BUILDING BACK BETTER: FORWARD LOOKING COMMUNITY-LED CLIMATE MODEL FOR PROJECTING CLIMATE RISKS IN FLOOD-PRONE DISTRICTS OF KHYBER PAKHTUNKHWA

At a Glance

The climate induced floods in 2022 in Pakistan have had a devastating impact exceeding USD 30 billion[1], approximately 12% of country's GDP [2], and USD 1593 Mn. across multiple districts in Khyber Pakhtunkhwa (KP), Pakistan, leading to significant loss of lives, destruction of infrastructure, and disruption of socio-economic activities that are expected to have a spillover effect to other areas of the economy. This underscores the need to adopt a proactive approach towards understanding and addressing climate risks in Pakistan, a lot of which will entail efforts on climate adaptation and resilience building.

Global experts now strongly recommend using downscaled climatological and hydrological forecasts to mainstream climate resilience across communities. Though this has been rarely done in Pakistan, this policy brief puts forth a strong argument in favor of leveraging forward looking approaches as it can help alleviate the risk of miscalculating **flood risks that are expected to increase dramatically in the coming years due to climate change and changing weather patterns.**

This policy brief also builds upon SEED's existing work to support construction of climate resilient infrastructure in KP, using climate modeling & socio-economic pathway analysis that can benefit all stakeholders including government administrations, disaster management authorities, donors, academia and researchers, and civil society organizations. **The goal is to identify and implement targeted adaptation measures tailored to address specific local climate risks, with the greatest socio-economic returns for society.**

To achieve this, SEED is working with the Communication and Works (C&W) department in KP to identify vulnerable infrastructure assets critical to the community and develop proposals that incorporate climate resilience aspects in rehabilitation planning. **The study leverages complex tools and simulation techniques with the intention to supplement, rather than substitute infrastructure development efforts of the KP government,** and has helped SEED generate climate projections specific to the northern region of KP alongside river Swat.

The implications of these projections are far-reaching: rising temperatures could lead to increased heat waves, influencing human health, energy demands, and urban planning. Furthermore, altered precipitation patterns and intensified river flow have significant implications for water resource management and flood risks. SEED's projections also predict that peak floods under certain scenarios may increase by as much as 27%. **These findings underscore the urgent need for proactive measures to mitigate climate risks and adapt local infrastructure.**

While this study builds upon infrastructure as a pilot for SEED's approach towards incorporating climate resilience, it also highlights the need for a paradigm shift in how public projects are planned and developed, emphasizing the shift towards planning based on these projections rather than past trends. Predictive models generate evidence for policy making, leading to more informed decisions that will aid in sustainable and resilient development, safeguard communities, and ensure sustainable development in a region facing severe climate risks.

---

1 https://www.pc.gov.pk/uploads/downloads/PDNA-2022.pdf

2 GDP for 2021 = USD 348,262,545 from World Bank https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=PK; 1USD = PKR 229.62 from Google.com on 20th January 20, 2023)

Problem Statement

As a result of the 2022 floods in Pakistan, primarily induced by unprecedented intensity of monsoon rain and highest since 1961, the country faced loss in connectivity due to the damaged transportation infrastructure, and economic damage to roads and bridges alone is estimated to be over USD 4,323 million. This affected 13,115 km of national road network and 439[3] bridges for which the government focused on providing immediate relief and flood rehabilitation. In SEED's assessment however, expenditure on infrastructure development or rehabilitation often lacks thorough planning. Climate resilience is deprioritized in project design because it raises the initial capital cost of construction and because the severity of climate risks & impacts into the future is less understood due to lack of knowledge of changing weather patterns into the future. This method of planning is contrary to a finding of a 2019 study by the World Bank which suggests that the creation of more resilient infrastructure may increase capital costs by an average of 3-4%, but the return on this investment can be as high as 4 times the cost of the original project.

To tackle these issues, SEED is providing technical assistance through a team of specialized engineers to the Communication & Works (C&W) Department by **identifying critical public infrastructure assets that are vulnerable to climate-induced disasters and then supporting development of climate resilient project plans leveraging available field data and climate modeling techniques.** A core purpose of the initiative is to also incorporate available tools and techniques that would support climate risk assessment & climate-proofing of infrastructure assets being designed against the effects of future climate-induced disasters and hence enable stakeholders in 'building back better'.

SEED's Methodology

Outlined below is a methodological framework to integrate resilience in critical infrastructure assets using climate modeling techniques. The brief sheds light on all key stages of the SEED study starting from the climate vulnerability assessment, climate modeling study, and lastly the field application of the results of the study to enhance climate resilience of a set of 25 roads and 10 bridges in target districts of KP that have increased vulnerabilities to Climate change. The focus however is mostly upon the use of climate modeling techniques and primary field data to forecast climate risks in target districts for subsequent policy uptake.

The study has been undertaken in collaboration with, and using support from, the C&W Department to ensure participatory approach and to incorporate their technical feedback and buy-in across the study, while ensuring departmental capacities in planning better are also enhanced.

3 IOM Pakistan, Situation Report No. 2: Pakistan Floods Response - December 31, 2022

The broad steps for the study undertaken, are delineated and briefly explained in table below:

Approach	Analysis Performed	Key Result
Stage 1 - Multi criteria assessment to prioritize most important infra-assets for local community	SEED undertook work for identifying and mapping critical infrastructure assets by employing a multi-criteria assessment, considering technical, socio-economic, and climate parameters. Working closely with flood-affected communities in KP, SEED prioritized understanding of the community needs, enhancing climate resilience, and integrating these priorities into provincial planning. Through 8 FGDs and 14 Key Informant Interviews in four districts, including marginalized groups, specific requirements for infrastructure projects were gathered. These inputs are now integral to the development of 10 infrastructure projects, reflected in the PC-I documents. A comprehensive summary of community priorities is encapsulated in the report titled 'Demand Led Development.'	The team identified what the community needs most for fixing flood-damaged infrastructure and prioritized the rehabilitation process for those assets that would bring the most value to the local area.
Stage 2 - Resilience scoring to identify most vulnerable infra-assets	Climate resilient vulnerability assessment was conducted across the prioritized assets in stage 1 to identify most vulnerable assets to climate induced floods.	The team successfully identified a roster of critical infrastructure assets requiring urgent integration of climate resilience measures to prevent future climate-induced damages and catastrophes.
Stage 3 - Assessing future climate risks (i.e. across an 80-year time horizon) to the select infra-assets using climate modeling techniques.	Following the selection of key infrastructure assets and their respective locations, SEED focused on collecting historical climate data and creating hydrological models for climate projections for next 80 years. The process involved extensive data collection, including 30 years of climate data from PMD weather stations and discharge data from WAPDA and Irrigation Department gauging stations in KP. Additional data sources included soil data from FAO, digital elevation models from SRTM, and greenhouse gas emissions scenarios from SSPs and GCM data on the World Bank climate change Knowledge Portal. SEED's methodology emphasized localized insights by downscaling global climate model outputs, refining projections to a regional level. Computational analysis, including simulations and collaboration with experts, integrated climate model outputs with downscaled data to generate diverse projections, particularly around river flow discharge. This analysis formed the basis for flood frequency analysis and identified peak flood years in the target area. Rigorous validation using daily discharge data from the irrigation department, coupled with sensitivity analysis, ensured the accuracy of the model's predictions and identified potential uncertainties by adjusting input parameters within plausible ranges.	The resulting projections from the climate models offer an intricate understanding of KP's climate trajectory, calling for swift and innovative policy interventions to ensure the region's resilience. The convergence of rising temperatures, altered precipitation, and changing hydrological patterns necessitates collaborative efforts among policymakers, development partners, and local communities.

Approach	Analysis Performed	Key Result
(Continued)	The climate change projections provide critical insights into the evolving climatic landscape of Khyber Pakhtunkhwa (KP). These projections, based on meticulous analysis of different emission scenarios, yielded significant findings that underscore the urgency of adaptive measures. **The key results and their implications are highlighted in Exhibit A.**	*(Continued)*
Stage 4 - Integrating Climate risks into future government planning of infrastructure assets and thereby enhancing resilience.	The most transformative aspect of SEED's methodology is thinking a step ahead and practically integrating climate projections into the government's infrastructure design/plans. This has led to the development of the 10 PC-1 projects for a set of prioritized roads and bridges that incorporate climate resilience aspects into every stage of the planning lifecycle, from design to proposal development, and subsequent allocation of Annual development Budget. SEED team has also used in-house public investment management (PIM) tools it has developed recently that include Pakistan's updated Bridge code, Model TORs, and Technical appraisal checklists to ensure a holistic approach to mainstreaming climate change objectives in project planning.	This approach is expected to necessitate a shift in how infrastructure is conceptualized and realized, and by utilizing climate projections in different spheres of planning and development, the government shall be able to identify and implement targeted adaptation measures tailored to address specific local climate risks.

Emerging Policy Options

The following potential policy options emerge from the aforementioned study.

Figure: Select Policy Options Delineated for Public Agencies that Result from the Use of Climate Modeling Techniques

POLICY OPTIONS STEMMING FROM SEED STUDY

INVEST IN EXPANDING GEOGRAPHICAL SCOPE OF CLIMATE MODELLING

Allocate funds to develop and acquire advanced climate models that can provide accurate and region-specific predictions

AUGMENT WATER RESOURCE MANAGEMENT

Implement effective water resource management strategies based on hydrology studies to optimize water usage and mitigate flood risks

PROMOTE RESEARCH AND CAPACITY BUILDING

Encourage research institutions to conduct studies on climate impacts and support capacity building inititaives for local stakeholders

TAKE A LONGTERM VIEW & INVEST IN NATURE BASED SOLUTIONS

Integrating nature-based solutions (e.g Swat plantation) or enhancing infrastructure life. Promote strategies that integrate natural ecosystems into infrastructure planning. Advocate for the incorporation of wetlands, floodplains, and green spaces in urban blueprints

CONDUCT VULNERABILITY ASSESSMENTS

Incorporate climate projections in urban planning and infrastructure development:

1- Critical infrastructure: Integrate climate risk assessments and forward-looking predictions into infrastructure planning and development policies

2- Key Developments: These can include (i) power houses (ii) transmission lines (iii) grid-stations (iv) schools (v) hospitals

BUILD KNOWLEDGE CAPACITIES

SEED is also undertaking a similar study for Indus basin region in KP and is building government capacities in the process. However, more needs to done to build capacities and develop systems for climate modeling and forecasting and for integrating the knowledge in planning processes. This will require a collective approach from development partners and governments

The application of forward-looking approaches in infrastructure development signifies a crucial departure from relying solely on historical climate data. The importance of embracing these methodologies stems from the inadequacy of past climate trends in designing infrastructure resilient to extreme events. SEED's approach, providing a cost-effective, real-time, and community-centered climate vulnerability assessment at the district level, holds promise for more robust planning.

Success, however, hinges on reliable climate modeling data, advanced prediction tools, and accurate primary climate indicators. Effective collaboration among government agencies, research institutions, and international donors is equally vital. These factors will collectively ensure the effectiveness of forward-looking strategies, fostering resilience and prosperity in the face of escalating climate threats.

Conclusion & Recommendations

Amidst the burgeoning field of climate modeling, the KP government has a strategic window to systematically start investing in expertise that will help mitigate impact of foreseeable climate risks. SEED's support to the C&W department demonstrates how climate projections can be integrated into infrastructure planning; enhancements in design plans for 25 roads and 10 bridges, coupled with the integration of climate strategies into key design documents, & inclusion in the ADP budget for FY24 amounting to PKR 790 million/USD 3 million, form a robust foundation for future climate adaptation work to follow. SEED's own focus going forward includes extending coverage of this study to the Indus basin region of KP, focusing on impactful vulnerability assessments for more efficient public investments and more resilient local communities.

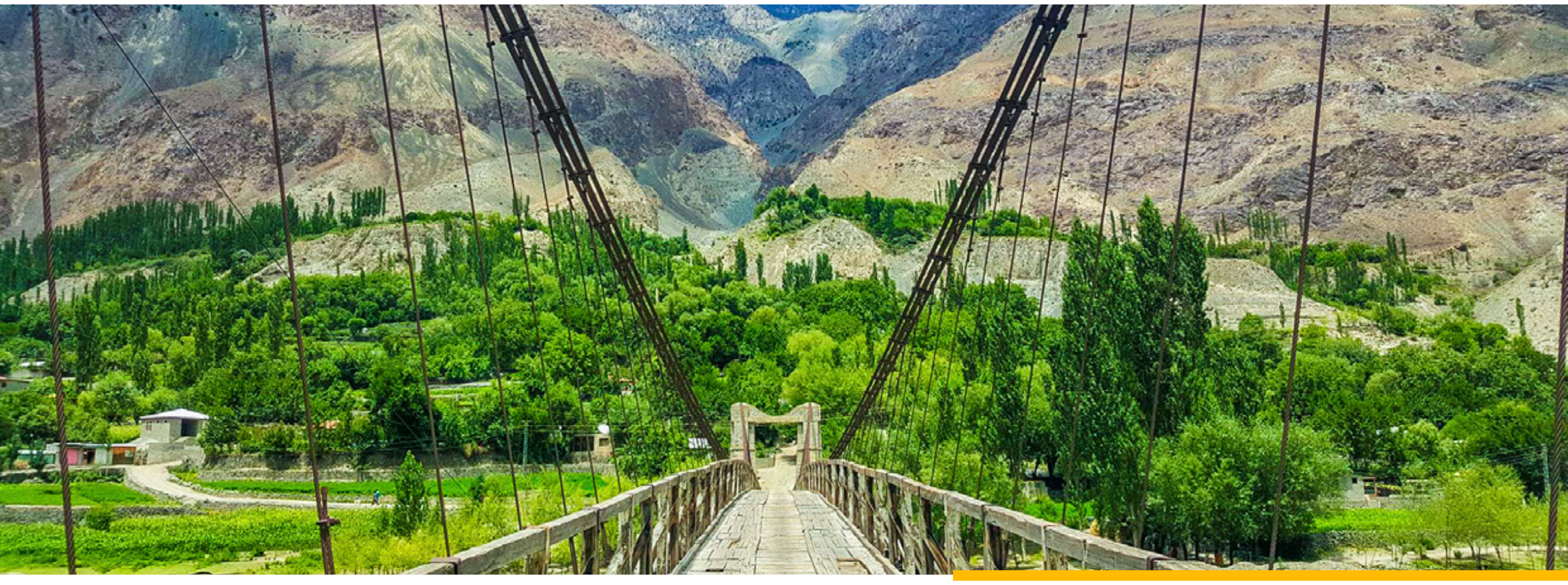

EXHIBIT A - CLIMATE PROJECTIONS & POTENTIAL IMPLICATIONS FOR TARGET DISTRICTS RESULTING FROM SEED STUDY

CLIMATE DIMENSION	PROJECTIONS	IMPLICATION 1	IMPLICATION 2	IMPLICATION 3
Temp Trends	Both maximum and minimum daily temperatures exhibit a consistent increasing trend across all regions of the study area (Swat, Lower Dir, Charsadda, and Nowshera). The annual mean temperature, a vital metric, demonstrates an alarming upward trajectory. This trend is prevalent in both the Optimistic and Worst-case scenarios, where it may rise by 5.7-degree calcium, which may have devastated impacts.	Temperature Extremes: Escalating temperatures necessitate heightened resilience against heatwaves, impacting human health, energy demands, and urban planning.	Agricultural Adaptation: Increasing temperatures could alter crop suitability, requiring adaptive agricultural practices to ensure food security.	
Precipitation Patterns	The study also reveals changes in precipitation patterns that would result in increased floods (projected 80-year return period flow at river Swat is expected to increase. When combined with intensified daily precipitations, this leads to augmented stream flows, carrying implications for water resource management and flood risks.	Flood risks and droughts impacting agriculture, water availability, and infrastructure. Biodiversity loss, agricultural disruptions, economic hardships, and public health challenges further compound the overall impacts.	Hydrological Extremes: Elevated stream flows necessitate robust flood management strategies and infrastructure to mitigate potential damages.	Water Resource Planning: Altered precipitation patterns call for adaptive strategies in managing water availability and distribution.
Stream Flow Changes and Flood Risks	Stream flow estimates, exemplified by the Chakdara control station, reflect variations in flood risks where the peak floods may increase by 19% to 27%.	Flood Preparedness: The differing scenarios emphasize the importance of tailored flood preparedness measures and resilient infrastructure.	Urban Planning: Urban areas must be equipped to handle altered flood dynamics and manage associated risks.	




www.seed-pk.com

BUILDING BACK BETTER:
FORWARD LOOKING COMMUNITY-LED CLIMATE MODEL FOR PROJECTING CLIMATE RISKS IN FLOOD-PRONE DISTRICTS OF KHYBER PAKHTUNKHWA, PAKISTAN