environmental and socio-economic outcomes in a broad way.

Climate Adaptation Challenges in Pakistan

The issue of climate adaptation in Pakistan is firmly established in its recent past of such devastating climatic incidents as the 2010, or 2022 floods, each of which had disastrous socio-economic consequences. In 2010 the floods hit more than 20 million of people, over 1,700 people died and more than 20 percent of the land area of the country was flooded. The damage consisted of homes (above 1.1 million), significant damage to infrastructure (roads and bridges), damage caused to crops (in the fields) above 2 million hectares and massive destruction to standing crops (Kirsch et al., 2012). The total reconstruction expenditures were more than Rs. 578 billion and the Sindh province and Punjab province suffered the highest damage. The small farmers and unskilled laborers were greatly hit by the floods as it put them further under the poverty line after years of poverty alleviation efforts. Six months later, 54.8% of houses were destroyed and 86.8% of

households displaced and 88% stating loss of income with the rural populations the most victimized and the slowest to recover (Pakistan: Flood Impact Assessment, 2011).

The 2022 floods were worse: it hit 33 million, took more than 1,700 lives and is estimated to have caused economic losses equal to US$30 billion. More than 2 million of housing units were spoiled, 780,000 aptly destroyed (Pakistan faces $30b loss after floods, 2024). There was an increase of the national poverty rate of 4.0 to 4.3 percentage points which took an estimated 9 million people back to the poverty line. This caused far reaching insecurity in food supply whereby a population is projected to increase to 14.6m people affected compared to the initial 7 million (Poverty impacts of Pakistan flood 2022, 2023). Besides the devastating loss of property and lives, the floods caused a proliferation of water borne diseases and 83.4% of flood victims were found to be ill or disabled following the occurrence. Almost 40% of individuals were homeless and about half of their income was lost, which emphasized the fact that low-income households as well as rural households are more exposed (Khan et al., 2024).

Even though the magnitude of these catastrophes, the traditional flood control system and waterworks in Pakistan have turned out to be insufficient. Most of the flood infrastructure e.g. embankments, barrages and big dams is colonial and hence overdue, ill maintained, and with heavy sediments. The core storage reservoirs; Tarbela, Mangla and Chashma are already experiencing a rapid loss of storage capacities as the largest of them; Tarbela, stands to lose 57 percent of capacity by 2025 with accumulated sediments (Aslam, 2018). These reservoirs were primarily intended to serve as irrigation and hydropower but serving as a second purpose flood control therefore restricting their capability in regard to extreme incidences. Flood management as laid out in standard operating procedures is old fashioned and not only is there a lack of laws to cover everything that occurs during floods, institutional coordination is weak and floodplain control implementation is poor. Lack of integrated flood mitigation plans, inadequate early warning mechanisms, and poor maintenance of infrastructures are also some of the league that enhance vulnerabilities to floods and droughts (Qureshi, 2011).

Pakistan is experiencing a water crisis that is characterized by its ever-increasing severity and urgently demands new adaptation strategies that could be cost-effective and sustainable. The water per capita has since dropped down to less than 860 cubic meters per 1000 inhabitants in 2009 compared to 5,000 cubic meters in 1950 and the nation lies well below the water-stressed level. About 95 percent of the fresh water in Pakistan is consumed by agriculture, but the system is very inefficient with 40-60 percent of all water being lost through the traditional flood irrigation system. Water systems in the cities have a large rate of water leakage and theft, and very little groundwater is regulated, which leads to a rapid loss of aquifers. High costs and subsidies available are retained through the low rate of adoption of water saving technologies applied like drip and sprinkler irrigation (Rasheed et al., 2023). Mismanagement in institutional and policy level, interprovincial squabbles, and insufficient investment on storage infrastructure add to the crisis. As these pressures are compounded with climate change, there is an urgent demand of integrated water resource management, ecosystem restoration, and scaling up nature-based solutions which can provide resilience to water resources and equitable access to water resources in the long term (Water governance in Pakistan, 2025).

Table 1: *Major Climate Adaptation Challenges in Pakistan*

Challenge	Description
Floods Impact	2010: 20 million affected, 1,700 deaths, 1.1 million homes damaged
2022 Floods Impact	33 million affected, 1,700 deaths, $30 billion economic loss
Water Scarcity	Per capita water dropped from 5,000 m^3 (1950) to <860 m^3 (2009)
Infrastructure Issues	Aging dams, sedimentation, poor maintenance, limited flood control
Institutional Challenges	Fragmented governance, weak coordination, poor policy implementation
Financial Constraints	Low adaptation funding, high costs, limited private investment
Technical Capacity	Lack of trained personnel and climate science knowledge
Socio-economic Barriers	Poverty, illiteracy, cultural resistance to climate awareness

The Recharge Pakistan Project: Design and Implementation

The Recharge Pakistan Project is a historical project on climate adaptation aiming to change the way Pakistan deals with floods and water resources entirely by encompassing a mammoth-scale implementation of ecosystem-based adaptation (EbA) and Green infrastructure. The project was envisioned after climate disasters and in the wake of devastating floods, primarily in the year 2010 and 2022, which demonstrated the boundaries of the existing infrastructure and the necessity of nature-based solutions. (Recharge Pakistan, 2023). Its inception is embedded in an alliance of national and international partners: The Government of Pakistan (Ministry of Climate Change and Federal Flood Commission) WWF-Pakistan, the Green Climate Fund (GCF), the United States Agency for international development (USAID), and The Coca-Cola Foundation (Recharge Pakistan Project, 2023). These entities in their turn, have mustered a total investment value of 77.8 million U.S. dollars with a 66-million grant from GCF, 5 million each by the USAID and The Coca-Cola Foundation, and 1.8 million by the WWF, resulting in the largest-ever ecosystem-based adaptation project in Pakistan (What is Recharge Pakistan? 2024).

The areas covered by the project are among the essential climate-sensitive locations in Indus Basin like Dera Ismail Khan and Ramak watershed in Khyber Pakhtunkhwa, Manchar Lake in Sindh, and Chakar Lehri watershed in Balochistan. These regions are chosen due to their sharp vulnerability to floods and droughts, their ecological and socio-economic importance. The interventions will be both site-specific and scalable and therefore, these interventions can be a template to implement in other vulnerable areas in Pakistan (Recharge Pakistan, 2023).

Recharge Pakistan interventions focused on core strategies are grand and multidimensional. This work will rehabilitate 14,215 hectare of degraded wetlands (and forests) mainly in Dera Ismail Khan and nearby watersheds. This ecosystem reconstruction would increase the natural naturalization, association and storage of floodwaters, lessen the soil erosion and better the biodiversity (What is Recharge Pakistan? 2024). Further, 34km of the natural route of water streams are to be restored within Ramak watershed and around the Manchar Lake to enhance the ability of the landscape to carry and store the floodwater in a risk-free way. There will also be 127 additional green infrastructural interventions such as recharge basins and storm water retention areas that will cause upsurge in groundwater recharge and minimize flood risks to more than 50,000-hectare lands. The direct beneficiaries of these actions are over 680,000 people, and the

indirect beneficiaries include over 7 million residents of the Indus Basin, also ensure 53,000 tons of CO 2 equivalent reduction of greenhouse gases (Recharge Pakistan, 2023).

One of the pivot points of the project is that it focuses on the concept of community-based natural resource management and diversification of livelihoods. The implementation of climate-resilient agricultural practices, the support of small businesses that focus on agriculture and forestry, and the provision of alternative ways to obtain income and avoid putting a strain on vulnerable ecosystems by Recharge Pakistan are introduced with close cooperation with local communities (Ahmad, 2024). Seven business will be assisted by using specific intervention, encouraging sustainable economic opportunities and developing long-term resilience. Participatory planning and training go hand-in-hand, so that the community and the government staff become able to plan, operate and maintain these interventions. The strategy helps to not only mitigate the short-term climate vulnerabilities but also supports the overall enabling climate of nature-based solutions through including EbA and green infrastructure in the national and provincial policies, including National Water Policy and National Adaptation Plan (Recharge Pakistan Project, 2023).

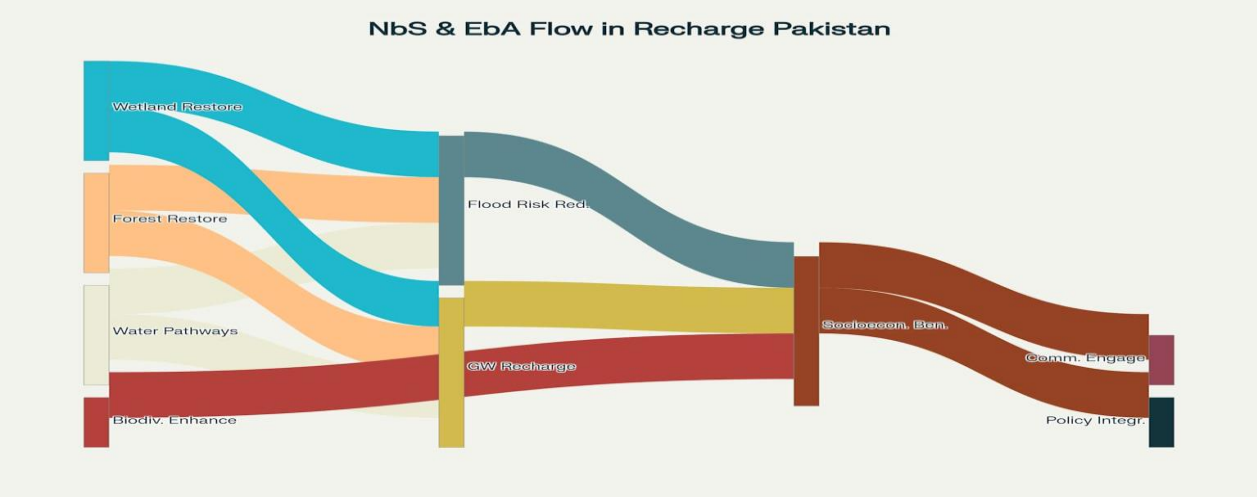
Mechanisms of Nature-Based Adaptation

Restored wetlands, floodplains and forests act as a natural front against climate excess by absorbing, storing and slowly releasing floodwaters and in the process minimize the level and severity of floods downstream. Given the setting of the Recharge Pakistan Project, the interventions are aimed to slow down the rate of runoff, increase the infiltration and stabilize the soils, and their combination results in the elimination of the flood hazard and the possibility to recharge the groundwater (New Report from Pakistan, 2018). In particular, restoring 14,215 hectares of degraded forests and wetlands, rehabilitating 34 kilometers of water flow paths, and building 127 green infrastructure interventions (recharge basins, retention areas, and others) will also help solve the issue of flooding on more than 50,000 hectares of the territory and grasp approximately 20 million cubic meters of water. Such interventions, which are nature-based, not only limit the speed/volume of flowing floodwaters, but also enhance water quality, replenish the aquifers and sustain the river base flows during dry periods, which act as a buffer against flood and also against drought situations. Ecological benefits go even further, as there is more vegetation covering the soil and it decreases soil erosion, risk of landslides, as well as helps maintain the local ecosystem better in case of future climatic shocks (Recharge Pakistan, 2023).

One of the major ways to scale and sustain such advantages could be the adoption of ecosystem-based adaptation (EbA) and green infrastructure to the national and provincial climate policies in Pakistan. Combating climate change, employment creation, and reducing energy costs can all be achieved by the project of recharging of Pakistan, which is directly coordinated with the National Water Policy, the Adaptation National Plan Pakistan and the Provincial Adaptation Plans so that whatever one learns in the course of action, it is integrated in future planning and investment (Khattar, 2024). Implementation of the project is coordinated and guided by a multi-stakeholder National Working Group which is chaired by the Ministry of Climate Change and includes representation of the Federal Flood Commission and provincial departments. The purpose of this institutional arrangement is to exercise a paradigm shift to mainstream EbA and green infrastructure into regulatory practices, revise standard operation practices of both flood and water management and reverse the trend of depending on the use of grey infrastructures. Cost-effectiveness and sustainability will also be evident by economical assessments and tight monitoring that will add strength towards the increase of such interventions in terms of adaptation in Pakistan (Recharge Pakistan, 2023).

The other essential mechanism through which the nature-based adaptation achieves effectiveness and sustainability is community engagement. The Recharge Pakistan Project is focused on participatory planning, training, and local ownership, in close collaboration with communities to plan, carry out, and run the interventions. This approach involves use of the local experience and indigenous knowledge thus providing locally acceptable solutions that are relevant to the context. The capacity building activities may incorporate teaching of government employees and local authorities and residents concerning EbA and green infrastructure administration, sustaining small firms and the splitting of livelihoods in agriculture and woodland, or restoring fascination to practice and government agencies in remote and woody areas (Bhatti, 2025). Aspects given as evidence in comparable projects in Pakistan show that community-led projects increase adaptive capacity, promote social capital, and resiliency of shocks. It is estimated that the project will directly impact more than 680,000 individuals and indirectly more than 7 million, including a special focus on the empowerment of women and the marginalized population due to inclusive participation and an equitable distribution of the benefits (New Report from Pakistan, 2025).

Figure 1: *Analysis of NbS and EbA Mechanisms*



In this flow diagram, the Recharge Pakistan Project defines how nature-based solutions (NbS) and ecosystem-based adaptation (EbA) can be adopted to realize climate resilience. It describes the recovery of wetlands, forests and water flows, resulting in the lower risks of floods, an increase in groundwater recharge, better biodiversity and also social and economic impacts on the community and integration of policies.

Project Outcomes and Impact

Recharge Pakistan Project is an innovational way of climate adaptation, which means applying nature-based means to respond to the increased threats of floods and droughts in the Indus River Basin. Being one of the biggest climate adaptation projects in the history of Pakistan, the project is to be scaled up to become a model of ecosystem-based adaptation (EbA) and green infrastructure solutions, and its potential outputs are great and its immediate effects are promising. The interventions that the project undertakes are well planned with the view of minimizing the area covered by floods, by more than 50,000 hectares and they include restoration of degraded forests and wetlands as well as creation of green infrastructure like recharge basins and retention areas. It is estimated that these measures will an estimated 20 million cubic meters of their water and thus reduce the risk of floods and increase their groundwater recharge, which is vital in building resilience to drought and ensuring the sustainability of agriculture (Recharge Pakistan, 2023).

The direct socio-economic benefits are expected to impact more than 680,000 people whereas the people benefiting indirectly are more than 7 million individuals who either live in or depend on the Indus Basin ecosystem. Such advantages do not only stop at direct flood control: through soil stabilizing and adding extra vegetation, the interventions minimize erosion and the potential of landslides, as well as the quality of water and the increase of biodiversity. The approaches to climate-resiliency are also being used to improve local livelihoods, especially in the agriculture and forestry sectors, in the development of alternative income streams and thus the resilience of communities and economic sustainability. The project is also supposed to help in cutting down greenhouse gas emissions of about 53,000 tons of CO2, which contributes to the larger climate mitigation objectives of Pakistan.

The project is based on a strict monitoring and evaluation system that aims at to track project progress against major indicators like ecosystem health, flood mitigation, water storage, and socio-economic resilience. The framework consists of restoring 14,215 hectares of forests and wetlands, recovering 34 kilometers of the water flow ways, and the establishment of 127 green infrastructure interventions. Such attempts are closely tracked so as to help in evidence-based management or adaptive efforts besides creating excellent precedents which can be duplicated in other future adaptation endeavors in Pakistan. The evidence-based nature of the project aims at affecting policy, and new government guidelines on how to incorporate EbA and green infrastructure interventions are being drawn up based on the data and lessons emerged. This will make sure that the advantages and the sustainability of these adaptation measures are institutionalized in the national and provincial levels (Khan, 2024).

The projected effects of Recharge Pakistan are not purely environmental events, but also include large social and economic aspects. The project lowers the chances of communities being displaced, their livelihoods being destroyed, and being exposed to health risks caused by extreme weather events by helping such communities to increase their resilience. Recovery of the wetlands and riparian areas boosts the local fisheries and wildlife adding more versatility to income sources and enhancing food security. The project includes training programs of governmental personnel and communities who live in the area in which adaptation strategies based on nature are designed, managed, and replicated. This element of capacity building also makes sure that the gains after implementation are sustainable in nature and also that local stakeholders can take charge on future climate adaptation exercises.

Recharge Pakistan is a mutual effort by the Government of Pakistan, the Green Climate Fund, USAID, The Coca-Cola Foundation, and WWF, and an overall amount of 77.8 million dollars will be invested. Such a partnership model uses international knowledge and funds to solve local problems, which is relevant to Pakistan and its national climate change objectives and global adaptation and reduction activities. It is expected that with the success of the project future investments in nature-based solutions may follow and prove the effectiveness and cost-efficiency of nature-based solutions to mitigate climate risks in the long run (Recharge Pakistan, 2023).

Table 2: *Key Interventions and Outcomes of the Recharge Pakistan Project*

Intervention/Outcome	Value/Description
Restored Wetlands and Forests (hectares)	14,215
Water Flow Pathways Restored (km)	34
Green Infrastructure Interventions	127
Flood Risk Reduction Area (hectares)	>50,000
Water Storage Capacity (million cubic meters)	20
Direct Beneficiaries (people)	680,000+
Indirect Beneficiaries (people)	7,000,000+
Greenhouse Gas Emission Reduction (tons CO_2 eq.)	53,000

Challenges and Weaknesses

In the case of Pakistan, taking nature-based solutions (NbS) to climate adaptation to implementation encounter numerous and interconnected deficits in technical, financial, and governance issues, as evident in the Recharge Pakistan Project. In a technical sense, the issues involved in Pakistan are ecological and hydrological systems which demand superior scientific knowledge along with its strong data to plan, enact, and track NbS. The absence of talented employees and the overall inadequacy of climate science in training programs restrict the technical ability of agencies promoting NbS to the same extent as it ensures that the general population lacks the necessary knowledge (Soni et al., 2025). This capability deficiency is further caused by the lack of integrated training and capacity-building activity on governmental level, local leaders and community stakeholders especially in vulnerable areas like Khyber Pakhtunkhwa. These fundamental capabilities are absent, and, with them, the formulation and sustenance of interventions, such as the restoration of wetlands, agroforestry, and the management of floodplains, tend to be less ideal, decreasing the lasting performance and resilience of NbS initiatives (Khan, 2024).

The key limitation of the NbS widespread implementation in Pakistan is the lack of money. On the estimate by the country on Nationally Determined Contributions (NDCs), it is projected that the adaptation and resilience of financing will cost approximately 152 billion dollars and total adaptation and mitigation will cost 200 billion dollars in the year 2030. Nevertheless, the flow of finance in climate change is very biased, where projects on adaptation such as NbS are given a very low share of funds, compared to mitigation (Pakistan: First Review Under the Extended Arrangement Under the Extended Fund Facility, 2025). The picture in the climate finance sphere is currently the domination of international financiers, with 5 percent of climate finance tracking being domestic contributions. The fact that the adaptation projects are perceived to be of greater risk and that they are smaller in scale further contributes to the underfunding as the adaptations are not very attractive to the investor in the private sector. Moreover, the absence of a national green taxonomy and a comprehensive implementation plan on the sectoral level of adaptation is that there are no direct financial roadmaps or incentives that can drive and draw investment in NbS, which further increases the current adaptation finance gap (Accelerating Green and Climate Resilient Financing in Pakistan, 2023).

The institutional fragmentation in Pakistan has very strong links with the issues of governance in the country. The task of environmental management and climate adjustments is divided between

various ministries and agencies that are poorly coordinated and whose mandates overlap. They are also not doing well in the implementation of the policies. Such institutional disintegration is also worsened by ineffective regulation capacity, low openness to the population, and inadequate coordination among the most important stakeholders (Seddon, 2020). Devolution in environmental governance can lead to mixed instructions as well as doubling of work thus compromising the effectiveness and efficiency of NbS implementation. Furthermore, the lack of strong systems of monitoring and flexible governance models ensures that it is hard to measure the effects of the projects, the lessons to be learned, and the adaptation strategies with changing climate challenges and communities in need (Syed, 2024).

The cost-efficiency and stability of NbS in relation to the manufactured alternatives continues to be a matter of concern. The amount of protection that NbS can offer tends to vary according to the climate threats magnitude, their frequency, strength of local ecosystem, and socio-economic system weaknesses. As compared to engineered or grey infrastructure, whose overall effects are more predictable and quick to achieve, NbS take longer to achieve their outcomes and the outcomes may be hard to measure. Such unpredictability makes cost-benefit analyses difficult and may cause both policymakers and investors to place a lesser priority on NbS. Moreover, there is generally an inadequate consideration of trade-off between various ecosystem services and between various stakeholder interests, which in some cases result in maladaptation or conflict e.g. when afforestation with exotic species threatens the local supply of water or agricultural revenues (Seddon, 2020).

Additional scaling barriers of NbS are associated with socio-economic and cultural realities. The success of these solutions depends on the rural communities, which lack access to financial resources, environmental awareness, and the policy process representation, in general. Poverty and illiteracy are the socio-economic limitations of the people where people are not able to participate in environmental conservation or practice grass roots innovations in this field. Additionally, structural and cultural resistance discourages mass education and awareness campaigns against climate change, and it may frustrate NbS acceptance by the masses (Bhatti, 2025).

The policy and regulation systems also pose great challenges. Previous land use entitlements, environmental and sectoral policies and other legislations may be incompatible with the demands of NbS, leading to regulatory conflicts and delays to the realization of projects. As an illustration, incentives toward intensive agriculture or after-disaster recovery can create an unintentional burden to ecosystem rebuilding or adoption of sustainable land management. Its further limiting factor is the absence of systematic instructions on how to include NbS in your national and provincial climate plans (Seddon, 2020).

Lastly, the uncertainties and risks brought about by the variability of climate, including the fact that floods, droughts, and other extreme weather events are becoming more frequent and severe, are recurrent threats regarding the sustainability of NbS interventions. There is a need to have adaptive management strategies but these strategies are limited due to unavailability of data, lack of monitoring capacity, and flexibility of the institutions. Climate change is dynamic, which necessitates an iterative evidence-based style of project design and implementation, which, in most cases, are not engrained in the existing governance system (Soni, 2025).

Policy Implications and Scalability

Recharge Pakistan is transforming Pakistan policy landscape on climate adaptation by integrating nature-based solutions (NbS) and ecosystem-based adaptation (EbA) into the national water and climate strategies of Pakistan. The most important policy implication of the project is that the

project will mainstream NbS in National Water Policy, National Adaptation Plan and Provincial Adaptations Plans and this is a purposeful move away from traditional grey infrastructure planning to integrated and systems-based flood and drought management (Recharge Pakistan, 2024). It is not a symbolic integration as it is realized in the implementation of more than 35,000 acres of forest land and wetland restoration, 21 miles of rehabilitation of water flow peaks, and the development of 127 green infrastructure interventions implemented throughout the provinces. These activities will aim at slowing and soaking up the water, reducing the risk of a disaster and enhancing water storage, creating a powerful evidence base to guide and revise government adaptation investment processes in the future.

The transition towards a new policy which is initiated by Recharge Pakistan is built on scientific evaluation and is embraced with a group of national and international partners, such as Ministry of Climate Change, Federal Flood Commission, Green Climate Fund (GCF), USAID, The Coca-Cola Foundation, and WWF. The coalition makes it so that conformity in policy is not just at the federal level but also at the provincial and local levels where the implementation of said policy is most essential. Recharge Pakistan is developing an enabling environment in climate action which is both vertically integrated and horizontally coordinated by instilling NbS into planning systems across all administrative levels. The policy framework of the project is also driven by the need to combine NbS with the existing grey infrastructure and shift away the intended adaptation measures toward a more comprehensive approach of resilience harmonizing the advantages of natural and man-made systems (Recharge Pakistan, 2023).

One more important policy implication is that the project focuses on institutionalization of adaptive management and evidence-based decision-making. Recharge Pakistan is also producing data, instruments and good practices that are applied to training the governmental personnel and local communities on NbS design, implementation and monitoring. This element of capacity building is vital to continuing the policy drive and to make sure that the adaptation strategies are dynamic to the emerging climate risks and local demand. The framework to monitor the project addresses ecosystem health, floods reduction and socio-economic resilience measures that are turned into actionable data to be used by the policymakers to improve and expand measures. The mechanisms play a key role in ensuring learning and flexibility is integrated into the policy cycles, which is much needed in light of the uncertainties in climate change issues (Recharge Pakistan, 2023).

Recharge Pakistan also shows the importance of national policy-alignment with international climate framework and climate finance mechanisms. The biggest investment in ecosystem-based adaptation in Pakistan involves the project departure of 77.8 million dollars, with a $66 million GCF grant, marking the largest ever contribution to climate emissions in Pakistan, and a strong signal to the policymakers that global climate finance can be used in funding NbS (Recharge Pakistan, 2023). Such alignment releases major resources and also makes sure that the adaptation approaches in Pakistan are aligned with international best practices and to enhance the status of the country at the international level (Recharge Pakistan Leads Paradigm Shift Towards Ecosystem-Based Adaptation and Nature-Based Solutions at COP29, 2024).

The policy design of the project also includes scalability since the project is geared towards context-specific replication and upscaling in other climate-vulnerable areas. The piloting interventions of D.I. Khan, Ramak, Manchar and Chakar Lehri watersheds are being used as a demonstration area to the other parts of the country. The policy framework promotes the recording and sharing of the experiences, so that other provinces and nations can adapt the same model to very specific ecological and socio-economic situations wherein they operate (Recharge Pakistan, 2024). Moreover, the priority of the project in terms of promoting climate-resilient livelihoods and

local enterprises guarantees the distribution of benefits of the NbS as many people will become interested in them and support policy integration in the future (Recharge Pakistan, 2023).

Table 3: *Policy Implications and Scalability of Recharge Pakistan*

Policy Aspect	Description
Mainstreaming NbS	Integrated into National Water Policy, National Adaptation Plan, Provincial Plans
Institutionalization	Adaptive management, evidence-based decision making, capacity building
International Alignment	Funding from Green Climate Fund, USAID, global best practices
Scalability	Replication potential in other vulnerable areas, knowledge sharing
Community Engagement	Focus on livelihoods, local enterprises, inclusive participation

Conclusion

The Recharge Pakistan Project is an excellent display of how nature-based solutions (NbS) and ecosystem-based adaptation (EbA) can play in climate resilience in the most vulnerable situation. Incorporation of ecological restoration and community interaction and policy compatibility are able to bring huge environmental, social and economic rewards. Through rehabilitation of more than 14,000 hectares of degraded wetlands and forests, restoration of natural water routs as well as the construction of 127 green infrastructure measures, the project has had a high impact on reducing the flood risks, increasing the recharge of groundwater as well as diversity in the Indus Basin. Such interventions have had direct impacts on more than 680,000 people and indirect benefits of over 7 million people, a testimony to the magnitude and inclusivity of NbS in dealing with climate-induced disasters. The participatory nature of Recharge Pakistan that focuses on the implementation of community-based natural resource management and livelihoods diversification has enhanced local capacities, as well as engendering the feeling of ownership of adaptation strategies. Additionally, this strategy enhances technical results and offers the sustainability of the interventions in the long run, since the local knowledge and priorities are reflected in the design and implementation of the project. The fact that the project is in line with national policies, including the National Water Policy and the National Adaptation Plan, also institutionalizes NbS and EbA and makes them easier to introduce into the wider scope climate and water management plans.

On its part, the project shows significant success; however, it also indicates the existing issues, such as the lack of technical capacities and available funds, the fragmentation of the institutional structure and uncertainty of climate effects. To overcome them, it is necessary to invest in capacity building on a long-term basis, enhance coordination of stakeholders, and develop adaptive management frameworks that could address the changing climate risks. Furthermore, the evidence-based elements of the project, as well as its effective monitoring system, offer great insights regarding the expansion of NbS to other climate-at-risk areas. To sum up, the Recharge Pakistan Project can be regarded as an effective example of a long-term sustainable adaptation to climate change. It shows that strongly backed by proper governance, policy coherence, and community engagement, NbS can provide resilient, equitable and enduring benefits. The results of the project promote a shift in paradigm towards integrated and system-based approach in lieu of the traditional

infrastructure-intensive interventions and that it is focusing on balancing human development with ecological integrity since it will become a road map in terms of adaptation in the future in Pakistan and beyond.

Conflict of Interest

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