EVALUATING EFFECTIVENESS OF POLYCENTRIC CLIMATE GOVERNANCE IN PAKISTAN: A CASE STUDY OF GLOF-II

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ABSTRACT

We are now living in what is aptly described as "Age of Adaptation". In this age effectiveness of governance arrangements is critical to achieving resilience outcomes. This study evaluates the effectiveness of climate governance in Pakistan focusing on GLOF-II project. This case study uses the lens of polycentric climate governance, with particular attention to participation, adaptive capacity, accountability and sustainability of outcomes. The research develops and applies a tailored theoretical framework to assess how multiple, interacting centers of decision making shape adaptation outcomes and how their effectiveness is perceived by the beneficiary communities.

The study adopts a multidisciplinary mixed-methods approach and draws on project documentation, key informant interviews, focus group discussions, structured field observations and remote sensing data. The research evaluates the project's contributions to community based disaster preparedness, infrastructure development, and stakeholder coordination, while also interrogating institutional dynamics underpinning these interventions. We do so by exploring the nature and role of polycentricity in shaping relationships between local communities, subnational authorities, federal institutions, and international donors.

Our findings suggest that despite its ambitious scope and normative alignment with polycentric governance principles, the GLOF-II project demonstrates uneven effectiveness. While the governance model reflects polycentricity in design by engaging multiple line departments and stakeholders responsible for delivering outcomes, this has not translated into improved coordination or adaptive outcomes. Instead, fragmented institutional arrangements, capacity constraints, and unclear accountability mechanisms have limited the project's effectiveness. Our study finds that while the polycentricity in design enabled broader institutional participation, in practice its weak nature created coordination and resource mobilization challenges. This resulted in diffused responsibility that constrained effective adaptation. Our findings highlight the importance of not only designing polycentric systems, but ensuring their functional integration through clear accountability, continuous local engagement, context sensitive technical planning and adaptive governance mechanisms.

It is important to acknowledge that community level findings are derived from fieldwork conducted in four project valleys and therefore may not be generalizable across the diverse and socio-ecological contexts of Gilgit-Baltistan and Khyber Pakhtunkhwa. Nevertheless, these cases provide valuable insights into how polycentric governance arrangements operate in practice at the local level. The research provides policy relevant insights by highlighting the need to strengthen vertical and horizontal coordination mechanisms, invest in local institutional capacity, and most importantly ensure community participation and ownership more meaningfully within project design and implementation. This study provides empirical evidence within theoretical debates on polycentric governance and contributes to broader discussions on how donor funded climate adaptation initiatives can move beyond institutional complexity toward more context specific and adaptive effective governance outcomes for beneficiary communities.

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ABBREVIATIONS

EWS	Early Warning Systems
GB –EPA	Gilgit Baltistan Environmental Protection Agency
GBDMA	Gilgit Baltistan Disaster Management Authority
GBRSP	Gilgit Baltistan Rural Support Program
GLOF	Glacial Lake Outburst Flood
MoCC	Ministry of Climate Change & Environmental Coordination
PnD	Planning and Development
UNDP	United Nations Development Program

INTRODUCTION

1.1. Background and Context of the Study

The northern areas of Pakistan, particularly Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa, are threatened by the global rise in temperatures. The region has some 3,000 glacial lakes, many of which pose serious threats to the remote communities and infrastructure resulting from the risk associated with Glacial Lake Outburst Floods (GLOFs). To mitigate these risks, the Green Climate Fund (GCF) co-financed the GLOF-II project, with a total budget of US$36.96 Million (with PKR50 million co-financing from the Government of Gilgit Baltistan) to scale up UNDP's GLOF-I project. The GLOF-II project is expected for the duration of July 2017 – December 2025 and cover 24 valleys across ten districts of GB and five districts of KP (UNDP, 2025). The infographic below gives an overview of this crucial project[3]:

Inforgraphic 1 GLOF-II Overview.

GLOF-II Pakistan is an ideal case study to evaluate the effectiveness of polycentric climate governance in Pakistan. This project is a collaboration between the Ministry of Climate Change (MOCC), United Nations Development Program (UNDP), Green Climate Fund (GCF), and several key governmental, non-governmental organizations, and actors to co-create responses to extreme weather conditions.

[3] Infographic is recreated by the authors. Based on the information shared here: https://www.adaptation-undp.org/sites/default/files/resources/glof-ii-infographic.pdf

Given the project's complexity, its significance, scale, resources involved, and potential impact, an independent evaluation is critical to assess its effectiveness, challenges, and outcomes. The evaluation aims to assess the effectiveness of the project's performance against the key performance indicators (KPIs) in selected valleys and examine GLOF-II alignment with the GCF's Evaluation Standards and UNDP's Social and Environmental Standards. This multi-modal mix-method evaluation study provides an understanding of polycentric climate governance and generate lessons for improving climate governance. It aims to provide insights to ensure better coordination, accountability, and transparency in future projects.

1.2. Purpose and Scope of the Study

Climate adaptation projects like GLOF-II, which depend on multi-level stakeholder coordination and governance, face challenges in delivering measurable, long-term outcomes. In the context of climate governance, polycentric climate governance resulting from the collaboration of local, national, and international actors offers a valuable framework for managing complex/wicked climate risks. However, its effectiveness remains underexplored, particularly in ecologically fragile and less developed regions.

This research addresses the gap by evaluating the GLOF-II project's implementation through the lens of polycentric climate governance. It applies the practical framework developed by Bennett & Satterfield (2018), which adopts a systems approach to assess environmental governance across key dimensions of effectiveness (i.e., Direction, Coordination, Capacity, Informed, Accountable, and Efficient). The study also integrates the updated evaluation criteria of the Green Climate Fund (GCF) for assessing GLOF-II's impact potential, paradigm shift potential, sustainable development potential, needs of the recipient, and country ownership. By combining these frameworks, the study aims to generate insights into how governance models can enhance the impact, scalability, and long-term community resilience and sustainability of climate adaptation initiatives.

1.2.1. Guiding Questions

Climate adaptation projects like GLOF-II, which depend on multi-level stakeholder coordination and governance, face challenges in delivering measurable and sustainable outcomes. While polycentric climate governance resulting from the collaboration of local, national, and international actors offers a promising framework for managing complex and 'wicked' climate risks. However, its effectiveness in ecologically fragile and politically constrained environments remains underexplored. This research addresses the gap by evaluating the GLOF-II project's implementation through the lens of polycentric climate governance. It aims to assess the project's relevance, outcomes, effectiveness, synergies, sustainability, and challenges. In doing so, this study seeks to understand how such governance models can contribute to building long-term community resilience in ecologically fragile and politically constrained environments.

The study pursues the following key objectives:

1. **Evaluate the effectiveness** of the GLOF-II project in mitigating glacial lake outburst flood (GLOF) risks and improving disaster preparedness in vulnerable communities of Northern Pakistan.

2. **Assess and explore the role and nature of polycentric governance**, focusing on how collaboration among local, national, and international stakeholders has shaped the design, implementation, and outcomes of GLOF-II[4].

3. **Measure project outcomes against both the selected key elements of Effective Environmental Governance Evaluation Framework (Bennett & Satterfield, 2018)** and the **Green Climate Fund (GCF) evaluation criteria**. These frameworks have been combined to ensure alignment of both theoretical understandings and practical project expectations.

To operationalise the evaluation, we will be specifically exploring the following questions:

a) Relevance: Was GLOF-II designed effectively to address the specific risks of GLOFs and the needs of vulnerable communities in Northern Pakistan?
b) Outcomes: How successful has the project been in reducing GLOF risks and enhancing community resilience through infrastructure, early warning systems, and disaster preparedness?
c) Effectiveness: To what extent has polycentric governance encompassing local, national, and international actors contributed to the effectiveness of the project?
d) Country ownership: How actively have national institutions and local stakeholders led or co-owned the project's design and implementation?
e) Sustainability: Will the benefits of the GLOF-II project continue beyond its completion? How sustainable are the interventions? How resilient are the interventions to future climate and political risks?
f) Paradigm shift: Has the project resulted in a transformative paradigm shift in the operative nature of climate governance?
g) Challenges and Lessons Learned: What governance, technical, and political challenges were encountered during the project and how were they addressed? What lessons can be drawn to improve future climate adaptation projects in similar contexts

1.3. Relevance to Public Policy

This evaluation project provides insights for climate adaptation policy and governance in Pakistan. It evaluates effectiveness of GLOF-II, which operated in glacial regions vulnerable to outburst floods and focuses on strengthening early warning systems, community-based preparedness, and climate-resilient infrastructure. This study generates independent, evidence-based findings on what interventions were most effective, helping policymakers improve disaster risk reduction strategies and allocate resources more effectively and efficiently. The evaluation also informs how polycentric climate governance frameworks function in practice and their alignment with international funding mechanisms like the Green Climate Fund. It highlights and identifies coordination gaps and

[4] We have reviewed publicly available project documents to gain a clearer understanding of GLOF-II and the polycentric climate governance model it employs. This process helped us better comprehend the GLOF-II structure, objectives, and how multiple stakeholders collaborated within GLOF-II's governance framework to manage climate risks effectively.

accountability challenges, the research supports more responsive, transparent, and accountable polycentric climate governance. The findings are useful not only for strengthening local resilience but also for guiding similar adaptation efforts in comparable high-risk regions.

THEORETICAL AND ANALYTICAL FRAMEWORK: LITERATURE REVIEW

The revised Atlas of Mortality and Economic Losses from Weather, Climate, and Water-related hazards during 1970-2021, by the World Meteorological Organization (WMO), reveals that extreme weather, climate, and water-related events have resulted in around 12000 disasters claiming roughly 3 million lives. Notably, 90% of those succumbing to these disasters are from developing countries. Besides the colossal human loss, the associated economic losses amount to US$4.3 trillion (WMO, 2023). While the contextual realities and governance structures vary among the developing countries, many share common challenges in terms of inadequate climate policy frameworks, finance, and technology. It is in this context that the Paris Agreement and its commitment gain salience, and the need for global climate funding arises.

2.1. Evaluating Effectiveness and Polycentric Climate Governance

The environmental governance entails several actors (e.g, government, private businesses, non-profit organizations, and local communities) and relations between these actors are characterized by means of governing. In the realm of climate governance, the Non-State-Market-Driven (NSMD) governance systems are also gaining salience along with Command and Control-based policies (Benson & Jordan, 2017).

Variables like governance capacity and legitimacy are also crucial for effective governance in the face of wicked problems (Christensen et al., 2016). Tackling the wicked problem requires collaboration among multiple actors (Nohrstedt, 2015). These effective collaborative networks allow co-creating public value (Acar et al., 2025). Regional environmental issues can also be resolved with mandated collaborative platforms (Mu & Cui, 2024). However, the success of these collaborative processes is determined by the governance dynamics, network positions, and interagency communications in cross-sectoral collaborations (Howes et al., 2015; Lihua et al., 2020; Zheng et al., 2025). During crises, intergovernmental coordination is often marred by friction (Aldrich, 2019)

Several factors, like the nature of democratic institutions, interest groups, public opinions, and media coverage, can influence the climate action policies (Al-Shidi et al., 2021; Bernauer & Koubi, 2009, 2013). Studies suggest that resilient policies can be created by increasing information about the issue (Sanchez et al., 2017). However, in some cases, to avoid disclosures, there are often political incentives to manipulate data (Liu & Kong, 2021).

Effective collaborative governance is based on inclusivity, power parity, sustainability, accountability, shared principles, regulations, and motivation. The efficient and effective processes entail activities such as constant monitoring, feedback loops, information exchange, coordination, collective learning, and knowledge sharing. Depending on the causes, composition, and environmental context, every collaborative network is distinct (Prysmakova-Rivera & Pysmenna, 2021). The networked government perspective can enable the evaluation of maps and explore the nature of intergovernmental crisis coordination in managing wicked problems (Kapucu et al., 2024)

Other evaluation frameworks offer useful theoretical underpinnings to evaluate the polycentric climate governance for effectiveness, equity, responsiveness, and robustness. This practical framework employs a systems approach and provides insights to evaluate the institutional,

structural, and procedural elements of environmental governance across the evaluation criteria (Bennett & Satterfield, 2018). These frameworks can be combined to develop and assess the performance and productivity of the collaborative governance based on the actions, outcomes, and adaptations undertaken by collaborating organizations in the network across performance indicators (Emerson & Nabatchi, 2015). The creation of public value, indicated by vertical as well as horizontal democratic accountability, procedural rationality and justice, problem-solving capacity, and effective performance, has also been used to assess the cross-sectoral collaborations (Page et al., 2015).

However, it is important to note that collaborative governance is marked by 'complex accountabilities' where often it is difficult to navigate due to uncertainty about who should hold whom accountable and what responsibilities or outcomes they are expected to deliver (Bryson et al., 2015).

Evaluating effectiveness of adaptation governance is characterized by complexities of defining and measuring effectiveness in climate change adaptation. Frames of effective adpatation inlcude, maximizing economic benefits, improved wellbeing, vulnerability reduction or adaptive capacity enhancement, enhanced resilience, Sustainable adaptation, avoiding maladaptation, ecosystem-based adaptation, community-based adaptation, adaptive governance, ensuring equity and justice and transformation (Singh et al., 2022). The multidimensional nature of effective adaptation governance can be captured by employing integrative frameworks to evaluate effectiveness (Etana et al., 2022). Frameworks of polycentric climate governance and evaluation strategies are being increasingly used together to understand and strategize adaptation actions to deal with the complex problems (Schoenefeld, 2023). The Green Climate Fund has developed robust evaluation criteria and standards to ensure that the funded projects deliver measurable and sustainable climate benefits. The updated GCF criteria assess the project on five key factors: impact potential, paradigm shift potential, sustainable development potential, needs of the recipient, and country ownership (GCF, 2022.).

The evaluation studies commissioned by the implementing partners place competing demands on the independent evaluators. Without recognizing these, the evaluations may end up focusing on learning rather than on accountability (Faling et al., 2024). Arguments have been made for evaluation studies to adopt methodologically pluralist approaches that focus on contexts as central to understanding impact trajectories and effectiveness. While performance based evaluation strategies are crucial, these need to be coupled with evaluations of broader development strategy reforms grounded in genuine country ownership, aligned incentives, and coherent sequencing from problem identification to implementation are required. It is imperative to have knowledge of how interventions evolve across time, scale, and institutional settings. A close engagement with social, political and institutional contexts in which projects are embedded is also needed using a mix of qualitative, quantitative, and historical methods. All these insights cannot be generated through application of "gold standard" designs such as randomised controlled trials (Woolcock, 2009). Likewise, evaluations and explanatory analyses should involve all stakeholders including affected actors and ideally actor analysis, process analysis and network/institutional analysis should be done

to capture the complexity of the networks and environments (Haass & Guzman, 2020; Klijn et al., 2025).

The current architecture of climate governance is characterized as either multilevel or polycentric climate governance (Heinen et al., 2022). These take into account the horizontal and vertical linkages along with the formal and informal coalitions (Jänicke, 2017; Lidskog & Elander, 2010). Polycentric climate governance models can facilitate collective action at multiple levels and are becoming conspicuous (Ostrom, 2010).

The multiplicity of development actors and initiatives results in challenges for policy consistency, accountability, and effective governance. Concerns have been raised regarding the fragmentation and obscured lines of responsibility and authority due to the involvement of numerous actors in climate governance. The simultaneous absence and presence of climate governance have blurred lines of accountability and heightened issues of fragmentation in our globalized world (Bulkeley & Newell, 2023).

However, in the context of the Global South, the pronounced power differentials and inequalities marked by undemocratic governance structures may render climate change mitigation and adaptation more complex (Sapiains et al., 2021). In this age of adaptation, it has been argued that analyses of adaptive capacity and pathways to transformative change in socio-political systems benefit from moving beyond regime-based approaches alone, by also engaging with social contract and human security perspectives, as well as insights from work on socio-technical change, self-organisation, and social learning (Etana et al., 2022; Pelling, 2010). There is a need to adopt diverse adaptation strategies for effective adaptation that enhances adaptive capacity by building resileince and reducing vulnerabilities (Etana et al., 2022). The cross-sectoral partnerships in southern contexts may enable disproportionate influence by state actors and sideline other stakeholders from participating in adaptation-related decisions, cementing the views of other stakeholders regarding the government's enhanced control over adaptation finance and inadvertently perpetuating existing inequalities by reinforcing exclusionary systems (Omukuti, 2020). Concerns have been raised about how these partnerships may provide "competences without agency" by offering new resources and knowledge to the beneficiaries without creating the necessary conditions for these to bring about meaningful changes in their lives (Vestergaard et al., 2020). However, the existing literature on polycentric climate governance largely reflects the realities of Northern perspectives. This study aims to contribute to the literature on polycentric governance from a Southern perspective by analyzing how power asymmetries in adaptation governance affect participation, equity, and the outcomes of cross-sectoral partnerships.

RESEARCH METHODOLOGY

This study adopts a mixed-methods approach, combining quantitative and qualitative data collection to comprehensively evaluate GLOF-II. The methodology is designed to align with GCF's evaluation criteria to ensure that all aspects of project implementation are considered. Broadly speaking, the evaluation strategy comprehensively assesses the relevance, outcomes, effectiveness, sustainability, and challenges of the GLOF-II project. Our data sources include project documents, in-depth key informant interviews, FGDs, and structured field observations. As indicated in our initial proposal we have also used satellite based remote sensing data to collect to assess the performance of selected indicators like an increase in the vegetative cover as well. During the course of this study we have also actively followed the local as well as national news and project-related social media posts closely over the course of this study.

3.1. Desk Review

Desk review included all publicly available project-related official documents (including approved project proposal, GCF and UNDP's relevant policies and guidelines, yearly progress reports, Baseline and Midterm Evaluation reports) to develop a comprehensive understanding of the project, identify stakeholders. This also enabled us to tailor our evaluation criteria to match the objectives of the project, develop relevant toolkits based on insights from the Green Climate Fund's own evaluation guidelines and scholarly literature.

3.2. Data Collection from Locales

For this study we visited multiple locales. It included relevant offices in Islamabad, and Gilgit Baltistan. The study is based on quantitative and qualitative indicators to evaluate the effectiveness of the project. A list of the selected indicators was developed based on the evaluation of the key performance indicators and our field visit check list included gathering data on the following indicators in selected sites:

- Number of EWS installed and operational
- Number of small-scale engineering structures constructed (with GPS coordinates if available)
- Number of slope stabilization/bio-engineered structures
- Number of irrigation schemes rehabilitated
- Number and quality of Safe Havens
- Number, usage and quality of CBDRMCs (Community Based Disaster Risk Management Centers)
- Number of Hazard Watch Groups (HWGs) established
- Equipment provided to HWGs
- Number and type of community capacity-building activities conducted
- Status of traditional practices supported (e.g., Ice Stupas)

The table, drawing on publicly available project data, illustrates the nature and scale of GLOF-II interventions across the selected study locales.

Table 1: The Nature and Scale of GLOF-II Interventions Across the Selected Study Locales

Intervention	Shimshal	Hassanabad (Shishper valley)	Ghulkin	Hussaini
Early Warning Systems	6	8	9	9
Flood Protection Walls	10 (800 meters)	8 (1,680 meters)	3 (3,050 meters)	3 (3,050 meters)
Irrigation Schemes	10 (10,200 meters)	13 (13,000 meters)	7 (700 meters)	8 (700 meters)
CBDRMCs	1	1	1	1
Safe Havens	3	3	2	2
Pony Tracks/ access route	1	1	1	1
Slope Stabilization Schemes	24 hectares	85 hectares	18 hectares	18 hectares
CBDRM Committees	1	1	1	1 (poster lists 9)
Hazard Watch Groups	1	1	1	1 (poster lists 70)
Awareness Sessions	8	7	8	6
Livelihood Trainings	4	2	4	3
Mock Drills	6	6	6	5
GLOF Risks Measures	9	9	3	3
Implementation of Project Gender Action Plan	2	2	1	1
Trainings on climate-resilient livelihoods, kitchen gardening, and disaster preparedness	29	25	40	40

Sources: Based on data from project data of GLOF2 Pakistan (n.d.).

Keeping in view the logistical constraints and budget limitations, we have also conducted structured interviews in select high-risk communities in the GLOF-II intervention areas from 30 respondents[5]. While we admit this may not be statistically representative at the national scale, this data would enable us to explore project reach (e.g. coverage of early warning systems), effectiveness and perceived changes in resilience. The findings of the online survey are only to complement qualitative methods, including key informant interviews and focus group discussions with the beneficiary communities, to triangulate findings and deepen understanding of governance dynamics and project outcomes in selected valleys.

As the PI and Co-PIs of the project, we have personally visited the sites and proactively engaged with the key stakeholders in the selected project evaluation sites to ensure the robustness and quality of the data collected. Notably, one of the Co-PIs is a resident of the area, which provided us a distinct advantage in engaging with local communities and stakeholders. Insights based on local knowledge are crucial in accurately evaluating the project's effectiveness, ensuring that the data collected is relevant. Our positionalities as independent researchers also enabled us to understand the dynamics

[5] Our main concern regarding the sample size is to have a reasonable number of respondents from the selected sites. The household data will help us evaluate the household and community level impacts of GLOF-II initiatives such as access to early warning systems and their perceived risk reduction etc. We plan to triangulate the responses of this household level data with project documentation and qualitative data to assess the effectiveness and local relevance of the project.

of the climate governance and update our evaluation strategy wherever the need arose in consultation with the key stakeholders.

Our findings are based on Key Informant Interviews (KIIs) with the key stakeholders, including local government officials, relevant stakeholders, project managers, and community leaders who provided insights into the project's performance against the key performance indicators (KPIs), implementation challenges, and successes. The key stakeholders were identified after an extensive review of relevant project documents. We conducted the interviews in multiple sites, which included the selected valleys and the relevant line departments involved in the project implementation. The study participants included CBDRMc members, focal persons from community organisations, community leaders, affected populations, project beneficaries and the project implementers from the following departments/institutions in Islamabad, Gilgit Baltistan and Khyber Pakhtunkhwa.

1. MOCC
2. UNDP
3. PnD
4. GBRSP
5. GBDMA/KPDMA
6. Forest Department
7. Agriculture Department
8. KIU
9. Environmental Protection Department GB and KP
10. CBDRMCs

We have conducted 45 interviews from relevant stakeholders. Interviewees represented the institutions that coordinated, or implemented different components of the project at national and local levels direct/indirect beneficiaries of the project, and community members in selected sites. We developed separate toolkits for the community members and project implementers to ensure that relevant information is obtained. See Annexures for the toolkits. Some of the sub-themes discussed during the semi-structured interviews centred around:

Project relevance and design

Nature of governance and implementation

Polycentricism in practice

Effectiveness and outcomes

Sustainability and impact

Challenges, risks, and adaptations

Lessons and Recommendations

Focus group discussions with the community members, with particular focus on women and vulnerable populations, to assess the effectiveness of community-based disaster risk management and the inclusiveness of the livelihoods initiatives carried out. We conducted three focus groups, involving 21 participants, for this evaluation in the selected project valleys. Our discussions lasted

between 60 to 90 minutes. Special attention was given to understanding how gender considerations have been integrated into these projects, as outlined in the GLOF project documents. This approach enabled us to evaluate not only the overall impact of the interventions but also the extent to which they addressed the specific needs and vulnerabilities of women, ensuring a more gender-inclusive framework for disaster risk management. Our focus group discussions centered on the following themes:

Understanding of GLOF Risks and Community Ownership

Resilience and Preparedness

Infrastructure and Local Impact

Local Institutions and Participation

Indigenous Knowledge and Cultural Relevance

Sustainability and Future Needs

3.3. Data Analysis and Interpretation

The multimodal data from the relevant project documents, field notes, structured observations, key informant interviews, and focus group discussions are analysed to evaluate the effectiveness of the project, identify the dynamics of polycentric climate governance, and assess its effectiveness. The multimodal data consisting of project documents, field notes, structured observations, key informant interviews, and focus group discussions was systematically analyzed using theoretically grounded analytical framework integrating GCF evaluation criteria, dimensions of effective governance, and polycentric climate governance lens. Field notes and transcripts were coded using meaning based segments which enabled us to identify the underlying narratives of interest. We examined the patterns across different actors including community members, implementing agencies, and government stakeholders. This allowed us to compare the convergences and divergences in perspectives.

Table 2: Analytical Framework Guiding Qualitative Coding and Analysis

Evaluating Effectiveness of Polycentric Climate Governance in Pakistan: A Case Study of GLOF-II		
Effective Environmental Governance Evaluation Framework (Bennett & Satterfield, 2018) Direction: Vision, policy alignment, clarity of objectives. • Coordination: Federal–provincial relations, UNDP–government interface, duplication, gaps. • Capacity: Skills, staffing, finance, local implementation ability. • Informed: Use of data, community knowledge, information flows. • Accountable: Who answers to whom, grievances, monitoring, exclusion. • Efficient: Delays, bureaucracy, slow approvals, flexibility vs rigidity.	**GCF Evaluation Criteria** • **Impact Potential**: Reduced risk, early warning effectiveness, losses avoided, feeling safer. • **Paradigm Shift Potential**: Change from business-as-usual, scaling, institutional learning, systems change. • **Sustainable Development Potential**: Livelihoods, gender inclusion, jobs, ecosystems, co-benefits or trade-offs. • **Needs of the Recipient**: Community priorities, poverty, remoteness, mismatch between design and needs. • **Country Ownership**: Government leadership, UNDP dominance, donor influence, sustainability after exit.	. **Polycentric Climate Governance** • **Multiple Centres**: Federal, provincial, UNDP, local, community authority. • **Cross-Scale Interaction**: Cooperation, conflict, bypassing state levels. • **Autonomy vs Control**: Local decision space vs central or donor control. • **Learning & Adaptation**: Feedback loops, adjustment during implementation. **Flexible to match local circumstance**

Source: Authors' compilations.

FINDINGS AND DISCUSSIONS: POLYCENTRIC CLIMATE GOVERNANCE IN PRACTICE

The governance model of the GLOF-II project is polycentric in nature. A polycentric governance model involves multiple centers of decision-making that operate independently but interact and coordinate with one another (Schoenefeld, 2023). GCF's own governing model is characterized by polycentric climate governance and involves multiple actors, authorities and decision centers (Risnawati, 2025). GLOF_II also involves multi-level governance structure involves coordination among federal, provincial, and local entities, as well as international partners, making it polycentric. However, our study highlights challenges in coordination and decision-making, showing what literature describes as weak polycentrism (Galaz et al., 2012; Gallemore & Munroe, 2013; Kim, 2020.) which have impacted the project's efficiency and effectiveness.

In this project:

1. **Federal Level**: The Ministry of Climate Change (MOCC) serves as the executing agency, providing overall coordination and oversight. Other federal entities, such as the Ministry of Economic Affairs, Ministry of Planning, Development & Special Initiatives, and the National Disaster Management Authority (NDMA), are involved in the Project Steering Committee (PSC).
2. **Subnational Level**: The governments of Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP) are designated as co-executing agencies. Provincial Planning & Development Departments (P&DDs) and Provincial Disaster Management Authorities (PDMAs) play key roles in implementing project activities.
3. **Local Level**: Local stakeholders, including District Disaster Management Authorities (DDMAs), Community-Based Organizations (CBOs), and local communities, are engaged in project implementation and effected directly and indirectly from the interventions.
4. **International Level**: The United Nations Development Programme (UNDP) acts as the Green Climate Fund (GCF) Accredited Entity, providing technical support, quality assurance, and oversight.

Role of Polycentric Governance in Shaping Outcomes, Opportunities, and Challenges Offered by the Adaptive Governance Model of GLOF-II

Our findings illustrate that despite the involvement of multiple line departments and stakeholders, a rigid governance model prevented flexibility and adaptation to contextual needs and challenges in project implementation. Flexibility and dispersed authority are considered vital for and effective polycentric governance mechanism (Jordan & Huitema, 2023). The effectiveness of a polycentric system depends on complex political and social dynamics, particularly the extent to which diverse actors and decision-making centers coordinate to address policy challenges (Morrison et al., 2023).

Undoubtedly, the nature of polycentricity is determined by power dynamics (Morrison et al., 2019). Our study shows that polycentric climate governance in Pakistan is also characterized by what is referred to as "shadows of hierarchy"(Jordan et al., 2018; Kaps & Komlosy, 2013). Therefore, due to lack of diffused authority and asymmetrical power relations, even in cases where communities or concerned implementing institutions highlighted issues and challenges, the project design remained inflexible preventing any revisions in the deliverables.

Studies in the context of evolving democracies, have highlighted that top-down approaches in disaster management and environmental governance are prevalent and polycentric arrangements tend to become complex (Vij, 2023). Our findings concur that cross-sectoral partnerships as highlighted by Omukuti, 2020 in southern contexts, may enable disproportionate influence by state actors and sideline other stakeholders, in our case beneficiary communities, and sometimes subnational institutions, from participating in adaptation-related decisions, cementing the views of other more powerful stakeholders regarding the government's enhanced control over adaptation finance and inadvertently perpetuating existing inequalities by reinforcing exclusionary systems.

4.1. Project Relevance and Alignment with Local Needs

The respondents agreed that GLOF-II was a much needed project. The project document as well as interviews with the key officials reveal that project is aligned to Pakistan's need. A preliminary discursive analysis of project key documents including the proposed proposal highlights the importance of the project for Pakistan and its alignment with local needs and international commitments. These documents refer to the threats posed by climatic changes, Pakistan's vulnerability to extreme heat and other hazards and it highlights the challenges that communities face.

The communities had mixed views related to the questions of project relevance and local needs.

Respondents suggested that interventions were inadequate to alleviate the community-specific vulnerabilities. For instance, in Hussaini, where the community faces an acute shortage of water resulting from the receding glacier, the community raised concerns. Interestingly, the Annual Performance Report, 2024, claims *"drinking water pipes were arranged to provide water for domestic purposes"* and the community *"enjoys water from Ghulkin/Hussani Glaciers and meets their domestic needs"* (page 92) (Fund, 2025b). However, interviews with residents reveal a starkly different picture:

> *"Neither GLOF-II provided any drinking project to Hussaini nor resolved our irrigation water issues… They gave us pipes from the middle of the Hussaini glacier, but the volume is very low and only one pipe is in use, which is not sufficient for our agricultural lands."*
>
> *"They say we have drinking water, but we still carry buckets from far-off springs, and nothing has changed."*

This discrepancy highlights a critical gap between project documentation and community experience, raising questions about the validity of reported outcomes and the effectiveness of stakeholder engagement in project design and monitoring.

Similarly, the livestock breeds and agricultural inputs distributed under the livelihood scheme were not ecologically appropriate for high-altitude regions like Shimshal. Participants shared that livestock could not survive the cold or adapt to the local feeding practices. These concerns were raised regarding the seeds provided under kitchen gardening training where some respondents highlighted that the seeds didn't germinate or grow due to short growing seasons and poor soil.

The mismatch between inputs and local conditions reflects **paradoxical success** (Faling et al., 2024), where outputs are delivered but outcomes and their sustainability remain elusive.

In Shimshal Valley, a local resident who also serves as the project focal point raised serious concerns about the irrigation scheme implemented under GLOF-II. According to him, the budget approved for constructing the water channel and tank was insufficient even to cover basic logistical costs, particularly given the challenging mountainous terrain. Transporting materials to the project site alone exceeded the total allocated budget.

When these concerns were communicated by the community to the project representatives, the response was dismissive: *"This is what's approved, we can't change it now."* This reflects a broader issue of minimal community involvement during the project design phase, resulting in interventions that were financially unrealistic and operationally impractical.

Moreover, the resident reported that when community members raised these issues, they were threatened with exclusion from future projects, reinforcing the perception that GLOF-II followed a top-down, non-inclusive approach. These accounts highlight the need for participatory planning, context-sensitive budgeting, and respectful engagement with local stakeholders to ensure that adaptation efforts are both effective and equitable.

4.2. Project Outcomes and Effectiveness

4.2.1. CBDRMCs and Safe Heavens

During our field visit in July, 2025, the CBDRMCs in Ghulkin and Hussaini, were incomplete. In Ghulkin, CBDRMc was constructed next to the moraine. The community members noted that the Jamat Khana, located next to CBDRMc, was being relocated due to its vulnerable location. Some respondents raised concerns over the quality of the upgradation done in the school designated as a safe haven. According to community members, the improvements were minimal, limited to whitewashing the walls and delivering a few chairs and tables. School authorities further noted that even this limited work was conducted during extreme cold weather conditions, when construction and related activities are generally not viable in the region.

Similarly, while project documentation lists two designated safe havens for the Hussaini area, field visits and consultations with residents reveal a different reality. In practice, only one school has been declared a safe haven, which appears to have undergone renovation and upgradation twice. This raised concerns among local representatives, who questioned both the accuracy of project reporting and the adequacy of facilities provided. Some residents also pointed out that the location of the Safe Heaven was unsafe and not very accessible.

Picture 1 Access to Incomplete Building of CBDRMC in Hassanabad June, 2025

Source: Authors' compilations.

Picture 2 Access to Safe Heaven in Hassanabad

Source: Authors' compilations.

Picture 3: Incomplete CBDRMC in Ghulkin. This CBDRMC is constructed next to Jamat Khana which is being relocated due to it location near Morain.

Source: Authors' compilations.

4.2.2. Early Warning Systems and its Coverage

Our participants contested the number of EWS reported in the project valleys. Even in places where EWS were installed in the project valleys, the communities weren't receiving any weather updates. The data wasn't publicly available. Concerns were also raised about the post-project ownership and

maintenance of the EWS. Some also raised concerns about the capacity and competence of personnel at the provincial level to handle and maintain the system installed. Residents in Hassanabad expressed frustration over the lack of local capacity to operate the EWS. Another government official noted that the District Commissioner was sent for EWS training, yet he was transferred just four months later. No resident was trained or equipped to manage the system. This situation highlights a critical gap in sustainability and community ownership of disaster preparedness infrastructure.

The United Nations Development Programme (UNDP) has highlighted the installation and operationalization of Early Warning Systems (EWS) under the GLOF-II project as a key adaptation priority. According to an official Facebook post, on June 28,2025, 136 EWS sites have been established across vulnerable valleys in Gilgit-Baltistan and Khyber Pakhtunkhwa, with 92 stations in Gilgit-Baltistan alone transmitting real-time data to the Pakistan Meteorological Department. These systems have reportedly enabled timely evacuation during recent events, with UNDP emphasizing their effectiveness in safeguarding lives and livelihoods (United Nations Development Program, 2025).

Picture 4: EWS in Hussaini

Source: Authors' compilations.

Picture 5: EWS in Ghulkin

Source: Authors' compilations.

During our interviews, some participants also raised concerns regarding the ecological footprints of Early Warning Systems being installed by various organisations. Recent news from Gilgit-Baltistan also highlights the paradoxical consequences of disaster risk reduction interventions when environmental safeguards are overlooked. The installation of advanced weather stations under the donor-funded GLOF-II project, intended to strengthen the region's early warning system for glacial lake outburst floods, has itself been found to contribute to environmental degradation. Specifically, the Gilgit-Baltistan Environmental Protection Agency (GB-EPA) imposed a fine of Rs 5 million on the project for undermining the aesthetic and ecological integrity of the high-altitude Kutwal Lake in Haramosh, Gilgit, by placing weather monitoring equipment on sensitive green area adjacent to the lake. Rather than enhancing resilience, the intervention risks producing new forms of ecological harm and undermining the very environmental assets it aims to protect. This case underscores the importance of aligning climate adaptation and disaster risk reduction measures with robust environmental governance frameworks to prevent maladaptive outcomes (Nagri, 2025).

4.2.3. Slope Stabilization Interventions

Another major component of the project included slope stabilization. Remote sensing analysis of selected plantation and slope stabilization sites under the GLOF-II project indicates a mixed picture regarding implementation and verifiability of reported outcomes. At Khaplu Nullah (Ghanche), satellite imagery suggests the presence of slope stabilization measures and an estimated 5-hectare area showing increasing vegetation cover between 2020 and 2025, broadly aligning with reported plantation activities initiated in 2021. However, for other sites including Shishper Nullah, Hassanabad Valley, and Shimshal, there are notable inconsistencies between reported coordinates and observed land use or elevation characteristics. In some cases, the specified locations correspond to agricultural land or areas where newly planted vegetation cannot be clearly distinguished. Temporal NDVI analysis for Shimshal further indicates an overall decline in vegetation cover within the broader area, although the absence of precise site boundaries limits attribution of observed changes to project interventions. Across sites, discrepancies between spatial data provided by the Forest Department and UNDP, coupled with limitations in GPS accuracy, constrain reliable assessment of effectiveness. These findings highlight the importance of need to improve geospatial data practices, including the use of accurate coordinates and clearly defined site boundaries. A detailed site-wise analysis of selected valleys, including supporting imagery, is provided in the Annexure.

4.2.3. Changes in community awareness, preparedness, and resilience

All the respondents in the selected valleys knew about the project. Participants were aware of Hazard Watch groups, but their actual functionality remained unclear to many. Specifically, local communities were uncertain about the groups' effectiveness in monitoring potential lake outburst events, conducting mock drills, and preparing residents to respond to emergencies.

This ambiguity appears to stem in part from overlapping institutional roles. In addition to the GLOF-II initiative, organizations like the Aga Khan Agency for Habitat (AKAH) also operate in the region, deploying similar community-based groups such as the Community Emergency Response Teams

(CERT). Many individuals serve across both platforms, which has led to blurred lines of responsibility, diluted accountability, and confusion during emergency mobilization.

One of our FGD participants narrated how the first aid training provided helped to resuscitate a community member and saved his life. However, she also mentioned that *"while the trainings were provided to create livelihood opportunities and build resilience but the inputs to practice the skills were inadequate"*. This was mentioned elsewhere in another community where 20 women attended a training to use an oil extract machine to supplement the household income, but the capacity of the machine provided was insufficient and therefore it remained unused. However, the project implementers were pressuring the community to install signage announcing the "establishment of Oil Extraction Unit" in the community.

Our discussions, with women were reflective of concerns regarding creating "competences without agency" by Vestergaard et al., 2020 where it seemed women were offered new resources and knowledge without creating necessary conditions for meaningful changes in their lives.

Picture 6: Unused Oil Extraction unit

Source: Authors' compilations.

Picture 7: An uninstalled signage lying in Ghulkin which mentioned projects never delivered in the community

Source: Authors' compilations.

Picture 8: Another uninstalled signage in Ghulkin which mentioned inaccurate project costs and failed to acknowledge share contributed by the community

Source: Authors' compilations.

Picture 9: An uninstalled signage in Hussaini which mentioned projects never delivered in the community

Source: Authors' compilations.

In three locales, we came across signage that local communities declined to install, citing discrepancies between stated claims and actual interventions. The other three interventions mentioned in the project were not carried out at all. In one community, where this signage was installed, the CBDRMc member informed that these projects were not carried out, and while we have installed the board, we have also communicated our reservations regarding the wrong claims to the officials.

Our field observations indicate that in several project sites, community members have refrained from installing project boards because they contained claims about interventions that were not actually implemented. The deliberate removal or absence of these boards reflects local skepticism toward donor narratives of success and underscores the disjuncture between official project reporting and lived community experiences. Such acts of resistance, though subtle, can be read as a form of

accountability politics, whereby communities contest external representations of development outcomes. While Bryson et al., (2015) have highlighted that collaborative governance is marked by 'complex accountabilities' where often it is difficult to navigate due to uncertainty about who should hold whom accountable and what responsibilities or outcomes they are expected to deliver our interactions with the communities show they are aware of who to hold accountable.

4.3. Efficiency and Synergies

The project documents reveal that despite its potential, GLOF-II has encountered several challenges, such as project restructuring, revised targets, and delays in implementation.

The GCF's Annual Performance Report (APR) 2022 revealed that a major restructuring was approved by the GCF secretariat which included *"reduction of vegetative cover targets under Output 2, Activity 2.3 from 240,000 Ha to 700 Ha"* and *"change in the co-financing commitment of Government of Gilgit Baltistan (PKR 50,000,000) from USD 500,000 to USD 280,946 based on the exchange rate as of Dec 2021"* (Fund, 2023). Similarly, APR 2018 mentions the "impact on the pace of implementation" following the change in government after the 2018 elections (Fund, 2019). The subsequent report mentions that the *"Execution Entity called for another review of implementation arrangements"* and several other "operational challenges" (Fund, 2020). According to APR, 2024, the project which was envisaged to be completed in a period of 2017-2022, applied its third non-cost extension which was approved in November, 2024 which ended on December 30,2025 (Fund, 2025a).

In July, 2024, UNDP publically expressed concerns on "slow-progress" in GB and stressed on the need to improve coordination and utilize the budget (Abbas, 2024).

Our respondents often highlighted the systemic challenges in the planning, implementation, and governance of GLOF-related projects in Gilgit-Baltistan. Despite notable efforts by agencies such as UNDP, EPA, and GBDMA, the lack of coordination, outdated data, weak community integration, and bureaucratic inertia continue to undermine long-term climate resilience.

Two of our key informant interviews revealed that in Khaplu, Ghanchi, approximately 16,000 saplings planted under the GLOF-II project did not survive due to the unavailability of water. This outcome points to significant shortcomings in resource planning and highlights coordination gaps between implementing agencies and relevant line departments. The failure underscores how inadequate interdepartmental collaboration, particularly between forestry and irrigation authorities, can compromise the effectiveness of climate adaptation measures and result in wasted resources and missed opportunities for long-term resilience building.

4.4. Sustainability of Outcomes

Sustainability of the project outcomes was repeatedly questioned during the field interactions at multiple levels. For instance, there was no clear exit strategy which showed how the CBDRMCs would be used. Similarly, several participants pointed out that there were no SOPs to ensure the post-project sustainability of EWS systems installed.

One long-term impact of the project appears to be the awareness levels in the community. However, can this be solely attributed to the project? Many participants believed this was owing to the lived

experiences of communities that were at the forefront of the challenges posed by the glacial melt and environmental degradation. It was common to hear terms like 'indigenous knowledge', 'resilience', and 'climate change' interspersed in casual community conversations in the valleys we visited.

Participants also questioned whether this project has actually strengthened the capacity of the implementing partners or the participating communities.

4.5. Challenges and Lessons Learned

The project posed technical, political and financial challenges. On a technical level, GLOF-II project faced significant technical barriers, particularly around the performance of Early Warning Systems (EWS). Information gleaned from both local communities and the Gilgit-Baltistan Environmental Protection Agency (GB-EPA) suggest that weather stations and alarm systems often failed to operate during critical events. In some instances, the equipment itself contributed to environmental degradation, as in the case of Kutwal Lake, raising concerns about context-inappropriate technologies. Similarly, large-scale afforestation efforts encountered problems of water scarcity, with approximately 16,000 saplings in Ghanchi perishing due to inadequate irrigation. These examples point to shortcomings in environmental suitability assessments, technical maintenance, and resource planning.

At the political level, competing claims over project success became a barrier in their own right. While implementing agencies and donor organizations highlighted GLOF-II as a model of resilience, recent public commentary and local experiences shared by the respondents often contradicted these narratives, exposing tensions between official discourse and lived realities. Political sensitivities around donor funding further constrained open acknowledgement of shortcomings. Moreover, the absence of transparent accountability mechanisms such as parliamentary scrutiny or independent audits meant that project narratives were shaped more by institutional reputations than by evidence of effectiveness.

Institutional fragmentation further limited the project's effectiveness. Weak coordination between key departments, such as forestry, irrigation, and disaster management authorities, led to resource wastage and duplication of effort. The lack of systematic community participation in planning and monitoring also created a gap between institutional priorities and local needs. Training programs and awareness campaigns, though designed to promote participation, often functioned as one-off workshops rather than sustained engagements.

4.6. Adaptive Responses

Despite these barriers, several adaptive practices emerged. Local communities in Ghizer, for instance, relied on traditional knowledge and informal warning systems to trigger evacuations during glacial lake outburst floods highlighting the resilience of endogenous practices when technological systems faltered. At the institutional level, the GB-EPA's imposition of a fine on the project at Kutwal Lake marked an important assertion of regulatory authority, signaling that even donor-funded projects are not beyond environmental scrutiny. In addition, recent debates generated through media coverage and public commentary have encouraged a more critical engagement with the performance of adaptation interventions, opening space for learning and reform.

4.7. Implications for Scaling and Replication

The barriers encountered suggest that scaling the GLOF-II model without modification would risk reproducing its shortcomings. Technical interventions such as EWS require stronger maintenance systems, contextual adaptation to fragile mountain ecologies, and integration with local knowledge practices. Politically, scaling necessitates transparent reporting, political oversight, and mechanisms for independent evaluation to strengthen legitimacy. Institutionally, replication must prioritize interdepartmental coordination and embed meaningful community participation, which goes beyond tokenism, as a continuous process rather than a procedural formality.

Ultimately, the GLOF-II experience demonstrates that adaptation projects in high-risk regions cannot rely solely on technological solutions or donor-driven narratives. For replication at scale, resilience must be co-produced through technical robustness, political accountability, and institutional integration that places communities at the centre of adaptation governance.

CONCLUSIONS

The GLOF-II project, while ambitious in scope and critical in intent, reveals a complex interplay of technical, institutional, and socio-political challenges that have limited its potential. Field evidence and stakeholder testimonies highlight a pattern of top-down implementation, fragmented coordination, and ecological misalignment. Despite the installation of early warning systems and livelihood interventions, the lack of sustained maintenance, community ownership, and adaptive planning has compromised the intended results. The preliminary findings from the field engagement and document review are as given:

Contested Effectiveness: Success Narratives and Local Disconnects: While the implementers narrate it has achieved success in technical risk reduction, its overall effectiveness is constrained by governance deficits, including weak polycentric coordination, lack of transparency, limited community trust, and design flaws. The project reflects a predominately technocratic approach that insufficiently engages with the political economy and governance complexities of climate adaptation in Pakistan.

Institutional Fragmentation and Weak Polycentric Governance: The weak polycentricism resulted in institutional fragmented governance structures, overlapping mandates, and capacity gaps at institutional levels. Local institutions lacked capacity to deliver tasks in hard to manage terrains. The mandates and jurisdiction of institutions also overlapped in delivering certain tasks creating implications for effectively and efficiently delivering on milestones. Lack of polycentricity undermined legitimacy and limited technical and administrative capacity constrained effective implementation.

Data Transparency, Monitoring and Evaluation Constraints: In is imperative for ensuring effective climate governance in Pakistan to employ updated and reliable data. However, multiple official sources consulted during this study revealed significant mismatches with ground realities.

Participants raised concerns regarding outdated data for valley identification, coupled with weak monitoring, evaluation, accountability, and learning (MEAL) mechanism which were also highlighted in the midterm evaluation. The third party midterm evaluation report documented the unsatisfactory progress of GLOF-II project, amply highlighting the measures which should be taken to ensure progress. The concerns by participants indicated systematic transparency and data governance failures. The MEAL mechanisms were inadequate, and ineffective.

Technical Misalignment and Operational Gaps: Undoubtedly, in the context of climate adaptation, Early Warning Systems (EWS) and technical interventions remains central. These interventions installed should be adequately planned for maintenance, staffing, technical capacity and sustainability. However, their design and implementation reflected significant misalignment with field realities. During our fieldwork, for instance, we learned that weather station equipment required an 8x10 base, yet initial designs allocated only 4x4, suggesting a disconnect between technical specifications and on-ground realities. This inevitably caused delays in land acquisitions and caused cost escalations. Similarly, terrain-specific challenges (cold desert, high altitude, seasonal labor risks) were not factored into planning. In such terrains, the rigid and unrelaistic timelines lead to mismatch in intervention delivery and caused delays. Likewise, infrastructure in high altitude with

ecologically fragile mountainous terrain raises concerns about the ecological footprints of these technological interventions. To allay the technical as well as financial constraints adaptive planning is required.

Community Engagement and Ownership Deficit: Community engagement at design level remained minimal and largely symbolic, with the notion of "community on board" not meaningfully operationalized in planning. The absence of continuous engagement, information sharing, and participatory monitoring undermined trust, ownership, and has raised concerns about long term sustainability of interventions.

Livelihood, Social Protection, and Resilience Gaps: Livelihood interventions and capacity building trainings of the communities without adequate inputs and sustained guidance limited their sustainability and relevance for local communities. Some participants also shared concerns regarding the misalignment of inputs with agroecological realities.

Participants consistently highlighted the lack of social protection mechanisms as cash transfers, relocation support, or contingency planning for internally displaced persons (IDPs), as a critical gap. Residents noted that after the 2022 Shisper Glacier outburst floods, which submerged large parts of Hassanabad, there was no contingency plan in place to guide relocation, or recovery efforts. Resilience was narrowly framed around infrastructure, with critical gaps in social protection mechanisms such as cash transfers, relocation planning, and contingency support for displaced populations. This highlights the urgent need to embed adaptive social protection and recovery planning into future climate adaptation efforts.

POLICY RECOMMENDATIONS

Strengthen Institutional Coordination and Polycentric Climate Governance: There is a dire need to define to streamline mandates across NDMA, PDMAs, DDMAs, EPAs, PMD, and other actors to ensure effective coordination and reduce duplication. Strengthening polycentric climate governance arrangements with clear accountability mechanisms and enhanced monitoring capacities will improve coherence, adaptability and responsiveness in climate governance.

Institutionalize Transparency and Data Accessibility and MEAL mechanisms: For climate governance to work in Pakistan, it is important to mandate and establish robust MEAL institutional mechanisms. Open access to regularly and accurately updated project data can ensure alignment between reported indicators and ground realities. Building transparent data systems through public dashboards along with regular third-party verification mechanisms can strengthen accountability, rebuild trust, improve evidence based decision making and adaptive governance. Greater transparency not only enhances accountability but also enables independent monitoring of climate interventions.

Improve Technical Planning and Context Sensitive Design: Any future interventions, must collect and use updated glacial lake data, and scientific assessments for site selection and hazard mapping. Including local expert as well as communities can ensure better understanding of socio-ecological dynamics to guide context-specific design. Participatory approaches in problem identification and hazard mapping can also enable project designs which reflect terrain-specific needs, variation is costs and seasonal constraints. The adaptation projects must reassess the policy of cost-capping in hard to reach terrains to allow contextually appropriate and adaptive project design. Context specific design can not only improve sustainability of outcomes but also reduce the risk of maladaptation. Context specific participatory project designs are likely to be sensitive to the local socio-political dynamics, power relations, and vulnerability patterns.

Institutionalize Community Led Adaptive Governance Approaches and Trust Building Mechanisms: Community participation must be embedded across all stages including design, implementation, and evaluation, through formalized participatory structures. Ensuring regular communication on project progress against project milestones will enhance transparency, create community ownership and build trust among beneficiary communities. This will also ensure interventions remain aligned to local needs and indigenous knowledge systems.

Integrating Livelihoods, Social Protection, and Adaptive Resilience: It is imperative to embed adaptive social protection measures like cash transfers, relocating planning and contingency frameworks for displaced populations in the wake of climate emergencies to ensure a more holistic and equitable approach to climate resilience. Similarly, livelihood interventions should be tailored to agroecological contexts to ensure sustainability and local relevance.

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APPENDICES

Appendix I: Remote Sensing Data Evaluating the Effectiveness of Slope Stabilization Efforts in Selected Valleys

Site: Khaplu Nullah, Ghanche (Lat: 35.130566, Lon: 76.316209)

According to the project report, plantation activities and slope stabilization measures have been implemented in the Khaplu Nullah area. A review of the site using imagery from Google Earth indicates that slope stabilization measures are present in the vicinity of the specified location, as illustrated in Figure 1.

The area depicted in the figure is estimated to cover approximately 5 hectares. Forest department GB provided the coordinates for this location only for Khaplu Nullah in Ghanche. GLOF-II site indicated the milestone as *"slope stabilization covering 35.5 hectares of land through bio-engineering techniques and microwatershed significantly reducing the threats of landslides and soil erosion"*.

Figure 1: Satellite Imagery Showing Plantation and Slope Stabilization Measures in the Khaplu Nullah Area

Source: Google Earth.

According to the data shared by Forest department, plantation activities in the study area were initiated in 2021. To assess the progress of these interventions, satellite imagery spanning the period from 2020 to 2025 was analyzed. The temporal analysis indicates a clear increasing trend in vegetation growth within the region.

For comparative purposes, representative imagery, with AOI bounded in red, from the years 2020, 2024, and 2025 has been included in the report, as illustrated in Figure 2.

Figure 2: Satellite Imagery Illustrating Plantation Growth at Khaplu Nullah

Note: The left, center, and right images correspond to the years 2020, 2024, and 2025, respectively.
Source: Planet Scope.

Site: Shishper Nullah (Lat: 36.29985682, Lon: 74.59024418)

According to the data provided by the Forest Department, the concerned department has planted approximately 2,000 saplings, including Ailanthus, Kikar, and Sea-buckthorn. However, the provided geographic coordinates correspond to an area that appears to be agricultural land, as illustrated in Figure 3.

This discrepancy may be attributed to potential inaccuracies in the GPS measurements. Nevertheless, in the absence of precise location data for the intervention site, it is not possible to reliably assess the effectiveness of the project.

It is also important to highlight the discrepancy observed regarding the official data. The GLOF-II website, Shishper also known as Hassanabad indicates the milestone as for the valley to be, "*slope stabilization covering 85 hectares of land through bio-engineering techniques significantly reducing the threats of landslides and soil erosion"* in text while the inforgraphic for the valleys states it 7.6 hectres.

Figure 3: Satellite Imagery of the Shishper Nullah Site Indicating the Location Specified in the Project Report

Source: Google Earth.

Site: Hassanabad Valley (Lat: 36.72089157, Lon: 74.86673391)

According to the data shared by Forest Department, approximately 2,000 poplar saplings (Poplar) were planted at the specified location. However, the provided coordinates appear to be inaccurate and may be affected by measurement errors. This discrepancy could potentially be attributed to the use of a low-accuracy GPS device during data collection.

As illustrated in Figure 4, the identified location appears to be situated at a higher elevation than that reported (i.e., 2,678 meters above sea level), indicating a possible inconsistency in the recorded site information.

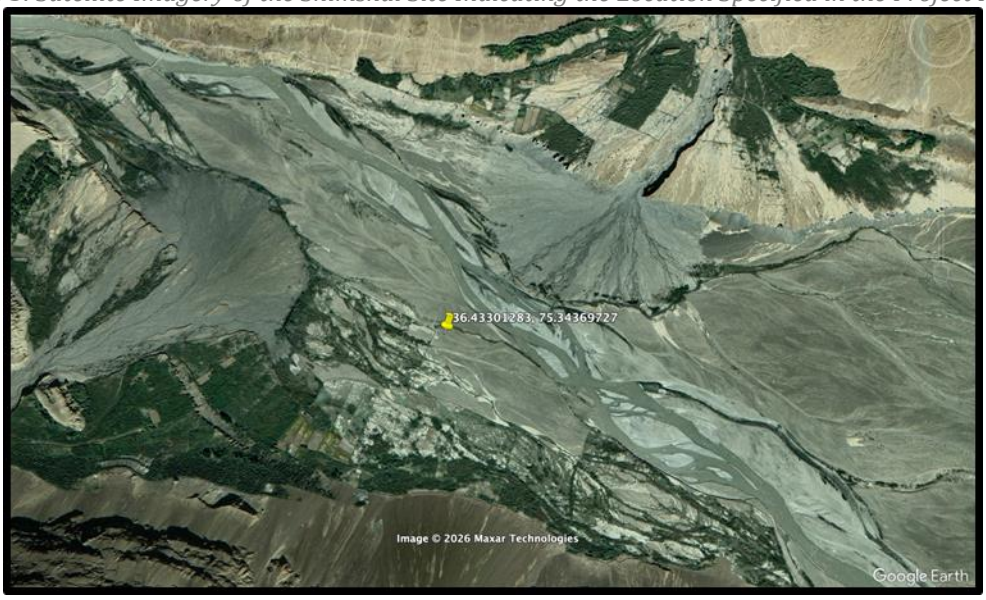
Figure 4: Satellite Imagery of the Hassanabad Valley Site Indicating the Location Specified in the Project Report

Source: Google Earth.

Site: Shimshal (Lat: 36.43301283, Lon: 75.34369727)

At the Shimshal site, the concerned department reported the plantation of approximately 2,500 long-shoot cutting of indigenous plants. The referenced location is illustrated in Figure 5, where substantial vegetation cover can be observed in the surrounding area. However, the precise location of the newly planted vegetation cannot be clearly identified from the available information.

Figure 5: Satellite Imagery of the Shimshal Site Indicating the Location Specified in the Project Report



Source: Google Earth.

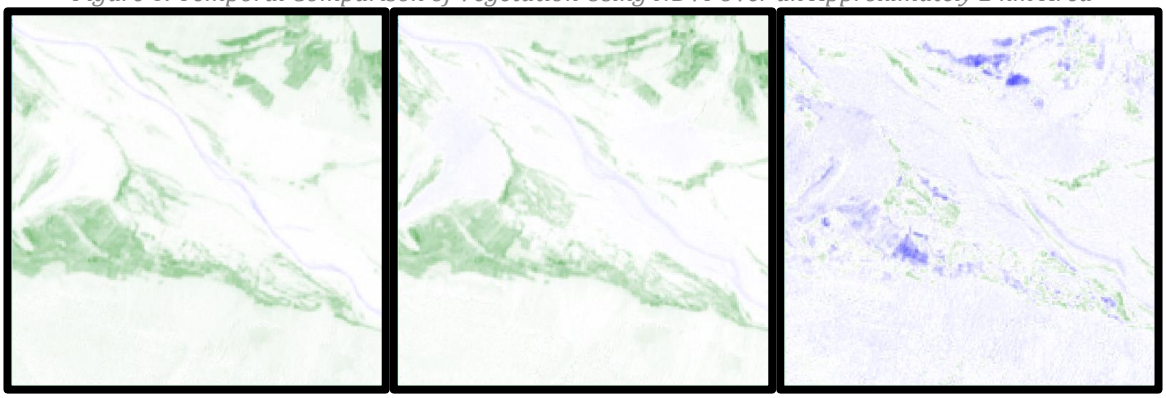
To analyze the temporal evolution of vegetation, the Normalized Difference Vegetation Index (NDVI) was computed for an approximately 2 km radius around the specified location (shown as yellow pointer in Figure 5). Figure 6 presents three panels arranged from left to right: NDVI for the year 2020, NDVI for the year 2025, and the difference between the two NDVI datasets.

In the NDVI maps for 2020 and 2025, green tones indicate the presence and density of vegetation. In contrast, the NDVI difference map uses color to highlight changes over time: green represents an increase in vegetation, while blue indicates a reduction or loss of vegetation cover.

To ensure a fair and consistent comparison, only high-quality Sentinel-2 imagery acquired during the months of April and May was selected for both years. The mean NDVI for these months was calculated to minimize the influence of seasonal variability and atmospheric noise.

The analysis reveals that areas exhibiting a decline in vegetation (represented by blue regions) are more extensive than those showing vegetation gain (green regions). This suggests an overall reduction in vegetation cover within the study area over the analyzed period. However, it is difficult to mention that the areas with gain in vegetation belong to the plantation areas without accurate location or boundary outlines.

Figure 6: Temporal Comparison of Vegetation Using NDVI Over an Approximately 2 km Area



Note: From left to right: (a) mean NDVI for April–May 2020, (b) mean NDVI for April–May 2025, and (c) NDVI difference (2025–2020). Green in (a) and (b) indicates vegetation presence, while in (c) green represents vegetation gain and blue represents vegetation loss.
Source: Sentinel-2.

The data on GLOF-II website, indicates the milestone for Shimshal as *"slope stabilization covering 24 hectares of land through bio-engineering techniques significantly reducing the threats of landslides and soil erosion"*.

Observation & Suggestions:

Based on the analysis, it is evident that the concerned department has undertaken plantation activities across the region. However, there appear to be positional accuracy limitations in the devices used to record geographic locations. As a result, some reported coordinates correspond to areas where no discernible vegetation is observed, or they fall within regions that were already vegetated (as demonstrated in the previously referenced sites). This introduces uncertainty and makes it challenging to reliably assess the effectiveness of the plantation efforts or to distinguish newly planted areas from existing vegetation.

To enhance transparency, accuracy, and public accessibility, it is recommended that the concerned department maintains geospatial datasets in the form of shapefiles or clearly defined boundary outlines for each plantation site. This would enable precise spatial analysis, facilitate validation of plantation activities, and support more informed monitoring and evaluation of outcomes.

Appendix II: Interview Guide: Project Implementers and Stakeholders

I. Project Relevance and Design

- What were the core objectives of GLOF-II?
- In your view, is the project aligned with local needs and community-specific vulnerabilities?
- How was the project tailored to the socio-ecological context of Gilgit-Baltistan?
- What were the expected co-benefits or secondary outcomes of the project?

II. Governance and Implementation

- What is the governance model adopted under GLOF-II? Would you classify it as adaptive or polycentric? Why?
- How has the governance model influenced the outcomes of the project?
- What coordination mechanisms were used across institutions and administrative levels?
- How many organizations or institutions were involved in implementation and how were roles distributed?
- What were the main governance challenges faced?

III. Effectiveness and Outcomes

- Has the project achieved its intended outcomes?
- What is the current coverage of Early Warning Systems (EWS)?
- What small-scale infrastructure or mitigation measures were implemented?
    - (E.g. slope stabilization sites, irrigation schemes, safe havens)
- Has GLOF-II led to measurable improvements in community preparedness or institutional capacity?
- Can you share examples of effective interventions?

IV. Sustainability and Impact

- What steps have been taken to ensure the financial and institutional sustainability of project outcomes?
- How has the project contributed to long-term resilience in the region?
- Is there political will to continue or scale the project?
- Can GLOF-II be replicated in other regions?
- What policies can enhance its long-term impact?

V. Resource Use and Efficiency

- How were project resources allocated and utilized?
- Were there overlapping activities? If yes, were they complementary or duplicative?
- How effective was the resource coordination among stakeholders?

VI. Challenges, Risks, and Adaptations

- What were some technical, political, or institutional challenges encountered?
- Were there any adaptive strategies or innovative solutions developed in response?
- What are the political or operational risks going forward?
- What key lessons were learned from project implementation?

Appendix III: Focus Group Discussion (FGD) Guide: Communities

Theme 1: Understanding of GLOF Risks and Community Ownership

- What do you understand about GLOF threats?
- Did you feel the project helped raise awareness about GLOF events and their impacts?
- How do you perceive the purpose of the awareness campaigns? Were they useful?

Theme 2: Resilience and Preparedness

- Do you feel better prepared to respond to GLOF events after this project?
- What specific actions or measures are now in place for protection?
- What does "resilience" mean to you? Do you feel your community is resilient now?
- Did the project help build your knowledge or skills (e.g. trainings, mock drills)?

Theme 3: Infrastructure and Local Impact

- Are there Early Warning Systems in your area? Do they work well?
- Were any physical structures (e.g. slope stabilization, irrigation improvements) built in your area?
- Do you know about slope stabilization or bio-engineered structures? Have they helped?
- Have local farming practices changed due to water-efficient technologies?

Theme 4: Local Institutions and Participation

- Are you part of any CBDRM Committee or Hazard Watch Group?
- Do these groups have the capacity to respond to disasters?
- Have you received any emergency equipment or training?

Theme 5: Indigenous Knowledge and Cultural Relevance

- Has the project supported any indigenous practices like Glacial Grafting or Avalanche Harvesting?
- How important are these practices to your community? How can they be preserved?

Theme 6: Sustainability and Future Needs

- Do you think the project outcomes will last?
- What support would help you stay prepared in the future?
- What should be improved in future projects like this?

Appendix IV: Community Interview Data

i. **Demographics**

- Household size
- gender
- income level

ii. **Risk Perception & Project Awareness**

- Are you aware of any recent efforts to reduce flood risks?
- Do you feel better prepared now compared to five years ago?

iii. **Participation & Equity**

- Were you or anyone in your household involved in any consultation or training?
- Do you think your needs were considered?

iv. **Outcomes & Effectiveness**

- Did you notice any infrastructure improvements?
- Have floods or damages reduced in the past 3 years?

v. **Trust & Accountability**

- Do you know where to report problems with infrastructure?
- How would you rate the responsiveness of local authorities?

vi. **Sustainability**

- Are you involved in any maintenance or local management efforts?
- Do you expect these changes to last?

vii. **Open-Ended Feedback**

- What would you like to see done differently?