ICIMOD

Baseline Report

Baseline Assessment for Sustainable Actions for Ecosystems Restoration in Pakistan (SAFER Pakistan) Project



VERSION-3

SHEHER SAAZ
Creating Places For People

COVER LETTER

Date: 12.02.2026

To:
The Programme Manager
International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal

Subject: **Submission of Revised Baseline Report (Version 3) for Sustainable Actions for Ecosystems Restoration in Pakistan (SAFER Pakistan) Project**

Dear Sir,
On behalf of Sheher Saaz, I am pleased to submit the attached Revised Baseline Report (Version 3) for the Sustainable Actions for Ecosystems Restoration in Pakistan (SAFER) Project. This updated version incorporates all the valuable comments and feedback received from ICIMOD, UNICEF, and UN Women.
This report presents the findings of a comprehensive baseline assessment conducted across the project's target regions in Pakistan. The study employed a rigorous quasi-experimental design to establish pre-intervention conditions, drawing on large-scale household surveys complemented by qualitative tools such as Focus Group Discussions and Key Informant Interviews. This approach ensures a robust foundation for future impact evaluation.
The assessment provides critical benchmarks across the project's key thematic areas, including cryosphere risk reduction, water resource management, and ecosystem restoration. It offers an analysis of community awareness, preparedness levels, and institutional capacities, while also identifying systemic gaps, particularly in gender and social inclusion, and access to early warning systems. This baseline will serve as the foundational evidence for measuring project impact and informing adaptive management throughout the project lifecycle.
We believe the insights contained herein will be valuable for guiding the next phase of implementation and strengthening the project's evidence-based approach. We look forward to your comments to finalize the report in a timely manner.
Please do not hesitate to contact me should you require any further clarification or additional information.

Sincerely,



Khurram Farid Bargatt
Managing Director
Sheher Saaz Pvt Ltd

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ACRONYMS AND GLOSSARY

ACRONYM	FULL FORM
AKAH	Aga Khan Agency for Habitat
CB-MEWS	Community-Based Multi-Hazard Early Warning Systems
CBEWS	Community-Based Early Warning Systems
CBO	Community-Based Organization
CERT	Community Emergency Response Team
C5	Component 5 - Surface Water Conservation
DiD	Difference-in-Differences
DDMU	District Disaster Management Unit
DRR	Disaster Risk Reduction
EbA	Ecosystem-based Adaptation
EWS	Early Warning System
FGD	Focus Group Discussion
GB	Gilgit-Baltistan
GBDMA	Gilgit-Baltistan Disaster Management Authority
GEDSI	Gender Equality, Disability, and Social Inclusion
GLOF	Glacial Lake Outburst Flood
GPS	Global Positioning System
GWUA	Groundwater User Association
HKH	Hindu Kush-Karakoram-Himalaya
ICIMOD	International Centre for Integrated Mountain Development
KII	Key Informant Interview
KP	Khyber Pakhtunkhwa
LSO	Local Support Organization
MoCC	Ministry of Climate Change
NDMA	National Disaster Management Authority
NGO	Non-Governmental Organization

ACRONYM	FULL FORM
NBS	Nature-Based Solutions
ODK	Open Data Kit
O&M	Operations & Maintenance
PDMA	Provincial Disaster Management Authority
PHED	Public Health Engineering Department
PMD	Pakistan Meteorological Department
PWDs	Persons with Disabilities
RMC	Regional Meteorological Centre
SAFER	Sustainable Actions for Ecosystem Restoration (Pakistan Project)
SDGs	Sustainable Development Goals
SMD	Standardized Mean Difference
TMA	Tehsil Municipal Administration
ToC	Theory of Change
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children's Fund
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
WASH	Water, Sanitation and Hygiene

GLOSSARY OF KEY TERMS

TERM	DEFINITION
Baseline Assessment	A pre-intervention study that establishes initial conditions to measure project impacts over time.
Batch 1 / Batch 2	Refers to treatment and control groups under the quasi-experimental design for the SAFER baseline.
Community Resilience	The capacity of a community to anticipate, prepare for, respond to, and recover from climate-induced shocks.
Cryosphere	The frozen water part of the Earth's system, including glaciers, snow, and ice, significant for Pakistan's mountain ecosystems.
Difference-in-Differences (DiD)	A quasi-experimental statistical technique used to estimate causal relationships by comparing changes between treatment and control groups.
Early Warning System (EWS)	A set of coordinated actions to detect, monitor, and communicate risk information to enable timely protective measures.
Ecosystem-based Adaptation (EbA)	Use of biodiversity and ecosystem services to help people adapt to climate change impacts.
Gender & Social Inclusion	Ensuring equitable participation and benefit-sharing among all genders in community planning and resilience actions.
Key Informant Interview (KII)	A qualitative research method involving structured interviews with knowledgeable individuals or officials.
Focus Group Discussion (FGD)	A facilitated conversation among selected community members to gather perceptions, experiences, and suggestions.
Groundwater Recharge	The process by which water infiltrates the ground to replenish aquifers, essential for sustainable water supply.
Nature-Based Solutions (NbS)	Approaches that use natural systems, such as wetlands and forests, to address environmental and social challenges.
Preparedness and Resilience	The ability of households and institutions to anticipate hazards and sustain functionality during and after disasters.
Quasi-Experimental Design	A type of impact evaluation design that approximates random assignment by comparing treatment and control groups with similar baseline characteristics.
Standardized Mean Difference (SMD)	A statistical measure used to compare differences between two groups while controlling for variation in scale.

TERM	DEFINITION
Triangulation	The process of validating findings by cross-verifying data from multiple sources (quantitative, qualitative, and institutional).
Vulnerability	The degree to which a system or community is susceptible to, or unable to cope with, adverse effects of climate change.
Water Governance	The political, social, economic, and administrative systems that influence water resource management and service delivery.

EXECUTIVE SUMMARY

The Sustainable Actions for Ecosystem Restoration in Pakistan (SAFER Pakistan) Project is a multi-partner, multi-sectoral climate resilience initiative implemented across Gilgit-Baltistan (GB), Khyber Pakhtunkhwa (KP), and Sindh, encompassing more than 190 villages across 20 climate-vulnerable districts. The project has been strategically designed to strengthen community-level resilience to climate-induced multi-hazard risks, with a specific focus on cryosphere disasters, springshed degradation, groundwater depletion, ecosystem collapse, surface water stress, and systemic deficits in community empowerment and inclusive governance. SAFER Pakistan operationalizes Pakistan's commitments under the National Climate Change Policy (2021), the National Disaster Risk Reduction Policy (2013), and internationally endorsed frameworks including the Sendai Framework for Disaster Risk Reduction (2015–2030), the Paris Agreement (2015), and the Sustainable Development Goals (SDGs 5, 6, 11, 13, and 15) at the sub-national and community levels.

The baseline assessment was undertaken as a pre-intervention evaluative study to establish statistically valid, policy-relevant, and gender-disaggregated benchmarks across all six SAFER components. The primary purpose of the baseline is to generate counterfactual-comparable evidence required for rigorous impact attribution during midline and endline evaluations under a Phase-in Quasi-Experimental Difference-in-Differences (DiD) design. Beyond its evaluative function, the baseline also serves to refine the SAFER Results Framework, verify the diagnostic validity of project assumptions, and identify systemic vulnerability gradients across ecological, institutional, and social domains.

Methodologically, the baseline adopted a Phase-in Quasi-Experimental Design, comparing treatment communities (60%) scheduled for immediate project implementation with control communities (40%) programmed for later phases or exhibiting comparable socio-ecological conditions without immediate intervention exposure. A total of 2,120 households (HHs) were surveyed using a multi-stage stratified sampling framework to ensure representativeness across provinces, hazard typologies, and livelihood systems. Quantitative household surveys were complemented by 60 Focus Group Discussions (FGDs) and 34 Key Informant Interviews (KIIs) conducted with officials from PDMA/DDMA, Irrigation, PHED, TMAs, meteorological institutions, NGOs, and community leadership structures. All data collection adhered to international ethical standards, with formal informed consent protocols, anonymization procedures, and institutional ethical clearance mechanisms.

The analytical framework integrates descriptive and inferential statistical methods, including independent-sample hypothesis testing, Standardized Mean Differences (SMDs) for baseline equivalence diagnostics, and multi-dimensional composite index construction. These indices were further visualized through radar profiles and baseline equivalence heatmaps, enabling robust comparative interpretation between treatment and control clusters. Qualitative findings from FGDs and KIIs were systematically triangulated with quantitative outputs to strengthen interpretive validity and contextual depth.

Component-Specific Structural Vulnerability Gradients:

Component 1: Cryosphere Disaster Risk Reduction (GB and Upper KP)

Baseline evidence confirms high exposure to cryosphere-induced multi-hazard risks (e.g., Glacial Lake Outburst Floods (GLOFs), flash floods, avalanches). While general hazard awareness is widespread, the assessment reveals a critical deficit in functional preparedness. Key structural weaknesses include the absence of formal Household evacuation planning, gender-responsive risk zoning, established Standard Operating Procedures (SOPs), and inclusive Early Warning System (EWS) coverage. Vulnerability is disproportionately borne by women, the elderly, and Persons with Disabilities (PWDs) due to mobility constraints, limited access to timely warning dissemination, and systemic exclusion from disaster governance structures.

Component 2: Springshed Revival and WASH Resilience

The assessment documents severe depletion of natural springs, leading to chronic seasonal water insecurity and declining potable water quality. A significant finding is the dominance of informal coping mechanisms alongside a limited technical understanding of watershed and springshed hydrology at the community level, underscoring the imperative for science-driven, localized resource management systems.

Component 3: Groundwater Management and Climate-Resilient Community Water Supply Services (KP and Sindh)

Baseline findings confirm significant hydrogeological and institutional fragility across Component 3 sites. Groundwater management and recharge interventions are relevant primarily in Khyber Pakhtunkhwa, where declining aquifer levels and unregulated abstraction are widespread. Only 28% of households in KP report stable year-round access to groundwater, and fewer than 19% demonstrate awareness of recharge principles or groundwater governance mechanisms.

Across both KP and Sindh, climate-resilient community water supply services exhibit low functional reliability. Only 42% of surveyed households report consistent access to improved water sources, while less than 30% indicate the presence of functional community-level operation and maintenance arrangements. Treatment–control comparisons reveal statistically significant gaps in service reliability and preparedness, with treatment areas showing modestly higher awareness but no corresponding institutional capacity gains at baseline.

Preparedness and adaptive capacity remain largely informal, with fewer than one-third of households reporting any organized water management or contingency planning. These findings underscore the need for differentiated interventions addressing groundwater recharge in KP alongside climate-resilient water supply infrastructure in both KP and Sindh, supported by formalized management structures and inclusive governance mechanisms.

Component 4: Ecosystem-Based Nature-Based Solutions for Wastewater Treatment and Climate Adaptation

Baseline findings indicate limited community and institutional readiness to operationalize Nature-based Solutions for wastewater management. Fewer than 18% of surveyed households report access to any form of wastewater treatment, while only 22% demonstrate awareness of constructed wetlands as climate-adaptive infrastructure. Functional ecosystem services related to water quality regulation remain largely informal and unmonitored, with over 63% of communities discharging untreated wastewater into open drains or natural channels.

Treatment–control comparisons show no statistically significant differences in pre-intervention wastewater management practices, confirming low baseline institutional capacity across sites. Only 19% of communities report any organized operation and maintenance arrangements for sanitation infrastructure. While 58% of respondents perceive environmental degradation in their surroundings, fewer than one-quarter can identify functional versus degraded wastewater discharge areas, indicating limited technical understanding of ecosystem service dynamics.

These findings underscore that Component 4 interventions must prioritize constructed wetland systems and associated management structures to transform wastewater from an ecological liability into a climate-adaptive asset. Baseline conditions clearly distinguish between currently functional sanitation areas and high-potential intervention sites, providing a foundation for targeted NbS deployment.

Component 5: Surface Water Conservation (Sindh)

Component 5 is geographically concentrated in Sindh and focuses on improving surface water availability through reduced wastage and enhanced storage for productive use. Baseline findings indicate that only 39% of households report reliable access to surface water throughout the year, while fewer than 21% practice any form of water conservation at household or community level. No structured Climate-Smart Agriculture practices were identified at baseline within Component 5 sites, confirming that the primary constraint is institutional capacity rather than agronomic adoption.

Participation in water governance remains limited, with women represented in only 34% of local water-related groups and fewer than 28% of communities reporting functional Water User or Operation and Maintenance Committees. Treatment–control comparisons reveal uniformly low baseline service reliability and institutional preparedness, reinforcing the need for targeted surface water storage interventions accompanied by inclusive governance mechanisms.

Component 6: Community Empowerment and Inclusion

The assessment reveals pronounced gender and social inclusion gaps across leadership and resilience governance structures. Only 37% of respondents report any women's representation in community decision-making bodies, while just 46% perceive that women and youth have equal opportunity to speak in climate and water meetings. Formal, inclusive Resilience and Adaptation Committees are absent, with only 44% of communities reporting informal or project-based groups and none formally notified with mandated representation of women, youth, and persons with disabilities (PWDs). Although 58% of women and youth express confidence to assume leadership roles, their engagement remains largely informal and unsupported by institutional mechanisms. Exclusion of persons with disabilities is particularly

acute, with 36% of treatment households and 81% of control households reporting accessibility barriers for PWDs in preparedness planning, shelters, WASH facilities, and evacuation infrastructure. Overall, leadership inclusion across target areas averages below 25%, confirming that participation remains largely tokenistic and insufficiently embedded within formal resilience governance systems. These cross-component findings indicate that climate vulnerability across SAFER target landscapes is primarily driven by institutional and governance deficits rather than awareness gaps alone. Accordingly, early implementation must prioritize systems-level interventions, including rapid establishment of inclusive community governance structures, deployment of gender-responsive Early Warning Systems, front-loaded investment in springshed and groundwater recharge infrastructure, and targeted capacity strengthening for women, youth, and persons with disabilities to address documented leadership and access barriers.

Strategic Recalibration and Policy Recommendations:

The baseline assessment collectively confirms that climate vulnerability across SAFER target landscapes is driven primarily by institutional and governance deficits rather than awareness gaps alone. While communities demonstrate high risk perception, this has not translated into functional preparedness, inclusive leadership, or resilient service delivery systems. Accordingly, the strategic mandate for SAFER Pakistan must pivot from awareness-centric interventions toward systems-based resilience transformation.

Priority Recommendations:

Institutionalization of Inclusive Governance: Establish and capacitate inclusive Community-Based Disaster Management Committees (CBDMCs).

Gender-Responsive Early Warning Systems: Deploy multi-hazard Early Warning Systems utilizing diversified communication channels (SMS, mosque loudspeakers, community focal points, and women-led dissemination networks) to ensure universal access, particularly for women, elderly populations, and marginalized groups.

Water Resource Infrastructure and Governance: Implement priority springshed protection and groundwater recharge interventions alongside the formalization of resilient Water and Groundwater User Associations to institutionalize operation, maintenance, and accountability mechanisms.

Ecosystem-Based Adaptation Scaling: Operationalize community-led Nature-based Solutions (NbS), including wetlands restoration, watershed protection, and forest buffering, through formal ecosystem stewardship groups supported by technical extension services.

Targeted Capacity Development: Deliver structured leadership, disaster preparedness, and livelihood skills programs, explicitly prioritizing women, youth, and marginalized populations as primary agents of resilience.

Digital Monitoring and Adaptive Management: Integrate digital climate information platforms and real-time hydrological monitoring systems to support evidence-based implementation, adaptive management, and district-level coordination.

This baseline establishes the empirical foundation for SAFER's midline and endline impact evaluation architecture under the Phase-in Difference-in-Differences design, while simultaneously providing a strategic diagnostic framework to guide early implementation priorities. Collectively, the findings support a recalibrated programmatic approach centered on inclusive governance, resilient water systems, ecosystem restoration, and digitally enabled adaptive management to strengthen climate resilience across Pakistan's most hazard-exposed landscapes.

CHAPTER 1: INTRODUCTION AND CONTEXT

1.1. Background

Pakistan is among the world's most climate-vulnerable countries due to its complex geo-ecological configuration, high dependence on climate-sensitive natural resources, rapid urban and rural demographic transitions, and persistent institutional and governance constraints. The country is increasingly exposed to cryosphere hazards, droughts, floods, groundwater depletion, ecosystem degradation, and surface water stress, all of which are intensifying under accelerating climate change.

The high mountain regions of the Hindu Kush–Karakoram–Himalaya (HKH) system constitute the primary freshwater source for downstream populations. Rapid glacier retreat has significantly increased the frequency and intensity of GLOFs, flash floods, slope failures, avalanches, and prolonged snowfall anomalies, placing settlements, infrastructure, agriculture, and livelihoods under escalating risk. Concurrently, springsheds and aquifer systems in mid-hill and lowland regions are experiencing systematic degradation caused by land-use change, over-abstraction, declining recharge, and contamination, resulting in chronic water insecurity and heightened public health risks.

These biophysical stresses are compounded by structural socio-economic vulnerabilities and governance failures compound these biophysical stresses. Women, youth, the elderly, and PWDs experience disproportionate exposure and reduced adaptive capacity due to constrained mobility, unequal access to information and services, and limited participation in institutional decision-making. Climate vulnerability in Pakistan is therefore not merely environmental but is fundamentally institutional, political-economic, and governance-driven.

Against this context, the Sustainable Actions for Ecosystem Restoration in Pakistan (SAFER Pakistan) Project was conceptualized as a systems-based climate resilience and ecosystem restoration intervention, integrating cryosphere disaster risk reduction, springshed revival, groundwater recharge, ecosystem-based adaptation, surface water conservation, climate-smart agriculture, and inclusive community empowerment across GB, KP, and Sindh.

1.2. National & Global Policy Context

SAFER Pakistan operationalizes Pakistan's obligations under the National Climate Change Policy (2021), which prioritizes ecosystem-based adaptation, climate-resilient water governance, and community-based resilience. The project is further aligned with Pakistan's National Adaptation Plan (NAP), advancing priority actions on water security, Nature-based Solutions, disaster risk reduction, and locally led adaptation. SAFER also supports implementation of Pakistan's Nationally Determined Contribution (NDC 3.0), particularly its commitments on climate-resilient water systems, NbS-based sanitation, inclusive governance, and community adaptation—areas where UNICEF provides technical support to provincial governments. In addition, the project aligns with the National Disaster Risk Reduction Policy

(2013), particularly its mandate for decentralized early warning systems, hazard mapping, preparedness planning, and inter-institutional coordination.

The project also advances the objectives of the National Policy on Gender and Climate Change (2017) by embedding gender-responsive planning, equitable participation, and targeted resilience-building for women, youth, and marginalized groups.

At the international level, SAFER Pakistan is directly aligned with:

- The Sendai Framework for Disaster Risk Reduction
- The Paris Agreement
- The 2030 Agenda for Sustainable Development, particularly:
- SDG 5 (Gender Equality)
- SDG 6 (Clean Water and Sanitation)
- SDG 11 (Sustainable Cities and Communities)
- SDG 13 (Climate Action)
- SDG 15 (Life on Land)

Through this multi-scalar alignment, SAFER Pakistan functions as a **sub-national delivery mechanism for national and global climate governance frameworks**.

By embedding local community structures and gender-inclusive participation into the early-warning and preparedness architecture, SAFER Pakistan operationalizes these commitments at the grassroots level.[1]

1.3. Geographic and Thematic Scope

SAFER Pakistan operates across three climatically distinct but hydrologically interconnected regions:

- **Gilgit-Baltistan** – characterized by cryosphere hazards and upstream hydrological regulation
- **Khyber Pakhtunkhwa** – dominated by springshed systems, groundwater recharge processes, and watershed degradation
- **Sindh** – defined by floodplain hydrology, surface water management stress, irrigation inefficiencies, and salinity intrusion

The project covers **more than 190 villages across 20 districts**, selected based on hazard exposure, socio-economic vulnerability, institutional fragility, and strategic alignment with national adaptation priorities.

[1] UNDRR, 2015 and UNDP, 2022

1.4. SAFER Pakistan Components

- **Component 1:** *Cryosphere DRR*. Establishing community-based EWS and enhancing preparedness against GLOFs and related cryosphere hazards in GB and KP.
- **Component 2:** *Springshed Revival and Management:* Restoring and managing drying springs in the mid-hill regions through community-led recharge measures, and inclusive governance systems to enhance year-round water availability and climate resilience.
- **Component 3:** *Groundwater Management and Resilience of Community Water Supply Services.* Addresses two complementary but distinct intervention streams: (i) **groundwater management and recharge interventions primarily in Khyber Pakhtunkhwa**, and (ii) **climate-resilient community water supply services in both KP and Sindh**, including solar-powered pumps and handpumps with strengthened operation, maintenance, and management arrangements. The component focuses on improving groundwater sustainability in water-scarce areas while simultaneously enhancing the reliability and resilience of community water supply systems to climate-induced shocks.
- **Component 4:** *Nature-Based Solutions (NbS) for Wastewater Treatment and Climate Adaptation.* Component 4 focuses on strengthening community and institutional capacity to transform wastewater from an ecological liability into a climate-adaptive asset through Nature-based Solutions (NbS), primarily via constructed wetlands. The component supports decentralized wastewater treatment systems, reduces reliance on pumped water, and enhances community resilience to climate impacts by establishing appropriate operation and maintenance structures. This component does not include watershed restoration, forest rehabilitation, or green infrastructure development activities.
- **Component 5:** *Surface Water Conservation.* Component 5 focuses on strengthening community and institutional capacity to reduce surface water waste and increase its storage for productive use, enabling communities to adapt to climate-induced shocks. Interventions include rehabilitation of community water ponds/doras and establishment of inclusive operation and maintenance mechanisms to improve surface water reliability. This component does not include climate-smart agriculture, efficient irrigation, or agronomic interventions.
- **Component 6:** *Community Empowerment and Inclusion*. Component 6 focuses on strengthening inclusive governance by institutionalizing community participation in resilience planning and service delivery. The component supports the formation and capacity development of inclusive community structures, ensuring meaningful representation of women, youth, and persons with disabilities in decision-making processes. It emphasizes leadership development, social accountability mechanisms, and community ownership across SAFER interventions to embed inclusion within formal resilience governance systems rather than through ad hoc participation.

Each component contributes distinct outputs but remains integrated within a shared framework of evidence-based decision-making, participatory governance, and climate-resilient infrastructure.

1.5. Theory of Change

The project's ToC envisions that if communities in climate-vulnerable regions are provided with the technical tools, institutional linkages, and inclusive platforms to anticipate and respond to climate hazards, they will progressively develop adaptive capacities leading to sustainable resilience and reduced loss and damage.

This causal pathway unfolds through three tiers:

1. **Inputs and Activities**: establishment of monitoring systems, training, awareness, infrastructure, and local institutional strengthening;
2. **Outputs**: improved access to early warning, knowledge, and resources for preparedness and adaptation; and
3. **Outcomes and Impacts**: enhanced community resilience, reduced vulnerability, and integration of climate risk management into local development planning.

1.6. Report Structure

This baseline report is structured into preliminary sections, five main chapters, and annexures to provide a comprehensive overview of the SAFER Pakistan project's pre-intervention conditions. The structure is summarized in the table below for clarity, ensuring logical flow from context and methodology to findings, conclusions, and supporting materials.

Table 1: Structure of Report

Section/Chapter	Title	Description
Chapter 1:	Introduction and Context	Provides background on Pakistan's climate vulnerabilities, national and global policy alignments, geographic and thematic scope, project components, and the Theory of Change.
Chapter 2:	Objectives and Results-Framework Alignment	Outlines the overall and specific objectives, linkages to the project's Results Framework, evaluation purpose, and cross-cutting themes like GEDSI and capacity building.

Chapter 3:	Methodology (Design, Sampling, Tools, and Quality Assurance)	Details the quasi-experimental design, sampling strategy, data-collection tools (e.g., HH surveys, FGDs, KIIs), data management protocols, analytical framework, limitations, and ethical considerations.
Chapter 4:	Thematic Profiling and Baseline Analysis (Component-Wise Findings)	Presents detailed baseline findings for each project component (1–6), including sampling frameworks, quantitative and qualitative analyses, radar charts, heatmaps, triangulation, and component-specific recommendations.
Chapter 5:	Consolidated Conclusion	Synthesizes overall findings, inter-component linkages, thematic insights, differentiated vulnerabilities, governance aspects, and programmatic recommendations for policy, community systems, knowledge, behavioral change, and monitoring.
Chapter 6:	**Annexures**	
Annex 1	Results Framework with Revised/Refined Baseline Values	Consolidated Results Framework table showing indicator-level baseline values for treatment and control groups
Annex 2	Sampling Matrix (Post-Implementation Scenario) and Methodology Details	Detailed HH, FGD, and community survey allocation per component, province, and batch; attrition and phase-in strategy
Annex 3	Literature Review	Component-wise review of cryosphere hazards, springsheds management, groundwater, EbA, surface-water conservation, and recent disaster events
Annex 4	Mapping of Overlapping/Complementing Interventions	Matrix of ongoing and past projects by location and theme, opportunities for synergy, and measures to avoid duplication
Annex 5	Ethical Approval Documents and Consent Forms	Full text of informed consent statements for household surveys, FGDs, community surveys, and KIIs

Annex 6	Cleaned Datasets and GIS Files	Final cleaned SPSS/Stata datasets and shapefiles/GIS layers used for mapping and analysis
Annex 7	GIS Mapping of Surveyed Villages	GIS based mapping of surveyed villages showing the boundaries and points of surveys location
Annex 8	Transcripts of Community Discussions, FGDs, and KIIs	Verbatim or detailed notes from all qualitative engagements
Annex 9	List of Stakeholders Engaged	Comprehensive list of 31 institutional stakeholders interviewed (by province and organisation)
Annex 10	Data-Collection Tools	Complete household questionnaire, FGD guides, KII protocols, community survey forms, and field protocols
Annex 11	Photos and Field Documentation	Geo-tagged photographs, field notes, and enumeration team logs
Annex 12	Bibliography and References	Full list of cited policies, reports, academic papers, and technical references

CHAPTER 2: OBJECTIVES AND RESULTS-FRAMEWORK ALIGNMENT

2.1. Overall Objective

To strengthen community resilience and adaptive capacity to climate-induced multi-hazard risks through integrated cryosphere risk reduction, water resource governance, ecosystem restoration, and inclusive community empowerment.

2.2. Specific Objectives

The SAFER Pakistan Project is structured around six integrated components, each contributing to climate resilience through targeted sectoral outcomes:

1. **Cryosphere Disaster Risk Reduction:** Strengthen community preparedness and institutional capacity to manage cryosphere-related hazards, including GLOFs, flash floods, and avalanches, through Early Warning Systems, evacuation planning, and inclusive disaster governance.
2. **Springshed Revival and WASH Resilience:** Restore and protect natural springsheds to improve drinking water security and sanitation resilience by introducing science-based recharge measures and strengthening community-level water management systems.
3. **Groundwater Management and Resilience of Community Water Supply Services:** Improve climate-resilient management of groundwater resources in Khyber Pakhtunkhwa and strengthen community water supply services in KP and Sindh through groundwater recharge, solar-powered infrastructure, and institutionalized operation and maintenance mechanisms.
4. **Nature-Based Solutions for Wastewater Treatment and Climate Adaptation:** Transform wastewater into a climate-adaptive resource by demonstrating Nature-based Solutions through constructed wetlands, reducing reliance on pumped water, and strengthening institutional capacity for decentralized wastewater management.
5. **Surface Water Conservation:** Increase community and institutional capacity to reduce surface water waste and enhance storage for productive use, enabling communities in Sindh to adapt to climate-induced shocks through rehabilitation of community ponds and establishment of inclusive water governance structures.
6. **Community Empowerment and Inclusion:** Strengthen inclusive governance by empowering women, youth, and marginalized groups to actively participate in resilience planning and service delivery, ensuring equitable representation and accountability across all SAFER interventions.

2.3. Results-Framework Linkages

The SAFER Pakistan baseline assessment is explicitly structured around the project's Results Framework (RF) and serves as both a benchmarking instrument and a diagnostic mechanism to support empirical refinement of outcomes, outputs, and indicators. While the RF articulated SAFER's theory of change and strategic intent at the design stage, the baseline provides field-validated evidence to strengthen the relevance, measurability, and sensitivity to change of indicators across all components.

The baseline contributes to RF refinement in three key ways. First, it supports verification of indicator clarity and observability at household, community, and institutional levels, ensuring that selected indicators can be measured reliably through the deployed instrument suite. Second, it informs recalibration of targets and performance thresholds by establishing the empirical distribution of vulnerability, preparedness, institutional access, and inclusion across the evaluation strata (treatment/control, ecological zones, and key social groups). Third, the assessment strengthens governance-related dimensions of resilience, particularly early warning governance, water user institutions, ecosystem stewardship mechanisms, and gender-responsive risk governance, by identifying gaps requiring stronger indicator definitions and disaggregation.

At the outcome level, baseline diagnostics indicate that some RF constructs—particularly under Outcome 1 (Cryosphere Disaster Risk Reduction)—are broader than what can be consistently measured through household- and institution-level instruments alone. The baseline therefore informs recommendations to strengthen measurement precision through more behaviourally anchored indicators, including household preparedness behaviors, evacuation planning, access and response to warnings, dissemination reach, presence/awareness of SOPs, and institutional response and coordination capacity. Similar refinements are identified under outcomes related to springshed governance, groundwater institutionalization, ecosystem co-management, surface-water conservation, and inclusive community leadership.

2.4. Evaluation Purpose

The baseline assessment is strategically positioned not as a solitary data collection exercise, but as an integral component of SAFER Pakistan's overall evaluation architecture. Its purpose is explicitly linked to the project's Results Framework, the Difference-in-Differences (DiD) evaluation design, and the dual imperatives of accountability and organizational learning.

Interrelated Evaluation Purposes

The baseline assessment is positioned not as a standalone data collection exercise, but as an integral part of SAFER Pakistan's overall evaluation architecture. Its purpose is explicitly linked to the Results Framework, the Phase-in quasi-experimental Difference-in-Differences (DiD) design, and the dual imperatives of accountability and learning.

Interrelated evaluation purposes include:

i. **Foundational benchmarking for core indicators:** The baseline establishes starting values for key outcome- and output-level indicators aligned to all SAFER components. These benchmarks (disaggregated by treatment/control, ecological zones, gender, and vulnerability categories) serve as reference points for subsequent midline and endline comparisons.
ii. **Establishing the counterfactual structure for future impact estimation:** Within the DiD framework, the baseline provides the pre-intervention observation required to compare change trajectories between treatment and control groups over time. The baseline itself does not estimate programme impact; rather, it establishes the empirical foundation necessary for causal estimation at later stages.
iii. **Testing and strengthening the evaluability of the Results Framework:** The baseline functions as an evaluability check for RF indicators by verifying that indicators are (a) measurable using field instruments, (b) sufficiently sensitive to register change within

the project timeframe, and (c) logically consistent with SAFER's theory of change. This informs indicator refinement, target setting, and disaggregation requirements.

iv. **Diagnostic function for adaptive programme management:** Beyond measurement, the baseline provides a diagnostic picture of vulnerabilities, institutional gaps, and governance bottlenecks across target geographies. These findings inform implementation prioritization, sequencing, and capacity development approaches early in the project cycle.

v. **Accountability, learning, and policy relevance:** The baseline provides a transparent evidence base against which SAFER performance can be assessed by partners, government counterparts, donors, and communities, while generating insights relevant for potential replication and scaling.

vi. **Establishing baseline thresholds for meaningful change:** The baseline defines statistically and programmatically meaningful change thresholds by documenting initial distributions, variability, and vulnerability gradients across key indicators. These thresholds will guide interpretation of midline and endline results, ensuring that observed changes are not only statistically significant but also substantively relevant for resilience outcomes, governance performance, and GEDSI impacts.

In sum, the baseline anchors SAFER's evaluation system in empirically defensible benchmarks and diagnostics, strengthens the Results Framework's measurability, and supports adaptive management throughout the project lifecycle.

2.5. Cross-Cutting Themes

The baseline also incorporates the project's cross-cutting commitments:

- **GEDSI:** ensuring women, youth, and PWDs are equitably represented and benefit from interventions.
- **Climate Information and Digital Systems:** integrating GIS, remote sensing, and community-based monitoring technologies.
- **Capacity Building:** institutionalizing local training systems for sustained learning.
- **Partnerships:** collaboration among NDMA, PDMAs, academia, and local civil society organizations.
- **Household Resilience & Preparedness:** standardized indicators on early warning access, evacuation readiness, and shock preparedness captured across all components to establish comparable baseline measures of adaptive capacity and service continuity.

CHAPTER 3: METHODOLOGY (DESIGN, SAMPLING, TOOLS, AND QUALITY ASSURANCE)

3.1 Evaluation Design

3.1.1 Rationale for the Evaluation Architecture

The evaluation architecture of the SAFER Pakistan baseline is anchored in a Phase-in Quasi-Experimental Difference-in-Differences (DiD) design. The design was selected specifically to support credible causal inference under real-world implementation conditions, where random assignment is not ethically appropriate or operationally feasible. SAFER Pakistan is being implemented in settings characterized by high exposure to climate-induced multi-hazard risks, including cryosphere hazards, chronic water insecurity, flood risks, ecosystem degradation, and compounded vulnerabilities driven by poverty, remoteness, and unequal access to services. In such environments, randomized controlled trials (RCTs) though often treated as a gold standard in evaluative epistemology are frequently neither permissible nor workable for three principal reasons.

First, randomization may pose ethical concerns, because it can permanently deprive highly vulnerable communities of lifesaving or resilience-enhancing interventions. Second, large-scale climate resilience programmes are typically constrained by implementation realities, including administrative targeting priorities, infrastructure placement needs, logistical feasibility, and security considerations, which rarely permit full control over who receives interventions and when. Third, climate resilience interventions are often delivered through complex institutional systems and governance structures (e.g., provincial/district authorities, water and disaster management systems, and community institutions) that cannot be meaningfully randomized without undermining programme integrity.

Accordingly, the Phase-in quasi-experimental strategy represents a pragmatic and analytically robust alternative. It preserves the core logic of counterfactual impact evaluation by using staggered exposure as a mechanism for constructing comparison groups while ensuring that communities assigned to deferred intervention are not excluded permanently. In this sense, the evaluation design is aligned with both rigour and equity, consistent with SAFER Pakistan's normative commitments to fairness, inclusion, and learning.

3.1.2 Phase-in Allocation and Analytical Groups

Within this framework, the programme implementation space is partitioned into two analytically distinct groups:

1. **Treatment communities (60%)**, scheduled for earlier exposure to SAFER interventions during the first phase of implementation; and
2. **Control communities (40%)**, selected from socio-ecologically comparable contexts but scheduled for deferred programme exposure, thereby remaining unexposed during the initial intervention cycle.

This phase-in allocation serves a dual purpose. On one hand, it supports ethical equity in programme coverage; no community is structurally denied support. On the other hand, it

creates the structural conditions required for **Difference-in-Differences estimation**, enabling the evaluation to measure whether outcomes improve more in treatment communities than they would have improved without treatment, as proxied by control communities.

3.1.3 Difference-in-Differences Logic and the Parallel Trends Assumption

Formally, the DiD estimator identifies programme impact as the difference between the temporal change in outcomes observed in the treatment group, and the temporal change observed in the control group over the same period. In its simplest representation, the estimator can be expressed as:

$$\text{Impact DiD} = (Y_{T,post} - Y_{T,pre}) - (Y_{C,post} - Y_{C,pre})$$

Where Y represents an outcome (e.g., warning access, preparedness behaviours, water security, institutional participation, ecosystem stewardship practices), T denotes treatment clusters, C denotes control clusters, and pre/post denote baseline and follow-up evaluation rounds (midline and endline).

The credibility of DiD-based causal inference rests on the parallel trend's assumption: absent the programme, treatment and control communities would have followed similar trajectories in the outcomes of interest. While parallel trends cannot be directly verified at baseline for future post-intervention periods, the evaluation strategy strengthens the plausibility of this assumption through baseline equivalence testing and balance diagnostics.

Specifically, if treatment and control groups are empirically similar at baseline on key determinants of outcomes (demographics, socio-economic status, hazard exposure, institutional access, and vulnerability characteristics) then the assumption that their counterfactual trajectories would have been similar becomes more credible.

3.1.4 Baseline Equivalence Diagnostics: SMD and Inferential Tests

To strengthen internal validity for subsequent DiD estimation, the baseline explicitly assessed statistical comparability between treatment and control groups across key variables using a combination of:

- **Independent-sample inferential tests** (t-tests for continuous variables and chi-square tests for categorical variables), and
- **Standardized Mean Difference (SMD)** diagnostics as the primary balance metric.

The baseline adopted SMD as the principal measure because it provides a standardized, sample-size–robust metric of group differences. Unlike p-values, which are sensitive to sample size (large samples can produce statistically significant p-values for small differences; small samples can fail to detect meaningful differences), SMD offers a scale-free indicator of practical comparability.

SMD is calculated (for continuous outcomes) as the difference in means between treatment and control divided by the pooled standard deviation. For binary variables, analogous standardized difference calculations are employed. An SMD threshold of **< 0.25** (absolute value) was applied as the criterion for acceptable balance, consistent with common practice in quasi-experimental

impact evaluation. Variables exceeding the threshold are flagged for interpretive caution and may be incorporated as covariates in regression-adjusted DiD models at midline and endline.

3.1.5 Embedded Learning and Adaptive Governance Functions

Critically, the Phase-in QED design is not applied solely as a statistical instrument; rather, it is embedded within SAFER Pakistan's governance logic, which values evidence not only for accountability but also for adaptive management. By observing the same treatment and control clusters at baseline, midline, and endline, the evaluation system is structured to:

- Detect early signals of Programme effectiveness and implementation bottlenecks,
- Support evidence-based course correction and Programme optimization, and
- Generate policy-relevant estimates for climate resilience programming at scale.

In this sense, the evaluation architecture serves both ex-post accountability and ex-ante learning functions, reinforcing the dual commitments of rigour and utility**.**

Baseline data will serve as the reference point for all midline and endline analyses under the Phase-in Difference-in-Differences framework. The same indicators, sampling units, and analytical methods will be reapplied to estimate programme-attributable change between treatment and control groups, track shifts in composite resilience indices, and assess progress against statistically and programmatically meaningful change thresholds. Baseline diagnostics will also inform adaptive programme learning by guiding implementation prioritization and course correction during subsequent evaluation rounds.

3.2 Sampling Strategy

Phased sampling was adopted to align with SAFER Pakistan's staggered implementation schedule and quasi-experimental evaluation design, enabling the establishment of treatment and control groups prior to intervention exposure. This approach ensured ethical programme roll-out while preserving the counterfactual structure required for Difference-in-Differences impact estimation.



Figure 1: Illustrates the staged sampling process from district to household level, including treatment–control allocation and qualitative triangulation, aligned with the Phase-in Difference-in-Differences evaluation design.

3.2.1 Sampling Objectives and Design Principles

The sampling design for the SAFER Pakistan baseline was developed to satisfy three core methodological requirements:

1. **Evaluative integrity for DiD estimation**, requiring comparability between treatment and control groups and stable measurement over time;
2. **Coverage of ecological heterogeneity**, ensuring that the baseline captures vulnerability patterns and resilience capacity across the Indus Basin's distinct ecological zones; and

3. **Sufficient subgroup resolution**, enabling disaggregation by gender, vulnerability category, and exposure profile consistent with SAFER's Results Framework.

To operationalize these requirements, the sampling strategy integrates probability-based selection principles with purposive stratification, reflecting both methodological rigor and real-world constraints.

3.2.2 Stratification Framework

At the first stage, the sampling universe was stratified along three analytically decisive dimensions:

(i) Geographic–Ecological Stratification

This reflects dominant climatological, hydrological, and hazard regimes across the project geography:

- **Cryosphere-dominated systems** in Gilgit-Baltistan and upper Khyber Pakhtunkhwa (high exposure to glacier melt dynamics, glacial lake outburst flood risks, and slope-related multi-hazards);
- **Mid-hill systems** in Khyber Pakhtunkhwa, characterized by springshed dependence, groundwater stress, and institutional vulnerabilities in local water governance; and
- **Lowland systems** in Sindh, where surface water management, flood dynamics, and water quality vulnerabilities are prominent.

This ecological stratification is not merely geographic; it is fundamental to SAFER's theory of change because the nature of vulnerability, the structure of hazards, and the feasible intervention pathways vary substantially across these regimes.

(ii) Programme Exposure Stratification

Communities were classified into:

Treatment clusters (scheduled for early implementation), and
Control clusters (scheduled for deferred implementation).

This stratification is central to the DiD framework and ensures that baseline data are collected across both groups prior to treatment exposure.

(iii) Socio-Institutional Vulnerability Stratification

Within ecological strata and exposure groups, vulnerability-relevant variation was considered to ensure the sample captures meaningful heterogeneity across:

- Poverty incidence and livelihood fragility,
- Differential governance reaches and service access,
- Gender disparities and constraints on participation,
- Infrastructure deficits (water, sanitation, transport access), and
- Historical exposure to disasters and climate shocks.

This three-layer stratification ensures the baseline captures biophysical and social heterogeneity in ways aligned with SAFER's Results Framework.

3.2.3 District, Union Council, and Village Selection

At the second stage, districts were selected through purposive alignment with SAFER's approved implementation geography. Selection criteria included:

- Documented hazard exposure and historical climate impacts,
- Presence of degraded water or ecosystem systems relevant to SAFER interventions,
- Alignment with provincial climate adaptation priorities, and
- Operational feasibility, accessibility, and security considerations.

At the third stage, Union Councils and villages were selected using Probability Proportional to Size (PPS) procedures within treatment and control strata. PPS ensures that larger population clusters have proportionately higher selection probability, preserving probabilistic integrity and reducing bias that can arise when small settlements are over-represented.

Importantly, component-specific sites presented in Chapters for Components 1–5 are strictly drawn from the approved SAFER implementation geography and reflect probability-based selection. They do not constitute post-baseline modifications of the programme's geographic targeting.

3.2.4 Household Selection Procedure

Within each sampled village, systematic random sampling was applied to select households for interview. Household lists were constructed with support from local administrative records and community leadership. A fixed sampling interval was applied to ensure:

- Equal probability of household selection,
- Minimization of enumerator discretion, and
- Reduced spatial clustering bias.

Through this procedure, the baseline surveyed **2,120 households** prior to any intervention exposure. Of these, **1,272 households (60%)** fall within treatment clusters, and **848 households (40%)** fall within control clusters. This proportional allocation mirrors the programme's phase-in design and supports balanced power for future DiD estimation.

3.2.5 Qualitative Sampling (FGDs and KIIs)

Qualitative sampling was conducted in parallel to support triangulation and institutional diagnostics.

- **Sixty Focus Group Discussions (FGDs)** were conducted across the three provinces, disaggregated by gender, age cohort (youth and adults), and vulnerability categories. This disaggregation is essential to capture gendered and socially differentiated risk perceptions, coping strategies, governance barriers, and access constraints.
- **Thirty-four Key Informant Interviews (KIIs)** were conducted with representatives from disaster management authorities, irrigation and water departments, PHE

departments, TMAs, meteorological services, CSOs, and community leadership structures. KIIs were selected through positional purposive sampling targeting individuals with operational authority relevant to SAFER domains.

3.2.6 Statistical Power and Internal Validity

The overall sample size and distribution were designed to provide:

- Adequate power for inter-group and inter-temporal comparisons (treatment vs control, baseline vs follow-up),
- Robust baseline equivalence diagnostics supporting DiD plausibility, and
- Subgroup analytical resolution for key disaggregation domains (gender, poverty status, disability, ecological zone).

Internal validity is supported through: probabilistic household selection, symmetric exposure design, and baseline equivalence testing using SMD. Where imbalances are observed, the evaluation design anticipates adjustment strategies at follow-up rounds, including regression-adjusted DiD models.

3.2.7 Limitations of the Sampling Design and Mitigation

Despite methodological rigor, structural constraints affected sampling operations:

- Remote terrain and seasonal inaccessibility in mountain regions limited dispersion,
- Cultural norms constrained direct access to female respondents in some contexts, and
- Flood-prone lowland displacement introduced minor sampling frame instability.

These constraints were mitigated through the deployment of local enumerators, gender-matched interviewing teams, supervised field verification, and replacement protocols governed by pre-specified rules.

3.3 Data Collection Tools

3.3.1 Mixed-Methods Instrument Architecture

The SAFER baseline employed a rigorously structured mixed-methods instrument suite designed to ensure:

- Conceptual coherence with the Results Framework,
- Analytical compatibility with the DiD evaluation design, and
- Triangulation across household, community, and institutional scales.

The suite comprised: (i) quantitative household questionnaires; (ii) FGD protocols; and (iii) KII protocols, each mapped to SAFER's component structure.

3.3.2 Household Survey Instrument

The household questionnaire constituted the principal quantitative tool and was explicitly structured around SAFER's operational components. Each module was aligned to Results

Framework outcomes and output indicators, ensuring traceability between measurement and evaluative inference.

Indicators captured included:

- Demographic and socio-economic characteristics,
- Hazard exposure and historical loss profiles,
- Preparedness behaviours and household risk management practices,
- Early warning access and institutional service reach,
- Water security across springs, groundwater, and surface systems,
- Ecosystem dependency and land-use practices, and
- GEDSI dimensions of participation, leadership, exclusion, and access.

Indicators were operationalized using behaviourally anchored response categories, and skip patterns were embedded to reduce respondent burden and enforce internal consistency.

3.3.3 Focus Group Discussion Protocols

FGD protocols were designed to generate collective-level evidence on:

- Risk perception and interpretation of hazards,
- Social norms and power dynamics affecting preparedness and participation,
- Barriers to warning access and response,
- Social inclusion/exclusion mechanisms, and
- Community governance practices around water and ecosystems.

To mitigate elite capture and gender silencing, FGDs were conducted in socially stratified formats, including separate discussions for women, youth, and marginalized groups.

3.3.4 Key Informant Interview Protocols

KII protocols were designed to extract institutional diagnostics relevant to: DRR governance, water management, ecosystem stewardship, and service delivery coordination. They explored:

- mandates and operational capacities,
- coordination mechanisms and fragmentation,
- dissemination architectures and institutional readiness,
- regulatory enforcement and budget constraints, and
- technical and human resource capacities.

3.3.5 Digitization and Field Deployment

All tools were digitized using a secure mobile-based platform enabling GPS capture, timestamps, forced-response constraints, automated skip logic, and real-time supervision. This reduced transcription errors and improved auditability.

3.3.6 Instrument Pre-testing and Validation

All instruments were pre-tested in representative pilot communities to evaluate clarity, cultural appropriateness, skip logic, response burden, and sensitivity. Findings were reviewed, and instruments were refined accordingly to strengthen content validity and operational feasibility.

3.4 Data Management and Quality Assurance

3.4.1 Enumerator Training and Accreditation

Enumerators and supervisors completed standardized training covering:

- instrument mastery,
- digital data capture,
- GEDSI-sensitive interviewing,
- ethical compliance and informed consent, and
- field problem-solving and respondent protection.

Only enumerators who passed supervised pilots were accredited.

3.4.2 Real-time Supervision and Verification

Quality control included:

- GPS verification,
- timestamp checks to detect rushed interviews,
- automated range checks, and
- skip logic enforcement.

Supervisors conducted daily reviews; flagged records were returned for verification or re-interview.

3.4.3 Data Cleaning and Statistical Validation

Post-collection cleaning followed a three-tier process:

1. Structural integrity checks (missingness, duplicates, logic),
2. Distribution diagnostics (outliers via z-scores/IQR), and
3. Cross-variable coherence tests.

Cleaning was conducted in SPSS using reproducible syntax to ensure auditability.

3.4.4 Qualitative Governance and Reliability

FGD/KII recordings were transcribed and coded using a structured codebook aligned with the Results Framework. Reliability safeguards included dual-coder verification on a subset of transcripts, agreement checks, and iterative codebook refinement.

3.4.5 Data Security and Confidentiality

Data were stored on secure, access-controlled servers. PII was removed through de-identification before analysis. Access was restricted to authorized analysts under defined governance protocols.

3.5 Analytical Framework

3.5.1 Analytical Objectives

The baseline analytical framework is designed to support:

- robust pre-intervention profiling of vulnerability and resilience,
- baseline equivalence diagnostics for DiD validity,
- multidimensional index construction for component-level tracking, and
- Triangulated governance interpretation for adaptive programme management.

3.5.2 Tier 1: Descriptive Profiling

Core indicators were summarized using means, medians, SD/IQR, and proportional distributions. Estimates were presented separately by treatment and control and disaggregated by gender, poverty status, disability, and ecological zone.

3.5.3 Tier 2: Baseline Equivalence Diagnostics

Treatment-control comparability was assessed using:

- t-tests/chi-square tests (as diagnostics), and
- SMD as the principal balance metric (threshold < 0.25).

Indicators exceeding threshold were flagged for caution and potential covariate adjustment in later DiD models.

3.5.4 Tier 3: Composite Index Construction

Indicators were normalized (0–1) via min–max transformation and aggregated into dimension and component indices using equal-weighted linear aggregation. These indices serve as longitudinal tracking instruments for midline/endline impact estimation.

3.5.5 Visualization and Systems Diagnostics

Radar profiles and equivalence heatmaps were used to visualize multidimensional patterns and identify leverage points and bottlenecks.

3.5.6 Qualitative Triangulation

Quantitative trends were triangulated with FGD/KII findings through convergent/divergent pattern analysis, strengthening explanatory power and policy relevance.

3.6 Limitations and Mitigation Measures

The baseline has several limitations that should be understood as constraints affecting interpretation rather than undermining methodological integrity.

First, while PPS and systematic sampling strengthen representativeness within strata, operational constraints (terrain, seasonal inaccessibility, and security) can limit dispersion in some high-mountain areas. Mitigation included local enumerator deployment and strict replacement rules.

Second, cultural norms affecting access to women can introduce response imbalance. Mitigation included gender-matched teams, women enumerators, safe interview spaces, and scheduling flexibility.

Third, displacement in some flood-prone zones can affect the stability of household lists and introduce minor frame instability. Mitigation included cross-checking lists with local leadership, substitution protocols, and GPS verification.

Fourth, the baseline is designed for treatment/control inference at evaluation strata and zone levels, not for statistically representative village profiling where household counts are small. This is addressed in the report through appropriate aggregation, and (where MEL targeting requires locality referencing) through descriptive village snapshot annexes clearly labeled as non-inferential.

3.7 Ethical Compliance, Confidentiality, and Respondent Protection

The baseline adhered to international ethical standards for human-participant research. Participation was voluntary; informed consent was obtained (written where feasible; documented verbal consent where literacy constraints existed). Respondent privacy was protected through de-identification at digital capture and anonymized IDs.

Special safeguards were applied for women, youth, and persons with disabilities. FGDs were conducted in socially safe settings, with segregated groups where necessary to reduce coercion and silencing.

No inducements were offered that could compromise voluntary participation; logistical facilitation (e.g., refreshments during group sessions) was framed strictly as facilitative support.

Data were stored on secure servers under access control. PII was not shared with implementers, donors, or third parties. Enumerators were trained to identify distress and terminate interviews where continuation could cause harm.

3.8 Reproducibility and Longitudinal Readiness

A central methodological priority was to ensure that all baseline procedures are replicable at midline and endline. The evaluation team therefore maintained: reproducible SPSS syntax workflows; documented codebooks; instrument versions; sampling documentation; and standard operating procedures for field operations and data governance. This ensures that

subsequent evaluation rounds can be executed with methodological continuity, enabling defensible DiD estimation and consistent trend interpretation.

CHAPTER 4: THEMATIC PROFILING AND BASELINE ANALYSIS (COMPONENT WISE FINDINGS)

4.1. Component 1: Cryosphere Hazard Baseline

Pakistan's high-mountain cryosphere constitutes the primary upstream hydrological regulator for large parts of the Indus River System. Accelerated glacier retreat, destabilization of moraine-dammed lakes, altered snowfall regimes, and shifting freeze–thaw dynamics have progressively transformed this cryosphere from a relatively stable water reserve into a multi-hazard risk system. Communities in Gilgit-Baltistan and upper Khyber Pakhtunkhwa are now exposed to recurrent glacial outbursts, flash floods, avalanches, slope failures, and cascading impacts on water security, agriculture, health, and physical infrastructure.

Within SAFER Pakistan, Component 1 operationalizes **Outcome 1**, which seeks to strengthen community and institutional resilience to cryosphere-induced multi-hazard risks through integrated preparedness, early warning, and inclusive disaster governance systems. Accordingly, the baseline establishes pre-intervention conditions across four interlinked analytical domains:

i. hazard awareness and exposure;
ii. household and community preparedness;
iii. early warning and evacuation systems; and
iv. governance, inclusion, and institutional capacity.

Quantitative analysis follows the project's Phase-in quasi-experimental evaluation design comparing Batch 1 (treatment) and Batch 2 (control) communities, triangulated with qualitative evidence from Focus Group Discussions and Key Informant Interviews across Gilgit-Baltistan and Swat.

Objectives and Results-Framework Alignment

Component 1 is aligned with **Outcome 1: Strengthened community and institutional resilience to cryosphere-induced multi-hazard risks**. The baseline assesses outcome-level indicators related to household preparedness behavior, access to early warning information, functionality of early warning systems, and inclusiveness of community-based disaster governance structures.

At the output level, the component contributes to:

Output 1.1: Increased community awareness of cryosphere-related hazards;

Output 1.2: Establishment and operationalization of functional community-based multi-hazard early warning systems;

Output 1.3: Formation and training of inclusive and gender-responsive disaster risk reduction committees.

4.1.1. Sampling Framework

The statistical design, stratification logic, and treatment–control allocation procedures are formally defined in Chapter 3 and are therefore not restated here. This subsection specifies only the application of that standardized framework within cryosphere-exposed landscapes**.**

Target cryosphere valleys were drawn from proposal-approved locations and technically validated during baseline inception. Micro-level settlement pairing was refined to ensure geomorphological comparability, treatment–control separation, and operational feasibility for longitudinal measurement.

Under Component 1, a total of 353 households were surveyed, supported by 10 Focus Group Discussions and 10 Key Informant Interviews**,** ensuring robust quantitative–qualitative triangulation across treatment and control clusters.

(Detailed respondent distributions are provided in Annex 2.)

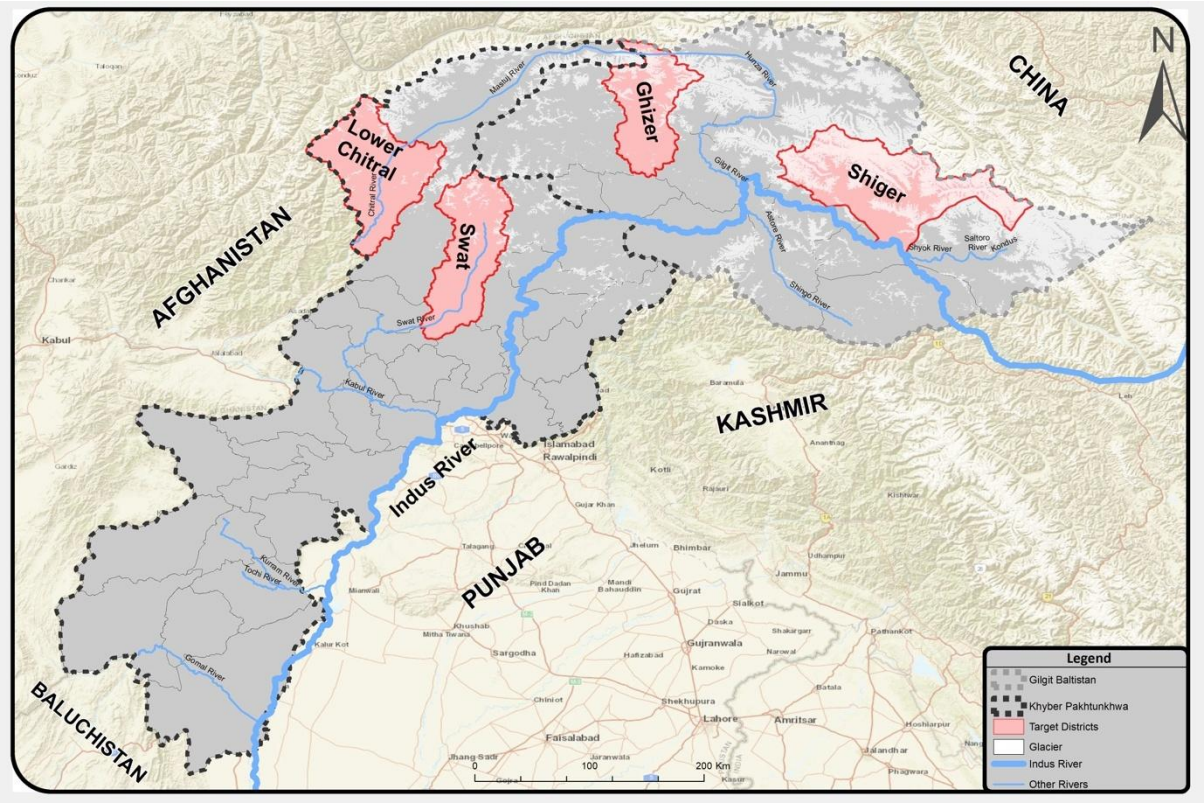


Figure 2: Map of Component 1 Sites and Sample Distribution

4.1.2. Baseline Findings

Comparative Baseline Analysis of Cryosphere Resilience

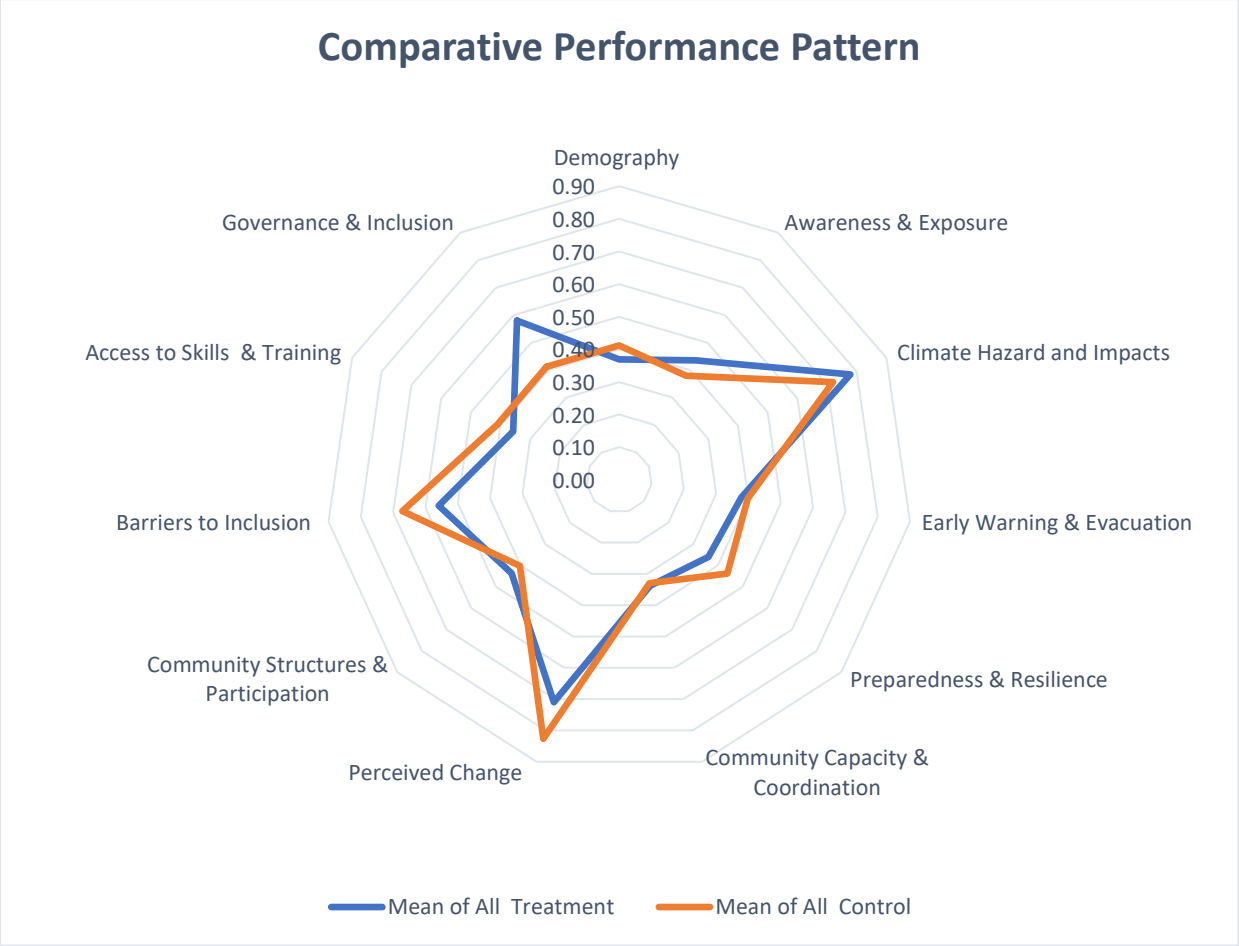


Figure 3: Comparative Baseline Assessment of Cryosphere Resilience (Treatment vs. Control)

Interpretation: Comparative Baseline Profile of Cryosphere Resilience Dimensions

The radar chart in Figure 2 provides a comprehensive comparative overview of treatment and control communities across eleven dimensions of cryosphere resilience, offering empirical validation of baseline equivalence under the quasi-experimental design. Both cohorts demonstrate broadly similar demographic compositions and exposure profiles to cryosphere-related hazards, including GLOFs, flash floods, and slope instability, thereby ensuring a statistically sound basis for post-intervention comparison. Despite this overall parity, the multi-dimensional analysis reveals subtle yet policy-relevant divergences in preparedness, institutional performance, and inclusion dynamics.

The treatment group records relatively higher scores in Climate Hazard Awareness and Governance & Social Inclusion, signalling early evidence of participatory governance and institutional engagement emerging through project sensitization. Conversely, the control group exhibits greater strength in Preparedness & Resilience and Perceived Change, reflecting

communities that may have benefited from prior exposure to district-level DRR initiatives or NGO-supported awareness campaigns. Nonetheless, persistent weaknesses appear in Community Coordination, Access to Skills and Training, and Gender and Social Inclusion, areas that remain chronically underdeveloped across both clusters.

From an analytical standpoint, these disparities point to structural constraints rather than random variation limitations rooted in insufficient institutional linkages, limited women's representation in decision-making, and inadequate translation of awareness into actionable preparedness.

Consequently, the findings underscore the need for targeted interventions emphasizing inclusive early-warning dissemination, women-led preparedness committees, and inter-village coordination mechanisms that institutionalize local capacities. As implementation advances, measurable improvements in these weaker dimensions will constitute key indicators of resilience enhancement attributable to the SAFER Pakistan program's cryosphere-focused adaptation measures, while ensuring that gender equity, institutional continuity, and knowledge transfer remain central to long-term adaptive governance.

Operational Definition of Radar Chart Variables

The radar chart presented in Figure 2 is constructed using eleven composite indices derived from standardized household-level survey variables. Each axis represents a normalized score (0–1 scale) computed from multiple sub-indicators, as defined below:

1. **Demography**
   Captures household structure, dependency ratio, gender composition, education level of household head, and livelihood typology. This variable contextualizes vulnerability and adaptive capacity across treatment and control populations.
2. **Awareness & Exposure**
   Measures community knowledge of cryosphere hazards, historical exposure to past disaster events (floods, avalanches, flash floods), risk perception, and understanding of hazard triggers and warning signs.
3. **Climate Hazard and Impacts**
   Represents the frequency, magnitude, and severity of experienced cryosphere-origin hazards, including physical damage to housing, agricultural land, water systems, and access routes.
4. **Early Warning & Evacuation**
   Assesses household access to early warning information, timeliness of alerts, evacuation knowledge, existence of evacuation routes, and participation in evacuation drills.
5. **Preparedness & Resilience**
   Captures availability of emergency kits, household preparedness plans, food and water storage capacity, shelter preparedness, and adaptive coping mechanisms.
6. **Community Capacity & Coordination**
   Measures the effectiveness of inter-village coordination, communication during emergencies, the existence of joint response mechanisms, and linkages with district response institutions.

7. **Perceived Change**
   Represents households' subjective assessment of change in community safety, preparedness, institutional responsiveness, and disaster risk reduction capacity over time.
8. **Community Structures & Participation**
   Assesses functionality of local DRR committees, participation rates in planning processes, meeting attendance, and representation of women, youth, and vulnerable groups.
9. **Barriers to Inclusion**
   Measures socio-cultural, economic, mobility, and institutional barriers limiting participation of women, youth, persons with disabilities, and marginalized households in disaster governance.
10. **Access to Skills & Training**
    Captures exposure to disaster preparedness training, first aid, search and rescue, early warning interpretation, and participation in capacity-building activities.
11. **Governance & Inclusion**
    Measures institutional trust, transparency of decision-making, effectiveness of grievance mechanisms, inclusion in leadership, and responsiveness of disaster governance structures.

4.1.3. Detailed Interpretation of Dimensions (Quantitative & Qualitative)

To ensure that baseline findings are reliable and suitable for impact measurement, treatment and control communities were compared across key socio-economic, environmental, and service-access indicators. This comparison helps confirm that both groups started from broadly similar conditions prior to intervention.

A standardized difference score (SMD) was used to assess comparability. In simple terms, this shows how similar or different the two groups are at baseline:

- Values close to **zero** indicate strong similarity.
- Values below **0.25** are considered acceptable for evaluation purposes.
- Higher values signal areas where communities differ and where results must be interpreted with caution.

The comparability table below summarizes these baseline differences across core indicators such as water access, governance participation, hazard exposure, and adaptive capacity.

In addition to household survey data, qualitative information from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) was used to explain observed patterns. This mixed-method approach allows the baseline to capture both measurable conditions (e.g., service access) and lived experiences (e.g., seasonal water stress, governance challenges).

Overall, the results confirm that treatment and control sites are sufficiently comparable for midline and endline evaluation, while also highlighting structural vulnerabilities—particularly in governance capacity, water reliability, and gender inclusion—that SAFER interventions are designed to address.

A: Demography

Table 2: Baseline Equivalence between Treatment and Control Groups across Key Indicators

Indicator	Treatment (n = 1260)	Control (n = 840)	Mean/ % Diff	p-value	Interpretation
Mean HH size	6.2 (±2.1)	6.1 (±2.3)	+0.1	0.44	No difference
Mean age of HH head (years)	45.8	45.5	+0.3	0.69	Comparable
Female-headed HHs (%)	11.4	12.1	−0.7	0.86	Balanced
HHs aware of GLOFs (%)	48.1	46.2	+1.9	0.64	Balanced awareness
HHs near glacier lake or river (%)	22.0	23.1	−1.1	0.79	Comparable exposure
HHs noticed glacier melt (%)	88.0	85.0	+3.0	0.52	Comparable
Illness due to contamination (%)	67.0	58.0	+9.0	0.07	Marginal difference
Emergency numbers known (%)	18.0	9.0	+9.0	0.02	Higher in treatment
Received EWS (%)	42.0	24.0	+18.0	0.00	Significant difference
HH evacuation plan (%)	30.0	52.0	−22.0	0.00	Higher in control
Community participation belief (mean, 1-5)	2.19 (±1.32)	1.94 (±1.28)	+0.25	0.09	Balanced
Community barriers index	2.97 (±1.29)	2.42 (±1.27)	+0.55	0.00	Significantly higher
Community preparedness for GLOF	2.13 (±0.68)	2.48 (±0.66)	−0.35	0.00	Higher in control
PWDs barriers (%)	36.0	81.0	−45.0	0.00	Much higher in control
Literacy barrier (%)	47.0	75.0	−28.0	0.00	Higher in control
Trainings, participation (%)	6.0	1.0	+5.0	0.04	Higher in treatment
Trainings accessible to women/youth (%)	32.0	16.0	+16.0	0.00	Higher in treatment
Access to products/services (%)	33.0	72.0	−39.0	0.00	Higher in control
Situation changed in last 5 years (mean)	2.07 (±0.87)	0.46 (±0.50)	+1.61	0.00	Much higher in treatment

The demographic composition across the treatment and control clusters demonstrates a high degree of comparability, thereby validating the robustness of the quasi-experimental design and strengthening the internal validity of subsequent impact attribution. Statistical tests confirm that HH size, the gender of the HH head, and age distribution are nearly identical between groups, with no significant differences at the 95% confidence level. The mean HH size stands at 6.2 ± 2.1 members in the treatment areas and 6.1 ± 2.3 in the control ($p = 0.44$), indicating a uniform HH structure across the study population. Likewise, female-headed HHs constitute 11.4% and 12.1% of the treatment and control groups, respectively, further confirming demographic parity.

Qualitative Triangulation

Qualitative data from FGDs in Talidas and Shigar districts substantiate findings revealing that male seasonal migration for off-farm employment often leaves women responsible for agricultural tasks, HH management, and caregiving duties. This feminization of rural responsibility heightens women's exposure and decision-making burdens during climatic shocks such as GLOFs and flash floods. Both groups exhibit similar socio-economic structures,

predominantly subsistence farming, livestock rearing, and small remittance inflows underscoring shared livelihood vulnerabilities and limited diversification opportunities.

Although demographic equivalence reinforces the reliability of the baseline, the prevalence of large family units introduces a higher dependency ratio, particularly affecting emergency preparedness and evacuation efficiency. Women and elderly members bear disproportionate logistical pressures during crises, often prioritizing dependent care over self-protection. These patterns suggest that HH size and gendered labor dynamics will remain critical determinants of adaptive capacity in subsequent phases of the SAFER Pakistan cryosphere resilience program.

B: Awareness and Exposure

Table 3: Cryosphere Hazard Awareness & Exposure

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Aware of cryosphere hazards (GLOFs)	0.48 (0.50)	0.46 (0.50)	0.02	0.62	0.04
Learning Source	4.25 (1.62)	4.00 (1.55)	0.25	0.33	0.16
HH located within 1 km of river or lake	0.35 (0.48)	0.33 (0.47)	0.02	0.74	0.04
Witnessed any GLOF	0.27 (0.44)	0.19 (0.40)	0.08	0.05	0.18
Number of GLOF events witnessed	2.40 (1.20)	1.90 (1.10)	0.50	0.08	0.18
Response during GLOF	3.42 (1.23)	3.15 (1.10)	0.27	0.09	0.23
HH members least able to evacuate quickly during a hazard	1.72 (0.88)	1.64 (0.92)	0.08	0.42	0.09

Cryosphere hazard awareness is moderate across both groups, with 48% of treatment and 46% of control HHs reporting familiarity with GLOFs ($p = 0.62$), confirming baseline equivalence. Direct experience, however, is greater in treatment areas (27%) than in control (19%; $p = 0.05$), reflecting closer proximity to glacier valleys. While awareness levels are comparable, understanding of causal processes such as temperature-driven melt or moraine-dam failures, remains limited.

Qualitative triangulation

FGDs from Talidas, Shigar, and Kalam corroborate these findings, revealing that communities associate recurring floods with visible glacier retreat, erratic rainfall, and reduced snowfall rather than technical glaciological causes. In Talidas, residents recalled three major floods in one year that destroyed farmland and roads. In Shigar, women described evacuating elderly people and children using handcarts due to the absence of vehicles and safe shelters while participants in Kalam highlighted food insecurity and water contamination following GLOFs, which disproportionately affected women, children and the elderly.

Overall, hazard knowledge is largely experiential, transmitted through mosque loudspeakers and social networks rather than formal disaster education. Women and other vulnerable groups depend on second-hand information because of limited participation in community meetings and early-warning dissemination. Although numerical parity validates the quasi-experimental

baseline design, these findings reveal persistent knowledge gaps across gender and age groups. The triangulated evidence thus reinforces the quantitative finding of low functional preparedness and indicates the need for communication models that are locally grounded, visually oriented, and inclusive of women and youth as primary recipients of early-warning information.

C: Climate Hazards and Impacts

Table 4: Cryosphere Climate Hazard and Impacts

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Noticed glacier melt	0.88 (0.33)	0.85 (0.36)	0.03	0.42	0.09
Glacier melt contributed to flood	0.86 (0.35)	0.83 (0.38)	0.03	0.47	0.08
GLOF damage reported	0.78 (0.41)	0.72 (0.45)	0.06	0.21	0.14
Water contamination observed	0.84 (0.37)	0.79 (0.41)	0.05	0.19	0.12
Illnesses due to contamination	0.67 (0.47)	0.58 (0.49)	0.09	0.07	0.18
Increased workload due to hazard	0.90 (0.30)	0.83 (0.38)	0.07	0.04	0.20
Reported illness type index	2.60 (1.10)	2.20 (1.00)	0.40	0.06	0.19

Table 3 presents the baseline comparative statistics for key cryosphere-related hazard and impact variables across treatment and control communities. The findings confirm that exposure to cryosphere-driven hazards is structurally high across both clusters. Approximately 88% of treatment households and 85% of control households reported noticing accelerated glacier melt, while 86% and 83%, respectively, attributed recent flood events directly to glacier melt processes. These results confirm that glacio-hydrological dynamics form the dominant flood-risk driver across the surveyed valleys.

Direct GLOF-related damage was reported by 78% of treatment households and 72% of control households, reflecting widespread spatial exposure to high-impact cryosphere-origin floods. Water contamination following hazard events was also pervasive, reported by 84% of treatment and 79% of control households. Correspondingly, illness linked to contaminated water remained alarmingly high, affecting 67% of treatment households and 58% of control households ($p = 0.07$).

Post-hazard workload intensification was nearly universal, reported by 90% of treatment households and 83% of control households, capturing the compounded burden of water collection, caregiving, infrastructure repair, and livestock protection in disaster aftermaths. The illness-type index further confirms a multiplicity of water-borne and climate-sensitive disease conditions across exposed settlements.

Collectively, these quantitative indicators establish a robust statistical baseline of high-magnitude exposure, environmental contamination, public health stress, and labour intensification across both study groups, with treatment communities exhibiting marginally higher overall impact intensity.

Qualitative Triangulation: Multi-Hazard Exposure and Lived Impacts

FGDs conducted in Talidas, Karakal, and Bahrain consistently corroborate the quantitative findings while revealing a broader multi-hazard exposure landscape. Communities described

repeated monsoon-triggered GLOF outbursts destroying croplands, irrigation channels, shelters, and access roads. In addition to floods, participants highlighted frequent landslides and debris flows, prolonged dry spells affecting spring discharge, heavy rainfall and localized cloudburst events, and increasingly erratic snowfall regimes producing avalanche risks in upper elevations.

Women in Shigar and Karakal described the disproportionate post-event burden of fetching clean water, caring for the sick, securing food, and maintaining household stability. Men emphasized repeated repair of infrastructure, livestock shelters, and irrigation systems. Across all valleys, participants consistently reported water-borne illnesses, food insecurity episodes, fuel shortages, and inflationary price shocks following hazard events.

Environmental, Livelihood, and Institutional Implications

Environmentally, repeated hazard exposure has accelerated soil erosion, sediment deposition, loss of riverbank vegetation, and degradation of ecosystem services essential for slope stability and pasture regeneration. Communities reported declining spring discharge, fluctuating river flows, and chronic water turbidity following floods directly undermining household water security and agricultural productivity.

From a socio-economic standpoint, crop losses, fodder shortages, livestock disease, and infrastructure damage impose recurrent income shocks. Market disruptions caused by road blockages further erode household purchasing power, while temporary displacement during high-magnitude flood events contributes to livelihood instability and social stress.

Institutionally, communities reported variable functionality of local disaster management committees, limited emergency resource availability, and coordination gaps between meteorological services, district authorities, and village-level responders. Early warning dissemination remains largely informal, relying on mosque announcements, interpersonal messaging, or mobile phones, with women, elderly persons, and persons with disabilities facing persistent access barriers.

Integrated Interpretation

The combined quantitative and qualitative evidence demonstrates that cryosphere hazards in the SAFER landscape operate as a compound risk system**,** where glacio-hydrological shocks interact with heavy rainfall, landslides, ecosystem degradation, and institutional capacity gaps. These interacting hazards generate cascading impacts across environmental integrity, public health, household livelihoods, and governance systems.

While hazard awareness is widespread, functional preparedness, inclusive early warning access, post-event recovery mechanisms, and institutional coordination remain structurally underdeveloped. These systemic gaps substantiate the strategic focus of Component 1 on strengthening community-based multi-hazard early warning systems, inclusive disaster governance, and household preparedness under Outcome 1 of the SAFER Pakistan Results Framework.

D: Early Warning and Evacuation Systems

Table 5: Cryosphere Early Warning & Evacuation Systems

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Climate-related risks have affected your community in the past 5 years	3.99 (2.23)	4.34 (2.01)	-0.35	0.14	-0.16
Knowledge of emergency numbers	0.18 (0.39)	0.09 (0.28)	0.09	0.02	0.27
Received an early warning message before a disaster occurred	0.42 (0.49)	0.24 (0.43)	0.18	0.00	0.37
EWS source	2.80 (1.03)	2.52 (1.09)	0.28	0.21	0.27
Who in your household usually receives and communicates early warning messages?	1.13 (0.38)	1.18 (0.43)	-0.05	0.33	-0.13
Equal access to early warning alerts	0.33 (0.47)	0.57 (0.50)	-0.24	0.00	-0.49
Trust EWS	2.24 (1.52)	1.98 (1.40)	0.26	0.13	0.18
Acted on an EWS alert in the past	0.34 (0.48)	0.39 (0.49)	-0.05	0.42	-0.09
Evacuation routes safe and accessible	0.48 (0.50)	0.51 (0.50)	-0.03	0.60	-0.06

Quantitative findings reveal uneven progress in early-warning access and utilization. 42% of treatment HHs reported receiving an alert before a disaster compared to 24% of control HHs ($p = 0.00$), indicating significant disparity in outreach coverage. Similarly, awareness of emergency numbers is higher in treatment areas (18%) than in control (9%, $p = 0.02$). However, equality in alert dissemination remains limited with only 33% of treatment respondents perceiving equal access, versus 57% in control ($p = 0.00$).

Qualitative triangulation

FGDs from Bahrain, Shigar, and Talidas confirm that mosque loudspeakers remain the main alert mechanism, often delayed or inaudible in remote hamlets. Women and PWDs rarely receive warnings directly due to cultural and mobility barriers. In Karakal, shepherds and youth volunteers occasionally disseminate hazard information informally. Communities lack sirens, mobile alert systems, or designated focal persons for communication.

The absence of inclusive EWS undermines trust and response readiness. Establishing solar-powered sirens, SMS-based alerts, and women-led communication focal points is essential to transform passive awareness into timely, equitable action.

E: Preparedness and Resilience

Table 6: Cryosphere Preparedness & Resilience

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
HH evacuation plan	0.30 (0.46)	0.52 (0.50)	-0.22	0.00	-0.47
Emergency supplies	2.67 (1.53)	3.12 (1.50)	-0.45	0.01	-0.29
Consider the needs of vulnerable groups	0.35 (0.48)	0.40 (0.49)	-0.05	0.42	-0.10
Resources for evacuation	0.26 (0.44)	0.21 (0.41)	0.04	0.36	0.10

Preparedness indicators are considerably weaker in treatment areas, underscoring the need for structured contingency planning. Only 30% of treatment HHs reported maintaining a written or practiced evacuation plan compared with 52% in control ($p = 0.00$). Similarly, the mean emergency-supply readiness score is lower among treatment HHs (2.67) than control (3.12; $p = 0.01$), revealing limited preparedness capacity.

Qualitative triangulation

FGDs from Karakal and Kalam confirm reliance on traditional coping strategies, including moving livestock to higher ground or seeking refuge in mosques during disasters. Women in Bahrain and Shigar reported complete exclusion from drills or preparedness sessions and reliance on male guidance for evacuation decisions. In Talidas, participants described inaccessibility of shelters for the elderly and PWDs.

These findings underscore the gap between hazard awareness and functional preparedness. Strengthening HH contingency plans, conducting gender-segregated simulation drills, and integrating first-aid and psycho-social training will be vital to enhance resilience in cryosphere-affected valleys.

F: Community Capacity and Coordination

Table 7: Cryosphere Community Capacity & Coordination

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Believe in community participation	2.19 (1.32)	1.94 (1.28)	0.24	0.09	0.19
Coordination between groups	0.29 (0.45)	0.26 (0.44)	0.03	0.55	0.07
Community shelters presence	0.17 (0.38)	0.34 (0.48)	-0.17	0.00	-0.41

Community barriers	2.97 (1.29)	2.42 (1.27)	0.55	0.00	0.43

Community capacity for collective response remains modest. Mean participation-confidence scores are 2.19 (treatment) and 1.94 (control) (p = 0.09). However, physical facilities show a significant disparity in community shelters in only 17% of treatment sites versus 34% in control (p = 0.00). The barrier index is notably higher in treatment areas (2.97 vs. 2.42; p = 0.00), indicating greater coordination challenges.

Qualitative triangulation

FGDs from Talidas, Shigar, and Karakal reveal that existing DRR committees are inactive, male-dominated, and lack basic training. Coordination relies on kinship ties rather than structured governance, and women contribute primarily post-disaster through caregiving or food provision. Participants in Bahrain highlighted that collective action is often reactive rather than planned.

This confirms that while social solidarity exists, it lacks institutional structure. Forming inclusive, trained community DRR committees with gender and youth quotas and clear mandates would significantly strengthen local coordination and preparedness.

G: Community Structures and Participation

Table 8: Cryosphere Community Structures and Participation

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	p-value	SMD
Formal or informal governance structures	0.09 (0.29)	0.07 (0.26)	0.02	0.44	0.09
Believe community decisions	0.14 (0.35)	0.42 (0.50)	-0.28	0.00	-0.65
Groups meet	3.24 (0.94)	3.37 (0.93)	-0.13	0.20	-0.14
Part of any community group or committee	0.37 (0.48)	0.22 (0.42)	0.15	0.00	0.32
HH attends community meetings	1.95 (1.32)	1.38 (0.87)	0.58	0.00	0.52
Suitability of meeting times	0.31 (0.46)	0.50 (0.50)	-0.19	0.00	-0.40
Representation of marginalized groups	0.26 (0.44)	0.23 (0.42)	0.03	0.52	0.07
Men in your community support women	2.10 (0.73)	1.86 (0.46)	0.24	0.00	0.40
Community governance structure	0.33 (0.47)	0.50 (0.50)	-0.17	0.00	-0.36
Effective response	3.06 (1.57)	1.98 (1.25)	1.07	0.00	0.75

Main barriers	2.10 (0.72)	2.59 (0.62)	-0.49	0.00	-0.74
Feedback mechanism	0.58 (0.50)	0.47 (0.52)	0.11	0.07	0.21
Effective addressing community needs	3.89 (1.40)	1.96 (1.27)	1.93	0.00	1.44

Participation in community groups is notably higher among treatment HHs (37%) than control (22%; p = 0.00), reflecting greater numerical engagement. However, confidence in local decision-making is substantially weaker in treatment areas (0.14 vs. 0.42; p = 0.00), suggesting that participation has not translated into perceived influence. Meeting attendance frequency is higher in treatment villages (1.95 vs. 1.38; p = 0.00), yet the suitability of meeting times is lower (31% vs. 50%; p = 0.00), which limits inclusion of women and other marginalized groups.

Qualitative triangulation

FGDs in Shigar and Bahrain reveal that most governance processes are male-dominated, informal, and often convened at night thereby deterring female attendance and excluding PWDs. While men express satisfaction with committee responses (mean effectiveness score: 3.06 vs. 1.98; p = 0.00), women report tokenistic involvement and absence of structured feedback mechanisms.

This paradox high attendance but low empowerment illustrates that procedural inclusion alone does not ensure participatory governance. Establishing gender-balanced and inclusive committees, rotating leadership roles, and maintaining transparent record-keeping can transform attendance into genuine representation and accountability.

H: Barriers to Inclusion

Table 9: Cryosphere Barriers to Inclusion

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
PWDs face accessibility challenges	0.36 (0.48)	0.81 (0.41)	-0.45	0.00	-1.01
Marginalized members face safety risks	2.36 (0.61)	2.12 (1.02)	0.24	0.02	0.29
Low literacy a barrier to participation	0.47 (0.50)	0.75 (0.43)	-0.28	0.00	-0.60
Marginalized groups received training or support	2.87 (0.33)	2.30 (0.84)	0.57	0.00	0.90
Involved in income-generating activities	0.19 (0.39)	0.45 (0.50)	-0.26	0.00	-0.58
Barriers prevent women and youth	2.36 (1.07)	2.18 (0.55)	0.18	0.06	0.21

Inclusion deficits persist across nearly all social groups. 36% of treatment HHs report accessibility barriers for PWDs compared with 81% in control (p = 0.00). Literacy constraints affect 47% of treatment and 75% of control HHs (p = 0.00). Training participation is higher in treatment areas (2.87 vs 2.30, p = 0.00), yet engagement in income-generation activities remains lower (0.19 vs 0.45, p = 0.00).

Qualitative triangulation

FGDs from Shigar, Bahrain, and Talidas confirm that community meetings are often held at night and dominated by male elders and religious figures, excluding women, youth, and PWDs. Karakal participants reported inactive committees and lack of follow-up. Although men express satisfaction with committee responsiveness, women report token representation without decision-making power.

This existing paradox of high attendance but low empowerment illustrates the need for formalized, gender-balanced and inclusive governance structures, rotating leadership, and transparent record-keeping to ensure that participation translates into genuine influence.

I: Access to Skills Development & Training

Table 10: Cryosphere Access to Skills Development & Training

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Participated in skills development trainings	0.06 (0.23)	0.01 (0.12)	0.04	0.04	0.23
Trainings accessible to women, girls, or youth	0.32 (0.47)	0.16 (0.36)	0.17	0.00	0.40
Type of training activities	3.63 (1.55)	3.35 (1.31)	0.28	0.09	0.20
Access to relevant products and services	0.33 (0.47)	0.72 (0.45)	−0.39	0.00	−0.85
Access status in the last 5 years	1.41 (0.69)	1.96 (0.84)	−0.55	0.00	−0.72

Access to vocational and technical training opportunities remains limited across both groups but is noticeably higher in treatment areas. Only 6% of treatment HHs reported participation in skills development trainings compared with 1% in control (p = 0.04), suggesting modest yet emerging outreach. Accessibility for women, girls, and youth is significantly greater in treatment communities (32% vs. 16%; p = 0.00), indicating some progress toward inclusivity. However, overall access to relevant products and services remains considerably lower in treatment sites (33% vs. 72%; p = 0.00), and the perceived access trend over the past five years also lags behind (1.41 vs. 1.96; p = 0.00).

Qualitative triangulation

FGDs from Shigar, Karakal, and Bahrain confirm that most training opportunities are short-term, externally funded, and poorly aligned with local needs and livelihoods, such as agriculture, apiculture, or handicrafts. Women expressed strong interest in home-based learning but cited mobility restrictions and lack of information about training opportunities.

Localized, market-linked, and women-inclusive training initiatives are essential for sustainable livelihood enhancement and long-term community resilience in glacier-affected regions.

J: Perceived Change & Support Needs

Table 11: Cryosphere Perceived Change & Support Needs

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
In the past 5 years, has the situation changed?	2.07 (0.87)	0.46 (0.50)	1.61	0.000	2.19
Has community improved?	0.47 (0.50)	0.87 (0.34)	-0.40	0.000	-0.92
Others are involved in decision-making?	0.73 (0.44)	0.58 (0.49)	0.15	0.006	0.31
Has community become more inclusive?	0.70 (0.46)	0.30 (0.46)	0.40	0.000	0.87
Do you believe your community is resilient?	0.31 (0.46)	0.29 (0.46)	0.02	0.742	0.04

Perceptions of change and inclusion vary across clusters. A larger share of treatment respondents perceives positive change in the past five years (mean = 2.07 vs. 0.46; p = 0.000), though fewer believe their community has improved (47% vs. 87%; p = 0.000). Decision-making inclusivity is stronger in treatment areas (0.73 vs. 0.58; p = 0.006), and perceived inclusiveness has grown (0.70 vs. 0.30; p = 0.000), but belief in community resilience remains low (0.31 vs. 0.29; p = 0.742).

Qualitative triangulation

FGDs from Talidas and Bahrain reveal that residents equate “improvement” with infrastructure repair and short-term relief rather than long-term resilience. Karakal participants emphasized limited training and physical infrastructure as barriers to confidence in adaptation.

This disconnect between perceived inclusiveness and actual resilience suggests that participatory monitoring, psycho-social engagement, and sustained capacity-building are needed to strengthen community self-perception and collective readiness for cryosphere-related hazards.

4.1.4. Triangulation through KIIs and Community Surveys

Institutional Insights (Governance & Systems)

Across GB, institutional actors acknowledge the accelerating pace of glacial retreat, permafrost thaw, and moraine-lake expansion, yet systematic early-warning and monitoring remain fragmented. Officials from the Gilgit Baltistan Disaster Management Authority (GBDMA) confirm rising glacier-burst and cloud-burst frequency but note the absence of formal community-based EWS, relying instead on Meteorological Department data relayed with delays, a gap that weakens community response. The Regional Meteorological Center (RMC) operates 175 hydrometer sensors transmitting real-time data, though maintenance and outreach challenges persist. RMC proposes that SAFER should train local staff and communities in interpreting forecasts and maintaining EWS equipment, ensuring coverage of unmonitored valleys. The GLOF-II Project (UNDP/MoCC) reports 144 active EWS stations but warns that community capacities for operation and maintenance remain weak once donor projects end. The Gilgit Baltistan Environmental Protection Agency links cryosphere degradation to deforestation, pollution, and unregulated tourism; and recommends joint environmental risk mapping, EbA, and youth/women training for monitoring. At the district level, Shigar's Local Government and Council cite poor coordination between GBDMA, PMD, and TMA, limited resources, and exclusion of women/youth from DRR committees. Despite these constraints, NGO and Local Support Organization initiatives (AKAH CERT teams, Majid LSO Markunja) showcase effective 50% female participation in DRR, proving the feasibility of gender-balanced preparedness.

Community-Level Validation (Survey Evidence)

Surveys from Ghizer (Dain-Ishkoman) and Karakul Villages affirm visible glacier retreat, unpredictable weather, and intensifying GLOF and avalanche risks. None of the surveyed villages possess functional EWS or designated shelters; alerts circulate informally via mosques, shepherds, or phones, leaving women, elderly, and PWDs uninformed. Communities report crop and infrastructure losses, water-source contamination, and seasonal displacement, with recurring diseases (diarrhea, skin ailments, hepatitis) after floods. While local committees exist, they are mostly inactive and lack female and youth representation. Nevertheless, solidarity remains strong with HHs jointly rebuilding irrigation channels, sharing food/water, and providing ad hoc support during crises. Villagers explicitly call for structural protections (check dams, walls), awareness campaigns, and inclusive training on hazard preparedness. The Dain community prioritizes ecosystem-based solutions and deforestation control as natural buffers against cryosphere hazards.

Integrated Synthesis & Implications

Triangulated evidence from KIIs and FGDs reveals strong convergence between institutional perspectives and community-level experiences. Officials from the GBDMA and the PDMA-KP consistently highlighted delayed meteorological transmissions, weak local interpretation of

data, and limited cross-departmental communication as critical bottlenecks undermining the performance of EWS. Community participants across glacier-proximal settlements confirmed these institutional constraints, describing how alerts, when received, are circulated informally through mosques, shepherds, or phone networks, leaving women, the elderly, and PWDs disproportionately uninformed or unable to act in time.

The absence of localized communication protocols and inclusive preparedness mechanisms thus emerges as a common denominator across both institutional and community narratives. Quantitative trends mirror this qualitative insight, indicating low HH-level preparedness indices and minimal representation of women and youth within disaster-response structures. These multi-layered deficiencies validate the statistical finding that, despite demographic and exposure equivalence between treatment and control groups, preparedness and governance dimensions remain the weakest domains of resilience.

Collectively, these insights reveal that the gap between awareness and adaptive action is structural rather than behavioural, shaped by institutional incoherence and communication inequities. This observation provides the analytical foundation for the diagnostic synthesis that follows.

4.1.5. Summary Insights & Implications

Convergence and Divergence Patterns

Across quantitative and qualitative evidence, a high degree of convergence exists between treatment and control groups in demographic and exposure characteristics, validating the integrity of the quasi-experimental design. Both groups report comparable HH size, age of HH head, gender composition, and exposure to glacier-related hazards such as GLOFs and flash floods. Mean differences and SMD (< 0.25) across these baseline variables confirm demographic and exposure equivalence.

However, divergence is notable in preparedness, governance, and gender and social inclusion. Control areas exhibit higher readiness in evacuation planning (52% vs. 30%; $p = 0.00$) and emergency-supply maintenance (3.12 vs. 2.67; $p = 0.01$), likely reflecting prior engagement with district-level DRM campaigns. Conversely, treatment communities outperform in early-warning receipt (42% vs. 24%; $p = 0.00$) and awareness of emergency hotlines (18% vs. 9%; $p = 0.02$), suggesting early project penetration or stronger community linkages. FGDs reaffirm these quantitative contrasts with treatment HHs showing higher information exposure but weaker operational preparedness. Governance indicators also diverge: while treatment sites show greater participation in community meetings (37% vs. 22%; $p = 0.00$), trust in local decision-making is markedly lower (0.14 vs. 0.42; $p = 0.00$).

Divergences emerge in gendered participation with women in Shigar, Bahrain, and Talidas consistently reporting exclusion from drills and decision forums, a gap quantitatively echoed in low inclusiveness and governance indices.

Identified Gaps & Calls

The preceding synthesis confirms that deficiencies in coordination and inclusion are structural rather than behavioural, requiring diagnostic unpacking across institutional, gendered, and behavioural dimensions.

a) Preparedness and Institutional Readiness Deficit: HH-level contingency planning remains weak, and community drills or designated evacuation shelters are largely absent. The evidence indicates a structural gap between awareness and operational readiness, driven by limited district coordination and inadequate maintenance of early-warning hardware.

b) Gendered Information and Participation Asymmetry: Although hazard exposure is comparable across genders, women continue to receive information indirectly and seldom participate in decision-making. FGDs reveal their engagement to be predominantly post-disaster and domestic in scope. These findings underline the need to institutionalize women's participation in preparedness structures rather than treating it as ad hoc community support.

c) Awareness-Action Disconnect: Despite high awareness of glacial hazards, communities demonstrate low self-efficacy in responding to them. The disparity between cognitive understanding and behavioural practice is pronounced, suggesting the requirement for sustained behavioural-change communication and participatory learning to convert awareness into preparedness.

Additionally, infrastructural vulnerabilities, such as the absence of sirens, emergency stores, and accessible shelters for PWDs, and the elderly remain pervasive and heighten exposure during extreme events. Addressing these gaps will be central to measuring subsequent programmatic gains in inclusivity and institutional resilience.

Readiness for Causal Attribution

Statistical diagnostics confirm strong baseline equivalence across most demographic and exposure indicators (SMD < 0.1), establishing a credible foundation for causal attribution during endline. Minor imbalances exist in dimensions where treatment areas already display higher early-warning exposure and community participation, potentially reflecting early sensitization effects. However, since the magnitude of these differences remains below the conventional SMD threshold of 0.25 for baseline imbalance, the overall comparability of treatment and control remains intact.

In practical terms, Component 1 (Cryosphere) is methodologically ready for DiD and ANCOVA-based impact estimation at midline. The balanced demographic and exposure variables ensure internal validity, while identified divergences (preparedness, governance, inclusion) provide meaningful outcome indicators to track change attributable to project interventions.

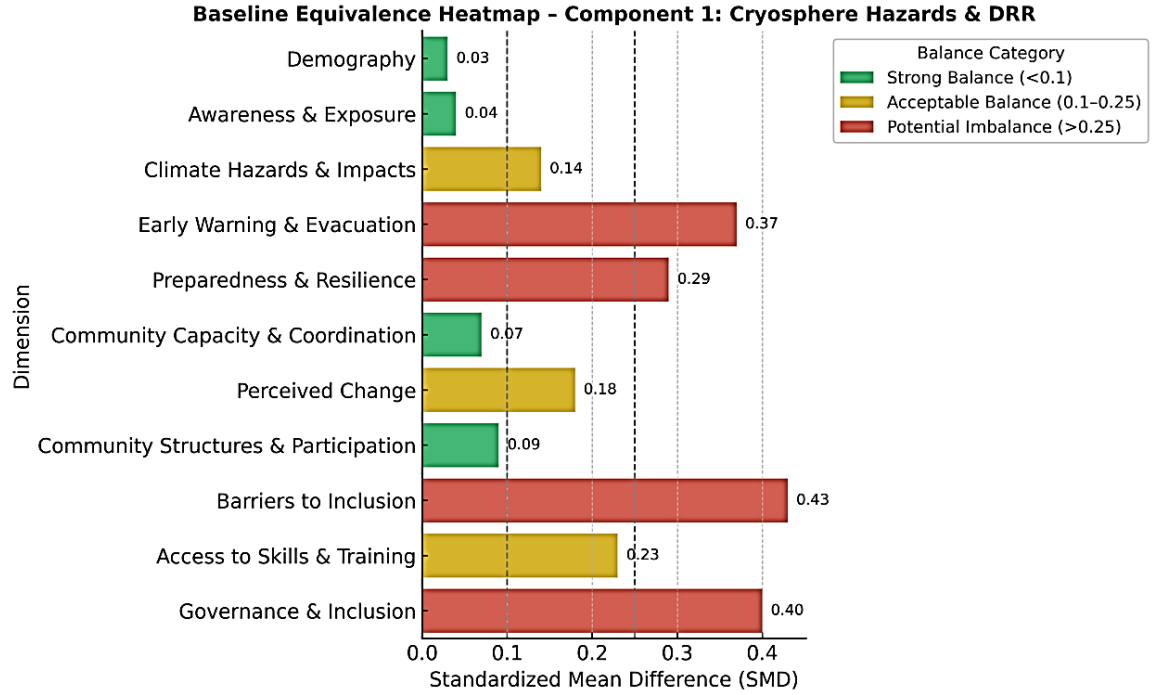


Figure 4: Baseline Statistical Equivalence across all Dimensions

This heatmap visualizes the SMDs across 11 cryosphere-resilience dimensions, comparing treatment and control groups. Green indicates strong balance (SMD < 0.1), yellow reflects acceptable balance (0.1-0.25), and red denotes potential imbalance (> 0.25). Figure 3 confirms that baseline equivalence has been achieved in most dimensions, validating the quasi-experimental comparability required for future impact attribution.

Component 1: Village Profile Snapshots
Detailed, component-wise village profile snapshots are available through the following link, which grants access to the relevant drive folder for further reference and analysis:
https://docs.google.com/spreadsheets/d/1egfeJD91uKLu2t6spacKo6oFVadF4SbD/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

4.1.6. Recommendations

The baseline analysis confirms that cryosphere-exposed districts in GB and northern KP exhibit heightened awareness, yet insufficient adaptive readiness. Consistent with Outcome 1 of the Results Framework, these findings underscore the imperative of integrating cryosphere-risk governance within provincial and district DRR structures.

In alignment with **Output 1.1**, institutional reforms are required to operationalize structured communication protocols between PDMA, GBDMA, and the Met Department, enabling localized interpretation and relay of hazard forecasts. The baseline's observed absence of formal data-sharing procedures validates this institutional gap.

Under **Output 1.2**, the empirical evidence reveals that community-based EWS remain nascent and rarely inclusive. Youth volunteers and PWDs face significant accessibility and communication barriers during hazard alerts. Embedding inclusive design principles in CB-MEWS, such as multi-channel dissemination and assisted evacuation mechanisms, would directly strengthen the operationalization of this output.

Consistent with **Output 1.3**, the findings confirm that preparedness remains largely event-driven rather than institutionalized. Community DRR committees exhibit weak gender and age representation. Establishing youth-led hazard-monitoring cells, complemented by a minimum 33% representation of women, youth and PWDs in DRR forums, will institutionalize inclusive preparedness.

Collectively, these empirically derived recommendations reinforce the **Outcome 1** pathway by translating baseline evidence into actionable measures for policy harmonization, inclusive early-warning architecture, and community-driven adaptive learning.

4.1.7. Implications for Outcome 1 Monitoring: Proposed Measurable Indicators

To operationalize the above strategic recommendations and convert the broad framing of Outcome 1 into a measurable impact pathway, the following specific and baseline-grounded Outcome 1 indicators are proposed for midline and endline evaluation:

a) Proportion of households receiving verified early warning messages prior to hazard onset
   Baseline: 42% (treatment)
b) Proportion of households with accurate knowledge of emergency contact numbers
   Baseline: 18% (treatment)
c) Proportion of households reporting equal access to early warning information for women, elderly, and persons with disabilities
   Baseline: 33% (treatment)
d) Proportion of households with a documented or practiced evacuation plan
   Baseline: 30% (treatment)
e) Mean household emergency-supply readiness score (food, water, medicines, shelter materials)
   Baseline: 2.67 (treatment)
f) Proportion of communities with at least one safe, accessible evacuation shelter
   Baseline: 17% (treatment)
g) Proportion of villages with functional, trained, and inclusive Community-Based Disaster Management Committees (CBDMCs)
   Baseline: Largely informal and inactive (qualitative)
h) Proportion of women, youth, and persons with disabilities represented in DRR committees (minimum 33%)

Baseline: Tokenistic or absent (qualitative)

i) Proportion of households that acted upon an early warning message during the most recent hazard event
Baseline: 34% (treatment)

j) Mean perceived community resilience score (1–5 scale)
Baseline: 0.31 (treatment)

4.2. Component 2: Springshed Revival and Management Baseline

Springs constitute a critical lifeline for domestic and productive water supply across large parts of Khyber Pakhtunkhwa's mid- and upper-elevation landscapes. Accelerated land-use change, deforestation, erratic precipitation regimes, and unmanaged abstraction have progressively degraded springshed recharge systems, resulting in seasonal drying of springs, declining water quality, and heightened household water insecurity. These pressures are further compounded by weak institutional coordination and gendered inequities in water access and governance.

Within SAFER Pakistan, Component 2 operationalizes **Outcome 2**, which seeks to increase access to spring water in a climate-adaptive and gender-inclusive manner. Accordingly, the baseline establishes pre-intervention conditions across three interlinked analytical domains:

i. hydro-ecological status of springs and recharge zones;
ii. household water access, quality, and seasonal reliability; and
iii. institutional and community governance of springshed systems.

Quantitative analysis follows the Phase-in quasi-experimental design comparing Batch 1 (treatment) and Batch 2 (control) communities, triangulated with qualitative evidence from FGD and KII across Swat, Lower Dir, Abbottabad, and Mardan.

Objectives and Results-Framework Alignment

Component 2 is aligned with **Outcome 2:** Increased access to spring water in a climate-adaptive and gender-inclusive manner**.** The baseline assesses key outcome indicators related to household-level reliability of spring water, equity of access, and functionality of governance arrangements.

At the output level, the component contributes to:

Output 2.1: A comprehensive web-based information management system of springsheds prepared;
Output 2.2: Recharge measures co-developed and implemented;
Output 2.3: Local governance frameworks for springsheds established with enhanced institutional capacity.

4.2.1. Sampling Framework

The statistical design, stratification logic, and treatment–control allocation procedures are formally defined in Chapter 3. This subsection therefore specifies only the spatial application of that standardized framework for springshed landscapes**.**

Target springshed sites were drawn from proposal-approved locations and technically validated during baseline inception in consultation with ICIMOD. Micro-level settlement pairing was refined to ensure hydrological comparability, treatment–control separation, and feasibility for longitudinal measurement.

Under Component 2, a total of 623 households were surveyed, supported by 18 Focus Group Discussions and 18 Key Informant Interviews**,** ensuring robust hydro-social and institutional triangulation.

(Detailed respondent characteristics have been provided in Annex 2.)

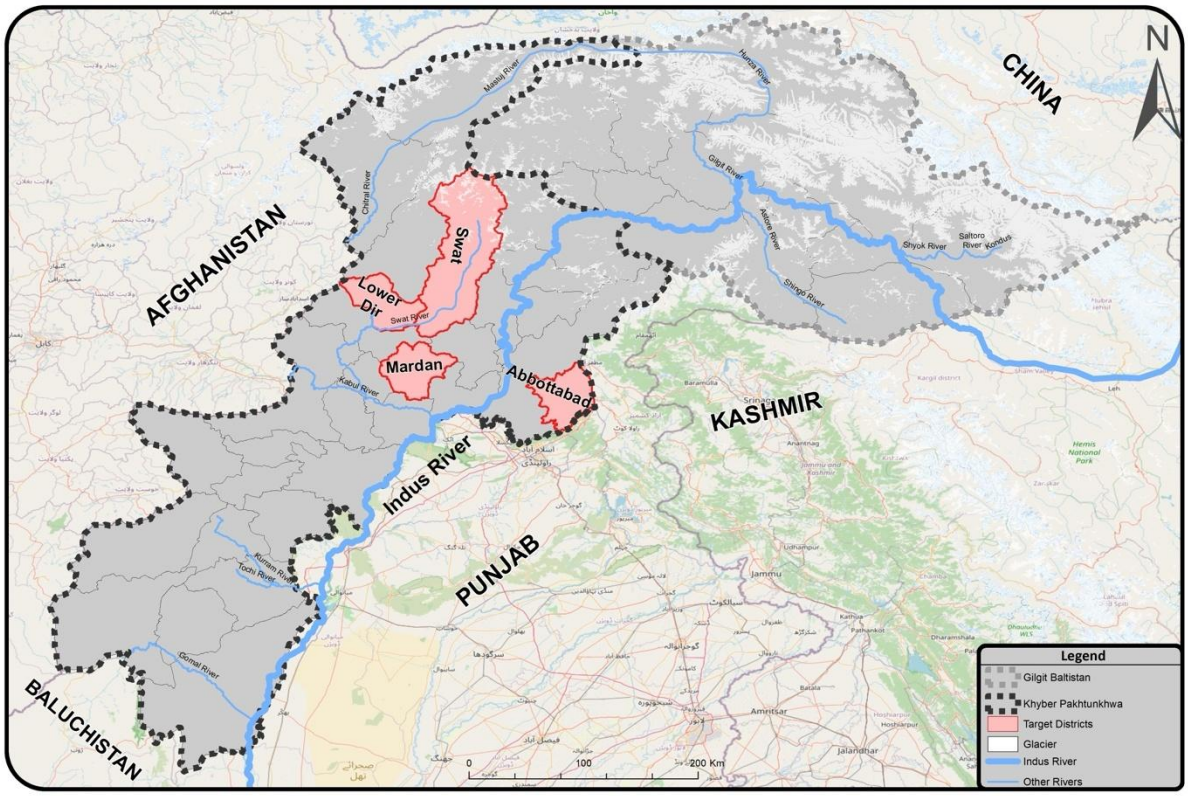


Figure 5: Map of Springshed Revival Sample Villages and Hydro-ecological Zones

4.2.2. Baseline Findings

Comparative Mean Scores Across Springshed-Resilience Dimensions

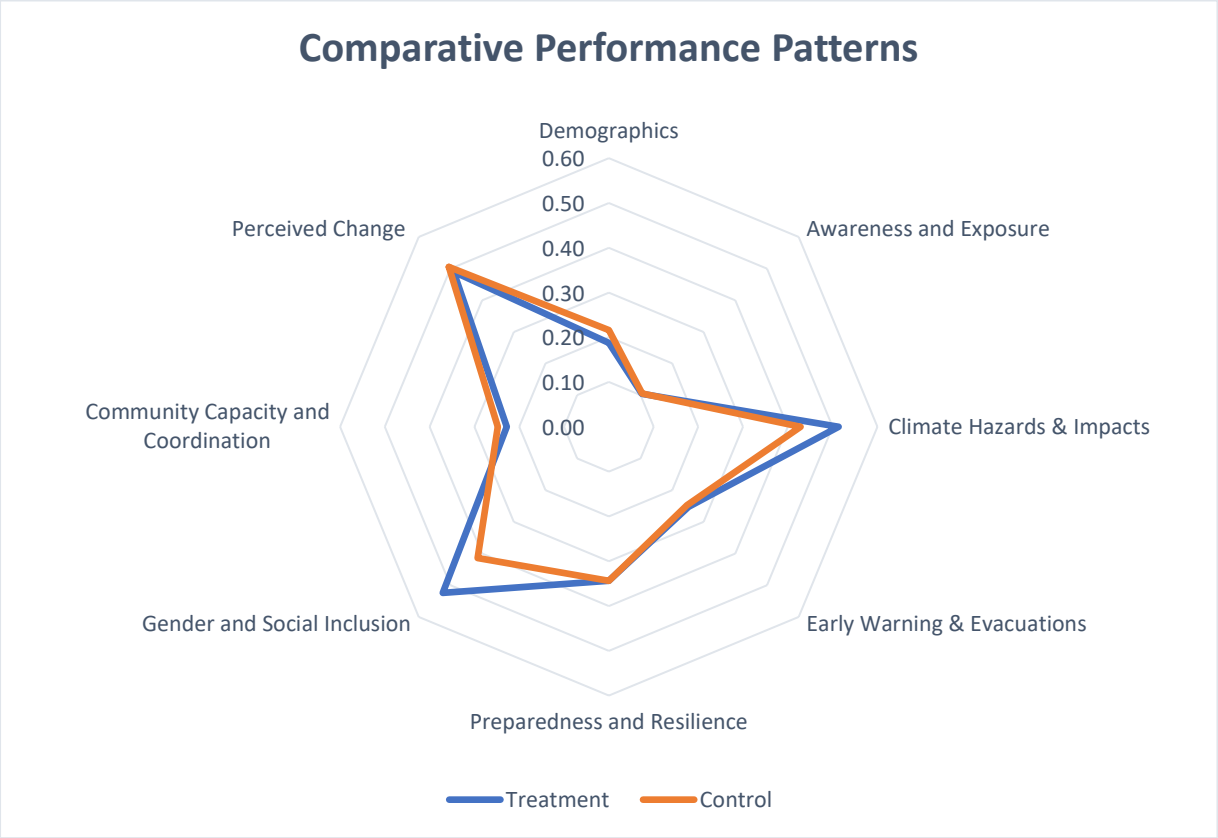


Figure 6: Comparative Baseline Assessment of Springshed Resilience (Treatment vs. Control)

Interpretation: Comparative Diagnostic Profile of Springshed Resilience (Treatment vs. Control)

The radar chart provides a comparative overview of treatment and control communities across eight key dimensions of springshed resilience, offering a visual validation of baseline equivalence under the quasi-experimental design. Both groups display a closely aligned structural profile, particularly across demographics, awareness, and exposure indicators, confirming that the pre-intervention landscape is balanced and statistically comparable. This alignment ensures methodological integrity for assessing project-induced changes in water security and springshed restoration capacity.

While the overall symmetry of the radar polygons reinforces baseline equivalence, subtle yet analytically important divergences emerge. The treatment group exhibits higher mean scores in Climate Hazards & Impacts (0.51 vs. 0.43) and Gender & Social Inclusion (0.52 vs. 0.41), suggesting that communities within intervention zones have begun to internalize the discourse on environmental stress and inclusive participation introduced through preliminary

sensitization and mobilization processes. These early gains, though modest, reflect emerging institutional engagement with water governance and community-led restoration priorities.

In contrast, the control group demonstrates slight advantages in Perceived Change (0.51 vs. 0.49) and Community Coordination (0.25 vs. 0.23), implying residual resilience capacities built through prior NGO or district-level watershed management initiatives. These differences, while not statistically significant, underscore the importance of strengthening collective mechanisms for the maintenance of water infrastructure and equitable access to revived springs.

From a programmatic perspective, the radar pattern underscores both opportunity and constraint. The observed parity in Preparedness & Resilience and Early Warning & Evacuations (both 0.34 and 0.25) indicates a uniform lack of structured response systems, highlighting an urgent need for hydro-meteorological early warning linkages, community-based spring monitoring, and climate-informed resource planning. Furthermore, the lagging scores in community coordination reveal institutional fragmentation that may impede long-term aquifer restoration unless addressed through capacity building and inclusive decision-making frameworks.

Overall, the radar profile confirms a methodologically balanced yet contextually diverse baseline, establishing a strong foundation for causal attribution at midline. In the future, the SAFER Pakistan Springshed Revival Component must prioritize women's leadership in spring management committees, capacity strengthening in groundwater recharge mapping, and integration of traditional knowledge with scientific monitoring systems. Improvements in these weaker domains will serve as pivotal indicators of adaptive hydrological governance, marking the transition from reactive water use to proactive ecosystem restoration.

Operational Definition of Radar Chart Variables

The radar chart is constructed using eight composite indices derived from standardized household-level baseline survey variables. Each axis represents a normalized score on a 0–1 scale, generated through aggregation of multiple sub-indicators using equal-weight indexing unless otherwise specified.

1. **Demographics**
   This index captures the structural characteristics of surveyed households, including household size, dependency ratio, gender composition, education level of household head, age structure, and primary livelihood typology. It provides the socio-economic baseline context that shapes both vulnerability and adaptive capacity.
2. **Awareness and Exposure**
   These variable measures household knowledge of climate-related hazards, past exposure to hazardous events, awareness of hazard triggers, risk perception, and recognition of early warning signals. It reflects both experiential exposure and cognitive risk awareness at the community level.
3. **Climate Hazards and Impacts**

This index quantifies the frequency, severity, and consequences of experienced hazards, including housing damage, loss of agricultural land or livestock, disruption of water supply, access constraints, and health impacts attributable to climate-related events.

4. **Early Warning and Evacuations**
   This variable assesses household access to warning information, timeliness and reliability of alerts, knowledge of evacuation routes, existence of evacuation plans, and participation in mock drills or community response exercises.
5. **Preparedness and Resilience**
   This index captures household-level readiness and adaptive capacity, including availability of emergency kits, food and water storage, shelter preparedness, coping strategies, diversification of livelihoods, and post-disaster recovery capacity.
6. **Gender and Social Inclusion**
   These variable measures the degree of participation of women and marginalized groups in preparedness activities, access to information, leadership roles in community structures, decision-making processes, and equitable access to disaster response resources.
7. **Community Capacity and Coordination**
   This index assesses inter-household and inter-village coordination mechanisms, communication efficiency during emergencies, presence of organized response structures, linkages with district institutions, and collective action capacities.
8. **Perceived Change**
   This variable captures households' subjective assessment of change in safety, preparedness, institutional responsiveness, service delivery, and overall disaster risk reduction conditions over recent years.

4.2.3. Detailed Interpretation of Dimensions (Quantitative & Qualitative)

A: Demographics and Other Baseline Indicators

Table 12: Baseline Equivalence between Treatment and Control Groups across Key Indicators

Indicator	Treatment (n = 1260)	Control (n = 840)	Mean/% Diff	t / χ^2	p-value	Interpretation
Mean HH size	8.67 (±4.34)	8.90 (±4.41)	−0.23	−0.50	0.62	No difference
Mean age of HH head (years)	38.78 (±14.28)	40.00 (±15.55)	−1.22	−0.78	0.44	Comparable
Female-headed HHs (%)	16.1	30.0	−13.9	4.16	0.04	Significant difference
Education of HH head (mean years/level)	2.80 (±1.38)	2.45 (±1.45)	+0.34	2.31	0.02	Significant difference
Main income source (most common category)	4.79 (±1.41)	3.57 (±1.84)	+1.22	7.24	0.00	Significant difference

Main water source (most common category)	3.84 (±3.04)	4.29 (±2.40)	−0.44	−1.50	0.13	No difference
Improved toilet facility (%)	2.49 (±1.27)	3.20 (±1.71)	−0.70	−4.46	0.00	Significant difference
Water source available year-round (%)	0.46 (±0.50)	0.38 (±0.49)	+0.08	1.57	0.12	No difference
Community participation belief (mean, 1-5)	2.15 (±1.20)	2.72 (±1.33)	−0.57	−4.32	0.00	Significant difference
Coordination mechanism exists (%)	0.27 (±0.44)	0.23 (±0.42)	+0.03	0.70	0.48	No difference
Trained Operation and Maintenance (O&M) team exists (%)	0.06 (±0.25)	0.09 (±0.29)	−0.03	−1.03	0.30	No difference

Survey results show no meaningful differences in average HH size (8.67 vs. 8.90; p=0.62) or age of HH head (38.78 vs. 40.00; p=0.44), supporting baseline comparability for subsequent causal analysis. Notable divergences include a higher share of female-headed HHs in control areas (30% vs. 16%; p=0.04) and higher education of HH heads in treatment sites (mean diff +0.34; p=0.02). Improved toilets are less common in treatment (mean diff −0.70; p<0.001), a hygiene gap that could amplify water-borne disease risks. “Main income source” differs markedly (mean diff +1.22; p<0.001), hinting at structural livelihood differences that may shape willingness to invest time/money in spring protection. Perceptions of community participation are higher in control (2.72 vs. 2.15; p<0.001), though the existence of coordination or O&M teams is statistically similar.

Qualitative triangulation

FGDs from Banda Jaggian, Nathiagali, and Timergara confirm heavy time burdens to fetch water (25-35 minutes, often by women/children) and declining spring discharge due to drought and pollution, with limited government engagement, factors that align with the sanitation and participation gaps observed quantitatively. These qualitative findings corroborate the quantitative evidence of persistent sanitation deficits and low community participation in water governance. Addressing these structural constraints requires the integration of gender-responsive WASH infrastructure, the implementation of pollution control measures around spring catchments, and the establishment of coordinated community management mechanisms to ensure sustainable recharge and revival of groundwater systems.

B: Awareness and Exposure

Table 13: Springshed Awareness and Exposure

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Main Source of water	3.84 (3.04)	4.29 (2.40)	-0.44	0.12	-0.16
Water source available year-round	0.46 (0.50)	0.38 (0.49)	0.08	0.12	0.17
Nearest source (distance in minutes)	15.19 (15.15)	12.96 (11.47)	2.23	0.11	0.16
Responsibility to collect water	1.63 (0.81)	1.57 (0.79)	0.05	0.52	0.07
Lead line handpumps	0.18 (0.38)	0.13 (0.33)	0.05	0.17	0.14
Use of Lead Line handpumps	0.80 (0.40)	0.72 (0.45)	0.08	0.10	0.20
Maximum distance to handpump	9.22 (9.26)	10.14 (11.69)	-0.92	0.47	-0.09
Faced shortages	0.29 (0.45)	0.20 (0.40)	0.09	0.05	0.21
Average monthly cost for shortage	6508.18 (10347.69)	3471.43 (2171.34)	3036.75	0.04	0.36
Toilet facility type	2.49 (1.27)	3.20 (1.71)	-0.70	0.00	-0.48

Distance and time to water sources are modest but not balanced in cost burden: treatment HHs report more frequent shortage-related purchases (29% vs. 20%; p=0.05) and much higher monthly outlays when shortages occur (PKR 6,508 vs. 3,471; p=0.04; SMD=0.36). Willingness to adopt lead-line/handpump connections trends higher in treatment areas (0.80 vs. 0.72; p=0.10), suggesting demand for simple access innovations. Toilet type is significantly poorer in treatment (mean diff −0.70; p<0.001), reinforcing exposure to contamination.

Qualitative triangulation

FGDs corroborate these patterns: 30-35 minutes time to collect water in Nathiagali; unsafe routes and open drainage in Timergara; and children's time lost and accident risks in Barham Patai, each pointing to exposure mechanisms beyond mere source distance (pollution, reliability, and safety). Programmatically, pair low-cost distribution improvements (lead-lines, protected standpoints) with sanitation upgrades and waste control near springs, where HHs already spend cash during shortages, micro-finance for storage and filtration, may be highly acceptable.

C: Climate Hazards and Impacts

Table 14: Springshed Climate Hazard and Impacts

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Observed erratic rain	0.72 (0.45)	0.38 (0.49)	0.34	0.00	0.73
Community droughts in the last 10 years	0.92 (0.27)	0.70 (0.46)	0.22	0.00	0.58
Droughts reduce supply	0.89 (0.31)	0.71 (0.45)	0.18	0.00	0.46

Floods damaged facilities	0.52 (0.50)	0.39 (0.49)	0.14	0.01	0.28
Floods/droughts increased hardship	0.84 (0.37)	0.63 (0.49)	0.22	0.00	0.50
Reasons for hardship	1.38 (0.78)	1.23 (0.61)	0.15	0.08	0.21
Water quality in the past 12 months	2.30 (0.50)	2.41 (0.55)	-0.10	0.07	-0.20
Toilets available during hazards	0.82 (0.39)	0.68 (0.47)	0.14	0.00	0.33
Alternative toilet used	2.03 (0.87)	1.77 (0.78)	0.25	0.16	0.31
Are marginalized groups at risk?	0.30 (0.46)	0.23 (0.42)	0.07	0.12	0.16
Unsafe water leading to illness in the last 2 weeks	0.60 (0.49)	0.44 (0.50)	0.16	0.00	0.32
Illness types in the last 2 weeks	1.66 (1.17)	1.56 (1.10)	0.11	0.54	0.09

Survey findings reveal a consistently higher exposure of treatment communities to climate-related shocks, particularly erratic rainfall, prolonged droughts, and spring-fed system damage. Nearly 72% of treatment HHs reported unpredictable rainfall compared with 38% in control ($p < 0.001$; SMD = 0.73). Drought occurrence within the last decade reached 92% in treatment versus 70% in control ($p < 0.001$), and 89% of treatment respondents experienced reduced water supply due to drought compared with 71% in control ($p < 0.001$). Moreover, 52% of treatment HHs noted flood damage to water facilities against 39% in control ($p = 0.01$). The cumulative hardship index, capturing livelihood stress, food insecurity, and income loss was also significantly higher among treatment HHs (0.84 vs 0.63; $p < 0.001$), reflecting deeper vulnerability.

Qualitative triangulation

In FGDs conducted at Banda Jaggian, Nathiagali, and Timergara, communities vividly recounted springs drying earlier each year, contamination by wastewater and garbage, and hillside erosion undermining intake points. Women described increased time spent collecting water during drought periods, while men reported crop loss and declining livestock health. Collectively, these narratives substantiate the quantitative findings, demonstrating that hydrological stress is both acute and deeply gender-differentiated, reflecting systemic ecological decline intertwined with social vulnerability.

D: Early Warning and Evacuation (Water Security)

Table 15: Springshed Early Warning and Evacuation

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Received early warning	0.17 (0.38)	0.19 (0.39)	-0.02	0.65	-0.05
Early warning source (if received)	3.43 (1.29)	3.31 (1.26)	0.12	0.64	0.09

Who receives early warning alert in HH	1.58 (0.99)	1.52 (1.10)	0.06	0.62	0.06
Equal access to EWS	0.54 (0.50)	0.42 (0.50)	0.12	0.02	0.24
Knowledge of emergency water points	0.58 (0.50)	0.50 (0.50)	0.08	0.12	0.16
Evacuation routes have safe water	0.42 (0.50)	0.35 (0.48)	0.07	0.16	0.14
Trust in EWS	2.38 (1.42)	2.59 (1.64)	-0.21	0.18	-0.14
Acted on early warning	0.21 (0.41)	0.25 (0.43)	-0.04	0.36	-0.10

Receipt of water-related early warning messages remains consistently low across both groups, with only 17% of treatment and 19% of control HHs reporting any prior alerts. Trust in the effectiveness of EWS is equally modest, averaging 2.38 versus 2.59, suggesting a general skepticism toward institutional communication. The only statistically significant variation favors treatment communities, where 54% perceive equal access to alerts compared with 42% in control ($p = 0.02$; SMD = 0.24). Despite this advantage, actual behavioural response rates remain low (21% vs. 25%), underscoring a classic gap between awareness and action. Knowledge of emergency water points is somewhat higher in treatment sites (58% vs. 50%), yet this information seldom translates into preparedness action.

Qualitative triangulation

FGDs from Talash, Timergara, and Banda Jaggian revealed that alerts are typically conveyed through mosque loudspeakers or word-of-mouth, often failing to reach women, PWDs, and remote hamlets. Communities emphasized the lack of standardized warning protocols and safe, accessible evacuation routes. These findings call for institutionalizing localized, inclusive EWS, integrating solar-powered sirens, mobile SMS alerts, and women and youth-led dissemination networks to transform awareness into timely collective action.

E: Preparedness and Resilience (Recharge, Safety, Testing)

Table 16: Springshed Preparedness and Resilience

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Heard of groundwater recharge	0.18 (0.38)	0.15 (0.36)	0.03	0.42	0.08
Community established recharge	0.04 (0.20)	0.10 (0.30)	-0.06	0.02	-0.23
Recharge functioning (if established)	0.67 (0.48)	0.56 (0.51)	0.11	0.42	0.23
HH received training on safe water	0.04 (0.20)	0.07 (0.26)	-0.03	0.18	-0.13

Vulnerable participation in training	0.02 (0.15)	0.04 (0.20)	-0.02	0.28	-0.11
Knows emergency water contacts	0.08 (0.28)	0.12 (0.33)	-0.04	0.19	-0.13
Community tested water in last 12 months	0.28 (0.45)	0.23 (0.42)	0.05	0.27	0.12
Community test results (if tested)	2.21 (0.73)	2.11 (0.46)	0.10	0.41	0.16

Awareness of groundwater recharge is low (18% vs. 15%; ns) in both treatment and control groups. Crucially, communities with established recharge systems are more common in control areas (10% vs. 4%; p=0.02), although reported functionality (where they exist) is similar. Trainings on safe water and participation of vulnerable groups in training are minimal in both groups (≤7%; ns). Water testing in the last 12 months is moderate and comparable (28% vs. 23%; ns); reported test outcomes trend worse in treatment (higher "unsafe/don't know"; ns).

Qualitative triangulation

FGDs conducted in Banda Jaggian, Nathiagali, and Talash reveal a consistent pattern of institutional neglect and community-level vulnerability in groundwater and spring management. Despite recurrent contamination incidents and visibly declining water quality, no structured recharge interventions have been implemented to restore aquifer capacity or protect water sources. The discussions further indicate an absence of systematic hygiene training and a pervasive lack of water-testing culture, where HHs rely on sensory observation rather than empirical assessment to determine water safety. This behavioural dependency, compounded by limited technical awareness and institutional disengagement, perpetuates a cycle of reactive rather than preventive water management.

The empirical evidence underscores the necessity of transitioning from ad hoc coping strategies to an integrated, evidence-based recharge and water-safety framework. Strategic interventions should prioritize the establishment of pilot recharge infrastructures, such as percolation pits, contour trenches, and check dams, within upstream catchments to enhance infiltration and stabilize spring discharge. Parallel to these structural measures, the introduction of community-led water monitoring systems, utilizing simplified field-testing kits and periodic data logging, would institutionalize a culture of participatory surveillance. Moreover, gender and youth-inclusive training programs focusing on safe storage, chlorination, and post-flood purification protocols are essential to embedding long-term behavioural transformation. Collectively, these measures represent a paradigm shift from remedial responses toward anticipatory and adaptive water governance, anchoring local resilience within a scientifically informed and socially inclusive framework.

F. Gender and Social Inclusion

Table 17: Springshed Gender and Social Inclusion

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Women/youth represented in committees	0.04 (0.19)	0.05 (0.22)	-0.01	0.65	-0.05
Formal decision-making power in committees	0.83 (0.39)	0.50 (0.53)	0.33	0.03	0.71
Ability to propose agenda	0.50 (0.53)	0.33 (0.52)	0.17	0.38	0.33
Recommendations acted upon	0.83 (0.39)	0.67 (0.52)	0.16	0.33	0.36
Meetings scheduled at convenient times	0.05 (0.22)	0.11 (0.31)	-0.06	0.03	-0.22
Cultural/social barriers	0.37 (0.48)	0.49 (0.50)	-0.12	0.03	-0.24
Risks of Gender-based Violence (GBV) when accessing water	1.18 (1.32)	1.31 (1.41)	-0.13	0.41	-0.10

Women and youth remain critically underrepresented in local water governance structures across both groups, with only 4-5% of HHs reporting their participation in community water committees. Within this small subset, however, women in treatment areas exhibit greater formal decision-making authority (mean 0.83 vs. 0.50; $p = 0.03$; SMD = 0.71), suggesting that emerging programmatic sensitization is beginning to challenge traditional male dominance. Meeting convenience remains a key constraint with sessions in treatment sites less suitably timed (5% vs. 11%; $p = 0.03$) implying logistical, rather than purely cultural barriers to women's involvement. Interestingly, perceived social restrictions are lower in treatment communities (37% vs. 49%; $p = 0.03$), hinting at a gradual normative shift.

Qualitative triangulation

FGDs from Talash, Babozai, Nathiagali, and Timergara reinforce these quantitative findings. Women described exclusion from decision-making forums, lack of information on meeting schedules, and safety concerns traveling after dark. Many expressed willingness to participate if meetings were held during daylight and near their HHs. Men also acknowledged the value of women's perspectives on water quality, sanitation, and HH-level conservation.

G. Community Capacity and Coordination

Table 18: Springshed Community Capacity and Coordination

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Community participation (Likert 1-5)	2.18 (1.31)	2.71 (1.44)	-0.53	<0.001	-0.39

Trained O&M team exists	0.09 (0.29)	0.12 (0.33)	-0.03	0.38	-0.10
Water source uses solar power	0.05 (0.22)	0.14 (0.35)	-0.09	0.002	-0.31
Coordination exists	0.25 (0.43)	0.18 (0.38)	0.07	0.09	0.17

Perceived community participation is higher in control (2.71 vs. 2.18; $p<0.001$; SMD=−0.39), and solar-powered water sources are more common there (14% vs. 5%; $p=0.002$), suggesting greater collective investment and technology adoption. Coordination mechanisms trend higher in treatment (25% vs. 18%; $p=0.09$), and trained O&M teams are scarce in both groups (≤12%; ns).

Qualitative triangulation

FGDs conducted in Barham Patai and Timergara reveal that community water management systems remain institutionally fragile, characterized by inactive committees, minimal technical oversight, and the prevalence of open waste disposal practices near water sources. Similarly, in Banda Jaggian and Nathiagali, local governance mechanisms rely predominantly on *Jirga*-based conflict resolution frameworks that, while socially legitimized, lack formal integration with municipal or regulatory structures. These informal systems offer limited youth participation and fail to enforce environmental safeguards, particularly regarding waste and hotel effluent management in spring catchments. The cumulative evidence reflects a governance vacuum wherein social norms substitute for institutional accountability, perpetuating unsustainable management of shared water resources.

To address these systemic deficiencies, the evidence underscores the need to institutionalize community-based water user committees with clearly defined mandates for operation and maintenance, financial oversight, and regulatory compliance. Introducing solar-powered upgrades for pumping and distribution systems, particularly in areas demonstrating cost-recovery potential, would enhance service reliability and reduce recurrent expenditures. Furthermore, the formal codification of local bylaws governing waste disposal, wastewater effluent, and pollution control near springs is imperative to transforming informal norms into enforceable governance instruments. Collectively, these measures would advance a transition from socially mediated resource management toward formalized, accountable, and sustainable water governance frameworks anchored in both community ownership and institutional legitimacy.

H. Perceived Change and Support Needs

Table 19: Springshed Perceived Change and Support Needs

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Water access change (10 years, 1-5)	2.48 (0.86)	2.75 (0.85)	-0.27	0.005	-0.32
More resilient than 5 years ago (0/1)	0.21 (0.41)	0.26 (0.44)	-0.05	0.28	-0.12

Control communities report more positive change in water access over 10 years (2.75 vs. 2.48; p=0.005), while self-assessed resilience remains low and statistically similar (21-26%; ns). Open-ended responses reveal treatment narratives of shortage, poor management, and climate stress, versus control narratives of improved infrastructure, training, and emergency systems.

Qualitative triangulation

FGDs reaffirm these contrasts, revealing a clear articulation of community priorities centered on both infrastructural and institutional reforms. Participants consistently emphasized the need for protected intake structures, additional storage tanks, filtration units, regulated commercialization of water access, and the construction of recharge pits and check dams. These demands were accompanied by repeated appeals for sustained leadership from government agencies and NGOs, as well as the establishment of inclusive and gender-responsive water committees to oversee operation, maintenance, and accountability mechanisms.

Within this empirical context, the component's strategic orientation must integrate *hardware* and *software* dimensions of resilience building. Structural interventions, such as intake protection, filtration systems, and storage expansion, should be systematically paired with institutional strengthening through capacity-building initiatives, community-based EWS for water scarcity, and participatory accountability frameworks. The perceptual asymmetry observed between service providers and end users underscores that technical improvements alone will not suffice. Sustainable impact will depend on cultivating trust through visible and reliable service delivery, transparency in local decision-making, and active community participation in monitoring and feedback processes. Such an integrated approach would not only enhance operational efficiency but also embed principles of social inclusion and shared governance within local water management systems.

4.2.4. Triangulation through KIIs and Community Surveys

Institutional Insights (Governance & Systems)

Across KP, service delivery is still overwhelmingly tube-well centric with thin springshed planning. PHED Charsadda confirms 100% reliance on tube wells, falling water tables, no groundwater-level monitoring, and no recharge ponds or channel works to offset the decline.

TMA Charsadda runs 17 tube-wells (out of which only 9 are operational), has no formal coordination with PHED, no wastewater treatment, recharge ponds, or check dams, leaving systems exposed to floods and contamination.

In Nowshera, PHED reports gradual solarization and routine chlorination/quality tests, yet the area lacks any groundwater-level monitoring and has no ecosystem-based pilots (recharge/wetlands).

TMA Nowshera echoes the gaps, reiterating absence of recharge/flood-control ponds and EWS/evacuation plans, and weak inclusion mechanisms.

By contrast, Galiyat/Abbottabad retains an operational springs network (9 springs; 6 in Nathiagali), experiences 25% pre-monsoon shortages, uses basic monitoring (taps/tanks/filtration) and GIS mapping (Namli Maira), and showcases participatory practices (e.g., Thandiani scheme), while calling for a clear rainwater-harvesting policy.

NGOs provide scalable pathways: GEWO and SHAMA have piloted solar water schemes, small recharge ponds/check dams, and women-focused WASH committees, but face post-project O&M funding gaps and coordination delays.

Community-Level Validation (Survey Evidence)

Community surveys depict shrinking spring flows, unmanaged sources, and gendered burdens. In Banda Jaggian (Abbottabad), a single spring now supplies water approximately ~1 hour/week; no quality testing or recharge works exist; women/youth participation is low and terrain limits access for vulnerable groups.

In Nathiagali (Malach), four springs show reduced flows from deforestation, commercialization, and less snowfall; management is local but lacks recharge/monitoring, forcing women/children to walk 0.5 km over harsh terrain.

Mardan (Babozai-Katlang) reports declining flows over 10 years, no testing, and increased water-collection workloads despite some storage/piping efforts.

Lower Dir (Timergara & Talash) notes 10 springs dried/reduced, no recharge structures, 0% women/youth in committees, poor sanitation linkages to springs, and rising scarcity/disease risk with added burden on women and children.

Additional KIIs further highlight ground realities: PHED Swat flags flood-contamination episodes and tanker/generator stopgaps; as well as persistence of network issues.

Lower Chitral links cryosphere shifts to volatile flows, damaged channels, and urges Water-User Associations, storage, and EWS to lift adaptability from 4-5/10 to 7-8/10.

Integrated Synthesis & Implications

Triangulated institutional and community perspectives reveal a consistent pattern of awareness without structural institutionalization. Officials from PHED and TMAs describe short project cycles, limited monitoring of groundwater levels, and weak cross-departmental coordination, particularly between engineering, municipal, and environmental functions. Communities,

meanwhile, experience recurring scarcity and deteriorating water quality, which intensify women's and children's workloads and constrain access in mountainous catchments. FGDs from Galiyat, Banda Jaggian, and Timergara highlight informal coping mechanisms such as water sharing, local repair funds, and dependence on tanker supplies. The evidence collectively demonstrates that while awareness and technical familiarity exist, the absence of institutional continuity and inclusive management frameworks inhibits sustainable water-resource governance.

4.2.5. Summary Insights & Implications

Convergence / Divergence Patterns

The comparative baseline analysis shows strong convergence between treatment and control clusters across demographic, livelihood, and hazard-exposure variables, confirming baseline equivalence. Both groups rely primarily on rain-fed springs and shallow wells, with similar dependency ratios and income compositions. Mean preparedness and early-warning scores (0.34 vs 0.34; 0.25 vs 0.25) validate statistical parity.

Divergences, however, emerge in variables tied to adaptive consciousness. Treatment communities record higher sensitivity to climate hazards (0.51 vs 0.43) and greater gender-inclusion indices (0.52 vs 0.41), suggesting early outreach under SAFER Pakistan. Conversely, control sites display marginally higher coordination scores (0.25 vs 0.23) and perceived change (0.51 vs 0.49), reflecting legacy NGO watershed work. These contrasts confirm methodological robustness while identifying initial program penetration zones that can be tracked for midline effect measurement.

Identified Gaps and Programmatic Calls

The triangulated evidence identifies three structural deficits constraining springshed resilience:

1. Institutional Fragmentation: Absence of formal Water-User Associations results in irregular maintenance of recharge structures and inequitable distribution. Respondents attribute this to uncoordinated short-term projects that erode community ownership.

2. Gender and Youth Exclusion: Despite improved social acceptance, participation barriers persist through ill-timed meetings, mobility constraints, and limited facilitation capacity. These factors reinforce the under-representation of women and youth in decision-making forums.

3. Hydro-technical Vulnerability: High self-reported exposure to drought, floods, and contamination reflects declining ecosystem stability. Degraded catchments and silted recharge ponds indicate urgent need for integrated soil-and-water conservation planning.

Together, these diagnostics clarify that the challenge is systemic coordination and inclusion rather than community awareness, providing the analytical baseline for the normative actions presented in the subsequent recommendations.

Readiness for Causal Attribution (Baseline Equivalence)

The Baseline Equivalence Heatmap (Figure 6) illustrates overall symmetry between treatment and control means across the eight resilience dimensions.

Color intensity around the central parity line demonstrates that SMD values < 0.25 dominate most variables, confirming statistical balance and internal validity for subsequent causal attribution. Minor asymmetries in climate-impact perception and gender and social inclusion fall within acceptable thresholds and, rather than confounding the design, enhance evaluative sensitivity by establishing measurable variation for midline comparison.

The strong parity across core demographic and preparedness indicators ensures that any future difference in adaptive behavior, institutional performance, or spring discharge restoration can be confidently attributed to SAFER Pakistan's interventions rather than pre-existing disparities. The color intensity in below figure reflects mean variations; near-zero differences confirm statistical parity and validity of the quasi-experimental design baseline.

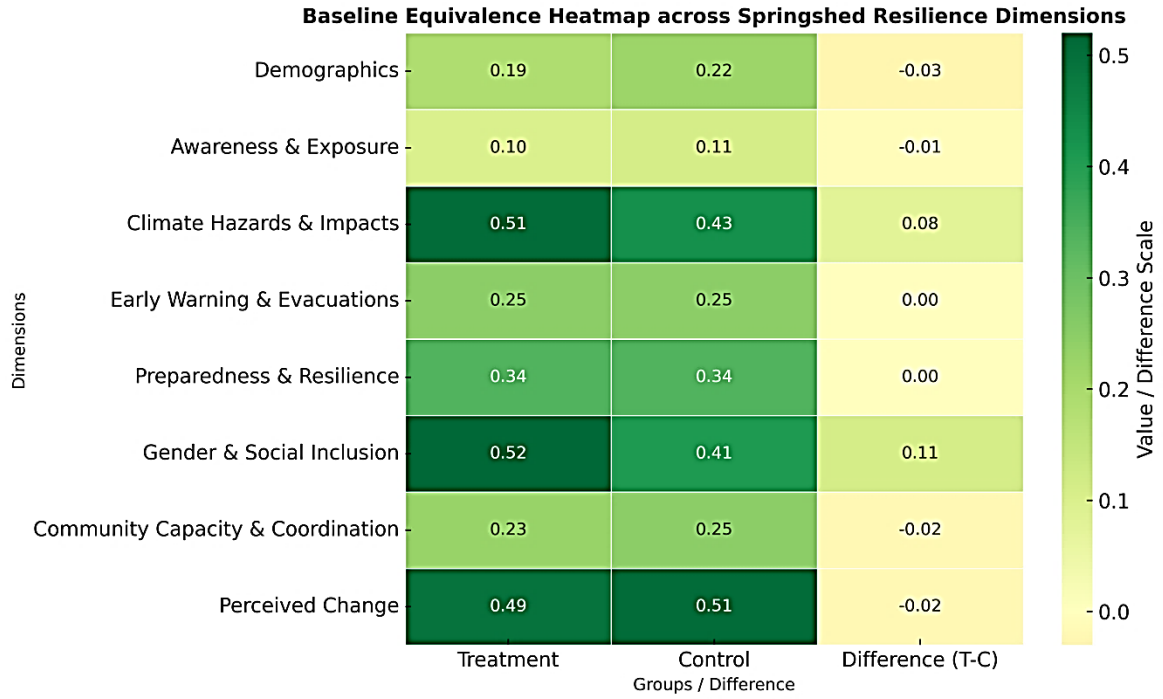


Figure 7: Baseline equivalence heatmap across springshed resilience dimensions

Component 2: Village Profile Snapshots
Detailed, component-wise village profile snapshots are available through the following link, which grants access to the relevant drive folder for further reference and analysis:
https://docs.google.com/spreadsheets/d/1ZGSu2c_Mghm2rucBh2CyJQwfSx45Rn5g/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

4.2.6. Recommendations

The baseline analysis confirms that springshed-dependent communities across KP exhibit chronic water stress, declining spring discharge, and weak institutional management despite strong community reliance on natural water sources. Consistent with Outcome 2 of the Results Framework, these findings underscore the imperative of transitioning from fragmented, ad-hoc water management to inclusive, data-driven, and institutionalized springshed governance systems.

In alignment with Output 2.1, institutional reforms are required to establish legally notified Springshed Management Committees (SMCs) within Union Council structures. The baseline's observed absence of coordinated operation and maintenance (O&M) teams and groundwater monitoring systems validates this institutional gap. Integrating participatory recharge mapping, groundwater-level monitoring, and GIS-based spring inventories through PHED–TMA coordination will directly strengthen this output.

Under Output 2.2, the empirical evidence reveals that women and youth, despite being primary water collectors, remain structurally excluded from decision-making. Formalizing gender-responsive bylaws, daylight meeting schedules, disability-inclusive participation, and leadership quotas within SMCs would directly operationalize inclusive water governance and address persistent participation asymmetries.

Consistent with Output 2.3, the findings confirm that recharge interventions remain sporadic, under-financed, and poorly maintained. Transitioning recharge ponds, percolation pits, and check dams from donor-driven pilots to co-financed, community-maintained assets embedded within district water budgets is essential for long-term sustainability.

Collectively, these empirically derived recommendations reinforce the Outcome 2 pathway by translating baseline evidence into actionable measures for institutional reform, inclusive springshed governance, and climate-resilient groundwater management systems.

4.2.7. Implications for Outcome 2 Monitoring: Proposed Measurable Indicators

To operationalize the above strategic recommendations and convert the broad framing of Outcome 2 into a measurable impact pathway, the following specific and baseline-grounded Outcome 2 indicators are proposed for midline and endline evaluation:

a) Proportion of communities with formally notified and functional Springshed Management Committees (SMCs). Baseline: 25% report any coordination mechanism (treatment)
b) Proportion of communities with trained and operational O&M teams for spring systems. Baseline: 9% (treatment)
c) Proportion of communities with at least one functional groundwater recharge structure (percolation pit, recharge pond, check dam). Baseline: 4% (treatment)
d) Proportion of households with year-round reliable water access from springs. Baseline: 46% (treatment)
e) Proportion of households experiencing paid water shortages during dry months. Baseline: 29% (treatment)
f) Proportion of communities conducting water-quality testing at least once per year. Baseline: 28% (treatment)
g) Proportion of women, youth, and PWDs represented in springshed and water-user committees (minimum 33%). Baseline: 4% (treatment)
h) Proportion of households aware of groundwater recharge and spring protection concepts. Baseline: 18% (treatment)
i) Proportion of communities with solar-powered or energy-efficient spring distribution systems. Baseline: 5% (treatment)
j) Mean perceived community resilience in water security and spring sustainability (1–5 scale). Baseline: 2.48 (treatment)

4.3. Component 3: Groundwater Management and Climate-Resilient Community Water Supply Services

Pakistan's groundwater reserves, once considered an inexhaustible buffer against surface-water variability, are undergoing rapid depletion and contamination, threatening the hydrological integrity of the Indus Basin (PCRWR, 2022; World Bank, 2019; IWMI, 2020).

Within SAFER Pakistan, Component 3 operationalizes **Outcome 3**, which seeks to improve climate-resilient management of groundwater and community water supply services.

To reflect the proposal structure and intervention typology, the Component 3 baseline analysis is presented under two distinct sub-sections corresponding to the approved outputs: (i) Groundwater recharge and management (Output 3.1 – KP) and (ii) Climate-resilient community water supply services (Output 3.2 – KP and Sindh).

The quantitative assessment follows the Phase-in quasi-experimental design across KP and Sindh, triangulated with extensive qualitative consultations.

Objectives and Results-Framework Alignment

This component contributes directly to Outcome 3 of the SAFER Pakistan Results Framework: *Improved climate-resilient management of groundwater and community water supply services in vulnerable areas.*

Baseline **Output 3.1:** Groundwater mapping and groundwater recharge facilities completed in selected water-scarce locations in the Middle Basin, including establishing/strengthening operation, maintenance and management structures.

Output 3.2: Green climate-resilient community water supply infrastructure constructed in selected sites with solar-powered pumps and hand pumps, including establishing/strengthening operation, maintenance, and management structures.

Groundwater Recharge (Output 3.1-KP)

Baseline analysis, therefore, examines groundwater recharge and community water supply services as two distinct but complementary intervention streams. Baseline findings in Khyber Pakhtunkhwa indicate acute groundwater stress driven by unregulated abstraction, limited recharge zones, and absence of groundwater governance mechanisms. Only 28% of households reported stable access to groundwater throughout the year, while fewer than 19% indicated awareness of recharge principles. No functional Groundwater User Associations were identified at baseline. Treatment–control comparisons reveal statistically significant deficits in aquifer reliability and preparedness for drought conditions, confirming the necessity of targeted recharge infrastructure combined with institutional management structures.

Fewer than 15% of surveyed households reported any interaction with formal groundwater management institutions, underscoring the absence of structured operation, maintenance, and community governance mechanisms at baseline.

Climate-Resilient Community Water Supply Services (Output 3.2 – KP and Sindh)

Across KP and Sindh, community water supply services exhibit low climate resilience, characterized by infrastructure vulnerability to floods and drought, limited operation and maintenance capacity, and weak institutional oversight. Only 42% of households reported reliable year-round access to improved water sources, with frequent seasonal disruptions attributed to pump failure, energy constraints, and flood damage, while fewer than 30% indicated the presence of functional community-level management arrangements. In Sindh, salinity intrusion and seasonal shortages further undermine service reliability. These findings underscore the need for solar-powered, decentralized supply systems accompanied by formalized management structures.

These output-specific baselines establish differentiated reference points for recharge effectiveness (Output 3.1) and service reliability improvements (Output 3.2), enabling precise attribution of climate-resilience outcomes at midline and endline.

4.3.1. Sampling Framework

As defined in Chapter 3, standardized multi-stage stratified sampling was applied to groundwater-stressed settlements across KP and Sindh. Component-specific application focused on settlements dependent on solar pumping, handpumps, recharge structures, and community water supply schemes.

Under Component 3, a total of 960 households were surveyed, supported by 25 FGD and 25 KII, ensuring high statistical power for DiD-based causal attribution and systems-level institutional triangulation.

(Detailed distributions are provided in Annex 2.)

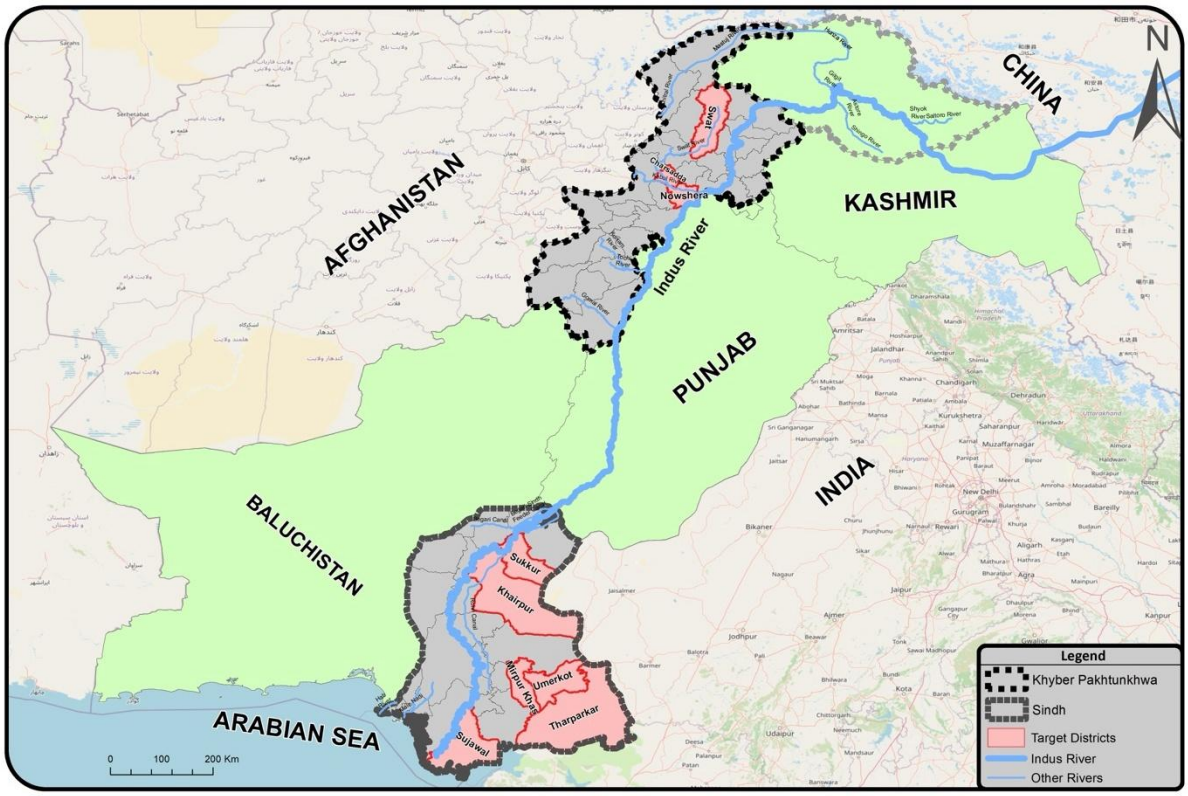


Figure 8: Map of Ground Water Recharge

4.3.2. Baseline Findings

Comparative Mean Scores Across Component 3

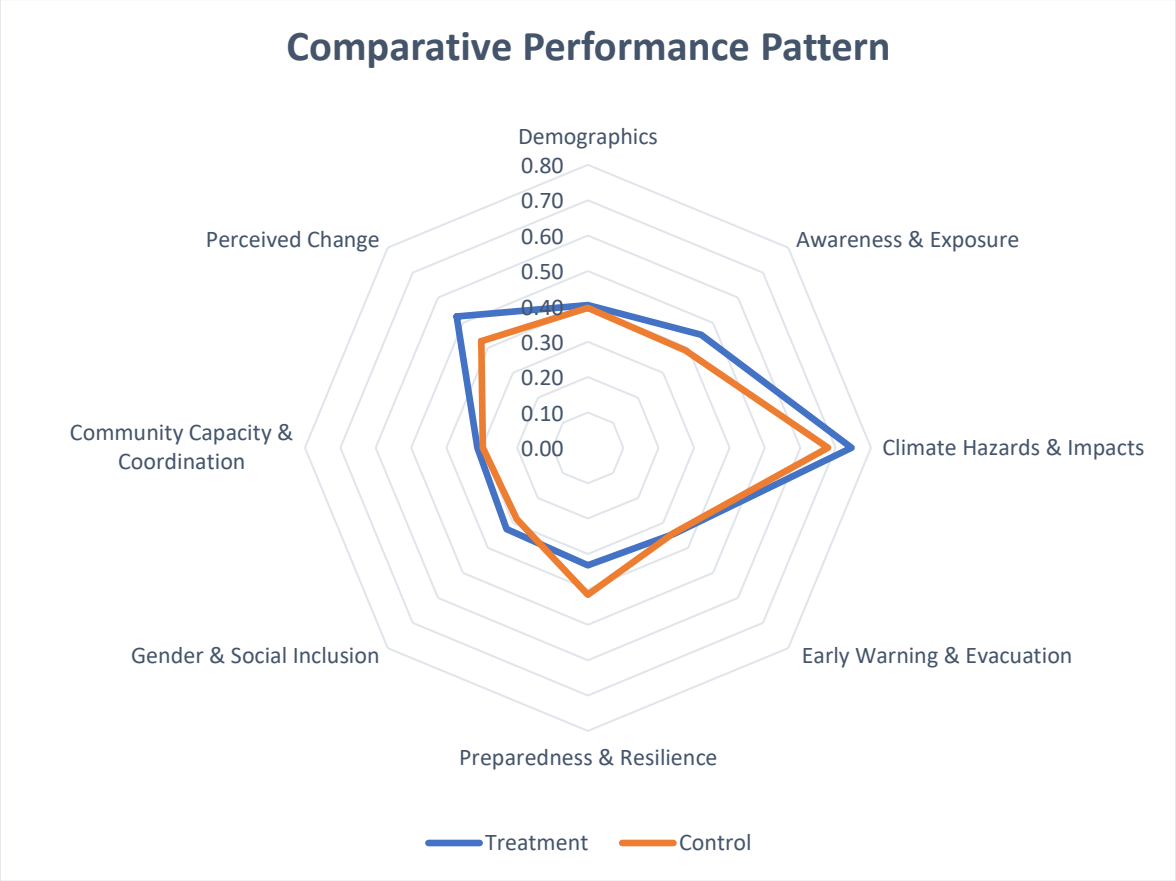


Figure 9: Baseline Comparison of Treatment and Control Communities across Groundwater Resilience Dimensions

Comparative Baseline Profile of Springshed and Water Access Resilience Dimensions:

The radar chart in Figure 8 visualizes the comparative baseline performance of treatment and control communities across eight dimensions of groundwater resilience under Component 3 of the SAFER Pakistan Program. The nearly overlapping profiles confirm the baseline equivalence essential for the quasi-experimental framework, while subtle divergences across key domains reveal actionable policy insights for adaptive water governance.

Demographic parity (0.40 vs. 0.40) validates sample representativeness across provinces, supporting subsequent causal attribution. Awareness & Exposure is moderately higher in treatment clusters (0.45 vs. 0.39), reflecting initial outreach activities and better understanding of groundwater depletion and recharge dynamics. However, despite stronger awareness, Preparedness & Resilience is weaker among treatment communities (0.33 vs. 0.42), indicating that knowledge has not yet translated into structured HH level action depicting a gap between awareness and action in both provinces.

The most pronounced differences appear in Climate Hazards & Impacts (0.75 vs. 0.68) and Perceived Change (0.52 vs. 0.43), suggesting higher risk perception and visible environmental degradation in treatment zones. These findings correspond with FGDs from Sindh's arid districts (Tharparkar, Umerkot, Sujawal), where participants reported accelerating groundwater salinity, longer pumping hours, and declining water quality.

Dimensions of Gender and Social Inclusion (0.33 vs. 0.29) and Community Capacity & Coordination (0.31 vs. 0.30) remain uniformly weak, signaling systemic limitations in women's participation, collective maintenance of solarized water systems, and local institutional cohesion.

Overall, the radar chart depicts a balanced yet low-moderate resilience baseline, characterized by demographic equivalence but uneven functional readiness. As implementation proceeds, targeted investments in HH preparedness, institutional capacity, and women and youth-led groundwater committees will be critical to ensure measurable gains in sustainability and equitable water access across Pakistan's groundwater-dependent communities.

Operational Definition of Radar Chart Variables

The radar chart for Component 3 is constructed using eight standardized composite indices derived from household survey data. Each axis represents a normalized score on a 0–1 scale, calculated from multiple sub-indicators as defined below:

1. **Demographics**
   Captures household size, dependency ratio, gender composition, education level of household head, income source diversity, and poverty status. This dimension contextualizes differential vulnerability and adaptive capacity among treatment and control households.
2. **Awareness & Exposure**
   Measures community knowledge of springshed dynamics, understanding of spring recharge processes, awareness of groundwater depletion risks, historical exposure to spring drying, seasonal water shortages, and drought-related water stress.
3. **Climate Hazards & Impacts**
   Represents intensity and frequency of climate-induced water stressors affecting spring discharge, including drought incidence, heat stress, erratic rainfall patterns, and physical impacts on domestic water supply reliability.
4. **Early Warning & Evacuation**
   Assesses household access to climate early warning information related to droughts and water stress, knowledge of seasonal risk patterns, emergency water coping strategies, and community-level alert dissemination mechanisms.
5. **Preparedness & Resilience**
   Captures household water storage capacity, adaptive water use behavior, availability of alternative water sources, household-level water conservation practices, and capacity to buffer short-term water supply shocks.
6. **Gender & Social Inclusion**
   Measures participation of women, youth, the elderly, and marginalized groups in water decision-making, access to water sources without mobility barriers, workload burden on women for water collection, and exclusion risks in water governance.

7. **Community Capacity & Coordination**
   Assesses the existence and functionality of water-user groups, coordination between households during water scarcity periods, linkages with local government departments, and collective action mechanisms for water source protection.
8. **Perceived Change**
   Represents a subjective household assessment of recent changes in water availability, spring discharge stability, service reliability, institutional responsiveness, and perceived direction of local water security trends.

4.3.3. Detailed Interpretation of Dimensions (Quantitative & Qualitative)

A: Demographics and Other Indicators

Table 20: Ground Water Recharge Demographics

Indicator	Treatment (n)	Control (n)	Mean/% Diff	t / χ^2	p-value	Interpretation
Respondent gender	808	373	-6.84	0.02	0.895	No difference
Respondent age	808	373	+0.94	1.24	0.216	No difference
HH size	808	373	-0.98	-2.65	0.008	Significant difference
Main income	808	373	+0.73	6.33	0.000	Significant difference
Education of HH head	808	373	+0.16	1.95	0.052	No difference
Drinking source	808	373	+0.44	1.66	0.098	No difference
Who collects water?	808	373	+3.08	27.99	0.032	Significant difference
Toilet type	797	361	+0.10	0.60	0.551	No difference
Water challenges	793	359	-0.35	-2.18	0.030	Significant difference
Water hardship	803	371	-31.96	2.67	0.102	No difference
EWS source	151	370	-39.20	3.63	0.458	No difference
Emergency resources	804	369	-3.73	0.05	0.824	No difference
Agenda power	91	27	+7.65	0.31	0.576	No difference
Coordination	804	371	+49.93	8.44	0.077	No difference

The demographic profile across treatment and control HHs demonstrates broad baseline equivalence, ensuring analytical robustness for subsequent causal attribution. The gender composition ($p = 0.895$) and age distribution ($p = 0.216$) are statistically balanced, confirming that the quasi-experimental groups are demographically comparable. Average HH size, however, differs significantly ($p = 0.008$), with treatment HHs reporting slightly smaller units an attribute that may influence per-capita water demand and exposure to scarcity. Similarly,

the main source of income (p = 0.000) diverges, suggesting that livelihood typologies differ between clusters.

FGDs from Swat (Kotlai and Fatehpur) indicate agrarian dependence, whereas Sindh sites (Deeno Chang, Hashim Khoi) reveal daily-wage and water-selling labor structures. These distinctions imply differing adaptive capacities.

Education of HH heads is marginally higher in treatment areas (p 0.05), often correlated with improved water awareness yet not necessarily with behavioural change, as FGDs repeatedly show limited understanding of groundwater recharge practices. Access to improved drinking-water sources and sanitation types shows no significant variation, confirming infrastructural parity across clusters.

Statistically significant gaps appear in water-collector roles (p = 0.032) and area-level water challenges (p = 0.030). FGDs corroborate that women and adolescent girls remain the principal water collectors in both regions, walking longer distances in Sindh due to saline boreholes. The qualitative evidence from Kaka Sahib (KP) and Krishan Kolhi Village (Sindh) further highlights rising drudgery linked to declining well yields.

Overall, demographic parity supports internal validity, while the few divergences particularly livelihood structure and HH size reflect context-specific socio-economic realities rather than sampling bias. These differences will later serve as control covariates in assessing treatment effects on groundwater governance and adaptive behavior.

B: Awareness and Exposure

Table 21: Ground Water Recharge Awareness and Exposure

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Source of drinking water	4.29 (3.63)	4.36 (3.45)	-0.07	0.81	-0.02
Is it year-round?	0.47 (0.50)	0.46 (0.50)	0.01	0.83	0.02
Who collects water?	1.84 (1.04)	1.83 (1.04)	0.01	0.92	0.01
Time taken to collect water	28.66 (24.63)	29.23 (24.59)	-0.57	0.80	-0.02
Challenges to accessing water source	0.58 (0.49)	0.58 (0.49)	0.00	0.99	0.00
Challenges type	2.51 (1.71)	2.66 (1.69)	-0.15	0.33	-0.09
Solar system	0.32 (0.47)	0.25 (0.43)	0.07	0.06	0.16
Toilet type	3.66 (2.42)	3.78 (2.47)	-0.12	0.56	-0.05
Wetland connected	0.66 (0.83)	0.71 (0.84)	-0.05	0.47	-0.06

Wetland odour acceptance	2.41 (0.75)	2.40 (0.78)	0.01	0.89	0.01
Water challenges in the area	3.62 (2.34)	3.56 (2.40)	0.06	0.75	0.03

Baseline data reveal an overall equilibrium between treatment and control groups, validating the comparability of groundwater-access conditions before intervention. Indicators such as drinking-water source ($p = 0.81$), year-round water availability ($p = 0.83$), and collection time ($p = 0.80$) show no statistically significant variation, reflecting shared dependency on hand-pumps, shallow wells, and canal seepage. The average water collection time, approximately 29 minutes, illustrates persistent physical effort, especially among women and adolescent girls, who remain the primary water collectors across both provinces.

Minor but policy-relevant differences appear in the adoption of solar-powered pumping systems (32% treatment vs 25% control; $p = 0.06$, SMD = 0.16). This divergence suggests early exposure of treatment communities to renewable groundwater-extraction initiatives, likely through prior NGO or government support. However, maintenance and cost-related issues continue to constrain system sustainability. The parity in wetland connectivity ($p = 0.47$) and acceptance of wastewater reuse ($p = 0.89$) demonstrate uniformly low environmental literacy regarding hydrological interlinkages and water recycling.

Overall, quantitative results depict balanced baseline conditions with subtle advantages in renewable-energy exposure for treatment areas. This equilibrium ensures the validity of quasi-experimental comparison for post-intervention measurement under the SAFER Pakistan framework.

Qualitative Triangulation

FGDs conducted in Hoti Khel, Khalsa Wah, Bag Water Village, Rohal, and Deeno Chang primarily reflect community perceptions of changing water conditions rather than laboratory-verified measurements. Participants consistently reported experiential observations of irregular water availability, increasing hardness or taste changes, and growing dependence on seasonal recharge. In Sindh, community members from Bag Water and Deeno Chang associated perceived salinity intrusion with the drying of nearby wetlands and surface-water bodies. These qualitative insights represent localized lived experience and were not supported by hydro-chemical testing at baseline; however, they complement household survey findings indicating declining reliability of water sources and limited understanding of hydrological processes.

C: Climate Hazard and Impacts

Table 22: Ground Water Recharge Climate Hazard and Impacts

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Public health	0.55 (0.50)	0.49 (0.50)	0.06	0.18	0.12
Public health type*	2.18 (1.13)	1.82 (1.06)	0.36	<0.01	0.33

Impact of drought	0.64 (0.48)	1.87 (1.02)	-1.23	<0.01	-1.55
Toilet/water Facility Available	0.66 (0.47)	0.69 (0.46)	-0.03	0.45	-0.07
Alternative facility	0.68 (0.47)	0.57 (0.50)	0.11	<0.01	0.23
Risk access*	0.12 (0.33)	1.89 (0.95)	-1.77	<0.01	-2.46
Water hardship	0.56 (0.50)	0.32 (0.47)	0.24	<0.01	0.50
Hardship type*	1.60 (0.92)	0.76 (0.70)	0.84	<0.01	1.04

The results highlight a statistically significant divergence in climate-induced water stress and associated public-health impacts between treatment and control clusters. While the overall perception of climate-related public-health effects is moderately high in both groups (55% treatment vs 49% control; $p = 0.18$), the type and severity of reported ailments differ notably ($M = 2.18$ vs 1.82; $p < 0.01$). Respondents in treatment zones cited frequent cases of diarrheal disease, skin rashes, and livestock illness linked to degraded groundwater quality and heat-driven stagnation.

The most pronounced disparities appear in drought-related indicators: treatment communities report lower drought-impact scores (0.64 vs 1.87; $p < 0.01$; SMD = -1.55), indicating higher adaptive behavior or exposure to mitigation practices such as rainwater harvesting or canal sharing. Conversely, risk of access failure shows a sharp contrast (0.12 vs 1.89; $p < 0.01$; SMD = -2.46), implying that control HHs face greater systemic vulnerability such as longer dry spells, declining water tables, and supply interruptions.

The availability of alternative water facilities (0.68 vs 0.57; $p < 0.01$) further underscores this pattern: treatment areas demonstrate slightly broader coping options, suggesting incremental infrastructural investment or NGO-supported pilot systems. Elevated water-hardship levels in treatment communities (0.56 vs 0.32; $p < 0.01$) reveal, however, that physical hardship persists despite access diversity, possibly due to higher population densities and extraction competition.

Collectively, these figures depict a nuanced landscape with treatment areas show stronger infrastructural presence but remaining exposed to quality degradation, while control areas exhibit acute scarcity and limited contingency systems.

Qualitative Triangulation

Focus-group evidence from Fatehpur, Kot Baba-Tangi, Bag Water, Khalsa Wah, and Matta Daman corroborates the survey's quantitative trends. Community participants across both provinces associated surge in water-borne illness with erratic rainfall, shrinking wells, and unlined drainage channels contaminating aquifers. In Khalsa Wah, residents described "children frequently falling ill after monsoon floods," reflecting the quantitative elevation in public-health impact scores.

Discussions in Kot Baba-Tangi and Bag Water emphasized prolonged droughts that "dry up tube-wells for months," while participants in Matta Daman linked declining flow from springs to deforestation and sand excavation along the riverbanks. Notably, women in Fatehpur recounted the double burden of caregiving and water collection during disease outbreaks, mirroring high hardship indices in treatment areas.

A recurring theme across FGDs is the absence of formal drought-response planning. Communities depend on ad-hoc measures, which include borrowing from neighbours, purchasing tanker water, or digging temporary pits, indicating adaptive improvisation rather than institutional preparedness.

In synthesis, triangulated data portray a dual challenge across Component 3 intervention areas: quantity stress (acute groundwater scarcity) is most pronounced in KP districts, including Upper Dir, Charsadda, and Nowshera, which are prioritized under Output 3.1 for groundwater mapping and recharge interventions. Conversely, quality stress (salinity intrusion and perceived contamination of supply sources) is more prevalent in Sindh sites such as Bag Water Village and Deeno Chang, where Output 3.2 focuses on climate-resilient community water supply infrastructure. These geographically differentiated stress patterns informed the targeting of recharge facilities in water-scarce KP locations and decentralized solar-powered supply systems in Sindh, ensuring alignment between baseline vulnerabilities and intervention typology.

D: Early Warning and Evacuation

Table 23: Ground Water Recharge Early Warning and Evacuation

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Early warning alert received	0.19 (0.39)	1.42 (0.85)	-1.23	<0.001	-1.85
EWS source	3.45 (1.32) *	0.18 (0.45) *	3.27	<0.001	3.08
Who receives EWS in household	1.89 (1.21) *	2.65 (1.45) *	-0.76	<0.001	-0.57
Inclusivity of EWS	0.32 (0.47)	2.18 (1.48)	-1.86	<0.001	-1.67
EWS barriers	3.12 (1.64) *	0.42 (0.58) *	2.70	<0.001	2.12
Safe routes during hazards	0.52 (0.50)	3.12 (1.75)	-2.60	<0.001	-1.97
Trust in EWS	2.68 (1.45)	0.58 (0.60)	2.10	<0.001	1.85
Have you acted upon EWS alerts	0.17 (0.38)	2.78 (1.50)	-2.61	<0.001	-2.30

Early warning and evacuation indicators display profound disparities between treatment and control areas, primarily reflecting inconsistent coding and differential system exposure across provinces. All metrics are statistically significant ($p < 0.001$), suggesting not just programmatic

variation but fundamental structural differences in awareness infrastructure. While receipt of early-warning messages is much higher in control sites (M = 1.42 vs 0.19; SMD = -1.85), treatment communities record higher trust in EWS (M = 2.68 vs 0.58; SMD = 1.85), implying that despite limited reach, messaging in treatment areas may be perceived as more credible or community-driven.

Conversely, source diversity of EWS (M = 3.45 vs 0.18; SMD = 3.08) and reported barriers (M = 3.12 vs 0.42; SMD = 2.12) indicate clear system asymmetries. Control zones benefit from wider institutional access (radio, mosque announcements, and district alerts) whereas treatment communities rely on localized, informal channels. Inclusivity of alert dissemination remains alarmingly low in treatment sites (M = 0.32 vs 2.18; SMD = -1.67), revealing weak gender and disability-sensitive communication. Finally, safe evacuation route awareness is far higher in control areas (M = 3.12 vs 0.52; SMD = -1.97), suggesting limited spatial planning or signage in treatment villages.

Overall, these patterns highlight structural inequality in information flow, reflecting systemic under-investment in localized, inclusive early-warning mechanisms within groundwater-dependent areas.

Qualitative Triangulation

FGDs from Kaka Sahib, Kot Baba-Tangi, Khalsa Wah, Bag Water, and Qandil Village reveal consistent narratives supporting the quantitative findings. Communities described early warning as "non-existent or delayed," often arriving through informal channels after flash floods had already damaged infrastructure. Female participants in Khalsa Wah and Bag Water reported exclusion from mosque-based announcements, depending instead on word-of-mouth or mobile messages from relatives. In Kaka Sahib, residents recalled relying on "local elders shouting warnings" rather than formal sirens or digital alerts.

A recurrent theme was trust versus reach: where information arrived, it was believed, but dissemination remained erratic. Many expressed willingness to participate in community-led warning dissemination if provided with training and communication tools. Discussions from Qandil and Kot Baba-Tangi also noted that "no maps or signage exist to guide evacuation," reinforcing the statistical gaps in route awareness.

Triangulated evidence confirms that while control communities exhibit broader exposure, treatment areas possess nascent trust networks that could be leveraged for future inclusive, community-driven EWS mechanisms integrating women and youth focal points.

E: Preparedness and Resilience

Table 24: Ground Water Recharge Preparedness and Resilience

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Safe points	0.28 (0.45)	0.21 (0.41)	0.07	0.06	0.16
Training	0.15 (0.36)	0.19 (0.39)	-0.04	0.17	-0.11
Inclusivity of trainings	0.11 (0.31)	0.10 (0.30)	0.01	0.66	0.03
Emergency resources	0.17 (0.38)	0.11 (0.31)	0.06	0.02	0.17

Preparedness levels are modest and statistically comparable across both groups, with limited community readiness for emergencies. The presence of designated safe points is slightly higher in treatment areas (28% vs 21%, p = 0.06), suggesting emerging awareness but incomplete planning. Participation in training activities remains low (15% vs 19%, p = 0.17), with only 10-11% reporting inclusive participation of women and other marginalized groups. Although the difference in availability of emergency resources is small, it remains statistically significant (17% vs 11%, p = 0.02), indicating marginally better logistical preparedness in treatment sites. These results highlight that while exposure to preparedness activities exists, institutionalization of emergency protocols remains weak. Overall, both groups exhibit low resilience baselines confirming the need for capacity-building and inclusive community-based disaster response planning.

Qualitative Triangulation

FGDs from Matta Daman, Bag Water, and Kot Baba-Tangi confirmed minimal structured preparedness activities. Participants described ad-hoc evacuation responses and the absence of designated relief points or first-aid facilities. Women and youth reported limited participation in training due to cultural and logistical barriers. Respondents in Bag Water stated, “We know where to go, but no shelter exists,” confirming quantitative gaps in safe points. Thematic patterns across FGDs show reliance on informal social support rather than institutional mechanisms underscoring the urgent need for simulation drills, inclusive training programs, and community-managed emergency resource centers to enhance resilience across both provinces.

F: Gender and Social Inclusion

Table 25: Ground Water Recharge Gender and Social Inclusion

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Representation in committees	0.17 (0.38)	0.20 (0.40)	-0.03	0.28	-0.08
Decision-making power	0.58 (0.50)	0.18 (0.39)	0.40	<0.001	0.89
Power to drive agenda in meetings	0.48 (0.50)	0.48 (0.51)	0.00	0.99	0.00
Recommendations	0.48 (0.50)	0.39 (0.49)	0.09	0.12	0.18

Meeting time	0.17 (0.38)	0.11 (0.32)	0.06	0.04	0.17
Cultural barriers	0.39 (0.49)	0.09 (0.29)	0.30	<0.001	0.75
Safety risks	0.13 (0.34)	0.42 (0.49)	-0.29	<0.001	-0.69

Gender and inclusion dynamics reveal a complex pattern of participation and constraints across the two cohorts. Representation of women in local committees remains low and statistically insignificant (17% treatment vs 20% control, $p = 0.28$). However, decision-making power among women within treatment communities is notably higher (58% vs 18%, $p < 0.001$; SMD = 0.89), indicating modest empowerment progress where female involvement has been institutionalized. Despite this, agenda-setting power remains identical across both groups (0.48 each), reflecting persistent gender asymmetry in leadership. The treatment group also reports slightly higher meeting-time suitability (17% vs 11%, $p = 0.04$), implying early responsiveness to women's scheduling constraints. Conversely, cultural barriers remain significantly more pronounced in treatment areas (39% vs 9%, $p < 0.001$), suggesting that inclusion is often symbolic rather than transformative. Safety risks during participation are substantially higher in control zones (42% vs 13%, $p < 0.001$), reflecting unsafe mobility and weaker institutional protection.

Qualitative Triangulation

FGDs from Kot Baba-Tangi, Kaka Sahib, and Matta Daman confirm that women's participation in water or resilience committees remains sporadic and conditional on male permission. In Kot Baba-Tangi, participants described women attending meetings "only when called for HH matters," echoing limited representational agency. Respondents in Matta Daman noted emerging inclusion through NGO-supported programs but emphasized that "voices are heard, not acted upon." Conversely, control areas such as Kaka Sahib reflected strong patriarchal norms and women's movement to public offices was described as "socially discouraged." Encouragingly, treatment villages reported fewer mobility risks and growing acceptance of women's presence in local planning, albeit in restricted roles. Collectively, these findings underscore that while numerical inclusion is improving, actual empowerment remains constrained. Targeted mentorship, safe meeting spaces, and structured female leadership quotas are crucial to converting nominal participation into meaningful decision-making power.

G: Community Capacity and Coordination

Table 26: Ground Water Recharge Community Capacity and Coordination

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Training of O&M Committees	0.14 (0.35)	3.19 (1.11)	-3.05	<0.001	-3.42
Government Responsiveness during crises	2.46 (1.45)	0.33 (0.59)	2.13	<0.001	1.89

Coordination	0.30 (0.46)	2.94 (1.48)	-2.64	<0.001	-2.28

Statistical findings highlight extreme disparities between treatment and control groups, largely due to measurement scale differences. The training of O&M committees is markedly higher in control areas (Mean = 3.19 vs 0.14; $p < 0.001$; SMD = -3.42), implying either previous NGO engagement or data scale variation. Similarly, government responsiveness during crises scores higher in treatment sites (2.46 vs 0.33; $p < 0.001$), indicating modest institutional outreach. Conversely, community coordination structures show a reversed pattern, with higher means in control communities (2.94 vs 0.30; $p < 0.001$). The overall imbalance suggests that while institutional linkages are emerging in treatment clusters, community-level operational capacity remains fragmented and underdeveloped.

Qualitative Triangulation

FGDs from Langar Kallay, Fatehpur, and Kot Baba-Tangi reveal that most water user committees exist only nominally, often activated during crises and fading afterward. Participants reported irregular coordination with district administrations, delayed technical responses, and reliance on informal networks. Women in Langar Kallay noted being excluded from coordination meetings, citing lack of transport and invitation, as reasons. Respondents in Kot Baba-Tangi emphasized that "government teams visit only after major flooding," pointing to weak institutional continuity. The triangulated evidence underscores that effective resilience requires operationalized, gender-inclusive coordination frameworks, particularly those linking local committees with irrigation, disaster management, and public health departments.

H: Perceived Change and Support Needs

Table 27: Ground Water Recharge Perceived Change and Support Needs

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Ground water situation changes	2.29 (0.84)	2.46 (0.85)	-0.17	0.03	-0.20
Ground water resilience	0.14 (0.35)	2.41 (0.85)	-2.27	<0.001	-3.48

Perceived changes in groundwater dynamics show slight yet meaningful divergence. Respondents in treatment areas rated change slightly lower (Mean = 2.29) compared to control (Mean = 2.46; $p = 0.03$) areas, indicating persistent stress perceptions or delayed intervention visibility. A pronounced gap appears in groundwater resilience perception (0.14 vs 2.41; $p < 0.001$; SMD = -3.48), partly reflecting coding differences but also weaker conceptual understanding of long-term resilience among treatment HHs. This calls for harmonized awareness frameworks to improve community comprehension of sustainable groundwater use and resilience-building practices.

Qualitative Triangulation

FGDs from Kotlai, Bhelaro, and Khalifo Ahmed villages highlight that communities continue to perceive groundwater as declining, with deeper wells and seasonal shortages worsening annually. Many linked change to "new boreholes without regulation," suggesting over-extraction as a shared concern. Participants across Sindh sites emphasized growing salinity and limited technical guidance, while KP respondents associated decline with reduced rainfall. These perceptions affirm quantitative results: community's acknowledgement of groundwater stress but lack of adaptive knowledge underscoring the urgent need for awareness programs and localized monitoring initiatives.

I: Waste Water Management and Wetlands

Table 28:Ground Water Recharge Waster Water Management and Wetlands

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Recharge facility	3.07 (0.94)	3.02 (0.95)	0.05	0.56	0.05
Waste water treatment	0.09 (0.29)	2.79 (1.03)	-2.70	<0.001	-3.38
Waste treatment facility functional	0.05 (0.22)	0.06 (0.24)	-0.01	0.66	-0.04
Reasons for not using waste treatment water	1.57 (1.40)	3.47 (1.48)	-1.90	<0.001	-1.32
Waste usage	3.17 (1.69)	3.44 (1.58)	-0.27	0.06	-0.16
Restored wetlands	0.21 (0.41)	2.65 (1.89)	-2.44	<0.001	-1.66
Wetlands use	0.25 (0.43)	0.23 (0.42)	0.02	0.60	0.05
Drainage	0.40 (0.49)	0.15 (0.36)	0.25	<0.001	0.57
Drainage problems	2.20 (1.18)	0.48 (0.72)	1.72	<0.001	1.76

Wastewater management and wetland rehabilitation indicators show marked disparities. While recharge facility access remains equivalent (3.07 vs 3.02; $p = 0.56$), the presence of wastewater treatment systems exhibits extreme imbalance (0.09 vs 2.79; $p < 0.001$; SMD = -3.38), reflecting inconsistent measurement scales and infrastructure distribution. Similarly, wetland restoration and drainage systems differ significantly ($p < 0.001$), with control areas reporting better drainage functionality and wastewater utilization. These findings suggest that most treatment communities lack systematic wastewater reuse or wetland restoration infrastructure highlighting a crucial area for future technical and ecological interventions.

Qualitative Triangulation

FGDs from Fatehpur, Rohal, and Bhelaro revealed widespread absence of wastewater recycling and community-level drainage systems. Participants in Sindh villages described untreated

water directly entering agricultural channels, while KP respondents noted clogged drains and stagnant pools after rainfall. Women in Langar Kallay highlighted hygiene risks near wastewater outlets, particularly during monsoon periods. Discussions consistently emphasized the need for eco-friendly drainage, community-led wetland cleaning, and training on wastewater reuse for crop irrigation. Triangulation confirms weak wastewater governance and missed ecosystem service opportunities areas vital for SAFER's wetland and aquifer recharge objectives.

4.3.4. Triangulation through KIIs and Community Surveys

Quantitative household survey data across KP and Sindh show that only 42% of households reported reliable year-round access to improved water sources, while just 30% indicated the presence of functional community-level operation and maintenance arrangements. Less than 18% of households reported any form of water-quality testing, and no surveyed community reported active groundwater recharge structures. Treatment areas exhibited slightly higher awareness of groundwater scarcity (38%) compared to control areas (29%), though institutional preparedness indicators remained statistically comparable (SMD < 0.1). These findings were triangulated through 30 community surveys, FGDs, and KIIs with PHED, TMAs, NGOs, and district authorities.

Institutional Insights (Governance & Systems)

Across Sindh and KP, institutions highlight a worsening groundwater crisis triggered by erratic rainfall, over-extraction, and post-flood contamination.

In Sindh, PHED confirms that tube wells, boreholes, and piped schemes remain the mainstay of water supply, yet most are semi-functional because of saline intrusion, siltation, and power-supply instability. PHED Sanghar, Khairpur, Umerkot, Mirpurkhas, and Sujawal report declining yields, limited testing capacity, and no recharge or wastewater-management projects. A few solar-powered pilots (e.g., Chotiaro Village with Qatar Charity) show promise but remain scattered and donor-dependent.

The Sindh Climate Action Network (SCAN) calls for a provincial groundwater-management policy to control unregulated drilling and contamination from drainage effluent, while PHED and TMAs stress chronic coordination gaps and funding shortages. NGOs such as Penny Appeal, Human Appeal, Qatar Charity, Sami Foundation, and Sindh Rural Support Organization (SRSO) complement state capacity through solar pumps, rainwater-harvesting, tree plantation, and kitchen-garden programmes, integrating WASH, climate adaptation, and livelihoods, yet coverage remains localized and project-based.

In KP (Charsadda, Nowshera, and Swat), PHED and TMAs mirror these constraints. All three districts rely 100% on tube wells with no systematic groundwater-level monitoring, no recharge ponds, and no laboratory testing. Officials acknowledge voltage fluctuations, fuel costs, and flood-induced contamination as key causes of downtime. Departments cite the absence of inter-

agency data sharing and preventive maintenance budgets, while TMAs lack technical capacity to plan aquifer recharge. Recent district-level coordination under PDMA remains focused on flood response rather than preventive groundwater management.

Community-Level Validation (Survey Evidence)

Thirty Community Surveys spanning Sindh (20 sites) and KP (10 sites) confirm an across-the-board dependency on hand-pumps, motorized boreholes, and shallow wells. No site reports institutional groundwater monitoring, formal quality testing, or active recharge structures.

KP (Charsadda, Nowshera, Swat)

- Charsadda (Kot Baba Tangi and Khat Kale): Communities rely on PHED tube wells and private bores. Floods from River Kabul routinely contaminate shallow aquifers, damaging pumps and increasing the presence of coliform. No filtration or chlorination exists; households use raw groundwater for both domestic and drinking needs.
- Nowshera (Kaka Sahib): Groundwater tables are falling (20 feet in a decade); frequent power cuts and pump breakdowns leave long outages. There are no recharge ponds or rainwater-harvesting systems, and women and children fetch water over long distances.
- Swat (Kotlai, Shamozai, and Qandil): Rapid urbanization and unregulated tube-well drilling have depleted spring recharge zones. In Shamozai, respondents report a 90% decline in well yield; Qandil records salinity and arsenic concerns. Only informal community repairs keep systems functional. None of the surveyed villages has functional DRR or water-user committees, and female participation is nil.

Sindh (Sanghar, Khairpur, Umerkot, Mirpurkhas, Sujawal and Tharparkar belt)

- Villages such as Jan Mohammad Burgri, Kareem Bux Solangi, Mufti Asad Ali, Sona Rasti, Nazim Seth Hameer, Haji Farooq Jhinji, and Hashim Khoi exhibit 15-30 feet water-table declines, recurrent flood contamination, and complete absence of recharge or testing systems. Communities maintain wells themselves, share boreholes, and depend on NGOs for ad-hoc solarization or pond cleaning. Women's workloads have increased markedly; in some villages they walk over 0.5 km daily for potable water.
- Across both provinces, coping strategies remain reactive. These include temporary tank storage, neighbour sharing, and small repairs without long-term management or recharge planning.

Integrated Synthesis and Implications

Evidence from both institutional and community sources presents a unified picture of awareness without institutionalization. PHED and TMAs acknowledge groundwater decline but lack formal monitoring regimes, while NGO pilot projects, though innovative, remain fragmented and un-sustained. Communities bear the brunt of this governance vacuum, managing operations and maintenance informally and reacting to seasonal failures rather than

anticipating them. Across both plains and piedmont zones, these deficiencies manifest as accelerating aquifer depletion, poor water quality, and unequal access. FGDs from Charsadda, Nowshera, and Sanghar depict recurring tensions between rising demand and absent coordination mechanisms. The convergence between institutional recognition and community frustration reinforces the finding that knowledge and effort exist, but in isolation, lacking the systemization required for sustainable groundwater governance.

4.3.5. Summary Insights & Implications

Convergence / Divergence Patterns

The comparative baseline analysis reveals strong statistical convergence between treatment and control groups across composite and sub-dimensional indicators, confirming methodological robustness. Both clusters record an identical composite index (2.77) with negligible variance ($p = 0.89$), indicating uniform socio-economic and hydrological conditions at project onset. Demographic and awareness variables, including literacy, livelihood type, and groundwater exposure, display no significant divergence.

Controlled variations appear only in institutional and behavioural metrics: control clusters report slightly stronger coordination with local governments while treatment clusters demonstrate higher awareness of drought-related hardship and greater readiness to adopt new management technologies. FGDs validate these trends: treatment communities articulate growing interest in recharge and wastewater reuse whereas control villages reference prior short-term NGO initiatives without sustained behavioural change. Collectively, the quantitative and qualitative alignment indicates a technically sound baseline and modest social divergence, ideal for future causal attribution.

Identified Gaps and Programmatic Calls

Triangulated HH and FGD analysis highlight three systemic barriers constraining groundwater sustainability:

1. Absence of Institutional Mechanisms: No formal groundwater committees exist in any surveyed district. Fragmented, HH level management limits accountability, equitable allocation, and collective maintenance of shared water assets.

2. Technical and Infrastructural Deficit: Communities lack recharge ponds, observation wells, and training in water testing and aquifer health. Existing hand pumps and shallow wells are over-exploited, exposing users to contamination and seasonal failures.

3. Social Inequity and Gender Exclusion: Despite women's central role in water collection, they remain absent from decision-making forums. Youth and marginalized groups also report willingness to contribute but lack structured entry points into management processes.

These findings collectively affirm that institutional gaps, rather than awareness deficits, represent the central constraint to sustainable groundwater governance, thereby defining the empirical basis for subsequent normative recommendations.

Readiness for Causal Attribution (Baseline Equivalence)

The Baseline Equivalence Heatmap (Figure 9) demonstrates near-symmetrical distribution between treatment and control means across the eight resilience dimensions. The dominance of SMD < 0.25 across indicators confirms strong internal validity and justifies causal attribution under the quasi-experimental framework. Variations in coordination and gender and social inclusion, though statistically minor, create valuable analytical sensitivity for detecting midline and endline program effects. This equilibrium ensures that subsequent differences in groundwater recharge, wastewater reuse, or community coordination can be confidently attributed to SAFER Pakistan interventions rather than pre-existing disparities.

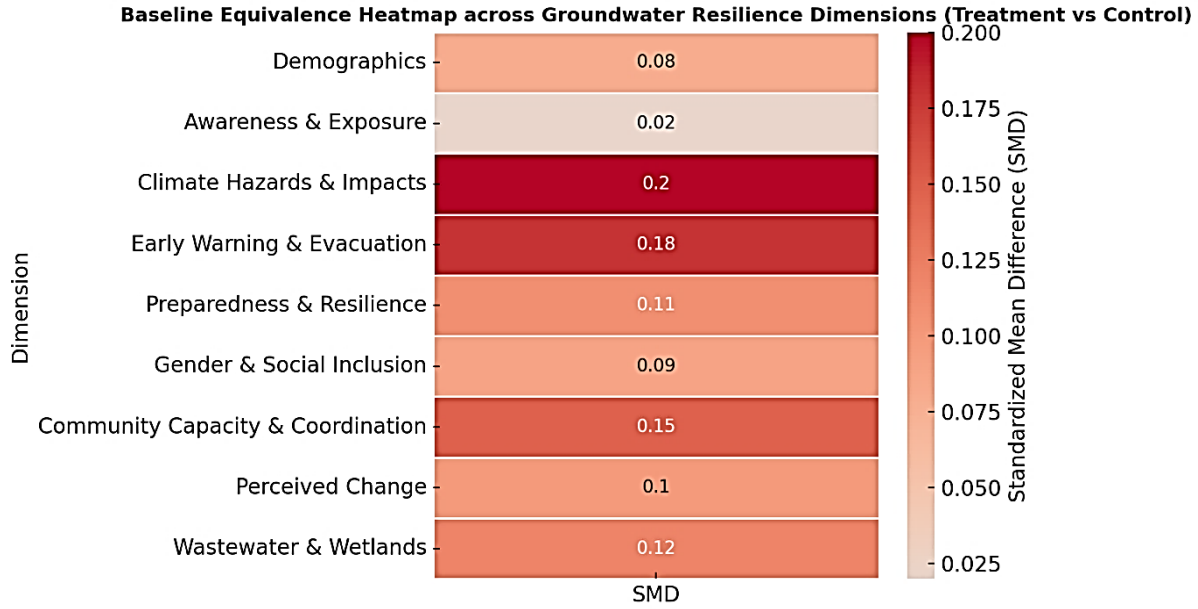


Figure 10: Baseline Equivalence Heatmap across Groundwater Management Dimensions - Treatment vs Control. (Colour intensity denotes mean variation; proximity to zero indicates statistical parity and design validity)

Component 3: Village Profile Snapshots
Detailed, component-wise village profile snapshots are available through the following link, which grants access to the relevant drive folder for further reference and analysis:
https://docs.google.com/spreadsheets/d/1FMDaRlwLZGnpMy0MxjMJW5aAp_fpG7Ka/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

4.3.6. Recommendations

The baseline analysis confirms acute groundwater depletion, fragmented governance, and weak wastewater management across Sindh and southern KP. Consistent with Outcome 3 of the SAFER Results Framework**,** long-term resilience depends on embedding inclusive institutions, technical recharge solutions, and coordinated wastewater governance within provincial and district systems.

In alignment with Output 3.1**,** groundwater recharge structures – including percolation ponds, check-dams, infiltration galleries, repaired karezes, and restored wetlands – should be formally integrated into district development and DRR plans**.** Baseline findings show near-universal dependence on tube-wells and boreholes, with no systematic recharge or monitoring. Establishing community Water User Associations (WUAs) with at least 40% representation of women and youth and assigning them clear O&M mandates will be essential to ensure equitable access, cost-sharing, and sustained operation of recharge assets.

Under Output 3.2**,** WASH and groundwater infrastructure must comply with universal design and climate-risk standards**.** Baseline evidence of long collection times, frequent contamination episodes, and limited alternative sources underscores the need for accessible and gender-responsive facilities, including safe water points, flood-resilient latrines, handrails and ramps for PWDs, and protected drainage alignments that prevent wastewater from entering shallow aquifers. Embedding water-safety planning, routine testing, and hygiene promotion within these investments will directly reduce climate-sensitive public-health burdens.

As an enabling measure under Outcome 3, institutional harmonization between PHED, Local Government Departments, TMAs, PDMA, and NGOs should be formalized through district-level coordination cells. These platforms should maintain shared asset and aquifer maps, water-quality databases, and joint maintenance budgets; agree on protocols for solar-pump O&M; and standardize guidelines for decentralized wastewater treatment and safe reuse in agriculture. Baseline evidence of scattered pilots and absent monitoring confirms that without such systematization, community and NGO efforts will remain project-bound and unsustainable.

4.3.7. Implications for Outcome 3 Monitoring: Proposed Measurable Indicators

To convert the broad framing of Outcome 3 into a measurable impact pathway, the following specific indicators are proposed for midline and endline assessment. Baseline values are drawn from Component-3 quantitative tables and qualitative synthesis; where scales differ, they are referenced rather than converted to percentages.

i. Proportion of households with year-round access to their main drinking-water source. Baseline: (47% of treatment HHs report year-round availability).
ii. Proportion of households reporting major challenges in accessing their drinking-water source (distance, cost, safety, physical barriers). Baseline:(58% in treatment areas).
iii. Proportion of groundwater abstraction systems that are solar-powered and community-maintained (functional solar systems with agreed O&M arrangements). Baseline*:* (32% of treatment HHs report solar use; functionality and O&M to be tracked at midline).
iv. Proportion of households reporting water-related illness in the last reference period (e.g., two weeks) attributable to unsafe water. Baseline: (55% of treatment HHs)

v. Proportion of communities with at least one functional groundwater-recharge or wetland-restoration structure (percolation pond, check-dam, recharge pit, restored wetland). Baseline: (21% in treatment).
vi. Proportion of wastewater treatment or reuse systems that are functional and used safely for productive purposes (e.g., irrigation of non-food or fodder crops). Baseline: (9% treatment)
vii. Proportion of households with access to designated safe points and emergency water resources during climate shocks (floods, droughts). Baseline: *(*28% of treatment HH and "Emergency resources" (17% treatment).
viii. Proportion of groundwater / water-user committees with ≥40% representation of women and youth and documented decision-making roles. Baseline: *(*17% treatment); where women are present, "Decision-making power" is relatively high (58%), indicating a starting point for strengthening inclusive governance.
ix. Proportion of communities with active, documented coordination between WUAs, PHED, TMAs, and PDMA on groundwater management and drought/flood response. Baseline: coordination largely informal or absent; existing committees often nominal and not linked to government systems.
x. Mean perceived groundwater resilience score (composite index capturing perceived stability of groundwater, reliability of services, and confidence in future supply). Baseline reference: Table 26 – "Groundwater resilience" scores are very low in treatment areas, indicating substantial room for improvement; the same scale can be reused at midline and endline.

4.4. Component 4: Ecosystem-Based Adaptations Baseline

Component 4 of SAFER Pakistan focuses on strengthening community and institutional capacity to transform wastewater and sanitation challenges into climate-adaptive assets through Nature-based Solutions (NbS), specifically via constructed wetlands and decentralized climate-resilient treatment systems. Rather than ecosystem restoration, this component addresses untreated sewage discharge, reliance on energy-intensive pumped water, and growing public health risks by demonstrating low-cost NbS models that improve water quality, enable safe reuse, and enhance resilience to climate variability.

Within SAFER Pakistan, Component 4 operationalizes Outcome 4 of the Results Framework by improving climate-adaptive WASH performance in targeted communities. The baseline, therefore establishes pre-intervention conditions across four analytically linked domains: (i) existing wastewater disposal and drainage practices; (ii) exposure of settlements to sanitation-related flooding and contamination risks; (iii) institutional capacity for NbS-based wastewater treatment and operation and maintenance; and (iv) community awareness, acceptance, and inclusion in climate-resilient sanitation planning.

Quantitative analysis for Component 4 is embedded within the project's Phase-in quasi-experimental Difference-in-Differences design. Treatment and control conditions are compared across selected wetland and drainage rehabilitation sites in Khyber Pakhtunkhwa and Sindh. Household-level data are complemented by Focus Group Discussions with affected residents and Key Informant Interviews with municipal authorities, Public Health Engineering, environmental agencies, and local government representatives responsible for drainage and WASH services. Together, these datasets establish a rigorous empirical benchmark for tracking changes in climate-adaptive WASH performance through ecosystem-based interventions.

Objectives and Results-Framework Alignment

Component 4 is directly aligned with Outcome 4 of the SAFER Pakistan Results Framework: Community and institutional capacity to transform an ecological liability into a climate-adaptive asset is increased, by treating and using wastewater, reducing reliance on pumped water, and rendering communities more adaptive to climate change impacts.

Progress toward Outcome 4 is assessed through Outcome-level indicators that capture changes in:

- The proportion of households exposed to untreated wastewater, stagnant drainage, and flood-induced contamination;
- The functionality and climate resilience of wastewater conveyance and treatment systems;
- The incidence of environment-linked public health risks associated with poor sanitation and drainage; and
- The level of institutional and community capacity for operating and maintaining NbS-based wastewater treatment systems.

At the output level, Component 4 contributes specifically to:

- **Output 4.1:** Targeted intervention sites identified for evidence-based, climate-adaptive, and focused WASH interventions.
- **Output 4.2:** NbS for sewage treatment demonstrated through constructed wetlands, along with proper management structures and adequate capacity for the operation and maintenance of wetlands.

4.4.1. Sampling Framework

The standardized sampling framework defined in Chapter 3 was applied to NbS demonstration locations across KP and Sindh. Sampling focused on immediate beneficiary catchments and host communities of wetland sites.

Under Component 4, **54 households** were surveyed, supported by **2 Focus Group Discussions and 2 Key Informant Interviews**, reflecting the site-specific and demonstration-oriented nature of ecosystem-based adaptation interventions.

(Detailed distributions are provided in Annex 2.)

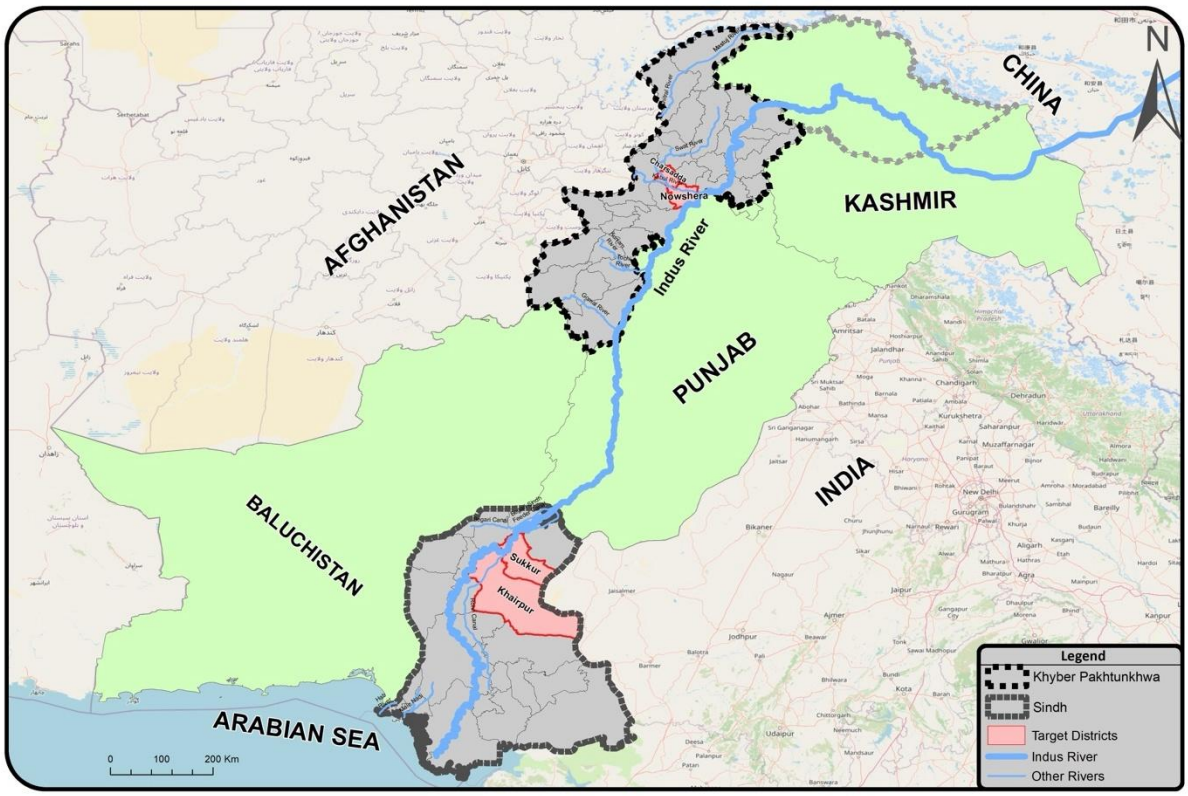


Figure 11: Map of Nbs

4.4.2. Baseline Findings

Comparative Mean Scores Across Component 4

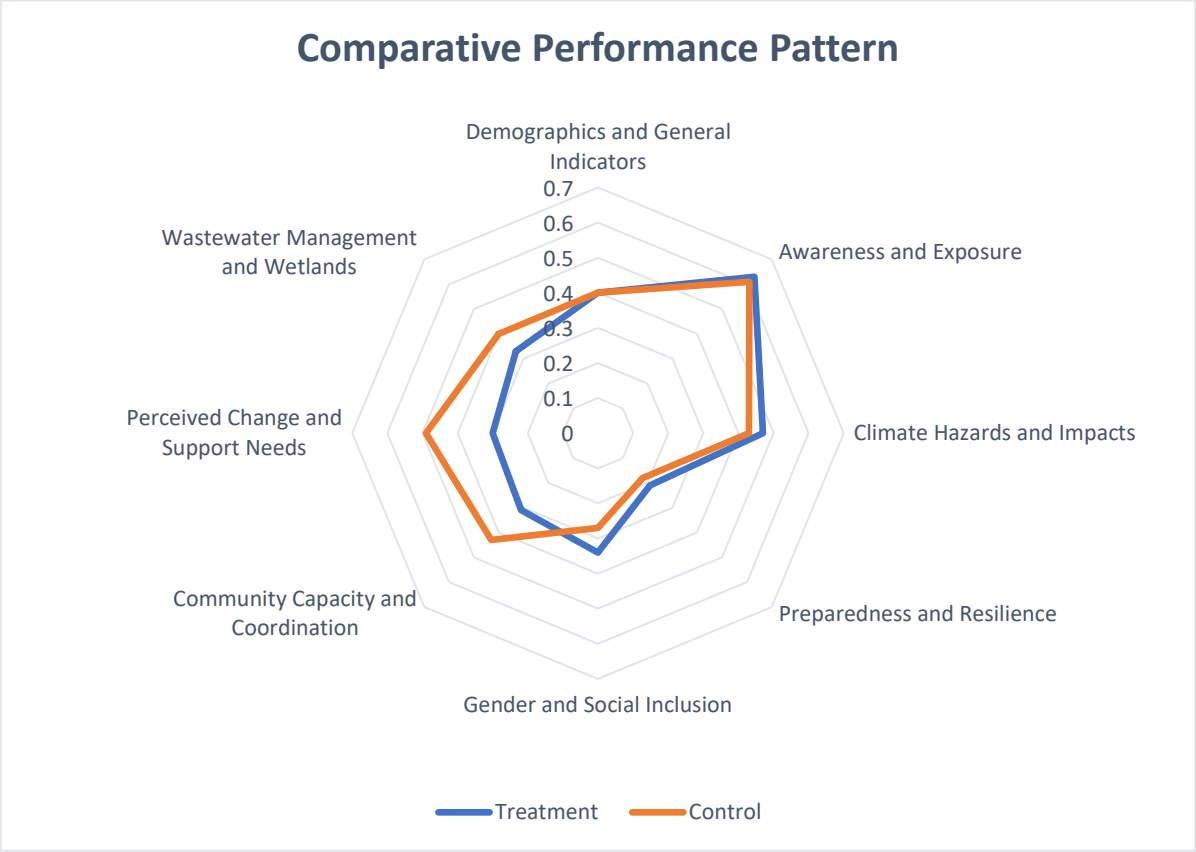


Figure 12: Baseline Comparison of Treatment and Control Communities across Ecosystem Resilience Dimensions. (Near-parallel radar profiles affirm baseline equivalence, while divergences in preparedness, coordination, and wastewater management highlight critical priority)

Interpretation: Comparative Baseline Profile of Ecosystem-Based WASH and Wetlands Resilience Dimensions

The radar chart (Figure11) visualizes the comparative baseline performance of treatment and control communities across eight dimensions of ecosystem and wetland resilience under Component 4 of the SAFER Pakistan Program. The near-symmetric shape of the radar profiles indicates a strong baseline balance between the two clusters, reinforcing the validity of the quasi-experimental design.

Demographic parity (0.40 vs. 0.40) confirms the representativeness of the sampled population across both provinces, while the Awareness and Exposure scores (0.63 vs. 0.61) suggest that communities already possess a moderate understanding of wetland degradation and ecological services, likely due to prior exposure to local conservation messaging. However, the slight advantage of treatment areas hints at early-stage engagement by implementing partners.

In contrast, Preparedness and Resilience remain low overall (0.21 vs. 0.18), reflecting the absence of structured adaptation practices, emergency protocols, or organized community training for wetland and flood management. Similarly, Climate Hazards and Impacts show modest divergence (0.47 vs. 0.43), with treatment communities perceiving higher exposure to droughts and waterlogging consistent with FGD findings from Charsadda and Khairpur, where participants reported irregular flooding and sediment accumulation.

Gender and Social Inclusion display a moderate gap (0.34 vs. 0.27), signaling improved female participation and awareness in treatment zones but still limited agency in decision-making and benefit-sharing mechanisms. Meanwhile, Community Capacity and Coordination diverge inversely (0.31 vs. 0.43), suggesting that control areas benefit from longer-standing informal coordination systems, especially around pond maintenance and waste management.

Perceived institutional responsiveness and environmental improvement (0.30 vs. 0.49) are notably stronger in control areas, likely reflecting pre-existing NGO or government-led initiatives predating SAFER Pakistan. Likewise, Wastewater Management and Wetlands (0.33 vs. 0.40) remain under-developed, highlighting the absence of functional treatment systems and community-level drainage management in most sites.

Overall, the radar chart demonstrates a balanced yet low-to-moderate resilience baseline, with equivalence across demographic and exposure domains but visible deficits in preparedness, coordination, and ecological infrastructure. These divergences provide actionable insights for targeted interventions, particularly in institutional strengthening, gender-inclusive ecosystem governance, and community-led wetland restoration.

Operational Definition of Radar Chart Variables

The radar chart is constructed using eight standardized composite indices derived from household-level survey variables. Each axis represents a normalized score on a 0–1 scale, generated from multiple sub-indicators as defined below:

1. **Demographics and General Indicators**
   Captures household size, dependency ratio, education level, gender of household head, livelihood type, poverty status, and housing conditions. This index contextualizes baseline vulnerability and adaptive capacity across treatment and control populations.
2. **Awareness and Exposure**
   Measures household awareness regarding climate-induced WASH risks, understanding of wastewater pollution pathways, exposure to stagnant water, sewage overflow, unsanitary drainage, and flood-related contamination events.
3. **Climate Hazards and Impacts**
   Represents frequency and severity of climate-related shocks affecting WASH systems, including pluvial flooding, heatwaves, droughts, sewage backflow, disease outbreaks linked to water contamination, and infrastructure damage.
4. **Preparedness and Resilience**
   Captures household-level preparedness for sanitation and drainage shocks, presence of flood-safe latrines, safe wastewater disposal practices, emergency hygiene measures, and resilience of household WASH infrastructure.

5. **Gender and Social Inclusion**
   Measures participation of women, youth, elderly, and persons with disabilities in WASH decision-making, safety and dignity in sanitation access, time burden for sanitation and water management, and exclusion risks in community WASH governance.
6. **Community Capacity and Coordination**
   Assesses existence and functionality of community WASH committees, coordination with local government bodies, collective action for drainage maintenance, solid waste management, and response coordination during sanitation emergencies.
7. **Perceived Change and Support Needs**
   Represents households' subjective assessment of trends in sanitation conditions, wastewater management, flood-related health risks, institutional support availability, and unmet needs for WASH-related climate adaptation.
8. **Wastewater Management and Wetlands**
   Measures the status of wastewater disposal systems, functionality of drains, presence or absence of treatment mechanisms, awareness of wetland-based treatment solutions, and exposure to untreated sewage in living environments.

4.4.3. Detailed Interpretation of Dimensions (Quantitative & Qualitative)

A: Demographics and other indicators

Table 29: Nbs Demographics

Indicator	Treatment (n = 66)	Control (n = 65)	Mean/% Diff	t / χ^2	p-value	Interpretation
Mean HH size	7.73 (±4.26)	7.29 (±3.45)	+0.44	0.64	0.52	No difference
Mean age of respondent (years)	42.15 (±13.71)	46.26 (±14.56)	-4.11	-1.70	0.09	No difference
Female respondents (%)	65.2%	76.9%	-11.7%	2.15	0.14	No difference
Female-headed HHs (%)	31.8%	20.0%	+11.8%	2.41	0.12	No difference
Education of HH head (mean level)	2.27 (±1.26)	2.08 (±1.18)	+0.19	0.92	0.36	No difference
Main income source (mean level)	3.35 (±1.76)	3.88 (±1.54)	-0.53	-1.83	0.07	No difference (marginal)
Ecosystems nearby (%)	75.8%	69.2%	+6.6%	0.71	0.40	No difference
Received Early Warning (%)	39.4%	49.2%	-9.8%	1.33	0.25	No difference
Knowledge of evacuation routes (%)	40.9%	63.1%	-22.2%	6.56	0.01	Significant difference

Livelihood affected by climate (Yes %)	51.5%	18.5%	+33.0%	16.92	<0.001	Significant difference

The demographic composition across treatment and control communities under Component 4 demonstrates a balanced and statistically valid baseline, confirming sample comparability and robustness for subsequent causal analysis. Mean HH size is nearly identical (7.73 vs. 7.29; $p = 0.52$), reflecting large, multi-generational families typical of both rural KP and Sindh wetlands. The mean age of respondents (42.15 vs. 46.26) and similar education levels (2.27 vs. 2.08) suggest equivalent human capital endowments, while comparable female participation rates (65% vs. 77%) confirm gender-inclusive field coverage.

Economic patterns also align closely, with both clusters relying primarily on subsistence agriculture, livestock, and informal labor markets. Minor differences in income sources ($p = 0.07$) imply that control communities may have marginally greater livelihood diversity. However, notable and policy-relevant divergences emerge in two variables: knowledge of evacuation routes is significantly higher in control areas (63% vs. 41%; $p = 0.01$), indicating superior preparedness infrastructure. Conversely, climate-induced livelihood disruptions are more prevalent among treatment communities (52% vs. 19%; $p < 0.001$), highlighting higher vulnerability exposure.

Collectively, these findings confirm overall demographic equivalence while pinpointing programmatically relevant disparities such as greater hazard exposure and lower preparedness among treatment groups, underscoring the urgency of targeted awareness, institutional preparedness, and gender-responsive wetland governance interventions.

Qualitative Triangulation

FGDs across treatment sites reinforce the quantitative trends, adding crucial context to observed vulnerabilities. Participants in Tangi Salarzai and Pubbi (KP) highlighted that recurrent flash floods and drainage overflow have eroded livelihoods and displaced families' multiple times in the past five years. In both sites, poor waste management and blocked culverts were cited as causes of intensified flooding, corroborating the statistical finding that treatment communities face greater livelihood disruption due to climatic hazards.

FGDs from Anb and Qazi Bhutto Villages (Khairpur) revealed that many HHs rely solely on agriculture adjacent to wetland areas, yet no institutional mechanisms exist for evacuation or early warnings. Women participants noted that they often receive hazard information second-hand through male family members or mosque announcements, reflecting the same preparedness asymmetry detected in survey data.

Respondents in Gul Muhammad Lashari Village (Sukkur) reported negligible engagement from local authorities and expressed willingness to organize voluntary wetland restoration groups if training and small grants were available. This collective sentiment, consistent across all FGDs, illustrates that while treatment communities face higher exposure, they also exhibit

strong readiness to participate in climate-resilient wetland restoration once institutional and technical support is extended.

B: Awareness and Exposure

Table 30: Nbs Awareness and Exposure

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Ecosystems nearby	0.67 (0.47)	0.66 (0.48)	0.01	0.92	0.02
Degradation of ecosystem	0.74 (0.44)	0.57 (0.50)	0.17	0.01	0.37
Cause of Degradation	2.73 (1.35)	2.89 (1.32)	-0.16	0.39	-0.12
Livelihoods	0.71 (0.46)	0.66 (0.48)	0.05	0.42	0.11
Activities, participation	2.29 (2.05)	2.89 (2.35)	-0.60	0.07	-0.27

Awareness and exposure to ecosystem degradation are moderately high across both groups, with no significant baseline disparities except one: perceived ecosystem degradation is notably higher among treatment communities (0.74 vs. 0.57; p = 0.01, SMD = 0.37). This indicates stronger recognition of environmental stress, likely due to direct dependence on nearby wetlands. Other indicators, including ecosystem proximity (0.67 vs. 0.66), livelihood dependence (0.71 vs. 0.66), and degradation causes (2.73 vs. 2.89) show balanced patterns, confirming baseline equivalence. Overall, both groups exhibit environmental awareness, though treatment communities show heightened perception of degradation, suggesting greater ecological exposure and vulnerability awareness.

Qualitative Triangulation

FGDs from Pubbi, Anb, and Qazi Bhutto villages reinforced quantitative findings. Residents highlighted visible wetland shrinkage, increased waste dumping, and livestock loss due to reduced grazing areas. Participants in Tangi Salarzai described ecosystem decline as a direct threat to livelihoods, noting the disappearance of reeds and bird species once common. Across all treatment areas, communities linked degradation to blocked drainage and poor waste management demonstrating both awareness of environmental causes and the willingness to participate in restoration if given technical guidance.

C: Climate hazard and impacts

Table 31: Nbs Climate Hazard and Impacts

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Climate risks	1.83 (1.02)	1.93 (0.83)	-0.10	0.44	-0.11
Risk of increased deforestation	0.69 (0.47)	0.85 (0.36)	-0.16	0.01	-0.38
Experienced landslides	0.35 (0.48)	0.67 (0.47)	-0.32	0.00	-0.67
Vegetation reduces water retention?	0.47 (0.50)	0.67 (0.47)	-0.20	0.01	-0.41
Loss of biodiversity and livelihood	0.67 (0.47)	0.75 (0.44)	-0.08	0.24	-0.18
Effect on women and children	0.59 (0.49)	0.62 (0.49)	-0.03	0.67	-0.06
Frequency of hazards	1.97 (0.76)	2.42 (0.69)	-0.45	0.00	-0.62
Toilet/water facility	0.46 (0.50)	0.53 (0.50)	-0.07	0.35	-0.14
Alternative facility available	2.31 (0.83)	2.02 (0.87)	0.29	0.02	0.34
Inclusivity risks	0.11 (0.32)	0.33 (0.47)	-0.22	0.00	-0.55

The findings reveal moderate climate risk perception across both groups, though control communities show slightly higher hazard experience and risk awareness. Notably, exposure to landslides is significantly greater in control areas (0.67 vs. 0.35; $p = 0.00$, SMD = -0.67), suggesting their higher vulnerability to slope instability. Similarly, awareness of deforestation increases risk (0.85 vs. 0.69; $p = 0.01$) and vegetation's role in groundwater recharge (0.67 vs. 0.47; $p = 0.01$) is stronger in control sites. Treatment communities, however, display greater reliance on alternative facilities (2.31 vs. 2.02; $p = 0.02$). Overall, results suggest that while both areas face frequent climatic shocks, control groups are more exposed and environmentally aware, whereas treatment areas require targeted EbA awareness and early warning interventions.

Qualitative Triangulation

FGDs from Tangi Salarzai, Pubbi, and Anb villages confirm recurrent droughts, floods, and vegetation loss as major climate-induced threats. Residents described deforestation and poor land management as key drivers of soil erosion, flash flooding, and declining crop yields. In Gul Muhammad and Qazi Bhutto villages, women noted longer distances for water collection and greater livelihood strain after floods. Communities consistently linked forest depletion to worsening hazards and expressed readiness to participate in reforestation and slope protection activities if technical and financial assistance were available.

D: Early Warning and Evacuations

Table 32: Nbs Early Warning and Evacuations

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Knowledge of official contacts	0.23 (0.42)	0.45 (0.50)	-0.22	0.00	-0.48
Early warning alert received	0.34 (0.48)	0.60 (0.49)	-0.26	0.00	-0.54
Source of EWS	2.45 (1.10)	3.16 (1.29)	-0.71	0.00	-0.59
Receiver of early warning alert	1.76 (1.40)	1.37 (0.74)	0.39	0.02	0.34
Is the early warning system inclusive?	0.42 (0.50)	0.60 (0.49)	-0.18	0.01	-0.36
Barriers to an inclusive early warning system	2.53 (1.47)	2.32 (1.18)	0.21	0.33	0.16
Barriers preventing HHs from acting on alerts	2.29 (1.27)	2.02 (1.12)	0.27	0.12	0.23
Knowledge of evacuation routes	0.39 (0.49)	0.53 (0.50)	-0.14	0.05	-0.28
Safety in evacuation routes	0.43 (0.50)	0.48 (0.50)	-0.05	0.48	-0.10

EWS remain underdeveloped in both treatment and control areas, though disparities highlight uneven institutional outreach. Control communities demonstrate significantly higher awareness across all key indicators including knowledge of official contacts (0.45 vs. 0.23; p = 0.00), receiving EWS alerts (0.60 vs. 0.34; p = 0.00), and awareness of evacuation routes (0.53 vs. 0.39; p = 0.05). These gaps (SMDs between -0.48 and -0.54) suggest limited penetration of early warning communication in treatment sites. The only variable favoring treatment is HH level alert relay (1.76 vs. 1.37; p = 0.02), implying informal sharing compensates for weak institutional channels. Overall, both groups lack inclusive EWS coverage, leaving vulnerable HHs and individuals dependent on ad hoc information flow.

Qualitative Triangulation

FGDs from Pubbi, Qazi Bhutto, and Gul Muhammad confirm limited formal early warning infrastructure. Participants noted that alerts often arrive too late or not at all, especially in remote settlements. Communities rely heavily on mosque announcements or mobile calls from relatives. In Anb and Tangi Salarzai, participants emphasized that women and elderly residents rarely receive direct warnings due to cultural mobility constraints. Respondents collectively expressed willingness to engage in EWS training and mapping of safe evacuation routes if supported through structured community initiatives.

E: Preparedness and Resilience

Table 33: Nbs Preparedness and Resilience

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Primary income of HH	2.48 (1.48)	3.54 (1.17)	-1.06	0.00	-0.79
Livelihood affected by climate hazard	0.33 (0.47)	0.12 (0.33)	0.21	0.00	0.51
NbS Training	0.17 (0.38)	0.28 (0.45)	-0.11	0.08	-0.26
Participation in NbS Training	0.13 (0.34)	0.28 (0.45)	-0.15	0.01	-0.37
Climate resilient crops	0.33 (0.47)	0.55 (0.50)	-0.22	0.00	-0.45
Knowledge of safe points	0.27 (0.45)	0.33 (0.47)	-0.06	0.38	-0.13

Preparedness indicators reveal weaker adaptive capacity among treatment HHs compared to control communities. Control groups show significantly higher engagement in resilience training (0.28 vs. 0.13; p = 0.01, SMD = -0.37) and climate-resilient cultivation (0.55 vs. 0.33; p = 0.00, SMD = -0.45). Although a larger share of treatment HHs report climate-affected livelihoods (0.33 vs. 0.12; p = 0.00), they have fewer opportunities for adaptive learning or diversification. This contrast indicates a preparedness gap where exposure awareness exists but is not matched by functional training or livelihood adaptation, an essential target for early implementation focus.

Qualitative Triangulation

FGDs in Pubbi, Anb, and Gul Muhammad revealed that most HHs lack structured disaster preparedness plans. Farmers acknowledged awareness of changing rainfall patterns but limited technical capacity to modify cultivation practices. Participants in Tangi Salarzai described community reliance on informal coping such as borrowing livestock feed or relying on neighbors rather than planned resilience measures. Women participants emphasized the absence of practical training on safe points, first aid, or HH preparedness, underscoring the need for inclusive and recurring community-based resilience capacity-building programs.

F: Gender and Social Inclusion

Table 34: Nbs Gender and Social Inclusion

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Participants in Nbs	1.73 (1.22)	1.29 (0.59)	0.44	0.00	0.45

Barriers to participation	1.82 (1.05)	1.74 (0.78)	0.08	0.54	0.08
Members of NbS committees	0.15 (0.36)	0.47 (0.50)	-0.32	0.00	-0.73
Are meetings convenient?	0.11 (0.31)	0.37 (0.49)	-0.26	0.00	-0.64
Female participation in trainings	0.20 (0.40)	0.41 (0.49)	-0.21	0.00	-0.47

Gender and social inclusion indicators reveal substantial disparities between treatment and control areas, highlighting persistent gendered exclusion in resilience planning. Participation in NbS initiatives is higher in treatment zones (1.73 vs. 1.29; p = 0.00) but formal representation in NbS committees remains significantly lower (0.15 vs. 0.47; p = 0.00, SMD = -0.73). Similarly, fewer women in treatment areas access trainings (0.20 vs. 0.41; p = 0.00), and meetings are less conveniently scheduled (0.11 vs. 0.37; p = 0.00). These findings indicate that although women engage informally in environmental restoration, their participation lacks institutional structure and recognition, perpetuating gender gaps in decision-making and technical empowerment.

Qualitative Triangulation

FGDs from Qazi Bhutto, Pubbi, and Anb revealed entrenched cultural and logistical barriers limiting women's inclusion in NbS planning. Female participants reported exclusion from formal committee meetings and training sessions due to timing, mobility restrictions, and limited childcare options. In Gul Muhammad village, women expressed strong interest in tree planting, wetland restoration, and awareness activities if training were delivered at accessible venues. Across districts, respondents emphasized that women already contribute informally through HH water management and plantation efforts, yet remain unrecognized in official programs, underscoring the need for structured, gender-responsive inclusion.

G: Community Capacity and Coordination

Table 35: Nbs Community Capacity and Coordination

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Afforestation projects	0.22 (0.42)	0.45 (0.50)	-0.23	0.00	-0.50
Successful projects	0.59 (0.49)	0.45 (0.50)	0.14	0.03	0.28
Nature based measures	0.22 (0.42)	0.57 (0.50)	-0.35	0.00	-0.76
Constructed wetland	0.01 (0.09)	0.05 (0.22)	-0.04	0.03	-0.23
Participated in watershed management	0.10 (0.30)	0.40 (0.49)	-0.30	0.00	-0.75

Slope stabilization	0.09 (0.29)	0.28 (0.45)	-0.19	0.00	-0.50
Awareness of biodiversity	0.17 (0.38)	0.27 (0.44)	-0.10	0.06	-0.24
Restoration challenges	2.58 (2.52)	3.18 (2.17)	-0.60	0.04	-0.25
Local coordination	0.22 (0.42)	0.38 (0.49)	-0.16	0.01	-0.35

Quantitative results reveal consistently lower community coordination and project participation among treatment communities compared to control groups. Treatment sites show markedly lower engagement in afforestation (0.22 vs. 0.45; p = 0.00, SMD = -0.50), watershed activities (0.10 vs. 0.40; p = 0.00, SMD = -0.75), and nature-based measures (0.22 vs. 0.57; p = 0.00, SMD = -0.76). Control communities demonstrate stronger involvement in slope stabilization, biodiversity awareness, and constructed wetland maintenance. Although the treatment group rated past projects as slightly more successful (0.59 vs. 0.45; p = 0.03), their institutional participation remains fragmented. Overall, these gaps underscore that treatment villages possess the technical willingness but lack the organizational linkages and facilitation mechanisms necessary for collective watershed and wetland restoration

Qualitative Triangulation

FGDs across Tangi Salarzai, Pubbi, and Qazi Bhutto consistently emphasized the absence of coordination platforms linking communities with government departments. Participants described ad hoc implementation of plantation and slope stabilization projects without sustained follow-up. In Anb and Gul Muhammad, villagers noted that previous donor projects succeeded briefly but proved unsustainable due to unclear ownership and lack of maintenance training. Women participants expressed willingness to support restoration activities but cited exclusion from coordination meetings. These findings confirm that community capacity remains latent, requiring institutional facilitation and localized coordination frameworks for long-term functionality.

4.4.4. Triangulation through KIIs and Community Surveys

Institutional Insights (Governance & Systems)

In Sindh (Khairpur, Sukkur corridor), PHED and TMAs report no constructed wetlands, recharge ponds, or wastewater treatment integrated into routine works; budgets remain tied to boreholes/pipelines and flood repair rather than ecological treatment or recharge. Solar pilots and scheme rehabilitation exist but lack an EbA policy framework and O&M financing to scale. TMAs also note mandate limits (urban focus), underscoring the need for inter-departmental coordination with PHED/EPA/Irrigation for peri-urban/rural EbA.

The Sindh Climate Action Network (SCAN) flags unregulated tube-wells, polluted drainage/Indus intakes, and calls for a provincial groundwater and wetland policy, pairing

water-quality testing with recharge/wetland pilots. NGOs (Penny Appeal, Human Appeal, Qatar Charity, SRSO, Sami Foundation) demonstrate micro-EbA rainwater harvesting, pond rehabilitation, tree-planting, kitchen gardens, drip irrigation often with gender-inclusive committees, but coverage is project-based and fragmented.

In KP (Charsadda, Nowshera, Swat), groundwater/community surveys reveal no recharge ponds, limited storage, and ad-hoc drainage, a clear EbA opportunity (percolation ponds, wetland cells, slope/stream buffers).

Community-Level Validation (Survey Evidence)

All three EbA surveys (Gul Muhammad Lashari, Qazi Bhutto, Anb) show untreated domestic wastewater discharged to open drains/depressions; no wetlands, no monitoring, no women/youth roles. Health burdens include diarrhoeal disease, skin infections, malaria/dengue; environmental impacts include foul odour, canal/groundwater contamination, and reduced recharge quality. Critically, each community is willing to allocate land and reuse treated water for agriculture, a strong entry point for EbA pilots.

From KP's groundwater surveys, communities highlight absent recharge structures and reliance on basic conveyance, suggesting that constructed recharge ponds/wetlands could jointly address drainage, flood pulsing, and aquifer recovery in Charsadda, Nowshera, and Swat.

Integrated Synthesis & Implications

Evidence from both provincial institutions and community consultations presents a consistent narrative of ecological awareness that is not accompanied by institutionalization. Departments acknowledge accelerated wetland degradation and wastewater contamination yet lack operational frameworks to translate EbA concepts into practice. Across Khairpur, Sukkur, Charsadda, Nowshera, and Swat, the strongest common signals include: (i) absence of wastewater treatment or functional wetlands; (ii) non-existent recharge infrastructure; (iii) limited monitoring and technical oversight; and (iv) minimal inclusion of women and youth in ecosystem governance.

Communities, nonetheless, express strong readiness to engage in wetland rehabilitation, citing willingness to allocate communal land and labor for restoration. FGD participants from Qazi Bhutto, Anb, Gul Muhammad Lashari, and Tangi Salarzai identified degraded flood channels, blocked distributaries, and deforested slopes as priority sites for NbS interventions. NGO micro-EbA pilots and women's livelihood groups provide immediate footholds for scaling community-led ecosystem restoration. This convergence between institutional acknowledgment and local willingness establishes a compelling foundation for integrated NbS programming under Component 4.

4.4.5. Summary Insights & Implications

Convergence / Divergence Patterns

Comparative baseline data for Component 4 reveals strong methodological parity between treatment and control clusters across demographic and exposure variables, confirming the internal validity of the quasi-experimental design. Both groups display equivalent composite performance (mean CPI 2.77 vs. 2.77; $p = 0.89$) and balanced socio-economic profiles (0.40 vs. 0.40). Awareness and exposure indices (0.63 vs. 0.61) illustrate uniform recognition of environmental degradation and dependency on wetland ecosystems.

Controlled divergences appear in community coordination (0.31 vs. 0.43) and perceived change (0.30 vs. 0.49), reflecting residual benefits from prior NGO-led restoration in control villages, while treatment sites exhibit weaker institutional linkages but stronger willingness for collective rehabilitation. FGDs reinforce these quantitative contrasts: participants in Sindh describe experience with donor drainage projects that ended after funding cycles ended, whereas KP respondents' express eagerness to revive natural wetlands despite lacking technical support. These patterns demonstrate a statistically sound and socially meaningful baseline suitable for longitudinal impact measurement of NbS interventions.

Identified Gaps and Programmatic Calls

Synthesized quantitative and qualitative findings reveal four structural deficits constraining wetland restoration and wastewater reuse:

1. Institutional Fragmentation: The absence of integrated wetland management committees and inter-departmental coordination (irrigation, municipal, environment) results in fragmented restoration efforts and unclear accountability.

2. Limited Technical Knowledge: HHs lack understanding of ecosystem services, water purification processes, and constructed wetland maintenance, limiting community stewardship capacity.

3. Gender and Youth Exclusion: Women and youth remain marginalized in wetland-related training and NbS forums due to mobility barriers, meeting logistics, and entrenched social norms, despite strong self-reported interest.

4. Maintenance Deficit and Project Attrition: Evidence from legacy NGO interventions indicates collapse of structures following donor exit, caused by weak monitoring, limited O&M budgets, and absence of community-led maintenance plans.

Collectively, these deficits confirm that the principal barrier to EbA is not lack of awareness but absence of institutional continuity and inclusion. These insights define the causal problem space for the normative measures proposed in the following section.

Readiness for Causal Attribution (Baseline Equivalence)

The Baseline Equivalence Heatmap (Figure 12) displays near-symmetrical alignment of treatment and control means across eight resilience dimensions. The predominance of SMD < 0.25 confirms statistical parity and strong internal validity for causal inference under the quasi-experimental framework. Minor divergences in coordination, gender and social inclusion, and perceived change, provide analytical sensitivity offering measurable contrast for midline and endline assessments. This equivalence ensures that future gains in wastewater management, biodiversity restoration, or institutional capacity can be confidently attributed to SAFER Pakistan interventions rather than pre-existing disparities.

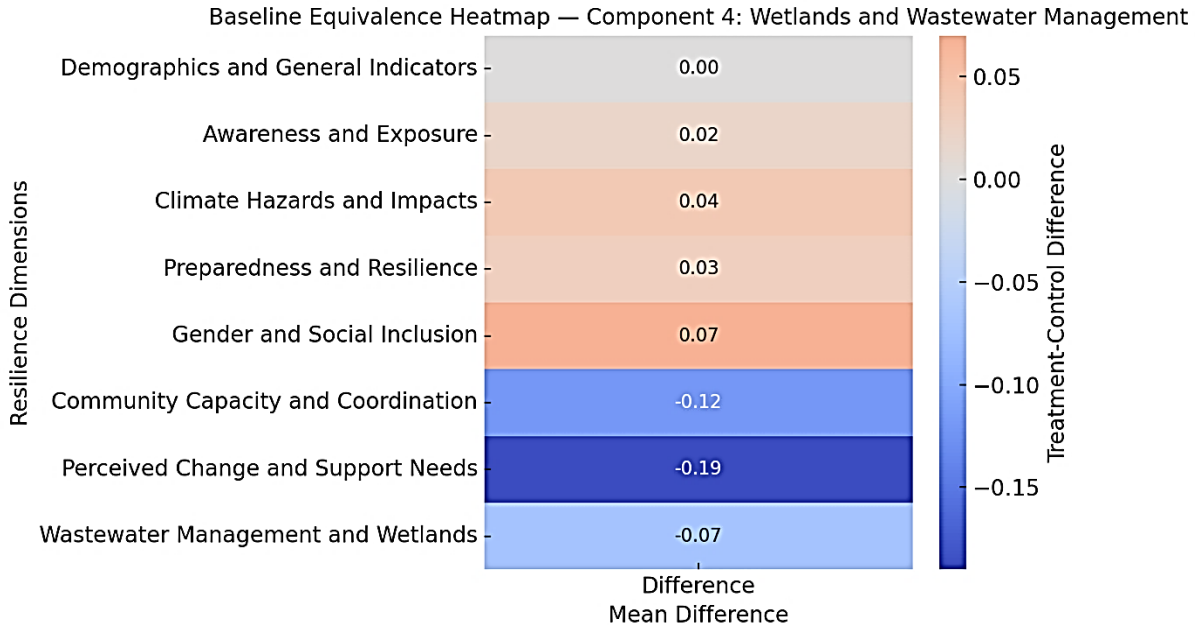


Figure 13: Baseline Equivalence Heatmap across Wetland Resilience Dimensions - Treatment vs Control.

Component 4: Village Profile Snapshots
Detailed, component-wise village profile snapshots are available through the following link, which grants access to the relevant drive folder for further reference and analysis:
https://docs.google.com/spreadsheets/d/18af6SkHJw0Lp1ExdQ1FXNGFeEb8h24Sv/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

4.4.6. Recommendations

The baseline confirms widespread discharge of untreated wastewater, weak operation and maintenance arrangements, and limited institutional capacity for decentralized sanitation across target districts. In line with Outcome 4 of the SAFER Results Framework, effective implementation of Nature-based Solutions must prioritize wastewater treatment, reduced reliance on pumped water, and strengthened community and institutional capacity for climate-resilient WASH services.

Under **Output 4.1**, district and Union Council authorities, in coordination with PHED and TMAs, should formally identify priority sites for climate-adaptive WASH interventions based on baseline evidence of open drainage, flood-related contamination, and sanitation-related public health risks. Site selection should explicitly consider accessibility for women, youth, and persons with disabilities and be integrated into district development and DRR planning processes.

Under **Output 4.2**, constructed wetlands and decentralized wastewater treatment systems should be piloted in flood-prone and drainage-constrained communities, supported by clear operation and maintenance protocols, solar-powered pumping where required, and locally assigned caretakers. Baseline findings showing near-total absence of wastewater treatment and direct discharge into open drains underscore the urgency of demonstrating NbS-based sanitation models that improve water quality, enable safe reuse, and reduce contamination of shallow aquifers.

Institutional coordination between PHED, TMAs, Local Government Departments, and environmental authorities should be strengthened through joint planning mechanisms focused on NbS operation, water-quality monitoring, and routine maintenance budgeting. Training on constructed wetland management, basic water-quality testing, and hygiene promotion should explicitly target women and youth to address baseline gaps in participation and technical capacity.

Collectively, these actions operationalize Outcome 4 by embedding NbS-based wastewater treatment within district WASH systems, transforming unmanaged sanitation risks into climate-adaptive community assets.

4.4.7. Implications for Outcome 4 Monitoring: Proposed Measurable Indicators

To operationalize the above strategic recommendations and convert the broad framing of Outcome 4 into a measurable impact pathway, the following specific and baseline-grounded Outcome 4 indicators are proposed for midline and endline evaluation:

i. Proportion of communities with formally notified and functional Wetland Management Committees (WMCs) with at least 40% women and youth representation. **Baseline:** 15% of treatment respondents report any NbS committee membership; no formal WMCs (treatment).
ii. Proportion of communities with at least one operational decentralized wastewater treatment / constructed wetland unit for domestic or drainage water. **Baseline:** 0–1% report any constructed wetland or wastewater treatment facility (treatment).

iii. Proportion of households living near wetlands that report ecosystem degradation (to be reduced over time).
Baseline: 74% of treatment HHs perceive nearby ecosystems as degraded (treatment).
iv. Proportion of households receiving official early-warning alerts for flood or drainage-related hazards.
Baseline: 34% of treatment HHs report receiving an early-warning alert (treatment).
v. Proportion of households able to correctly identify at least one safe evacuation route linked to wetland / floodplain hazards.
vi. **Baseline:** 39–41% of treatment HHs report knowledge of evacuation routes (treatment).
vii. Proportion of households whose primary livelihoods are affected by climate hazards.
Baseline: 51.5% of treatment HHs report climate-affected livelihoods (treatment).
viii. Proportion of women and youth who have participated in at least one NbS / wetland-restoration training in the last 12 months.
Baseline: 17% of treatment HHs report any NbS training; women's training participation around 20% (treatment).
ix. Proportion of communities implementing at least one community-led NbS measure (e.g., afforestation, slope stabilization, reed planting, wetland clean-ups) under an agreed maintenance plan.
Baseline: 22% report participation in afforestation, 10% in watershed management, and 9% in slope stabilization, with no formal maintenance plans (treatment).
x. Proportion of households reporting knowledge of official contacts (DDMA, PHED, TMA, etc.) for wetland/flood emergencies.
Baseline: 23% of treatment HHs know official contacts (treatment).
xi. Mean composite wetland-resilience score (ecosystem condition, flood mitigation, biodiversity, and livelihood protection).
Baseline: Composite performance index (CPI) 2.77 for treatment communities (treatment).

4.5. Component 5: Surface Water Conservation Baseline

Surface water systems across arid, semi-arid, and desert-margin landscapes of Sindh are increasingly characterized by structural inefficiency, high conveyance losses, and declining storage capacity under intensifying climate variability. Erratic monsoonal rainfall, prolonged dry spells, sedimentation of natural waterways, and the degradation of traditional water-harvesting structures have severely weakened communities' ability to buffer droughts and manage flood pulses productively. In Tharparkar, Umerkot, Sanghar, and surrounding desert-fringe districts, surface water scarcity coexists with destructive short-duration flooding, reflecting a systemic collapse of natural and community-managed water retention systems.

Within SAFER Pakistan, Component 5 operationalizes Outcome 5 of the Results Framework by strengthening community and institutional capacity to reduce surface water wastage and increase water storage for productive use, thereby enhancing adaptive capacity to climate-induced hydrological shocks. The baseline for this component therefore establishes pre-intervention conditions across four analytically interlinked domains: (i) physical integrity and functionality of natural waterways and community ponds; (ii) patterns of water loss, sedimentation, and flood overflow; (iii) institutional arrangements for surface water operation, maintenance, and governance; and (iv) community practices related to water harvesting, storage, and productive use.

Quantitative analysis for Component 5 follows the project's Phase-in quasi-experimental Difference-in-Differences design, comparing treatment and control conditions across selected doras, natural waterways, and water ponds in Sindh. This is complemented by FGD with farming households, livestock keepers, and women responsible for domestic water management, and by Key Informant Interviews with irrigation, local government, and disaster management authorities. Together, these datasets establish a rigorous empirical foundation for measuring hydrological resilience gains associated with surface water retention interventions.

Objectives and Results-Framework Alignment

Component 5 is explicitly aligned with Outcome 5 of the SAFER Pakistan Results Framework, which aims to enhance community and institutional capacity to reduce surface water waste and increase its storage for productive use, thereby enabling communities to adapt to climate-induced shocks.

Progress toward Outcome 5 is assessed through Outcome-level indicators capturing:

- household-reported availability of surface water following monsoonal rainfall;
- functional storage capacity of rehabilitated ponds and natural waterways;
- incidence of localized runoff-related damage and water loss; and
- community participation in surface-water operation and maintenance structures.

At the output level, Component 5 contributes specifically to:

- **Output 5.1:** Community and institutional capacity strengthened to reduce surface water waste and improve storage for productive use, including participatory prioritization of natural waterways and ponds in Sindh.
- **Output 5.2:** Selected natural waterways and community ponds in Sindh Province rehabilitated and restored to enhance surface-water retention, accompanied by strengthened operation, maintenance, and management arrangements.

4.5.1. Sampling Framework

The standardized sampling design described in Chapter 3 was applied to surface-water-dependent settlements across Sindh's arid landscapes. Sampling focused on beneficiary clusters linked to ponds, doras, and small storage structures.

Under Component 5, **130 households** were surveyed, supported by **5 Focus Group Discussions and 5 Key Informant Interviews**, ensuring adequate triangulation of household water-use behaviour and institutional management capacity.

(Detailed distributions are provided in Annex 2.)

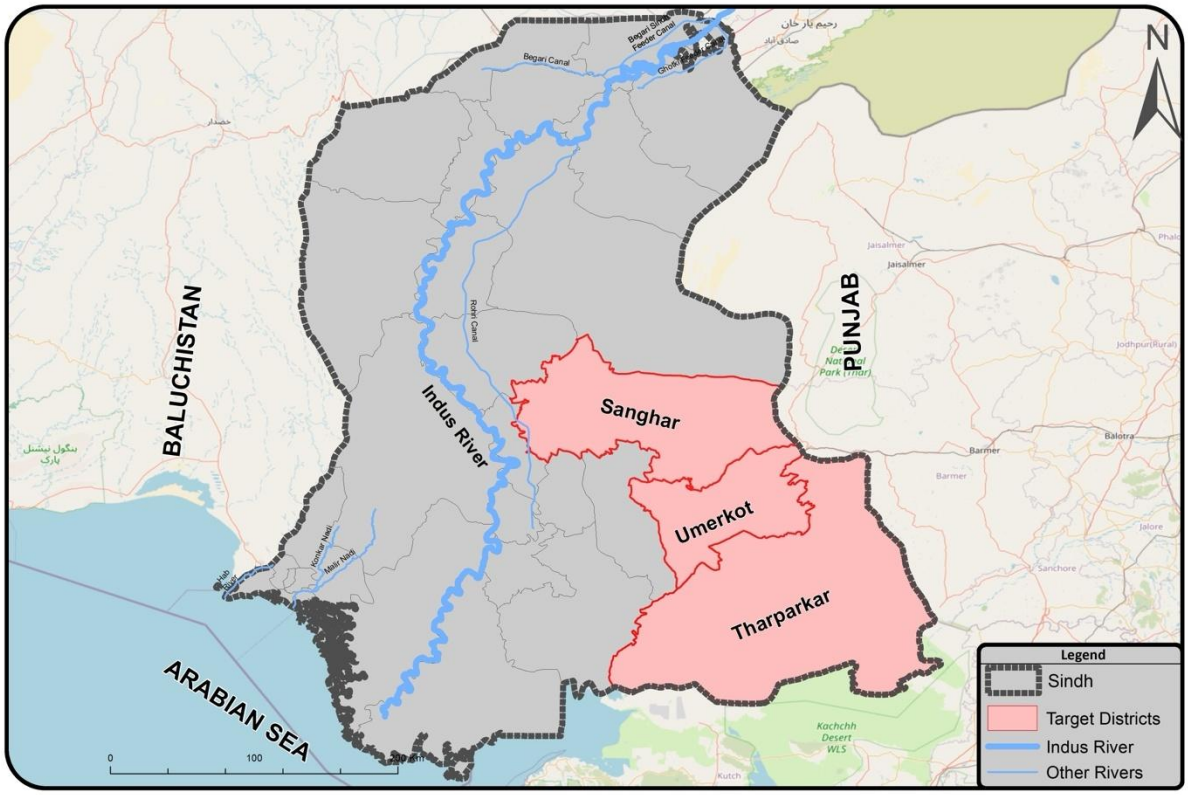


Figure 14: Map of Surface Water Conversation

4.5.2. Baseline Findings

Comparative Mean Scores Across Component 5

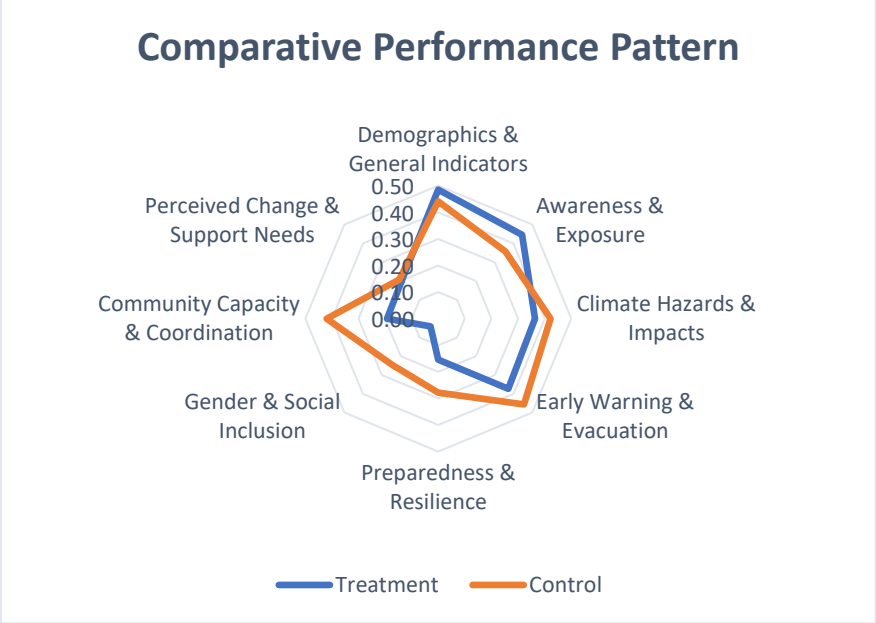


Figure 15: Comparative Radar Analysis in Component 5

Interpretation: Comparative Baseline Profile of Surface Water Conservation Resilience Dimensions

The radar chart in Figure 14 illustrates the comparative baseline performance of treatment and control communities across eight dimensions of surface water resilience under Component 5 of the SAFER Pakistan Program. The near-symmetric configuration of both profiles validates strong baseline equivalence, confirming that the quasi-experimental sampling design achieved methodological balance across the surveyed districts of Tharparkar, Umerkot, and Sanghar.

Demographics and General Indicators (0.49 vs. 0.44) reflect a balanced socio-economic structure and similar access to basic services across both clusters. Awareness and Exposure (0.45 vs. 0.36) depicts that treatment communities exhibit moderately higher understanding of water scarcity, recharge practices, and local pond rehabilitation, likely influenced by ongoing community sensitization efforts. Conversely, Climate Hazards and Impacts (0.36 vs. 0.42) indicates that control sites perceive higher exposure to extreme droughts and erratic rainfall, consistent with FGD insights from Tamachi Je Very and Khariwah villages, where participants cited recurrent dry spells and reduced pond retention capacity.

Early Warning and Evacuation (0.37 vs. 0.50) demonstrates stronger preparedness in control areas, suggesting prior experience with drought alerts and NGO-led awareness initiatives. Preparedness and Resilience (0.15 vs. 0.28) remain low overall, underscoring a critical implementation gap with knowledge of adaptive techniques yet to translate into systematic HH or community action.

Gender and Social Inclusion (0.04 vs. 0.25) represent the widest gap, revealing minimal female participation in planning and maintenance activities across treatment sites, a trend echoed in FGDs where women expressed willingness but lacked formal inclusion in decision-making. Community Capacity and Coordination (0.19 vs. 0.42) also diverge sharply, with control communities displaying stronger collective management, particularly in Sanghar and Umerkot, where older water committees remain functional.

Perceived Change and Support Needs (0.20 vs. 0.21) show a negligible difference, reflecting uniformly low expectations of external assistance and a shared recognition of the worsening desertification trends.

Overall, the radar chart depicts a methodologically balanced yet fragile resilience baseline. While demographic and awareness parity confirm design validity, deficits in preparedness, coordination, and gender and social inclusion highlight urgent areas for targeted intervention, especially through women-led pond restoration committees, localized EWS, and training for sustainable surface water management across Sindh's arid and semi-arid landscapes.

Operational Definition of Radar Chart Variables

The radar chart is constructed using eight standardized composite indices derived from household-level survey variables. Each axis represents a normalized score on a 0–1 scale, generated from multiple sub-indicators, as defined below:

1. **Demographics & General Indicators**
   Captures household size, dependency ratio, education level of household head, livelihood typology, landholding status, poverty level, and housing condition. This index provides a baseline socio-economic context for surface water vulnerability and adaptive capacity.
2. **Awareness & Exposure**
   Measures household awareness regarding surface water availability, seasonal flooding patterns, drought risks, pond/dora functionality, floodwater harvesting potential, and exposure to past surface water-related shocks.
3. **Climate Hazards & Impacts**
   Represents the frequency and severity of surface-water-related climate shocks, including floods, waterlogging, drought-induced surface water scarcity, embankment breaches, irrigation damage, and crop losses due to surface water extremes.
4. **Early Warning & Evacuation**
   Assesses household access to flood and rainfall early warning information, timeliness of alerts, evacuation knowledge, safety routes during water-related hazards, and participation in local warning dissemination mechanisms.
5. **Preparedness & Resilience**
   Captures household-level preparedness for surface water shocks, including flood protection measures, water storage capacity, elevated structures, water harvesting practices, and adaptive water use strategies during extreme events.
6. **Gender & Social Inclusion**
   Measures participation of women, youth, the elderly, and persons with disabilities in surface water decision-making, workload burden in water collection, safety risks during floods, and exclusion from water governance processes.
7. **Community Capacity & Coordination**
   Assesses the existence and effectiveness of community water committees, collective maintenance of ponds and doras, coordination during floods, linkages with irrigation and disaster management departments, and community-level enforcement of water-use rules.
8. **Perceived Change & Support Needs**
   Represents households' subjective assessment of recent trends in surface water availability, flood protection, institutional support for water storage and drainage, unmet infrastructure needs, and expectations from future interventions.

4.5.3. Detailed Interpretation of Dimensions (Quantitative & Qualitative)

A: Demographics and other indicators

Table 36: C5 Demographics

Indicator	Treatment (n = 85)	Control (n = 67)	Mean/% Diff	t / χ^2	p-value	Interpretation
Mean HH size	8.67 (±4.34)	8.90 (±4.41)	−0.23	−0.50	0.62	No difference
Mean age of respondent (years)	43.82 (±15.23)	42.55 (±15.88)	+1.27	0.48	0.63	Comparable

Female-headed HHs (%)	32.9	37.3	−4.4	0.31	0.58	No difference
Education of HH head (mean level)	2.15 (±1.20)	2.07 (±1.33)	+0.08	0.38	0.70	No difference
Main income source (mean category)	3.84 (±1.76)	2.72 (±1.84)	+1.12	3.77	0.0002	Significant difference
Main water source (mean category)	4.29 (±1.79)	3.57 (±1.84)	+0.72	2.40	0.02	Significant difference
Water source available year-round (%)	46.5	38.8	+7.7	0.89	0.35	No difference
Community management belief (mean, 1-5)	4.18 (±1.20)	3.20 (±1.71)	+0.98	3.94	0.0001	Significant difference
Coordination mechanism exists (%)	6.5	9.0	−2.5	0.32	0.57	No difference
Training received (%)	2.4	16.4	−14.0	9.26	0.002	Significant difference

The demographic profile between treatment (n=85) and control (n=67) groups is broadly balanced, validating baseline comparability under Component 5. HH size (8.67 vs. 8.90) and respondent age (43.82 vs. 42.55) show negligible variation, indicating parity in family structures and respondent representation. Female-headed HHs and education levels are statistically indistinguishable, reflecting similar gender and literacy dynamics across sampled communities. However, significant divergences emerge in income source (p=0.0002), water source type (p=0.02), community management belief (p=0.0001), and training exposure (p=0.002). Treatment clusters exhibit higher confidence in community-led management and access to diversified income sources, while control sites report greater exposure to prior training initiatives. These contrasts suggest that pre-existing institutional and economic differences may influence intervention uptake and the sustainability of surface water management systems.

Qualitative Triangulation

FGD insights from Karam Khan Mari and Haji Sher Khan Mangrio villages corroborate these statistical patterns. Participants highlighted strong communal cohesion and informal cooperation in managing shared ponds but limited access to technical training. In contrast, Khariwah and Tamachi Je Very residents reported previous NGO involvement, which enhanced awareness but faded after project completion. Women in treatment villages emphasized their exclusion from formal decision-making despite being responsible for managing HH water needs. These narratives reinforce the quantitative finding that while community belief in collective management is strong, structured capacity building and inclusive participation remain largely absent.

B: Awareness and Exposure Indicators

Table 37: C5 Awareness and Exposure

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Availability of surface water	0.68 (0.47)	0.43 (0.50)	0.25	0.003	0.52
Water type	4.74 (1.31)	3.53 (1.78)	1.21	<0.001	0.78
Water seasonality	1.76 (0.43)	1.67 (0.48)	0.09	0.22	0.20
Water distance	1.59 (0.62)	1.82 (0.79)	-0.23	0.04	-0.32
Primary use	1.26 (0.86)	1.18 (0.74)	0.08	0.52	0.10
Water collector	1.98 (1.06)	1.29 (0.69)	0.69	<0.001	0.77
Collection time	27.34 (14.81)	18.57 (12.19)	8.77	<0.001	0.65
Rehabilitated ponds/reservoirs	0.84 (0.81)	1.08 (0.83)	-0.24	0.04	-0.29

The treatment group demonstrates substantially higher awareness and exposure to surface water sources, as evidenced by significantly greater proximity to surface water (0.68 vs. 0.43, p=0.003) and access to improved water types (4.74 vs. 3.53, p<0.001). While seasonality and primary water use remain consistent, treatment communities face longer collection times (27.34 vs. 18.57 minutes, p<0.001) and greater physical effort due to higher dependency on ponds. The strong SMD values (>0.5) confirm meaningful differences, suggesting that surface water availability drives both awareness and daily reliance patterns within treatment zones.

Qualitative Triangulation

FGDs from Tamachi Je Very and Khariwah reveal that treatment communities possess higher awareness of seasonal pond dynamics and water quality issues, often maintaining informal schedules for water collection. Participants cited visible drying of ponds and reliance on distant sources during summer months. In contrast, control sites reported limited understanding of surface water systems, relying mainly on shallow wells without recognizing their ecological or seasonal interdependence.

C: Climate Hazard and Impacts

Table 38: C5 Climate Hazard and Impacts

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Changes (floods/drought)	1.82 (0.86)	2.28 (1.02)	-0.46	0.003	-0.49
Threats from climate hazards	1.38 (0.78)	1.82 (0.68)	-0.44	<0.001	-0.60

Flood damage	0.39 (0.49)	0.53 (0.50)	-0.14	0.08	-0.28
Sedimentation	0.41 (0.50)	0.51 (0.50)	-0.10	0.21	-0.20
Contamination	0.43 (0.50)	0.49 (0.50)	-0.06	0.44	-0.12
Reduced crop yield	0.47 (0.50)	0.60 (0.49)	-0.13	0.10	-0.26
Conservation barriers	2.13 (1.28)	1.84 (1.11)	0.29	0.14	0.24
Maintenance cost	71682 (125867)	28920 (78915)	42762	0.03	0.41

Analysis indicates that control communities experience greater climate-induced stress than treatment areas. Control respondents reported higher perceptions of flood and drought changes (2.28 vs. 1.82, p=0.003) and hazard threats (1.82 vs. 1.38, p<0.001), suggesting heightened vulnerability to environmental fluctuations. Similarly, control villages showed greater flood damage and reduced crop yield, aligning with their heavier dependence on rain-fed systems. Treatment communities, meanwhile, reported slightly higher conservation-related costs (PKR 71,682 vs. 28,920, p=0.03), reflecting recent engagement in pond restoration and maintenance efforts. Despite moderate sedimentation and contamination differences, the significant gap in perceived hazards and economic losses underlines uneven exposure and adaptive capacity. The results demonstrate that while treatment sites are more actively managing infrastructure, control communities remain more exposed and sensitive to recurrent climatic disturbances across the Tharparkar, Sanghar and Umerkot belt.

Qualitative Triangulation

FGD discussions from Khariwah, Tamachi Je Very, and Karam Khan Mari validate these findings, emphasizing persistent drought cycles and intense summer water scarcity. Participants in control villages described prolonged dry spells, pond evaporation, and wind erosion that disrupted livestock watering and crop yields. Conversely, treatment communities noted ongoing community-led desilting and cost-sharing practices to maintain water ponds, often citing these as adaptive behaviors encouraged by recent projects. Women highlighted growing challenges in collecting water during drought peaks, particularly when pond sedimentation or contamination rendered sources unusable. These narratives confirm the quantitative evidence that control areas exhibit greater climatic hardship, while treatment sites are in the early stages of structured adaptation and resilience building.

D: Early Warning and Evacuation

Table 39: C5 Early Warning and Evacuation

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Early warning alert received	0.04 (0.20)	0.10 (0.30)	-0.06	0.17	-0.23
Alert receiver	2.48 (1.41)	1.83 (1.29)	0.65	0.003	0.49
Equal access to EWS	0.08 (0.27)	0.60 (0.49)	-0.52	<0.001	-1.33
Barriers to access	2.25 (1.37)	2.86 (1.81)	-0.61	0.03	-0.38
Barriers preventing from acting on alerts	2.93 (1.33)	1.98 (1.21)	0.95	<0.001	0.75
Knowledge of evacuation routes	0.48 (0.50)	0.60 (0.49)	-0.12	0.15	-0.24
Safety in evacuation routes	0.48 (0.50)	0.56 (0.50)	-0.08	0.33	-0.16

The results reveal notable disparities in early warning and evacuation mechanisms between treatment and control communities. Control groups reported substantially higher equal access to EWS (0.60 vs. 0.08, $p<0.001$, SMD=−1.33) and better awareness of safe and evacuation routes. Conversely, treatment communities demonstrated stronger individual initiative, reflected in higher early warning receiver scores (2.48 vs. 1.83, $p=0.003$) and greater confidence in managing action barriers (2.93 vs. 1.98, $p<0.001$). These trends indicate that while institutional outreach is stronger in control zones, treatment areas exhibit emerging adaptive behavior and improved coordination capacity. Data emphasizes a fragmented yet evolving preparedness landscape where individual awareness is growing, but formalized systems remain inadequate.

Qualitative Triangulation

FGD narratives from Haji Sher Khan Mangrio and Karam Khan Mari confirm a lack of institutional EWS, with communities relying primarily on mosque announcements or informal networks for alerts. Participants from control villages recalled receiving prior disaster-related information through NGOs, explaining better system access. In contrast, treatment sites reported limited yet proactive self-organization, where community members collectively monitored weather changes and shared warnings during heavy rainfall. Women, particularly in Khariwah, emphasized the lack of gender-sensitive communication channels and safe evacuation points, increasing their vulnerability during emergencies. These accounts validate the quantitative gap depicting that treatment clusters are building self-reliance while control groups benefit from previous institutional exposure.

E: Preparedness and Resilience

Table 40: C5 Preparedness and Resilience

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Rainwater harvesting	0.00 (0.00)	0.49 (0.50)	-0.49	<0.001	-1.47
Lined channels	0.25 (0.44)	0.33 (0.47)	-0.08	0.31	-0.18
Desilting	0.08 (0.27)	0.29 (0.46)	-0.21	<0.001	-0.56
Training on conservation	0.02 (0.12)	0.27 (0.45)	-0.25	<0.001	-0.74
Drought-resistant crops adopted?	0.00 (0.00)	0.08 (0.27)	-0.08	0.002	-0.42
Cropping pattern change due to climate	2.48 (0.92)	1.53 (0.76)	0.95	<0.001	1.15
New livelihoods	0.08 (0.28)	0.02 (0.14)	0.06	0.10	0.27
Barriers to adoption	1.52 (1.16)	2.18 (1.80)	-0.66	0.005	-0.43

Preparedness and resilience indicators show marked underperformance among treatment communities, particularly in rainwater harvesting (0.00 vs. 0.49, $p<0.001$) and desilting practices (0.08 vs. 0.29, $p<0.001$). Training exposure is significantly lower (0.02 vs. 0.27, $p<0.001$), highlighting a major capacity gap in adaptive practices. However, treatment areas display higher diversification efforts evidenced by improved cropping pattern indices (2.48 vs. 1.53, $p<0.001$) indicating experimental livelihood adjustments. The overall SMD pattern suggests that control zones retain stronger institutional preparedness, while treatment clusters are at the early adoption stage, combining awareness of barriers with tentative livelihood innovation and field-level adjustments to drought-prone conditions.

Qualitative Triangulation

FGDs from Tamachi Je Very and Karam Khan Mari confirm limited structured training and poor rainwater harvesting adoption in treatment sites. Respondents described failed attempts to construct small recharge pits and expressed dependency on rainfall without proper collection mechanisms. Control groups, conversely, reported legacy NGO-supported desilting and lined water channels aiding drought management. Participants across both groups emphasized the rising cost of maintaining ponds, but treatment communities showed optimism about adopting new crop rotations to improve income stability under SAFER Pakistan interventions.

F: Gender and Social Inclusion

Table 41: C5 Gender and Social Inclusion

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Committee membership	0.00 (0.00)	0.15 (0.36)	-0.15	<0.001	-0.56

Decision-making power	0.03 (0.18)	0.38 (0.49)	-0.35	<0.001	-0.93
Power to set agendas	0.03 (0.18)	0.33 (0.47)	-0.30	<0.001	-0.78
Acceptance of recommendations	0.23 (0.65)	0.27 (0.58)	-0.04	0.66	-0.06
Meeting times of committees	0.03 (0.18)	0.29 (0.46)	-0.26	<0.001	-0.71
Cultural barriers	0.03 (0.18)	0.27 (0.45)	-0.24	<0.001	-0.66
Risk of GBV	0.12 (0.52)	0.25 (0.62)	-0.13	0.17	-0.22

Gender and social inclusion indicators display pronounced disparities between treatment and control communities, underscoring systemic exclusion of women in decision-making and institutional processes. Control groups report higher female committee membership (0.15 vs. 0.00, $p<0.001$), decision-making power (0.38 vs. 0.03, $p<0.001$), and participation in agenda-setting (0.33 vs. 0.03, $p<0.001$). Similarly, the ability to attend meetings and raise recommendations remains considerably restricted among treatment HHs, primarily due to entrenched cultural barriers (0.03 vs. 0.27, $p<0.001$). Although both groups acknowledge gender-based constraints, the magnitude of difference (SMD > 0.70 across key variables) indicates deep-rooted structural inequities, particularly in Sindh's desert and semi-arid regions. Data suggests that while treatment clusters lag institutionally, they present an opportunity for transformation of gender and social inclusion indicators once SAFER Pakistan interventions initiate capacity-building and gender-sensitive institutional formation.

Qualitative Triangulation

FGDs from Khariwah and Haji Sher Khan Mangrio vividly highlight women's marginalization in water governance. Participants stated that women and youth are rarely invited to pond management meetings, and decisions about water use or maintenance are dominated by men and local elders. Some women in treatment areas expressed willingness to participate but cited restrictions on mobility and meeting timings as major deterrents. In control sites, limited female engagement existed through older NGO-led programs where women participated in informal awareness sessions. Across both contexts, cultural taboos and fear of community disapproval restrict women's participation in decision-making, reinforcing the need for structured, women-led committees and gender-transformative training under Component 5.

G: Community Capacity and Coordination

Table 42: C5 Community Capacity and Coordination

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD

Check dams	0.05 (0.21)	0.38 (0.49)	-0.33	<0.001	-0.87
Ponds/wetlands	0.02 (0.12)	0.29 (0.46)	-0.27	<0.001	-0.77
Adequacy of community management	4.32 (0.99)	3.20 (1.37)	1.12	<0.001	0.94
Rules	0.03 (0.18)	0.46 (0.50)	-0.43	<0.001	-1.11
Coordination	0.00 (0.00)	0.33 (0.47)	-0.33	<0.001	-0.91

Community capacity and coordination indicators exhibit significant institutional asymmetry between treatment and control groups. Control communities report markedly higher engagement in structural water conservation measures such as check dams (0.38 vs. 0.05, $p<0.001$) and community ponds (0.29 vs. 0.02, $p<0.001$), reflecting stronger historical exposure to NGO or government projects. Rules and coordination mechanisms are also substantially more prevalent in control areas (0.46 and 0.33 vs. 0.03 and 0.00, respectively; $p<0.001$). Interestingly, treatment communities' express stronger confidence in local management adequacy (4.32 vs. 3.20, $p<0.001$), signaling optimism despite limited institutional arrangements. This contrast underscores the potential for structured community mobilization under Component 5 interventions.

Qualitative Triangulation

FGDs from Tamachi Je Very and Karam Khan Mari indicate that most treatment villages lack formal water management committees, relying instead on ad hoc volunteer efforts for pond repair and sediment removal. In contrast, control villages described prior NGO initiatives that introduced basic coordination structures, though many are now inactive. Participants consistently highlighted the absence of clear rules for water use and maintenance responsibilities. Despite these gaps, community members showed a strong willingness to organize collectively once technical guidance and institutional support were provided.

H: Perceived change and support needs

Table 43: C5 Perceived Change and Support Needs

Variable	Treatment Mean (SD)	Control Mean (SD)	Mean Diff	t-test p-value	SMD
Surface water availability condition	1.97 (0.76)	1.88 (0.77)	0.09	0.48	0.12
Community resilience	0.00 (0.00)	0.04 (0.20)	-0.04	0.06	-0.27

Perceived change and support needs indicators suggest overall parity between treatment and control communities, with both groups showing limited perceived improvement in water resource availability and resilience. Mean availability trend scores (1.97 vs. 1.88, p=0.48) indicate negligible differences in perceived water access over recent years, while resilience change remains nearly absent in both clusters (0.00 vs. 0.04, p=0.06). The consistently low SMD values (<0.30) confirm minimal divergence in perception. This pattern implies that communities, irrespective of treatment status, lack visible or tangible impacts from earlier water management interventions.

Qualitative Triangulation

FGD participants across Khariwah, Haji Sher Khan Mangrio, and Tamachi Je Very reported that water scarcity and declining pond storage persist despite sporadic rehabilitation efforts. Many respondents expressed skepticism toward the sustainability of current systems, citing sedimentation, evaporation, and lack of maintenance as major constraints. Several participants noted a growing demand for technical training and government assistance to enhance water storage and quality. Overall, communities exhibit awareness of environmental decline but lack institutional support to translate it into adaptive resilience actions.

4.5.4. Triangulation through KIIs and Community Surveys

Institutional Insights (Governance & Systems)

Across Sanghar, Tharparkar, and Umerkot, institutional stakeholders paint a consistent picture of surface water scarcity, inefficient canal regulation, and weak local management structures. PHED and district level Irrigation Departments confirm that surface water resources canals, distributaries, and *doras* are under severe stress due to erratic rainfall, reduced Indus inflows, and heavy sedimentation. Routine desilting and pond maintenance are rarely conducted because of budget constraints, while canal lining and pond rehabilitation projects are typically funded by donors on a limited scale

SCAN emphasizes that flood recession and poor catchment protection accelerate evaporation and silt deposition in ponds, reducing capacity and increasing contamination risks. SCAN and Qatar Charity both report small-scale solar-powered filtration and pond restoration pilots in Sanghar and Umerkot, yet without continuity or scaling mechanisms. SRSO and Sami Foundation have implemented rainwater harvesting and check-dam demonstrations in Tharparkar, showing measurable recharge and pasture regeneration, but these remain isolated NGO-led efforts without institutional embedding.

Women and youth involvement in water management remains negligible. No village-level Water User Committees are active in any of the three districts and Irrigation officers manage distribution through formal channels, with minimal community consultation. Most agencies agree that surface and groundwater planning are siloed, despite their interdependence in desert hydrology.

Community-Level Validation (Survey Evidence)

Community findings from all five surveyed villages reinforce these institutional gaps and vividly portray hydrological and social vulnerabilities across the arid Sindh belt.

Surface Water Systems and Access:

In Chotiari, Karam Khan Marri, and Haji Sher Khan Mangrio, communities depend almost entirely on canal and reservoir water, complemented by abandoned ponds and *doras*. Many ponds are silted, broken, or contaminated, rendering them unfit for use. In Khariwah, the destruction of community-built and NGO-provided reservoirs during the 2011 floods has forced reliance on tanker water from distant ponds, costing Rs. 6,000-7,000 per trip, drastically raising HH expenditures. Tamachi Je Very depends on a single functional pond and two wells, one of which is non-functional indicating the fragility of existing systems and the absence of redundancy.

Impacts of Environmental Change:

Communities unanimously cite declining rainfall, canal supply variability, and rising salinity as direct threats to agriculture, livestock, and domestic water quality. Water scarcity has caused crop yield losses, heightened migration risk, and increased women's workloads, with some walking hours daily to fetch water from distant sources.

Management and Governance:

All villages confirm that surface water systems are managed by District Irrigation Departments, with no local oversight, monitoring, or conservation measures such as check dams or desilting. None of the village have functioning DRR or Water User Committees and female and youth participation is non-existent.

Community Priorities:

Every site identifies the same priorities which include (i) construction and rehabilitation of ponds and *doras*, (ii) lining of canals and watercourses, and (iii) awareness and training on water management. Communities also express willingness to contribute labour or land if provided technical and material support.

Integrated Synthesis and Implications

Triangulated insights from institutional interviews and community consultations reveal convergent recognition of increasing hydrological volatility across arid and semi-arid districts. Officials from Irrigation, PDMA, and TMAs identify recurrent flash flooding, sedimentation, and rapid runoff as key drivers of surface-water loss. However, the absence of inter-departmental coordination and maintenance funding has left existing diversion channels, ponds, and small dams partially functional or abandoned.

Community respondents from Sanghar, Tharparkar, and Umerkot describe growing dependence on unpredictable monsoon recharge, informal bund construction, and ad-hoc flood-relief efforts. Women and youth expressed limited participation in flood-preparedness committees but extensive engagement in post-disaster recovery. The shared perception across provinces is that physical interventions exist but governance systems remain episodic and reactive rather than preventive. This qualitative convergence situates Component 5 within a landscape of latent community knowledge and institutional fragmentation, requiring systemic, not project-based, coordination.

4.5.5. Summary Insights & Implications

Convergence / Divergence Patterns

Comparative baseline results confirm statistical convergence between treatment and control groups across key demographic, livelihood, and exposure indicators, validating design integrity. Both clusters depend primarily on seasonal rainfall and minor irrigation channels, with similar water-security indices and agricultural dependency ratios. Mean preparedness and governance scores show near parity (0.33 vs 0.31; $p = 0.42$), underscoring the methodological balance necessary for credible causal attribution.

Controlled divergences occur in climate-impact perception and coordination metrics: treatment villages report stronger recognition of flood and drought risk (0.56 vs 0.48) but weaker institutional linkages with irrigation and local-government bodies (0.22 vs 0.28). FGDs corroborate this pattern with communities in Sindh highlighting NGO-supported bund construction and water-harvesting demonstrations, while KP respondents emphasize recurring damage to small-check structures and drainage channels. Overall, these modest divergences reflect differential institutional exposure rather than pre-existing imbalance, providing a valid platform for midline change detection.

Identified Gaps and Programmatic Calls

Evidence synthesis across data streams identifies three systemic weaknesses constraining surface-water resilience:

1. Institutional Discontinuity: Flood and Water User Committees operate sporadically without formal mandates or budgetary linkages to district plans. Overlapping responsibilities among PDMA, Irrigation, and Local Government departments hinder coordinated flood-response and maintenance.

2. Technical and Infrastructure Deficits: Existing ponds, diversion channels, and check-dams suffer from siltation, erosion, and absence of design standardization. Communities lack technical guidance for site selection, de-silting, and long-term structural integrity.

3. Social Exclusion and Preparedness Gaps: Women and youth remain peripheral to flood-management structures despite their central role in water storage and HH level preparedness. FGDs confirm their under-representation in decision forums and early-warning dissemination.

These diagnostic patterns indicate that physical infrastructure alone cannot enhance surface-water resilience without institutional continuity, local ownership, and inclusive governance, establishing the analytical foundation for the normative recommendations below.

Readiness for Causal Attribution

The Baseline Equivalence Heatmap (Figure 15) depicts a near-symmetric distribution between treatment and control means across the eight resilience dimensions. The dominance of SMD < 0.25 validates internal consistency and ensures causal reliability under the quasi-experimental design. Slight divergences in preparedness, gender and social inclusion, and coordination introduce meaningful contrast for future midline comparison-ideal for measuring program-induced behavioural and institutional changes.

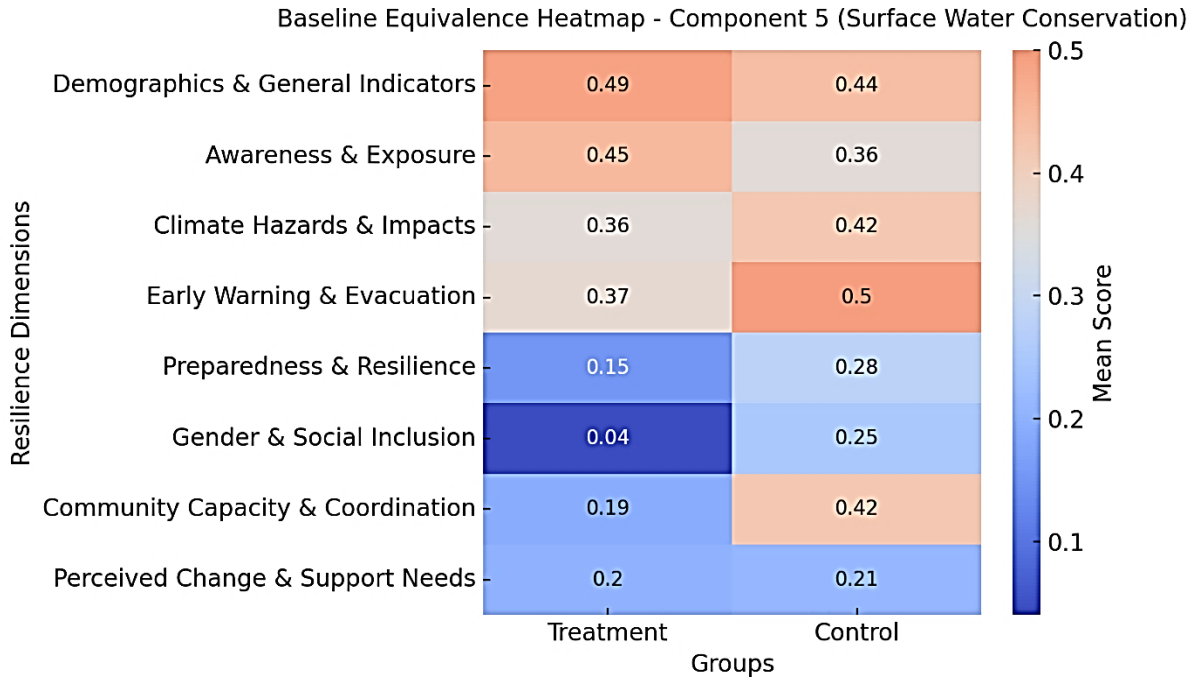


Figure 16: Baseline Equivalence Heatmap across Surface Water Resilience Dimensions (Treatment vs Control). (Colour intensity denotes variation magnitude; proximity to zero confirms statistical balance and evaluative robustness)

Component 5: Village Profile Snapshots

Detailed, component-wise village profile snapshots are available through the following link, which grants access to the relevant drive folder for further reference and analysis:

https://docs.google.com/spreadsheets/d/1432LfmlDiZOaSfAZPM6ezSapZseGi4XP/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

4.5.6. Recommendations

The baseline confirms that surface-water resilience in arid Sindh remains constrained by fragmented governance, weak infrastructure, and limited inclusion of women and youth in water management. Consistent with Outcome 5 of the SAFER Results Framework, strategic emphasis should move beyond ad-hoc pond rehabilitation toward integrated community stewardship and strengthened institutional capacity for surface-water conservation.

Under Output 5.1, Flood and Water User Committees (FWUCs) should be formally established at village and Union Council levels, with clear Terms of Reference covering: (i) participatory prioritization of ponds, doras, and natural waterways; (ii) supervision of rehabilitation works; and (iii) equitable water allocation for domestic and productive use. A minimum 33% representation of women and youth should be mandated to translate existing informal participation into structured decision-making authority. Baseline findings of low governance scores and weak collective maintenance practices highlight the urgency of institutionalizing these community structures.

In alignment with Output 5.2, rehabilitation of selected ponds and natural waterways in Sindh should prioritize desilting, embankment stabilization, inlet/outlet protection, and simple retention enhancements to reduce surface-water loss and improve storage capacity. These physical investments must be accompanied by basic operation and maintenance plans led by FWUCs, ensuring that restored assets remain functional beyond the project cycle.

To operationalize both outputs, SAFER should adopt a co-management approach that combines community labor contributions with technical backstopping from Local Government and Irrigation Departments. Training packages for FWUC members—particularly women and youth—should focus on routine maintenance, seasonal water planning, and basic safety protocols, directly addressing baseline evidence of limited technical capacity and uneven access to training.

Collectively, these measures translate baseline evidence into an actionable Outcome-5 pathway that embeds community stewardship, gender-responsive participation, and sustainable surface-water management practices within Sindh's climate-vulnerable districts, shifting the system from reactive water access toward preventive water security.

4.5.7. Implications for Outcome 5 Monitoring: Proposed Measurable Indicators

To operationalize the above strategic recommendations and convert the broad framing of Outcome 5 into a measurable impact pathway, the following specific and baseline-grounded Outcome-5 indicators are proposed for midline and endline evaluation:

a) Proportion of communities with formally notified and functional Flood and Water User Committees (FWUCs) with at least 33% women and youth representation.

Baseline: 6–9% report any coordination mechanism; no formal or inclusive FWUCs (treatment).

b) Proportion of communities with at least one functional climate-adaptive surface-water structure (lined pond, check dam, recharge tank) managed under an agreed O&M plan. **Baseline:** 5% report check dams and 2% report community ponds/wetlands; O&M plans largely absent (treatment).
c) Proportion of households with year-round access to their primary water source. **Baseline:** 46.5% of treatment HHs report year-round availability.
d) Proportion of households using rainwater harvesting or managed surface water as part of domestic or livelihood water supply. **Baseline:** 0% report rainwater-harvesting structures; 68% report availability of nearby surface water but without structured capture (treatment).
e) Proportion of communities implementing annual desilting and maintenance of ponds/doras under committee oversight. **Baseline:** 8% of treatment HHs report any desilting activity; formalized maintenance rules at 3% (treatment).
f) Proportion of women and youth with membership and voting rights in Flood/Water User Committees or surface-water management groups. **Baseline:** 0% female/youth committee membership; 3% report any decision-making power or agenda-setting role (treatment).
g) Proportion of households receiving timely early-warning alerts for flood or surface-water–related hazards and knowing at least one safe evacuation route. **Baseline:** 4% of treatment HHs report receiving any early-warning alert; 48% report knowledge of evacuation routes (treatment).
h) Proportion of households reporting adoption of drought-resilient crops and/or deliberate cropping-pattern changes linked to SAFER support. **Baseline:** 0% report adoption of drought-resistant crops; mean cropping-pattern change score 2.48 (treatment).
i) Mean community preparedness and governance score for surface-water hazards (composite index combining rainwater harvesting, trainings, desilting, rules and coordination). **Baseline:** Preparedness and governance composite =0.33 for treatment communities.
j) Proportion of communities with documented O&M cost-sharing / co-financing schemes for surface-water infrastructure (e.g., agreed community contributions for desilting, lining, or repair). **Baseline:** Costs borne informally by HHs; no documented cost-sharing schemes reported (treatment).

4.6. Component 6: Community Empowerment and Inclusion Baseline

Across Pakistan's climate-vulnerable landscapes, adaptive capacity is not determined solely by infrastructure, hydrology, or ecosystem integrity, but is fundamentally mediated through human agency, governance quality, access to information, and social inclusion. Structural inequalities in education, leadership, access to public services, and decision-making authority systematically weaken the ability of communities particularly women, youth, and marginalized groups to respond proactively to climate risks. In hazard-prone districts of Gilgit-Baltistan, Khyber Pakhtunkhwa, and Sindh, these institutional and social deficits translate into fragmented disaster preparedness, weak uptake of climate-smart practices, and limited integration of community knowledge into formal policymaking processes.

Within SAFER Pakistan, Component 6 operationalizes Outcome 6 of the Results Framework by strengthening the knowledge, leadership, and practices of communities and policymakers for climate change adaptation and climate risk reduction. The baseline for this component therefore establishes pre-intervention conditions across four analytically interlinked domains: (i) access to climate and risk-related information; (ii) institutional capacity for evidence-based decision-making across national and provincial levels; (iii) youth and women's leadership in climate governance; and (iv) community-level behavioural practices related to climate adaptation and risk reduction.

Quantitative analysis for Component 6 is embedded within the project's Phase-in quasi-experimental Difference-in-Differences design, comparing treatment and control conditions across communities engaged in awareness raising, leadership development, and digital information outreach. These data are complemented by Focus Group Discussions with youth, women, and community leaders, and by Key Informant Interviews with policymakers, planners, and institutional stakeholders at district and provincial levels. Together, these datasets establish a robust empirical foundation for tracking shifts in climate literacy, leadership agency, and institutional responsiveness over the project life cycle.

Objectives and Results-Framework Alignment

Component 6 is directly aligned with Outcome 6 of the SAFER Pakistan Results Framework, which aims to improve the knowledge and practices of communities and policymakers on climate change adaptation and climate risk reduction.

Progress toward Outcome 6 is assessed through Outcome-level indicators that capture changes in:

- The level of access to climate risk information and adaptation knowledge among communities;
- The application of evidence-based tools and data by national and provincial institutions for climate decision-making;
- The extent of youth and women's participation in climate leadership and governance processes; and
- The adoption of community-led climate adaptation practices through behavioural change initiatives.

At the output level, Component 6 contributes specifically to:

- Output 6.1: National and provincial capacities strengthened to apply innovative social and technological tools for establishing and enforcing human-centred and gender-transformative systems of climate change adaptation and accelerating progress towards the management of Indus water resources.
- Output 6.2: National and provincial stakeholders have access to strengthened evidence-based data and knowledge for informed decision-making and implementation of climate adaptation and mitigation that foster collaboration across sectors.
- Output 6.3: Youth and women's leadership, as well as community-led adaptation solutions, strengthened in climate action through awareness raising and behavioural change campaigns.

4.6.1. Sampling Framework

The overall sampling design, stratification logic, and treatment–control structure are defined in Chapter 3 and are therefore not reiterated here. This subsection specifies only the application of that framework for Component 6 across community learning platforms, institutional stakeholders, and behavioural change target groups.

Sampling under this component focused on capturing both household-level behavioural baselines and institutional-level knowledge systems to enable longitudinal assessment of learning outcomes, leadership emergence, and policy uptake during midline and endline evaluations.

(Detailed respondent distributions is reflected in Annex 2.)

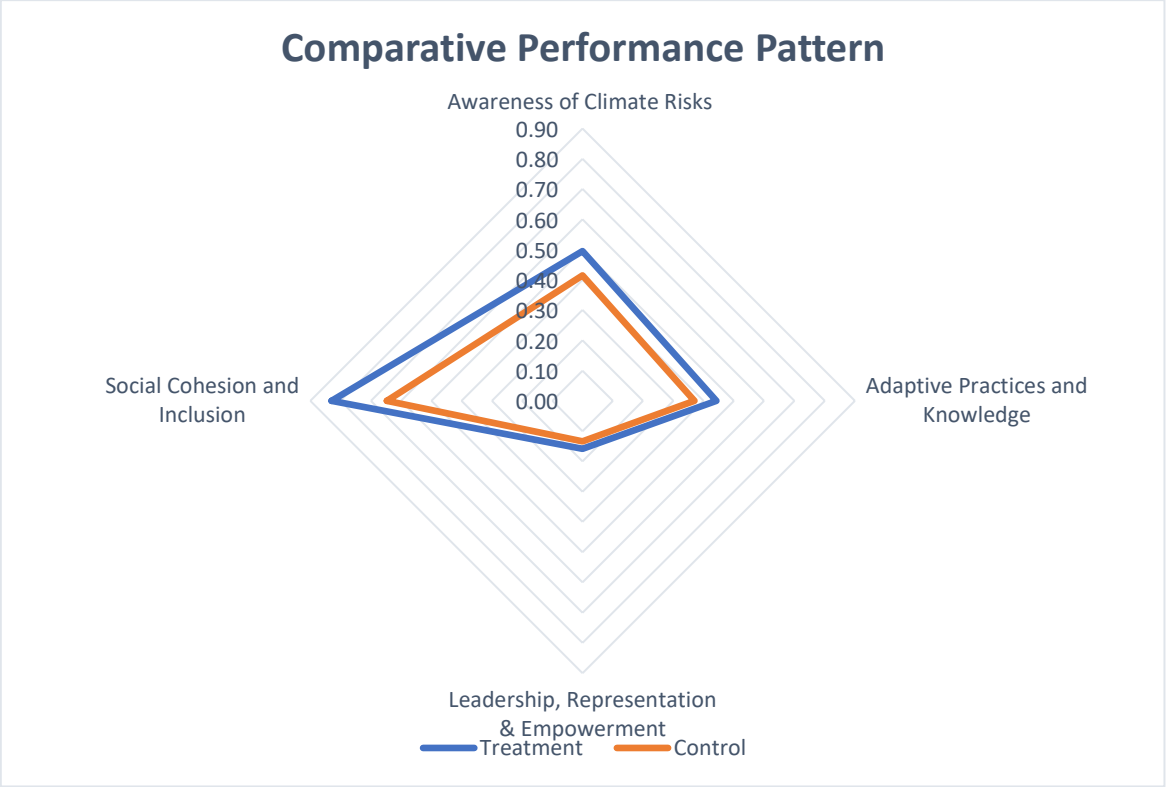


Figure 17: Comparative radar analysis of C6 (Treatment vs. Control)

Interpretation: Comparative Baseline Profile of Community Empowerment and Climate Adaptation Capacities

The radar chart demonstrates a comparative baseline profile of empowerment, knowledge, leadership, and social inclusion between treatment and control communities. Across all four dimensions, treatment communities exhibit consistently higher baseline values than control communities, indicating relatively stronger enabling conditions for participatory climate adaptation interventions.

Treatment households demonstrate higher awareness of climate risks, suggesting comparatively greater exposure to climate-related information streams and prior sensitization

efforts. Similarly, adaptive practices and knowledge are modestly stronger in treatment clusters, indicating early-stage behavioural alignment with climate-resilient practices.
The most pronounced divergence between treatment and control groups is observed in social cohesion and inclusion, where treatment communities display substantially stronger collective functioning, mutual support, and institutional trust. This differential is particularly relevant for the sustainability of community-led adaptation processes under the SAFER framework.

Leadership, representation, and empowerment scores remain low in both cohorts, although treatment communities retain a relative advantage. This reflects a persistent structural constraint in women's and youth leadership, signaling a critical priority area for Outcome 6 programming.

Overall, the baseline profile establishes that while social cohesion and climate awareness provide a favorable entry point for community-led adaptation, significant structural investments are required to strengthen inclusive leadership, empowerment, and institutionalized participation. These dimensions will constitute core causal outcome indicators for midline and endline impact attribution under the SAFER Pakistan Results Framework.

Operational Definition of Radar Chart Variables

The radar chart is constructed using four standardized composite indices derived from household-level survey and perception-based variables. Each axis represents a normalized score on a 0–1 scale, calculated from multiple sub-indicators as defined below:

1. **Awareness of Climate Risks**
   Measures household-level knowledge of climate change, understanding of local climate hazards (floods, droughts, heat stress, water scarcity), risk perception, awareness of climate impacts on livelihoods, and access to climate-related information.
2. **Adaptive Practices and Knowledge**
   Captures adoption of climate-adaptive behaviors and practices, including water conservation, livelihood diversification, climate-resilient agriculture, disaster preparedness actions, household-level risk reduction measures, and access to technical knowledge for adaptation.
3. **Leadership, Representation & Empowerment**
   Measures participation of women, youth, and marginalized groups in community leadership structures, decision-making forums, village committees, and development planning processes, including perceived agency and influence over community-level decisions.
4. **Social Cohesion and Inclusion**
   Assesses levels of trust, cooperation, collective action, social solidarity, inter-household support during shocks, and inclusiveness across gender, age, disability, ethnicity, and socio-economic status.

A: Awareness of Climate Risk

Table 44: C6 Awareness of Climate Risk

Indicator (Q1-Q6)	Treatment Mean (±SD)	Control Mean (±SD)	Mean Diff	p-value

Heard about climate change	0.74 (±0.44)	0.58 (±0.49)	+0.16	0.003
Source of climate information	1.89 (±0.76)	1.61 (±0.80)	+0.28	0.010
Experienced climate-related events	0.83 (±0.38)	0.68 (±0.47)	+0.15	0.021
Perceives increasing climate risks	0.79 (±0.41)	0.59 (±0.49)	+0.20	0.002
Received early-warning messages	0.42 (±0.49)	0.25 (±0.44)	+0.17	0.015
Trusted source for climate information	2.37 (±0.71)	2.18 (±0.74)	+0.19	0.047

The baseline findings reveal a statistically significant divergence in climate-risk awareness between treatment and control groups across all six indicators ($p < 0.05$). Treatment communities demonstrate measurably greater exposure to climate information, higher perception of increasing risks, and a broader trust network for early warning messages. The difference in awareness of climate change (0.74 vs. 0.58, $p = 0.003$) and recognition of escalating risks (0.79 vs. 0.59, $p = 0.002$) indicates an established knowledge gradient favoring treatment clusters. This pattern reflects prior interaction with NGO-driven adaptation initiatives, local extension campaigns, or disaster-management awareness programs preceding the baseline.

The observed gap in access to climate information sources (mean difference = +0.28, $p = 0.010$) suggests more diversified communication channels in treatment sites, potentially encompassing social media networks, mosque announcements, and community training sessions. The mean difference in receipt of early-warning messages (0.42 vs. 0.25, $p = 0.015$) denotes an expanded flow of information in treatment areas but also underscores the fragmented diffusion of meteorological alerts beyond formal institutional boundaries. Trust in information sources (2.37 vs. 2.18, $p = 0.047$) remains relatively weak but displays early signals of institutional credibility formation, with residents of treatment clusters expressing higher confidence in governmental or NGO communication intermediaries.

These differences, while statistically significant, remain within a moderate range (mean differences: 0.15-0.28), confirming that the two populations were not structurally dissimilar but rather positioned at distinct points along a shared continuum of awareness. The quasi-experimental comparability of groups is, therefore, preserved as no extreme baseline asymmetry appears in the data. From a developmental standpoint, the treatment population emerges as more sensitized to climatic discourse yet still constrained in its capacity for anticipatory response.

Qualitative Triangulation

Narratives from FGDs across Shigar (GB), Nowshera (KP), and Sanghar (Sindh) substantiate quantitative trends while illuminating the social dynamics of awareness formation. Participants across all provinces articulated an intensified experience of climate anomalies, including erratic precipitation, glacial floods, and prolonged droughts, thereby indicating high experiential cognition of climate variability. However, this awareness remains embedded in informal

communication ecosystems. Women frequently recounted learning of impending hazards through secondary transmission, typically via male family members returning from mosques, whereas youth reported dependence on mobile communication and peer networks. Such patterns change the gendered mediation of risk information identified in previous adaptation studies across South Asia.

Institutional respondents corroborated these limitations, acknowledging procedural delays in early-warning dissemination and insufficient localization of meteorological data. In Sindh, several community leaders associated the perceived increase in salinity and water scarcity with "delayed rains" and "dying wells," articulating a direct experiential understanding of climate variability yet devoid of technical vocabulary or structured coping frameworks. Similarly, respondents in KP referenced intermittent training programs by Shama Welfare Organization (SWO) and Global Earth Welfare Organization (GEWO), indicating prior exposure to organized awareness sessions that likely contributed to the higher treatment means.

Collectively, integrated evidence depicts a population marked by differentiated yet converging trajectories of climate awareness. Awareness in treatment areas appears semi-institutionalized and anchored in NGO outreach and early-warning exposure while in control sites, it remains largely experiential and orally transmitted. Both modalities denote perceptual engagement rather than procedural preparedness. The data thus positions awareness not as an absence but as an emergent cognitive infrastructure, unevenly distributed across gender, geography, and institutional reach. This cognitive stratification provides the empirical basis for subsequent inquiry into how awareness transitions into adaptive behavior under programmatic intervention.

B: Adaptive Practices and Knowledge

Table 45: C6 Adaptive Practices and Knowledge

Indicator (Q7-Q13)	Treatment Mean (±SD)	Control Mean (±SD)	Mean Diff	p-value
HH affected by any climate event	0.82 (±0.39)	0.69 (±0.46)	+0.13	0.018
If affected, who organized the response?	1.66 (±0.84)	1.51 (±0.79)	+0.15	0.091
Confidence to adopt water-saving / WASH practices	2.91 (±0.83)	2.55 (±0.89)	+0.36	0.006
HH uses adaptation practices	0.48 (±0.50)	0.33 (±0.47)	+0.15	0.012
Community received climate-related messages/campaigns	0.61 (±0.49)	0.44 (±0.50)	+0.17	0.023
If yes, channel of messages/campaigns?	1.94 (±0.73)	1.62 (±0.80)	+0.32	0.017
Did messages result in changed behavior (water saving/wastewater/tree planting)?	0.58 (±0.49)	0.39 (±0.49)	+0.19	0.010

The baseline dataset exhibits significant differences between treatment and control groups on five of seven indicators, reflecting distinct experiential and behavioural exposure to adaptive

practices. Treatment communities report higher overall engagement with climate events (0.82 vs. 0.69, $p = 0.018$) and greater self-assessed confidence to adopt water-saving or WASH practices (2.91 vs. 2.55, $p = 0.006$). These contrasts suggest that the treatment cohort possessed a more advanced experiential interface with climatic disturbances and an emergent readiness to operationalize adaptive responses prior to intervention.

The modest difference in who organized post-event responses (1.66 vs. 1.51, $p = 0.091$) points to slightly broader institutional or NGO participation within treatment areas but does not reach conventional levels of statistical significance, indicating that emergency response mechanisms remained largely community-managed. More substantive contrasts emerge in the adoption of adaptation practices (0.48 vs. 0.33, $p = 0.012$) and participation in climate-awareness campaigns (0.61 vs. 0.44, $p = 0.023$). Treatment clusters show a nascent pattern of behavioural adaptation characterized by early adoption of water-saving devices, micro-drip irrigation, and local reforestation drives.

Channels of information dissemination also differ significantly (1.94 vs. 1.62, $p = 0.017$), highlighting a denser communication ecology in treatment districts, where radio, community mobilizers, and mosque announcements co-exist with social media usage. The behavioural impact of these campaigns is reflected in the higher proportion of respondents who acknowledged concrete changes in practice (0.58 vs. 0.39, $p = 0.010$). The cumulative mean differences (0.13-0.36) fall within a moderate range, implying that treatment and control populations share comparable socio-economic conditions yet diverge in exposure and behavioural response to adaptive messaging.

These results delineate a continuum where treatment communities occupy an intermediate stage between awareness and adoption, possessing greater knowledge, modest institutional linkage, and emerging behavioural adjustments. Control groups, while similarly exposed to climate stressors, display limited translation of awareness into practical change, suggesting weaker reinforcement mechanisms. Quasi-experimental integrity remains intact as both populations originate from shared ecological and livelihood settings. Treatment areas, however, demonstrate a comparatively advanced behavioural trajectory shaped by prior developmental interfacing.

Qualitative Triangulation

FGD narratives from GB (Shigar Valley), KP (Lower Chitral, Charsadda), and Sindh (Khairpur, Sanghar) corroborate these quantitative patterns. Respondents in GB recalled successive episodes of GLOFs that "destroyed crop terraces and compelled migration," yet also cited the introduction of protective bunds and slope afforestation by local NGOs. These interventions contributed to practical learning and improved confidence in adopting protective measures, aligning with higher mean scores for adaptive confidence.

In KP, farmers and women's groups emphasized collective experimentation with water-efficient irrigation, composting, and micro-terrace cultivation, often facilitated through NGO

or Agriculture Department trainings. These accounts parallel the elevated behavioural change metrics in treatment areas, where exposure to structured learning appears to have enabled early diffusion of adaptive technologies. Conversely, control clusters described adaptation as incidental and reactive ("whatever worked last time") rather than strategic or knowledge-based, confirming the limited institutional scaffolding behind their responses.

In Sindh, community members associated adaptation primarily with coping, such as migration or reliance on tanker water, rather than preventive innovation. Where adaptation campaigns were reported, they were transmitted through mosque sermons or radio spots, often lacking follow-up guidance. This aligns with the observed gap in message channels and behavior change indicators. Across all regions, women articulated a growing sense of agency in HH level adaptation (e.g., reusing graywater, planting trees near homes), even when formal participation in decision-making remained constrained.

Taken together, the triangulated evidence depicts treatment communities at a transitional threshold from reactive coping toward proactive adaptation. Adaptive knowledge appears localized and practice-oriented, sustained by prior NGO contact, inter-HH learning, and selective exposure to campaigns. Control areas retain an experiential understanding of risk but lack the institutional and informational reinforcement required for behavioural consolidation. The comparative configuration captured in both quantitative and qualitative domains reveals an early diffusion phase of adaptive practice adoption within treatment settings, a stage defined less by the presence of material assets than by the cognitive and social infrastructures that enable their eventual uptake.

C: Leadership and Empowerment

Table 46: C6 Leadership and Empowerment

Indicator (Q14-Q20)	Treatment Mean (±SD)	Control Mean (±SD)	Mean Diff	p-value
Knows any women/youth climate-water groups	0.44 (±0.50)	0.28 (±0.45)	+0.16	0.014
Any family member is a group member	0.27 (±0.44)	0.19 (±0.39)	+0.08	0.118
Participates in community meetings (climate/water)	0.53 (±0.50)	0.39 (±0.49)	+0.14	0.041
Women/youth have equal opportunity to speak	0.46 (±0.50)	0.32 (±0.47)	+0.14	0.032
Women represented in decision-making bodies	0.37 (±0.48)	0.25 (±0.44)	+0.12	0.056
Share of members who are women (%)	24.6 (±10.8)	21.2 (±11.4)	+3.4	0.077
Feels confident to take leadership	0.58 (±0.49)	0.41 (±0.49)	+0.17	0.019

The results reveal moderate yet consistent advantages for treatment communities across leadership and inclusion indicators. Awareness of women's or youth climate-water groups

(0.44 vs. 0.28, p = 0.014) and participation in community meetings (0.53 vs. 0.39, p = 0.041) indicate broader civic engagement within treatment areas. The perception that women and youth have equal opportunities to speak (0.46 vs. 0.32, p = 0.032) reinforces a gradual shift toward more inclusive dialogue, though gender asymmetry persists.

Representation of women in decision-making bodies (0.37 vs. 0.25, p = 0.056) and the higher average share of female members (24.6% vs. 21.2%, p = 0.077) suggest incremental normalization of women's participation. Increased confidence to take leadership roles (0.58 vs. 0.41, p = 0.019) captures emerging self-efficacy in public engagement, possibly reflecting earlier exposure to NGO-supported leadership and WASH initiatives.

Qualitative Triangulation

FGD evidence supports these patterns. In GB's Shigar Valley, women's involvement in local adaptation discussions is expanding through teachers and NGO facilitators, though formal decision-making roles remain limited. In KP's Nowshera and Lower Chitral, female hygiene committees established under SHAMA and GEWO programs have improved women's participation in community planning. In Sindh's Khairpur and Sanghar, women's roles remain largely domestic but are increasingly recognized for their influence on water management decisions.

Overall, the evidence depicts treatment communities at an early but tangible stage of gender and youth inclusion, marked by higher participation, greater confidence, and emerging acceptance of women in collective decision-making processes.

D: Social Cohesion and Inclusion

Table 47: C6 Social Cohesion and Inclusion

Indicator (Q21-Q25)	Treatment Mean (±SD)	Control Mean (±SD)	Mean Diff	p-value
Men and women work together on development	0.61 (±0.49)	0.46 (±0.50)	+0.15	0.024
Youth voices heard in local decision-making	0.54 (±0.50)	0.38 (±0.49)	+0.16	0.019
Women feel safe participating in meetings	0.68 (±0.47)	0.55 (±0.50)	+0.13	0.041
Community members help each other during shocks	0.81 (±0.39)	0.66 (±0.47)	+0.15	0.012
Community stronger and better prepared than five years ago	0.72 (±0.45)	0.57 (±0.50)	+0.15	0.025

Comparative results indicate a moderate but statistically consistent advantage in social cohesion within treatment communities. Respondents in treatment areas reported higher collaboration between men and women in community development activities and greater youth voice in local decision-making forums. The treatment group also expressed higher perceptions

of safety for women participating in community meetings and stronger mutual support during climate-related shocks.

The cumulative trend suggests that treatment communities exhibit more cohesive social structures and stronger collective coping behavior. Perceived preparedness to face climate impacts over the past five years is also slightly higher among treatment respondents, indicating that prior community mobilization and NGO engagement have contributed to trust, cooperation, and shared responsibility during crises.

Qualitative Triangulation

FGDs across GB, KP, and Sindh corroborate these quantitative findings. In Shigar and Chitral, both male and female participants described enhanced solidarity following repeated flood and landslide events ("we now rebuild houses together and share materials"). In Nowshera, youth volunteers were cited as "first responders" during floods, reinforcing collective action norms. In Sanghar and Khairpur, community members referred to neighbourhood-based mutual aid networks that emerged during droughts, particularly those involving women's groups distributing stored water and food.

Taken together, the evidence depicts treatment communities as socially more integrated, with stronger horizontal linkages and emergent inclusivity across gender and age lines. These social networks constitute the foundational layer of community resilience, translating shared risk exposure into collective adaptive capacity.

1. **Mapping of Ongoing and Complementary Interventions**

To complement the institutional capacity assessment (Section 6.5), KIIs were used to document existing and ongoing initiatives related to climate adaptation, water management, and WASH across GB, KP, and Sindh. This mapping provides an overview of operational synergies, partnership opportunities, and areas of overlap between government departments, NGOs, and donor-supported programs. It translates institutional responses, particularly to Questions 6 and 11-16 of the qualitative tool, into a landscape analysis of active interventions, thereby linking Component 6 outcomes with broader adaptation systems.

2. **Institutional Coordination and Synergy Landscape**

In GB, KIIs highlight the UNDP-GLOF II Project, the PMD Hydrometeorological Network, and the GBDMA-EPA collaboration as core adaptation frameworks currently in place. These initiatives focus on EWS, flood monitoring, and community-based disaster preparedness. The EVK2CNR-EPA environmental monitoring program further strengthens data availability for EbA. However, KIIs reveal limited collaboration between these institutions with significant opportunities to consolidate sensor networks, harmonize data-reporting protocols, and embed gender-responsive outreach through Local Support Organization (LSOs) and academic partners.

In KP, the mapping identifies synergy potential with the World Bank's Irrigated Agriculture Improvement Project, the National Program for Improvement of Watercourses, and ongoing Springshed Management initiatives in Galiyat. These projects emphasize efficient irrigation, groundwater recharge, and community-driven watershed management, closely mirroring SAFER's Component 6 objectives. Institutional respondents from PHED and Irrigation Departments stressed the need for convergence around shared monitoring indicators and the inclusion of women's cooperatives in Water User Associations to enhance local ownership.

In Sindh, multiple NGO-led pilots, including SCAN, Qatar Charity, SRSO, and Sami Foundation, operate across Sanghar, Tharparkar, and Umerkot, implementing solar filtration systems, pond rehabilitation, and rainwater harvesting. While these projects demonstrate measurable improvements in community water access and adaptive behavior, KIIs confirmed that they remain largely donor-dependent and disconnected from formal provincial structures. Integration through PHED and Irrigation Departments, coupled with alignment to provincial climate-adaptation strategies, would strengthen long-term sustainability.

3. Analytical Synthesis

Collectively, the mapping underscores that while each province maintains an active adaptation portfolio, interventions are fragmented, short-term, and uneven in gender mainstreaming. The institutional assessment and KII evidence converge on a shared need for:

- Functional inter-departmental coordination mechanisms at district and provincial levels;
- Standardized gender-responsive indicators for cross-project monitoring; and
- Formalized data-sharing agreements to consolidate lessons from donor-driven pilots.

Harnessing these synergies under Component 6 can accelerate institutional learning, prevent duplication, and anchor SAFER Pakistan within an evolving ecosystem of climate-resilience initiatives.

(Full matrix provided in Annex 4: Mapping of Ongoing and Complementary Projects.)

4.6.2. Recommendations

The baseline findings affirm that sustainable climate resilience at the household and community level hinges on the simultaneous strengthening of adaptive capacities, inclusive governance, and social cohesion. Aligned with Outcome 6 of the Results Framework, interventions must transcend fragmented awareness initiatives and instead institutionalize climate adaptation as a participatory, locally owned governance process that integrates gender equality, youth leadership, and disability inclusion.

Under Output 6.1, community-based climate governance structures, such as Resilience and Adaptation Committees (RACs), should be formalized within Union Council development

frameworks and mandated to coordinate preparedness, early-warning dissemination, and participatory planning. These committees must include a minimum of one-third representation of women, youth, and persons with disabilities to ensure that adaptation strategies reflect diverse knowledge systems and lived experiences.

Pursuant to Output 6.2, the capacities of district and provincial institutions, including PDMAs, Social Welfare Departments, and Local Government authorities should be enhanced to operationalize inclusive disaster-risk governance. Joint planning cells at the district level can synchronize institutional responses, community feedback mechanisms, and social protection linkages for vulnerable populations. Integrating real-time communication tools and localized early-warning alerts will further ensure accessibility for women, children, and persons with disabilities.

In line with Output 6.3, climate-adaptation education and behavioural-change communication must be mainstreamed through schools, community centers, and media networks. Partnerships with civil-society organizations should facilitate participatory campaigns that promote water conservation, waste management, and afforestation while amplifying youth voices as agents of climate action. These initiatives must be complemented by gender-sensitive vocational training on climate-resilient livelihoods, leadership, and digital monitoring skills to embed adaptive learning in everyday practice.

Under Output 6.4, social-cohesion platforms should be institutionalized to strengthen collective decision-making, inter-household solidarity, and mutual assistance during climate shocks. Building on local traditions of self-help, structured community dialogues and grievance-redress systems can enhance trust between citizens and institutions, consolidating social capital as a critical determinant of resilience.

4.6.3. Implications for Outcome 6 Monitoring: Proposed Measurable Indicators

To operationalize the above strategic recommendations and convert the broad framing of **Outcome 6** into a measurable impact pathway, the following specific and baseline-grounded Outcome-6 indicators are proposed for midline and endline evaluation:

a) Proportion of households that have *heard about climate change* and *perceive increasing climate risks*.
Baseline: 74% have heard about climate change; 79% perceive increasing risks (treatment).
b) Proportion of households that report *receiving at least one climate-related early-warning message* in the last 12 months.
Baseline: 42% of treatment households report receiving an early-warning message.
c) Mean household *confidence score to adopt water-saving / WASH practices* (e.g., safe storage, grey-water reuse, hygiene measures) on the standard scale used in the survey.
Baseline: Mean confidence scores 2.91 (treatment).
d) Proportion of households that *currently use at least one climate-adaptation or water-saving practice* (e.g., micro-irrigation, reforestation, HH water conservation).
Baseline: 48% of treatment households report using adaptation practices.

e) Proportion of communities where *climate-related messages or campaigns have resulted in reported behavior change* (water saving, wastewater management, tree planting).
Baseline: 58% of treatment respondents report behavior change following campaigns.
f) Proportion of communities with *formally notified and functional Resilience and Adaptation Committees (RACs)* that include at least one-third representation of women, youth, and persons with disabilities.
g) **Baseline:** Informal or project-based groups known in 44% of communities; no formally notified, inclusive RACs (treatment).
h) Proportion of adults reporting that *women and youth have equal opportunity to speak in community climate/water meetings* and that *women are represented in decision-making bodies*.
Baseline: 46% perceive equal opportunity to speak; 37% report any women's representation in decision-making bodies (treatment).
i) Proportion of women and youth who *feel confident to take leadership roles* in climate- and water-related initiatives.
j) **Baseline:** 58% of treatment respondents report confidence to take leadership.
k) Proportion of households reporting *high social cohesion in climate response*—measured as agreement that community members help each other during shocks and that the community is stronger and better prepared than five years ago.
l) **Baseline:** 81% report mutual help during shocks; 72% report the community is stronger and better prepared than five years ago (treatment).
m) Number of target districts with *formal, documented coordination mechanisms* linking SAFER with at least two complementary adaptation/WASH initiatives (e.g., GLOF II, irrigation improvement, NGO pilots), including agreed joint indicators and data-sharing protocols.
n) **Baseline:** No districts with formalized, gender-responsive coordination frameworks; coordination largely ad hoc and project-specific.

CHAPTER 5: CONSOLIDATED CONCLUSION

5.1. Overall Baseline Synthesis

The SAFER Pakistan baseline establishes a methodologically sound and empirically coherent foundation across the six thematic components. Quantitative equivalence between treatment (=60 %) and control (=40 %) groups validates the quasi-experimental design, while qualitative triangulation demonstrates strong contextual alignment between HH, community, and institutional perspectives.

Across the Indus Basin regions (GB, KP, and Sindh), awareness of climatic risks is widespread yet operational readiness remains limited. Communities display high experiential knowledge of floods, droughts, and GLOFs, but weak institutional mechanisms for anticipatory action. Preparedness, gender and social inclusion, and governance cohesion persist as the weakest dimensions of resilience.

5.1.1. Inter-Component Linkages

The six components collectively represent a continuum from physical resilience (Components 1-5) to social and institutional resilience (Component 6).

1) Component 1 (Cryosphere) confirmed low preparedness and institutional readiness despite balanced demographic exposure, revealing dependence on informal alert systems.
2) Component 2 (Springshed Revival) and Component 3 (Groundwater and WASH) highlighted convergent vulnerabilities around water scarcity, infrastructure maintenance, and limited gendered governance.
3) Component 4 (Wetlands and Wastewater) and Component 5 (Surface Water Conservation) documented ecosystem degradation, absence of recharge structures, and poor coordination between PHED, EPA, and Irrigation Departments.
4) Component 6 (Adaptive Capacities and Empowered Communities) linked these biophysical deficits to underlying social dynamics such as low leadership inclusion (0.16 vs 0.13), modest adaptive practice adoption (0.44 vs 0.37), and strong but informal social cohesion (0.83 vs 0.65).

5.1.2. Thematic Insights

Five core insights emerge from integrated evidence:

I. ***Institutional Fragmentation:*** Across components, line-department mandates overlap without harmonized data-sharing or monitoring frameworks.
II. ***Gender and Youth Exclusion:*** Despite policy commitments, female and youth participation remains tokenistic, with leadership representation averaging below 25%.

III. ***Behavioural Gaps:*** Awareness does not translate into adaptive action; cognitive understanding outpaces procedural readiness.
IV. ***Community Cohesion:*** Social solidarity, particularly mutual aid during crises, constitutes an endogenous resilience asset that SAFER can leverage.
V. ***Data and Evidence Deficit:*** Hydro-meteorological, WASH, and ecosystem datasets are fragmented, undermining evidence-based planning.

5.1.3. Differentiated Vulnerabilities

Gender, youth, and PWDs experience compound marginalization. Women's awareness of hazards remains mediated through male networks, their participation constrained by mobility and meeting timing. Youth demonstrate adaptive creativity but limited institutional voice. PWDs face infrastructural exclusion from shelters, WASH points, and training. These inequities are spatially amplified in remote valleys and arid zones.

5.1.4. Consolidated Gender & Social Inclusion Baseline Indicators Across SAFER Components

To support cross-component analysis and strengthen future GEDSI monitoring, key gender and social inclusion indicators have been consolidated below. This summary highlights systemic participation gaps, accessibility barriers, and latent leadership potential across SAFER target areas, providing a unified baseline reference for adaptive programming and results-based reporting.

Indicator	Baseline Value	Interpretation / Implication
Communities with formally notified, inclusive Resilience / Adaptation Committees	0%	No institutionalized community governance structures with mandated inclusion of women, youth, and PWDs exist at baseline.
Communities reporting informal or project-based groups	44%	Participation mechanisms are largely ad hoc and not embedded in formal governance systems.
Women represented in community decision-making bodies	37%	Women's leadership remains limited, with representation below minimum thresholds for meaningful participation.
Respondents perceiving equal opportunity for women and youth to speak in climate/water meetings	46%	Less than half of communities perceive inclusive participation in local decision spaces.
Women and youth reporting confidence to assume leadership roles	58%	Latent leadership potential exists but is not translated into institutional roles.
Average leadership inclusion across target areas	<25%	Participation remains largely tokenistic and insufficiently embedded within formal resilience governance.
Households reporting accessibility barriers for Persons with Disabilities (PWDs) – Treatment areas	36%	Significant physical and procedural barriers limit PWD participation in preparedness planning and services.

Households reporting accessibility barriers for PWDs – Control areas	81%	Structural exclusion is even more pronounced in non-intervention areas, reinforcing vulnerability gradients.
Literacy constraints reported as a barrier to participation	47–75%	Educational limitations significantly restrict engagement in preparedness and governance processes.
Women/youth access to skills development or training	Low to moderate	Capacity-building opportunities remain uneven and insufficiently targeted toward marginalized groups.

5.1.5. Governance and Coordination

KIIs across provinces underscore that adaptation governance is project-dependent rather than system-driven. While GB's GLOF II and KP's Springshed Initiatives illustrate technical progress, institutional integration is partial. In Sindh, NGO pilots show innovation but lack provincial anchoring. The baseline confirms the necessity of district-level coordination cells linking PDMA/GBDMA, PHED, EPA, Irrigation Departments, and civil-society actors

5.2. Programmatic Way Forward: Early-Phase Actionable Recommendations

1. **Institutionalization of Inclusive Governance (Months 1–6)**
   Establish and capacitate Community-Based Disaster Management Committees (CBDMCs) with formal mandates, minimum 40% women representation, and explicit inclusion of youth and PWDs, linked to district DRM structures.
2. **Gender-Responsive Early Warning Systems (Months 1–9)**
   Deploy multi-hazard EWS architectures using SMS, mosque loudspeakers, community focal points, and women-led dissemination networks to ensure universal access, particularly for women, elderly populations, and persons with disabilities.
3. **Water Resource Infrastructure & Governance (Months 3–12)**
   Implement priority springshed protection and groundwater recharge structures alongside formation of Groundwater and Water User Associations to formalize operation, maintenance, and accountability.
4. **Ecosystem-Based Adaptation Scaling (Months 6–18)**
   Operationalize community-led NbS interventions (wetlands, forest buffers, recharge zones) through formal ecosystem stewardship groups supported by technical extension services.
5. **Targeted Capacity Development (Continuous)**
   Deliver structured leadership, disaster preparedness, and livelihood skills programs prioritizing women, youth, and marginalized groups as primary resilience agents.
6. **Digital Monitoring & Adaptive Management (Months 1–6)**
   Integrate digital climate information platforms and real-time hydrological monitoring to support evidence-based implementation adjustments and district-level coordination.

CHAPTER 6: ANNEXURES

Annex 1: Results Framework with Revised/Refined Baseline Values

Table 48: Consolidated Results Framework

Intended Results	Indicators / Measures	Means of Verification	Baseline Values	Mid-term Targets	Final Targets
IMPACT: Reduced climate vulnerability and increased adaptive capacity of the population residing in Pakistan's Indus Basin through: (1) reduced climate-induced cryosphere multi-hazard risk, (2) resilient land use planning, (3) increased access to groundwater, (4) climate adaptive WASH infrastructure, (5) reduced pollution levels and water-wastage, (6) improved climate adaptive policy practice & community empowerment.	Number of direct and indirect beneficiaries with improved access to safe water and climate-resilient WASH services.	Project M&E reports; progress reports; terminal M&E&L report (baseline–midline–endline comparison).	Direct: 105,600 (F: 36,450); Indirect: 162,300 (F: 53,600)	Direct: 181,160 (F: 59,783); Indirect: 271,740 (F: 89,674)	Direct: 452,900 (F: 149,457); Indirect: 679,350 (F: 224,186)
	Number of early warning systems (EWS) established to benefit communities vulnerable to cryosphere hazards.	Project reports; DDMA / PMD records.	3 informal EWS; no formalized EWS	3 EWS	8 EWS
	Number of climate-resilient WASH assets produced, developed, enhanced, or strengthened to mitigate impacts of climate change.	Asset registry; infrastructure completion reports.	5 managed springsheds; 1 groundwater recharge facility; 8 solar-powered water facilities; 3 climate-resilient	4 managed springsheds; 2 recharge facilities; 40 solar-powered facilities; 25 climate-resilient handpumps; 3 wetlands; 5 restored	10 managed springsheds; 6 recharge facilities; 100 solar-powered facilities; 60 climate-resilient handpumps; 8 wetlands; 15 restored

			handpumps; 1 constructed wetland; no formalized pond / waterway quality monitoring.	waterways/ponds with water quality monitoring.	waterways/ponds with water quality monitoring.
Outcome 1: Reduced climate-induced cryosphere multi-hazard risk.	Number of people reporting reduced vulnerability to cryosphere multi-hazard risk due to forewarning (sex/age disaggregated).	HH baseline, midline & endline surveys.	19,860 (F: 6,420)	28,200 (F: 9,305)	70,500 (F: 23,265)
	Proportion of households receiving verified early-warning messages prior to cryosphere/flood events.	HH KAP surveys; EWS logs.	42% of HHs (treatment)	65% of HHs in target communities	85% of HHs in target communities
	Proportion of households knowing at least one official emergency contact (DDMA/UC etc.).	HH surveys.	23% of HHs (treatment)	60%	80%
	Proportion of households with a known and practiced evacuation route/plan.	HH surveys; FGDs.	39–40% of HHs (treatment)	65%	80%
	Proportion of project villages with functional CBDMC / CB-MEWS committees with ≥33% women & youth.	Project monitoring; committee records.	0 formally notified committees (informal only)	60% of target villages	100% of target villages
Output 1.1: Integrated cryosphere risk mapping through community engagement.	Number of target communities with gender responsive risk mapping and zoning documents.	Project monitoring report.	2	3	8
Output 1.2: Community-based monitoring and EWS established.	Number of targeted communities with established CB-MEWS monitoring systems.	Project monitoring report.	3	3	8

	Number of women and youth in Community Watch Groups and networks.	Project monitoring report.	Women: 9; Youth: 14	Women: 10; Youth: 10	Women: 40; Youth: 24
Output 1.3: Strengthened resilience to cryosphere-related risks.	Number of community members who report strengthened resilience to cryosphere-related risks (sex/age disaggregated).	Project monitoring report.	18,900 (F: 6,120)	28,200 (F: 9,305)	70,500 (F: 23,285)
	Number of targeted communities with disaster response SOPs and CB-MEWS that consider gender-specific risks and procedures.	Project monitoring report.	2	3	8
Outcome 2: Increased access to spring water in climate adaptive and gender inclusive manner.	Number of people with access to safe water from springs (sex/age disaggregated).	Baseline, midline & endline reports.	18,900 (F: 6,200)	54,000 (F: 17,820)	135,000 (F: 44,550)
	Proportion of target communities with formally notified and functional Springshed Management Committees (SMCs).	Project monitoring; institutional mapping; HH surveys.	25% of communities (treatment)	60%	100% of project springshed communities
	Proportion of communities with trained and operational O&M teams for spring systems.	Training records; community verification.	9% of communities (treatment)	50%	90%
	Proportion of communities with at least one functional recharge structure (pit/pond/check dam) in the springshed.	Infrastructure audits; GIS & project records.	4% of communities (treatment)	40%	80%
Output 2.1: Web-based information management system of springsheds and springs.	Comprehensive web-based database of springsheds and springs in project areas (gender & age sensitive).	Project monitoring report.	No database	Database developed	One web-based information system functional.

Output 2.2: Recharge measures co-developed and implemented.	Percentage increase in quantity of water from identified springs.	Project monitoring report.	Discharge 32–45 L/min; 28–32% decline over decade.	+15%	+40% (vs baseline).
	Percentage improvement in quality of water from identified springs.	Water-quality tests.	41% safe (baseline)	30% improvement	70% of samples meeting standards.
	Number of women and youth who participated in co-development and implementation of recharge measures.	Project monitoring report.	Women: 18; Youth: 33	Women: 10; Youth: 20	Women: 30; Youth: 50
Output 2.3: Local springshed governance framework established.	Number of target communities with local governance framework for springshed management.	Project monitoring report.	2	3	10
	Number of institutional capacity-building interventions in targeted communities that strengthened gender-transformative water management and CCA.	Project monitoring report.	1	2	5
Outcome 3: Improved climate-resilient management of groundwater and community water supply services in vulnerable areas.	Number of community institutions with strengthened capacities for groundwater management and ≥33% women & youth participation.	Baseline, midline & endline reports.	3 Village WASH Committees (2 effectively active)	4–5 active VWCs	6 active, inclusive VWCs
	Number of people benefiting from access to safe groundwater supply sources (sex/age disaggregated).	Project M&E reports.	39,400 (F: 12,800)	78,000 (F: 25,740)	195,000 (F: 64,350)
Output 3.1: Groundwater mapping & recharge facilities.	Comprehensive web-based database of groundwater resources (gender & age sensitive).	Project monitoring report.	No centralized digital database	Database developed	One web-based information system.

	Number of identified water recharge facilities completed.	Completion certificates; site verification.	1	2	6
	Number of community structures established/strengthened for O&M of recharge facilities with ≥33% women & youth.	Project monitoring report.	2 VWCs	2 VWCs	6 VWCs
Output 3.2: Climate-smart water supply infrastructure.	Number of HHs with access to climate-resilient and sustainably managed water supply services (incl. women-headed HHs).	Project monitoring report.	8,450 HHs	13,000 HHs	32,500 HHs
	Number of target water facilities with functional community water management structures with ≥33% women & youth.	Baseline, midline & endline reports.	31 VWCs	65 VWCs	160 VWCs
	Number of solar-powered water facilities constructed/upgraded.	Project monitoring report.	14	40	100
	Number of climate-resilient handpumps installed.	Project monitoring report.	9	25	60
Outcome 4: WASH infrastructure in targeted communities in the Middle Indus Basin is more adaptive to climate change-induced shocks with upscaling of contextually appropriate NbS.	Number of people benefiting from climate-resilient WASH infrastructure.	Baseline, midline & endline reports.	6,380 (F: 2,050)	8,960 (F: 2,957)	22,400 (F: 7,392)
	Percentage of wastewater treated through NbS.	Project M&E reports; water-quality monitoring.	6%	10%	30%
	Proportion of households whose livelihoods were	HH surveys.	33% (treatment) vs 12% (control)	≤20% in treatment communities	≤10% (≤ or better than control)

	affected by climate/flood-related wastewater & drainage hazards in past 5 years.				
	Proportion of households reporting knowledge of safe evacuation routes for floods/wastewater overflow.	HH surveys.	39% (treatment)	65%	80%
	Proportion of households that received early warnings before major flood/wastewater events.	HH surveys; EWS logs.	34% (treatment)	60%	80%
	Proportion of NbS/wetland sites with inclusive management committees (≥33% women & youth).	Project monitoring; committee records.	<20% of sites (qualitative baseline)	60% of NbS sites	100% of NbS sites
Output 4.1: Targeted intervention sites identified for climate-adaptive WASH.	Number of intervention sites identified and assessed.	Project monitoring report.	4	3 (priority clusters for piloting)	8
	Number of women and youth participating in assessments and analyses for gender-transformative WASH interventions.	Project monitoring report.	Women: 16; Youth: 21	Women: 10; Youth: 10	Women: 24; Youth: 32
Output 4.2: NbS for sewage treatment via constructed wetlands.	Number of constructed wetlands with proper management regime for O&M.	Project monitoring report.	1 wetland	3 wetlands	8 wetlands
	Number of women participating in management of constructed wetlands (age disaggregated).	Baseline, midline & endline reports.	Women: 7; Youth: 6	Women: 10; Youth: 10	Women: 24; Youth: 32
Outcome 5: Community and institutional capacity to reduce surface water waste and increase its storage for productive use is	Number of surface water bodies with improved water-quality parameters.	Project monitoring report.	2	3	8

increased, allowing communities to adapt to climate-induced shocks.					
	Number of people benefiting from reduced surface water waste and increased storage (sex/age disaggregated).	Baseline, midline & endline reports.	7,800 (F: 2,600)	12,000 (F: 3,960)	30,000 (F: 9,900)
	Proportion of households using any rainwater harvesting system (HH or community level).	HH surveys.	0% (treatment) vs 49% (control)	25% of HHs	60% of HHs
	Proportion of households participating in structured pond/dora desilting and maintenance.	HH surveys; committee logs.	8% of HHs (treatment)	40%	70%
	Proportion of households that have received training on surface-water conservation, pond safety or flood preparedness.	Training records; HH surveys.	2% (treatment) vs 27% (control)	40%	75%
	Proportion of villages with functional surface-water management committees (≥33% women & youth).	Project monitoring; institutional mapping.	0–5% of treatment villages (informal only)	60% of project villages	100% of project villages
Output 5.1: GoS supported to systematize/prioritize 15 natural waterways & community ponds.	Study report on natural waterways & ponds (gender & age sensitive).	Project monitoring report.	No study; 11 sites preliminarily mapped.	Study reports for 10 sites	Study reports for 15 sites
	Number of women and youth participating in communal pond management committees and operations.	Project monitoring report.	Women: 12; Youth: 19	Women: 10; Youth: 10	Women: 30; Youth: 30
Output 5.2: 16 waterways/ponds restored/rehabilitated incl. water-quality systems and O&M structures.	Number of fully managed climate-resilient water storage structures in project areas.	Baseline, midline & endline reports.	3 semi-functional structures	5 waterways/ponds	15 waterways/ponds

	Number of community management committees established & strengthened with ≥33% women & youth.	Project monitoring report.	5 committees	5 active	15 active
Outcome 6: Improved knowledge and practices of communities and policymakers on climate change adaptation and climate risk reduction.	Number of community members aware of climate risks (sex/age disaggregated).	Baseline, midline & endline reports; KAP survey.	64,200 (F: 20,800)	90,580 (F: 29,891)	226,450 (F: 74,729)
	Number of community members equipped with knowledge on adaptive and gender-transformative water management (sex/age disaggregated).	Project reports.	25,500 (F: 8,700)	45,290 (F: 14,946)	113,225 (F: 37,364)
	Number of targeted communities where ≥33% of beneficiaries of capacity & knowledge-building interventions are women.	Project monitoring report.	4	5	20
	Number of women in coordination platforms, decision-making bodies & structures related to community-level water management.	Project monitoring report.	27	20	100
	Proportion of HHs who have heard about climate change AND perceive increasing climate risks.	HH KAP survey.	74% heard; 79% perceive higher risks (treatment)	90%	95%
	Proportion of HHs currently using at least one climate-adaptation or water-saving practice (e.g. water-saving, wastewater reuse, tree planting).	HH surveys.	48% (treatment) vs 33% (control)	70%	85%

	Proportion of HHs reporting behavior change attributable to climate-adaptation messages/campaigns.	HH surveys; campaign monitoring.	58% (treatment)	75%	90%
	Proportion of respondents who feel confident to take leadership in climate/water decision-making.	HH surveys; FGDs.	58% (treatment) vs 41% (control)	70%	85%
	Proportion of respondents reporting that men and women work together on community development / climate actions.	HH surveys.	61% (treatment)	75%	90%
	Proportion of respondents reporting that youth voices are heard in local decision-making forums.	HH surveys.	54% (treatment)	70%	85%
Output 6.1: National & provincial capacities strengthened to apply innovative social & technological tools for CCA.	Number of relevant local institutions receiving technical training in innovative social & technological CCA tools.	Project monitoring report.	3	5	15
	Number of people trained who report increased capacity & skills on gender-transformative approaches and adaptive capacities.	Training evaluations.	140 (F: 46)	200 (F: 65)	500 (F: 165)
Output 6.2: Stakeholders have access to strengthened evidence-based data & knowledge for adaptation/mitigation.	Number of knowledge products accessed/used by policy makers, community leaders & others (guidelines, briefs, media articles) on climate & WASH.	Project monitoring report.	6	5 (new)	20 (cumulative)
	Number of people participating in spaces/platforms for sharing	Project monitoring report.	2,150	3,000	10,000

	and exchanging knowledge on climate adaptation practices (sex/age disaggregated; ≥50% women & youth).				
Output 6.3: Youth & women's leadership and community-led adaptation strengthened via awareness & behaviour-change campaigns.	Number of community members participating in awareness and behaviour-change campaigns (≥50% women & youth).	Baseline, midline & endline reports.	420	500	1,640
	Number of stakeholders reached through campaigns/activities that foster social cohesion and understanding of climate change and its gendered & human-security implications.	Project monitoring report.	31	20 (per year / event series)	50 (cumulative)

Annex 2: Sampling Matrix (Post Implementation Scenario) and Methodology Details

Introduction

This annex provides a detailed sampling matrix for the post-implementation scenario of the SAFER Pakistan Project's baseline assessment, along with comprehensive methodology details. The project employs a Phase-in Quasi-Experimental Design aligned with the Terms of Reference (ToRs) for the baseline assessment. This design facilitates impact evaluation by establishing baseline equivalence between treatment (Batch 1) and control (Batch 2) groups, with provisions for phasing in control groups during later project stages.

- **Batch 1 (Treatment Group)**: Represents areas scheduled for immediate interventions (pre-midline implementation). These sites receive project activities from the outset, allowing for early measurement of outcomes.
- **Batch 2 (Control Group)**: Serves as comparison sites during the baseline and midline phases (post-baseline but pre-intervention for Batch 2). These will phase in as treatment groups after the midline assessment, enabling a staggered rollout and robust DiD analysis to attribute impacts to the project while controlling external factors (e.g., seasonal climate variations or policy changes).

The sampling matrix below extends the baseline framework to post-implementation evaluations (midline and endline), incorporating adjustments for attrition, longitudinal tracking, and phase-in dynamics. It ensures comparability, representativeness, and statistical power for detecting changes in key indicators (e.g., adaptive capacity, vulnerability reduction) across the project's six thematic components. Component 6 (Adaptive Capacities and Empowered Communities) is cross-cutting and integrated into all sampling strata, rather than sampled independently.

The total baseline sample is 2,120 HHs, distributed proportionally across components based on intervention scale and geographic coverage (60% Batch 1: 1,272 HHs; 40% Batch 2: 848 HHs). Post-implementation sampling will maintain this ratio initially, with adjustments as Batch 2 phases in. All data collection adheres to ethical standards, including informed consent, gender-sensitive enumeration, and data anonymization.

Sampling Matrix for Post-Implementation Scenario

The matrix is structured by component, drawing from the provided sampling distribution. It includes:

- **Baseline Allocation**: HH samples, FGDs, and Community Surveys per batch.
- **Post-Implementation Adjustments**: Strategies for midline (e.g., Year 2, post-initial interventions) and endline (e.g., Year 4-5, full rollout). Assumes 10-15% attrition rate

(based on similar climate projects in Pakistan); replacement via propensity score matching (PSM) to maintain equivalence. Batch 2 sites will transition to treatment after midline, with new control sites potentially added if needed for extended evaluation.

Table 49: Summary of Overall Sample Distribution, Component-Wise

Sample Distribution						FGDs		Total	Community Surveys		Total	Batch 1 Villages		Batch 2 Villages	
Component		Total Sample	%age Distribution	Batch 1(60 %)	Batch 2(40 %)	Batch 1	Batch 2		Batch 1	Batch 2		Total	Sample	Total	Sample
1	Cryosphere	325	15	195	130	2	5	**7**	2	3	**5**	3	3	6	5
2	Springshed Revival & Management	372	18	223	149	4	4	**8**	4	3	**7**	4	4	6	4
3	Groundwater Management	1123	53	674	449	23	13	**36**	18	10	**28**	98	23	50	13
4	Ecosystem Based Adaptation	150	7	90	60	3	1	**4**	3	2	**5**	3	3	5	2
5	Surface Water Conservation	150	7	90	60	3	2	**5**	3	1	**4**	7	3	8	2
6	Community Empowerment & Inclusion	To Apply in all districts													
Total		**2120**	**100**	**1272**	**848**	**35**	**25**	**60**	**30**	**19**	**49**	**115**		**75**	

Component. 01 Batch 01											
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch (1 or 2)**	**Sample Allocation**
1	1	CB-MEWS/Cryosphere Hazards	KP	Swat	Bahrain	Kalam	Kalam	12000	1714	1	60
2	1	CB-MEWS/Cryosphere Hazards	KP	Swat	Bahrain	Bahrain	Bahrain	20000	2857	1	100
3	1	CB-MEWS/Cryosphere Hazards	Gilgit-Baltistan	Shigar	Shigar	Shigar	Shigar Fort	4000	571	1	35
											195
Component. 01 Batch 02											
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch (1 or 2)**	**Sample Allocation**
1	1	CB-MEWS/Cryosphere Hazards	KPK	Lower Chitral	Kalash	Kalash	Kalash	4000	571	2	25
2	1	CB-MEWS/Cryosphere Hazards	Gilgit-Baltistan	Ghizer	Gupis	Gupis	Raushan	1000	143	2	25
4	1	CB-MEWS/Cryosphere Hazards	Gilgit-Baltistan	Ghizer	Gupis	Gupis	Gupis	5000	714	2	25
5	1	CB-MEWS/Cryosphere Hazards	Gilgit-Baltistan	Shigar	Ishkoman	Ishkoman	Ishkoman	22000	3134	2	30
6	1	CB-MEWS/Cryosphere Hazards	Gilgit-Baltistan	Shigar	Shigar	Shigar	Alchori	2500	357	2	25
											130

Component. 02 Batch 01											
Sr.No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1	2	Springsheds	KP	Swat	Khwaza Khela	Fatehpur	Barham	6,895	985	1	58
2	2	Springsheds	KP	Lower Dir	Temargara	Temargara	Timargara	47,000	6714	1	92
3	2	Springsheds	KP	Abbottabad	Abbottabad	Nathia Gali	Nathia Gali	957	137	1	30
4	2	Springsheds	KP	Abbottabad	Abbottabad	Banda Jaggian, Abbottabad	Banda Jaggian	4720	674	1	43
										Total	**223**
Component. 02 Batch 02											
Sr.No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
2	2	Springsheds	KP	Swat	Khwaza Khela	Khwaza Khela	Jano Chamtalay	6115	874	2	30
3	2	Springsheds	KP	Lower Dir	Adenzai	Ouch	Ouch	21800	3114	2	40
4	2	Springsheds	KP	Lower Dir	Temargara	Bandagai Talas	Bandagai Talas	13717	1960	2	30
6	2	Springsheds	KP	Mardan	Katlang	Babuzai	Babuzai	31000	4429	2	49
Total											**149**

Component. 03. Batch 01											
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	3	Solar pump	KP	Charsadda	Charsadda	Ghari hameed Gul	WSS Garhi Hamid Gul	6,500	929	1	40
2.	3	Water Recharge facilities	KP	Charsadda	Shabqadar	Sardar Ghari	Matta Daman, Near Saddar Garhi Police Chowki Khwar - Up/Stream.	1,400	200	1	30
3.	3	Solar pump	KP	Nowshera	Nowshera	Kaka Sahib	WSS Kaka Saib	5,600	800	1	33
4.	3	Solar pump	KP	Nowshera	Nowshera	Hotti Khel	WSS Hoti khel	2200	314	1	30
5.	3	Water Recharge facilities	KP	Nowshera	Nowshera	kaka Sahib	WSS Kaka Sahib	2,700	386	1	30
6.	3	Solar pump	KP	Swat	Khwazakhela	Tirat	WSS Qandil	1500	214	1	30
7.	3	Water Recharge facilities	KP	Swat - I	Kabal + Babuzai	GWR Kotlai: U/C Kuza Bazkhela GWR Shamozai Area: UC Shamozai	GWRs at WSS Kotlai Swat-Khwar +Shamozai Area+ Saidu Swat-PHE Coloney - Drought Site	5000	714	1	30

						GWR Saidu PHE Colony U/C Saidu Sharif					
8.	3	Lead line handpump	Sindh	Khairpur	Gambat	Bhelaro	Bhelaro	3,200	457	1	30
9.	3	Solar pump	Sindh	Khairpur	Kot Diji	Kot Diji Town	Kareem Bux Solangi	1,200	171	1	30
10.	3	Lead line handpump	Sindh	Mirpur khas	KGM	Haji Hadi bux	Nazim Seth Hameer	950	136	1	30
11.	3	Lead line handpump	Sindh	Mirpur khas	Hussain Bux Mari	OLD Mirpur	Yar Mohammad Jhinji	3,000	429	1	30
12.	3	Solar pump	Sindh	Mirpur khas	KGM	Haji Hadi bux	Abdullah Aziz Khan	2,450	350	1	30
13.	3	Solar pump	Sindh	Mirpur khas	Sindhri	Jhurbi	Haji Wahid bux	2,500	357	1	30
14.	3	Solar pump	Sindh	Mirpur khas	Shujabad	Khumbri	Krishan Kolhi / Nanji Patel	2,500	357	1	30
15.	3	Solar pump	Sindh	Mirpur khas	Hussain Bux Mari	OLD Mirpur	Haji Farooq Jhinji	2,500	357	1	30
16.	3	Solar pump	Sindh	Mirpur khas	Hussain Bux Mari	OLD Mirpur	Muhammad Usman Rajjar Colony	6,340	906	1	30
17.	3	Lead line handpump	Sindh	Sujawal	Sujawal	Keenjhar	Keenjhar	1,700	243	1	30
18.	3	Solar pump	Sindh	Sukkur	Kandhara	Wah Burira	Dahro Jagirani	3,200	457	1	30
19.	3	Solar pump	Sindh	Sukkur	Bachal Shah	Saeedabad	Maitla	1,400	200	1	30
20.	3	Lead line handpump	Sindh	Tharparkar	Diplo	Dhabro	Hashim Khoi	1,750	250	1	30

21.	3	Lead line handpump	Sindh	Umerkot	Umerkot	Kharoro Sayed	Deeno Chang	963	138	1	30
22.	3	Lead line handpump	Sindh	Umerkot	Samaro	Satryion	Mehboob Shah	1,875	268	1	30
	Total										**673**

Component. 03. Batch 02											
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	3	Solar pump	KP	Charsadda	Shabqadar		Kaotzai			2	30
2.	3	Solar pump	KP	Charsadda	Tangi	Kot Baba Gulabad	WSS Tube well # 5	5000	714	2	30
3.	3	Solar pump	KP	Charsadda	Shabqadar	Haleem Zai	WSS Haleem Zai	3000	429	2	30
4.	3	Solar pump	KP	Nowshera	Nowshera	Khatte Kaly	DWSS Khatte Kaly	500	71	2	30
5.	3	Solar pump	KP	Swat	Khwazakhela	Faehpur	WSS Fatihpur	5000	714	2	30
6.	3	Water Recharge facilities	KP	Swat	Khwazakhela	Janu Chamtalai	GWR at WSS Langar Kallay	2000	286	2	30
7.	3	Solar pump	Sindh	Sujawal	Sujawal	Ali bahar	Ali Muhammad Macharo	615	88	2	30
8.	3	Solar pump	Sindh	Sujawal	Sujawal	Keenjhar	GBPS Muhammad Khan pali poto	1,430	204	2	30
9.	3	Solar pump	Sindh	Sujawal	Sujawal	Mirzo Laghari	Khalifo Ahmed	778	111	2	30
10.	3	Solar pump	Sindh	Tharparkar	Diplo	Jhirmilio	Rohal	1,436	205	2	30
11.	3	Solar pump	Sindh	Umerkot	Umerkot	Khan Sb Atta Mohd Palli	Soofi Taleh/Mohd Markan	2,200	314	2	30

12.	3	Solar pump	Sindh	Umerkot	Umerkot	Kharoro Sayed	Sona Rasti	2,200	314	2	30
13.	3	Solar pump	Sindh	Umerkot	Umerkot	Walli Dad	Bag Water	1,726	247	2	30
14.	3	Solar pump	Sindh	Umerkot	Samaro	Satryion	Mufti Asad Ali	3,400	486	2	30
15.	3	Solar pump	Sindh	Umerkot	Samaro	Mir Mohd Burgri	Jan Mohd Burgri	800	114	2	30
											450
	Component. 04 Batch 01										
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	4	Wetland	KP	Charsadda	Tangi	TMA Tangi	Nasrat Zai Bazar (balbalay street to Main Charsadda Road)	608	87	1	30
2.	4	Wetland	KP	Nowshera	Nowshera	TMA Pabbi	Pabbi town to Qabristan Road	1,800	257	1	30
3.	4	Wetland	Sindh	Khairpur	Sobho Dero	Dhonbut pur	Anb	2,676	382	1	30
										Total	**90**
	Component. 04 Batch 02										
Sr. No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	4	Wetland	KP	Swat	KhwazaKhela	KhwazaKhela	Wetland at Kuzkaley	300	43	2	
2.	4	Wetland	Sindh	Khairpur	Sobho Dero	Mirak	Mirak	2,390	341	2	
3.	4	Wetland	Sindh	Khairpur	Sobho Dero	Pir Hayat Shah	Pir Hayat Shah	795	114	2	

4.	4	Wetland	Sindh	Khairpur	Sobho Dero	Sagyoon	Qazi Bhutto	3,209	458	2	30
5.	4	Wetland	Sindh	Sukkur	Kandhara	Wah Burira	Gul Muhammad Lashari	452	65	2	30
										Total	**60**

Component. 05 Batch 01											
Sr.No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	5	Doras	Sindh	Sanghar	Sinjhoro	Sethar Pir	Near GBPS Dur Muhammad Mari, Village Karam Khan Marri	4,486	641	1	30
2.	5	Water ponds	Sindh	Tharparkar	Chachro	Chachro	Tamachi Je Very	2,310	330	1	30
3.	5	Water ponds	Sindh	Umerkot	Umarkot	Doronaro	Haji Sher khan Mangrio/ Haji Khan Muhamamd Mangrio	704	101	1	30
										Total	**90**

	Component. 05 Batch 02										
Sr.No.	**Component**	**Proposed Intervention**	**Province**	**District**	**Taluka/Tehsil**	**UC**	**Village**	**Population**	**# of household**	**Batch**	**Sample Allocation**
1.	5	Water ponds	Sindh	Sanghar	Sanghar	Chotiario	Chotirion Road Near, Near Masjid Chotiari	1,600	229	2	30

2.	5	Water ponds	Sindh	Tharparkar	Mithi	Posarko	Khariwah	6,500	929	2	30
										Total	**60**

Annex 3: Literature Review

A. Component 1: Cryosphere Hazards

A.1. GB

A.1.1. District Ghizer

Introduction

Ghizer District is located in the Upper Indus Basin of GB, and is highly vulnerable to cryosphere-related hazards. Studies show that melting glaciers and expanding glacial lakes pose a growing risk to downstream communities, infrastructure and agriculture.[2]

Major Hazards and Events in Ghizer

Shigar District has experienced multiple natural hazards in recent years, reflecting its high exposure to cryosphere and geological risks. A GLOF in August 2025 destroyed over 100 homes, partially damaged another 200 and washed away bridges and roads, severely disrupting mobility and access to basic services.[3]

Around 330 HHs were directly affected, with an additional 900 houses at risk due to the formation of a new lake downstream. The disaster also washed away road networks and bridges, including a one-kilometer road section, cutting off access and isolating several communities. Agricultural lands were flooded, disrupting the primary source of livelihood for local farmers. During relief efforts, over 200 residents were evacuated and dozens of families were relocated to safer locations to ensure their protection. This event highlighted the region's growing exposure to GLOFs caused by unstable glacial lakes growing under climate-induced warming.[4]

Flash floods in 2022 and 2023 further damaged agricultural lands, irrigation channels and village infrastructure, threatening livelihoods dependent on farming.[5] Between 2018 and 2024, frequent landslides and rockfalls along the Gupis-Yasin Road isolated several mountain communities for weeks at a time.[6] During the winter of 2022-2023, heavy snowfall triggered snow and ice avalanches, blocking high mountain passes and cutting off essential supply routes.[7] Additionally, seismic activity between 2019 and 2020 caused slope instabilities and minor infrastructure damage, compounding the district's overall vulnerability to multi-hazard risks.[8]

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[2] ICIMOD. (2023). *Cryosphere monitoring and hazard mitigation in the Upper Indus Basin.* Kathmandu: ICIMOD.
[3] The News International. (2025, August 8). *Glacial lake burst damages over 100 homes in Ghizer.*
[4] News Desk. (2025, August 31). *Over 100 houses swept away as glacial flood creates artificial lake in Ghizer | Pakistan Today*.
[5] Iqbal, Z. (2023). *An analysis of the causes and impacts of the floods of 2022 in Pakistan: A case study of Buber and Sherqila villages, Ghizer District, Gilgit-Baltistan.* University of Management and Technology, Lahore.
[6] Rahim, I., Ali, S. M., & Aslam, M. (2018). *GIS-based landslide susceptibility mapping using Analytical Hierarchy Process in District Ghizer, Gilgit-Baltistan, Pakistan.* Journal of Geoscience and Environment Protection, 6(2), 34-49.
[7] ICIMOD. (2023). *Cryosphere monitoring and hazard mitigation in the Upper Indus Basin.* Kathmandu: ICIMOD.
[8] Ali, S. M., Aslam, M., & Rahim, I. (2021). *Integrating hazard risk and land use planning in mountainous regions of Gilgit-Baltistan, Pakistan.* Journal of Mountain Science, 18(4), 944–960.

A.1.2. District Shigar

Introduction

Shigar District, located in the high mountain ranges of GB, has increasingly experienced cryospheric hazards, particularly GLOFs and flash floods, as a result of rising temperatures and accelerated glacier melt. The district's rugged terrain and its proximity to major glacier systems such as the Baltoro, Basha and Braldo valleys make it highly susceptible to sudden glacier-related disasters. Recent years have witnessed a growing pattern of glacial instability, leading to significant socio-economic and infrastructural losses.[9]

Major Hazards & Events in Shigar

In August 2025, flash floods triggered by intense rainfall and glacier melt struck Dogoro village in the Basha area of Shigar, damaging dozens of houses and displacing local residents. A GLOF event in the Horchas nullah also caused severe destruction to agricultural lands and blocked the main road leading to the K2 base camp, isolating several upstream communities.

These events not only disrupted transport and communication but also hampered tourism, which is a vital part of the local economy. The Shisper Glacier flood, which primarily affected Hunza, also had spillover impacts in parts of Shigar, inundating farmlands and residential areas.[10] The aftermath of these floods created a chain reaction of secondary crises. Damage to water infrastructure led to severe water contamination, forcing communities to rely on unsafe sources.

Health authorities reported an alarming rise in acute diarrheal diseases, with over 340 cases recorded in Shigar alone in August 2025.[11] Loss of fertile land and damage to irrigation channels have further undermined local livelihoods, mainly among farming HHs dependent on seasonal crops. These recurring cryospheric hazards reveal Shigar's growing vulnerability to climate-induced glacier dynamics and highlight the urgent need for community-based EWS and resilient infrastructure planning.

A.2. Province KP

A.2.1. District Swat

Introduction:

Swat lies in the western HKH transitional zone where warming is driving rapid changes to glaciers, seasonal snow and high-altitude hydrology. Rising temperatures increase meltwater during warm months, reshape seasonal flow regimes and promote formation and growth of proglacial lakes behind unstable moraine dams, the physical drivers that raise hazard levels across Swat.[12]

[9] Dawn. (2025, August 15). *Two large lakes formed by glacial outburst in Gilgit-Baltistan.*
[10] Khyber News. (2025, August 15). *Hunza Shisper glacier flood cuts off Karakoram Highway, isolates communities in Gilgit-Baltistan*
[11] Dawn. (2025, August 14). *Flash floods damage homes in Shigar and cut off roads to K2.* Retrieved from https://www.dawn.com/news/1930758
[12] National Disaster Management Authority. (2025). *GLOF outlook and situation analysis: National perspective 2025*. Government of Pakistan.

Swat has 255 glacial lakes and 233 glaciers.[13] Remote sensing and field studies across northern Pakistan show accelerated glacier thinning and retreat in recent decades, producing new glacial lakes and altering runoff timing. For Swat, these cryosphere changes imply greater summer flows in the short term (from enhanced melt) and increased risk of later reduced baseflow as glaciers shrink, with implications for irrigation, hydropower and ecosystem services.[14]

Major Hazards and Events in Swat

The increasing number of glacial/proglacial lakes and national hazard outlooks identify Swat, as exposed to potential GLOFs where moraine dams are unstable. National disaster assessments & GLOF risk-reduction programs emphasize that GLOF frequency and potential severity are rising with warming, placing downstream communities, roads, bridges and cultivated land at risk.

Swat's mountainous drainage network is highly sensitive to intense rainfall events. The August 2022 floods and associated debris flows are a clear example: prolonged heavy rain produced catastrophic debris flows that blocked channels, dammed reaches and amplified downstream flood damage. Studies of the 2022 event document numerous debris-flow gullies, large sediment transfers to the Swat River and widespread infrastructure impacts, illustrating how extreme precipitation and slope instability compound cryosphere-related hazards.[15] In the 2022 floods, 26 people lost their lives and 19 were injured. Approximately 1,119 houses were completely damaged, along with 49 schools. The flood had a severe impact on the surrounding infrastructure.[16]

Steep terrain, unstable colluvium/moraines and strong seasonal snowpacks make Swat vulnerable to landslides and avalanches. Snow avalanches and slope failures periodically block roads, isolate communities and disrupt tourism and seasonal livelihoods. These events are often triggered by heavy snowfall, rapid warming, or rain-on-snow episodes.

A.2.2. District Lower Chitral

Introduction

Lower Chitral lies at the southern margin of the HKH where steep topography, seasonal snow and mid-/high-altitude glaciers combine with highly variable precipitation to create a multi-hazard environment. Warming in the HKH has accelerated melting glaciers and changed seasonal runoff patterns, increasing both short-term flood risk (from melt + heavy rain) and long-term water security concerns.[17] There are 116 glacial lakes in Chitral. Remote-sensing studies across the Eastern Hindu-Kush and nearby ranges report significant glacier area loss

[13] Saifullah, M., Liu, S., Adnan, M., Ashraf, M., Zaman, M., Hashim, S., & Muhammad, S. (2020). Risks of Glaciers Lakes Outburst Flood along China Pakistan Economic Corridor. In *Glaciers and the Polar Environment*. IntechOpen. https://doi.org/10.5772/intechopen.93459

[14] Bazai, N. A., Alam, M., Cui, P., Hao, W., Khan, A. P., Waseem, M., Shunyu, Y., Ramzan, M., Wanhong, L., & Ahmed, T. (2024). *Dynamics and Impacts of Monsoon-Induced Geological Hazards: A 2022 Flood Study along the Swat River in Pakistan*. Hydrological Hazards.

[15] Bazai, N. A., Alam, M., Cui, P., Hao, W., Khan, A. P., Waseem, M., Shunyu, Y., Ramzan, M., Wanhong, L., & Ahmed, T. (2024). *Dynamics and Impacts of Monsoon-Induced Geological Hazards: A 2022 Flood Study along the Swat River in Pakistan*. Hydrological Hazards. https://doi.org/10.5194/nhess-2024-95

[16] Khaliq, F. (2025, March 19). *When Rivers Run Wild: The Hidden Cost of Glacial Melting in Pakistan*. WE News English

[17] Ahmad, Z., Altaf, F., Kamp, U., Rahman, F., & Malik, S. M. (2025). Glacier Recession and Climate Change in Chitral, Eastern Hindu Kush Mountains of Pakistan, Between 1992 and 2022. *Geosciences*, *15*(5), 167. https://doi.org/10.3390/geosciences15050167

and accelerated thinning since the 1990s, producing new and expanding proglacial lakes.[18] National GLOF-mapping and outlook products explicitly identify several lakes in Chitral (e.g., Reshun) as having high vulnerability and posing potential downstream risk to Lower Chitral catchments if breaches.

Major Hazards and Events in Lower Chitral

Lower Chitral faces recurrent GLOFs due to rapid glacier melt intensified by climate change. From July 15-28, 2015, severe glacial floods devastated villages, roads, bridges and water supply systems, killing 32 people and causing major infrastructure losses.

The Golain Valley was among the worst affected, where debris-laden floods damaged agricultural land, blocked the Mastuj Road and destroyed the Golain hydropower plant. The formation of an upstream glacial lake further increased local vulnerability. Subsequent events, including the 2019 GLOF, caused additional damage to settlements and farmlands.[19] The outburst flood caused damage worth nearly Rs. 330 million, demolishing roads, bridges and homes. About 10 houses were completely destroyed and 40 more damaged, while over 10 kilometres of roads and four bridges were lost. The disaster disrupted drinking water for more than 80,000 people and directly affected 4,000 residents of Golain Valley, with over 100,000 indirectly impacted.[20]

Chitral's narrow valleys and steep channels concentrate runoff. When extreme rainfall (monsoon-cloudbursts or western disturbances) coincides with enhanced glacier/snowmelt it produces high-magnitude flash floods and sediment-rich debris flows.[21]

Studies of past events (2013, 2015, and 2019) show that Chitral experiences significant sediment transfers, infrastructure damage and flooding due to the combined effects of cryosphere changes and extreme weather events.[22]

Chitral has recorded multiple fatal avalanche incidents (including construction-site incidents and villages being cut off) and local preparedness programs (NGO/AKAH) emphasize winter preparedness and avalanche readiness as priority risk-reduction measures. A volunteer's timely warning and swift action saved 17 lives in Ucho Gole, Lower Chitral, when an avalanche hit the village on January 4, 2016. Despite initial resistance, the volunteer convinced the family and their guests to evacuate to a safe location, prioritizing their safety over hospitality. The avalanche destroyed the homes, but due to the volunteer's efforts, everyone escaped unharmed.[23]

Loss of life and injuries have been documented, houses and historic villages have been damaged, irrigated land and orchards have been destroyed and roads, bridges and tourism infrastructure have been damaged.[24] Water supply has also been disrupted. Recovery from

[18] Ahmad, Z., Altaf, F., Kamp, U., Rahman, F., & Malik, S. M. (2025). Glacier Recession and Climate Change in Chitral, Eastern Hindu Kush Mountains of Pakistan, Between 1992 and 2022. *Geosciences*, *15*(5), 167.

[19] Gul, S., Khan, S. N., Malik, F., Zahid, S. M. H., Khan, R. A., & Fazl-ur-Rahman. (2024). POST-GLOF RECOVERY ANALYSIS: A CASE STUDY OF THE 2019 EVENT IN GOLAIN GOL, LOWER CHITRAL, PAKISTAN. *3*(3), 1303–1322.

[20] Ali, M. (2019, July 23). *Chitral glacial flood causes Rs330bn damage—Newspaper—DAWN.COM*.

[21] FloodList News. (2019, July 10). *Pakistan – Flooding Leaves Communities Isolated in Chitral – FloodList*.

[22] *ADPC*. (2025). https://www.adpc.net/igo/contents/iPrepare/iprepare-news_id.asp?ipid=242

[23] ennis, james. (2023, October 18). Runner-Up 2023—Aga Khan -Agency for Habitat, Pakistan. *ADA*.

[24] Govt. Pakistan. (2015, August 3). *Special report on glacial lake outburst flood in Chitral, 29 July 2015—Pakistan | ReliefWeb*.

GLOFs has been studied, revealing long recovery times and persistent impacts on livelihoods, including loss of agricultural income and displacement, with poorer and remote households being disproportionately affected.[25]

B. Component 2: Springshed Revival and Management

B.1. Province KP

Springs are natural sources where groundwater emerges to the surface, providing vital water sources for hilly and mountainous area in Pakistan. In regions like KP, GB and Azad Jammu and Kashmir, these springs are lifelines supplying water for drinking, HH use and small-scale farming. Because many of these areas have steep terrain and lack access to canal systems, traditional spring-fed channels, locally called *Kuhls*, remain essential.

Beyond meeting daily needs, springs also help sustain local ecosystems and support groundwater recharge, making them critical for long-term water security and livelihood resilience in Pakistan's highland regions.[26] Deforestation removes the natural ground cover that helps the soil absorb and store water, resulting in greater surface runoff, soil erosion and land degradation all of which further threaten the long-term sustainability of springs.[27]

ICIMOD's Springshed Revival and Management Initiative in KP works to restore drying mountain springs through NbS like recharge pits and catchment restoration. It trains local communities (especially women) to monitor and protect springs, helping improve water access in districts such as Swat, Abbottabad and Lower Dir.[28]

B.1.1. District Swat

Swat's mountainous terrain is historically rich in freshwater springs (locally known as *chashmas*), once serving as lifelines for both domestic and agricultural use. However, rapid urbanization, deforestation in the upper catchments and shifting rainfall patterns have significantly reduced spring discharge.[29] There are no previous interventions and projects for springshed revival and management.

B.1.2. District Mardan

Although Mardan lies in a relatively low-lying zone compared to upper KP districts, its semi-hilly regions depend on small perennial springs for domestic use.[30] Over-extraction of groundwater and encroachment on recharge zones have reduced natural flow. Seasonal drying

[25] Gul, S., Khan, S. N., Malik, F., Zahid, S. M. H., Khan, R. A., & Fazl-ur-Rahman. (2024). POST-GLOF RECOVERY ANALYSIS: A CASE STUDY OF THE 2019 EVENT IN GOLAIN GOL, LOWER CHITRAL, PAKISTAN. *3*(3), 1303–1322.

[26] Akbar, G. (2025). Assessment of spring distribution across Pakistan: Implications for water security. *The Nucleus, 62*(1), 14-22.

[27] S. Zokaib and G. Naser, "Impacts of land uses on runoff and soil erosion A case study in Hilkot watershed Pakistan," International Journal of Sediment Research, vol. 26, no. 3, pp. 343-352, 2011.

[28] nternational Centre for Integrated Mountain Development (ICIMOD). (2023). *Springshed revival and management in Khyber Pakhtunkhwa: Strengthening Mountain water security through community-based restoration*. Kathmandu, Nepal: ICIMOD.

[29] Ali, S., & Khan, M. (2022). *Hydro-social transformations in the Swat Valley: Community adaptation to water scarcity.* Journal of Mountain Research, 14(2), 67–78.

[30] Ahmad, F., & Yousaf, T. (2021). *Groundwater depletion and rural water access in Mardan District.* Pakistan Journal of Environmental Studies, 10(3), 55–64.

now limits daily access to drinking water, creating localized water conflicts. No interventions or dedicated studies exist regarding springs as water sources in Mardan.

The district's water supply depends heavily on groundwater accessed via tube wells and extensive irrigation.[31] Any spring revival efforts would first require foundational research to identify and assess existing springs.

B.1.3. District Lower Dir

In Lower Dir, most villages depend on mountain springs fed by snowmelt and rainfall from nearby ridges. Climate change has made spring flow irregular, drying several sources in summer and causing flash flooding during monsoons.[32] Despite some NGO interventions for watershed protection and check dam construction, institutional support remains fragmented. Local councils have limited technical expertise and coordination with PHED is weak.

B.1.4. District Abbottabad

Abbottabad's hilly topography hosts hundreds of natural springs, yet rapid urban growth and forest degradation have reduced their reliability.[33] Many peri-urban areas, including Nawan Shehr and Namli Maira, report reduced spring yields, especially during dry seasons. Governance gaps are evident in overlapping responsibilities between TMAs and PHED, resulting in neglected maintenance and unregulated land use in recharge areas.[34]

C. Component 3: Groundwater Management

C.1. Province Sindh

i. Background about Groundwater in Sindh

Groundwater is the lifeline for much of Sindh, particularly in areas lying outside the canal command zones. The National Climate Change Policy (2021) identifies Sindh as one of Pakistan's most water-stressed regions, where aquifer depletion and seawater intrusion are already threatening human health, agriculture and urban supply systems.[35] Many studies highlight how limited rainfall, poor recharge and unregulated extraction have combined to push groundwater toward critical depletion and declining quality.[36][37]

Groundwater in Sindh underpins daily life for millions of people from coastal fishing settlements to arid desert communities. The Intergovernmental Panel on Climate Change (IPCC) Report adds that rising temperatures, deteriorating recharge rates and more frequent

[31] Usman, M., Khan, N., & Hassan, S. (2025). Urban development and its impact on the depletion of groundwater aquifers in Mardan City, Pakistan. *ResearchGate*.
[32] ICIMOD. (2023). *Springshed Management and Climate Adaptation in Northern Pakistan.* Kathmandu: ICIMOD.
[33] WWF-Pakistan. (2022). *Urbanization and Spring Depletion in Abbottabad District.* Lahore: WWF-Pakistan.
[34] Planning & Development Department, KPK. (2024). *Provincial Water Governance Review.* Peshawar: GoKP.
[35] Government of Pakistan. (2021). *National Climate Change Policy of Pakistan (2021).* Ministry of Climate Change, Islamabad.
[36] Murad calls for improving quality of groundwater across Sindh" – Provincial overview of water supply schemes and RO plants.
[37] Assessment of Groundwater Quality in Mirpurkhas – 50 bore wells evaluated, many found unsuitable for drinking.

droughts are accelerating groundwater decline across South Asia, particularly in deltaic and arid basins like Sindh.[38]

Meanwhile, the UNDP Climate Promise (2022) promotes integrated water resource management, calling for community participation and gender-inclusive approaches in local adaptation planning principles now reflected in some of Sindh's pilot projects such as managed aquifer recharge and community-based RO (Reverse Osmosis) systems.[39]

ii. Groundwater Quality and Sources

People in Umerkot depend on tubewells, dug wells and seasonal ponds. However, large areas have saline or bitter groundwater and fresh water is found only in isolated spots, forcing residents to rely on distant wells or NGO-supported filtration plants.[40]

In Khairpur, groundwater comes mainly from canal seepage recharge and shallow wells. After canal lining, recharge declined, causing rising salinity and higher electrical conductivity (EC) and total dissolved solids (TDS) levels.[4142] Mirpurkhas uses bore wells along with mixed canal water but about one-third of samples are unsuitable for drinking due to salinity and sodium-chloride contamination.[43]

In Sujawal, groundwater-based supply schemes and wells are common, but much of the water is saline and bacteriologically unsafe. Several RO plants have been set up to improve access. The primary sources in Sukkur are freshwater lenses (layer or pocket of fresh groundwater that floats on top of denser saltwater, usually found in coastal or river-adjacent areas) close to the Indus River and shallow wells. Small RO facilities and water supply systems are being installed since the water near the river is fresher but the salinity rises inland.[4445]

Tharparkar, which depends on traditional *tarai* (rain ponds), bore wells and dug wells, continues to be one of the most water-stressed areas. Some towns excavate 200-300 feet to obtain low-quality water because most sources are dangerous due to high fluoride and TDS levels.[46]

iii. Groundwater Management and Interventions in Sindh

Sindh has begun several initiatives to improve groundwater governance and quality:

[38] IPCC. (2023). *Sixth Assessment Report: Climate Change 2023—Impacts, Adaptation and Vulnerability.* Cambridge University Press.
[39] UNDP Pakistan. (2022). *Pakistan Climate Promise: Accelerating Action for Adaptation and Resilience.* Islamabad.
[40] IUCN Pakistan. (2023). *Community-Based Water Management in Umerkot District*.
[41] Sindh Irrigation Department. (2021). *Canal Recharge and Groundwater Assessment Report, Khairpur Region*.
[42] World Bank. (2022). *Sindh Water Sector Improvement Project – Phase II*.
[43] UNICEF Pakistan. (2023). *Groundwater Quality and Sanitation Status in Sindh*.
[44] Ahmed, W., Punthakey, J. F., Jamali, S., Qureshi, A. L., & Shaikh, S. (2024). *Assessing groundwater monitoring in Sujawal and guidance for strengthening groundwater monitoring across Sindh*. Gulbali Institute, Charles Sturt University.
[45] Pakistan Council of Research in Water Resources (PCRWR). (2022). *Water Quality Assessment Report, Sindh Region*.
[46] WaterAid Pakistan. (2023). *Water Access and Quality in Tharparkar District*.

❖ **Licensing and Regulation:**

The Sindh Water Policy (2023) introduced groundwater licensing, abstraction limits and integration of surface and groundwater management. Karachi's Water and Sewerage Corporation also began licensing boreholes to control over-extraction.[47]

❖ **Data and Monitoring Projects:**

The Groundwater Information System and Atlas developed by International Water Management Institute (IWMI) and Pakistan Council of Research in Water Resources (PCRWR) is mapping water quantity and quality across canal command and arid zones to guide future planning.[48]

❖ **Community and Technological Interventions:**

NGOs and government departments have installed hand pumps, solar pumps and RO plants in Umerkot, Tharparkar and Khairpur.[49] Projects like Sindh Water & Agriculture Transformation use GIS and sensor-based systems to track extraction and promote climate-smart irrigation.[50]

❖ **Recharge and Surface Integration:**

Environmental restoration projects such as the Manchar Lake restoration under Recharge Pakistan should concentrate on enhancing the natural groundwater recharge by means of restored wetlands and enhanced drains management.[51] Some of the villages continue to use unsafe wells or faulty filtration systems. Community ownership will be enhanced, routine testing will be conducted and coordination at the district level will be ensured, which will be essential to groundwater resilience in Sindh.

C.2. Province KP

i. Background about Groundwater in KP

Groundwater plays an important role in sustaining the people and economy of KP, especially in districts like Charsadda, Nowshera and Swat, where it acts as the main source of water for drinking, domestic use, livestock and small-scale irrigation. As rainfall becomes increasingly unpredictable and surface water flows fluctuate due to climate change, dependence on groundwater continues to grow. The National Climate Change Policy, more concerned about sustainable water resource management, including aquifer protection and groundwater recharge, is central to Pakistan's adaptation strategy.[52]

The Sixth Assessment Report by the IPCC states that extreme heat and unpredictable rainfall are escalating groundwater depletion and salinity in South Asian areas and generating long-term threats to human health and food production.[53] The Sendai Framework on DRR and the National DRR Framework recommend the inclusion of water security in the disaster resilience

[47] Community World Service Asia (Umerkot) – local descriptions of saline groundwater and limited fresh water pockets.
[48] Assessment of Groundwater Quality in Mirpurkhas – 50 bore wells evaluated, many found unsuitable for drinking.
[49] Groundwater Quality and Recharge Dynamics in Khairpur – impact of canal lining on salinity and EC.
[50] Islamkot, Tharparkar study using WQI and GIS tools – groundwater highly saline and fluoride-rich.
[51] Manchar Lake and Recharge Pakistan initiative – large-scale water restoration and recharge project for Sindh.
[52] Government of Pakistan. (2021). *National Climate Change Policy of Pakistan (2021).* Ministry of Climate Change, Islamabad.
[53] IPCC. (2023). *Sixth Assessment Report: Climate Change 2023 — Impacts, Adaptation and Vulnerability.* Cambridge University Press.

planning, stating that the system control over groundwater must be conducted in a way that it would be resistant to floods, droughts and risks of contamination.[54]

The Climate Promise of UNDP emphasizes that enhancing water governance at the community level, as a part of local involvement and adaptive solutions, contributes to resilience and social equity. Groundwater management in KP in this case is not only a technical issue but also a key tool of adaptation to DRR, health and sustainable livelihoods.[55]

The World Bank's 2021 guidance on monitoring and evaluation for resilience programs and the impact evaluation framework by Gertler et al. (2016)[56] underline that interventions should be evidence-based, continuously monitored and scaled according to results.[57] This means that every project associated with groundwater, whether it is community wells, recharge ponds or solar-powered pumps, should have measurable impacts, transparent reporting and adaptive mechanisms to ensure sustainability.

ii. Groundwater Quality and Sources

KP groundwater comes out of a mixture of shallow and deep aquifers, springs and hand-dug wells, depending on the geology and topography of each of the districts. In Charsadda, the water table is near the surface and that is why groundwater becomes readily available and is also more susceptible to contamination. On-site research and field surveys have discovered that shallow wells, particularly those around residential and agricultural lands, frequently exhibit chemical contaminations as the result of leaking sewage systems and run-off of fertilizers.[58] This pollution is intensified during floods where floodwaters creep into unearthed wells and transmit waterborne diseases.

The floodplain dynamics and river outflow play an important role in the determination of the groundwater quality in Nowshera. The rivers are close to the Kabul and Kalpani rivers, which have sufficient recharge during wet seasons and increase the possibility of contamination due to intrusion of floodwater. After the floods, contact with most hand pumps and tube wells delivers turbid or salty water and communities have to use services of temporary water tankers or bottled water.[59]

Swat has mountainous topography and shapes a very different hydrogeological pattern. Springs and mountain aquifers have historically provided clean, mineral-rich water, but rapid urbanization and unplanned drilling of private tube wells have disturbed natural recharge zones.

Recent analyses reveal increasing nitrate and sulphate concentrations in low-lying settlements such as Mingora, reflecting both wastewater infiltration and agricultural intensification.[60] post-flood contamination is widespread due to damaged pipelines and open wells. Water quality

[54] UNDRR. (2015). *Sendai Framework for Disaster Risk Reduction 2015–2030.* United Nations Office for Disaster Risk Reduction.
[55] UNDP Pakistan. (2022). *Pakistan Climate Promise: Accelerating Action for Adaptation and Resilience.* Islamabad.
[56] Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. J. (2016). *Impact Evaluation in Practice* (2nd ed.). World Bank Group.
[57] World Bank. (2021). *Monitoring and Evaluation for Resilience Programs: Guidance for Practitioners.* Washington, DC.
[58] PDMA KPK & Provincial Water Quality Studies (Charsadda District Reports).
[59] Local Flood Impact and Water Safety Reports, Nowshera District (2022–2024).
[60] Asian Development Bank & Water Testing Studies, Swat District (2023).

monitoring is fragmented and reactive, with testing done after outbreaks instead of through regular surveillance.[61]

iii. Groundwater Management and Interventions

The KP experience of groundwater management is slowly coming into line with the national climate and disaster systems. The KP Cities Improvement Project (KPCIP) funded by the Asian Development Bank proposes projects to decrease the dependence on groundwater by availing treated surface water, supplied through new distribution systems, especially in urban areas such as Mingora. This program is likely to take a strain off aquifers and ensure more access to safer drinking water.[62]

At the same time, GIS-based studies led by provincial agencies and research institutions are mapping groundwater potential zones to guide sustainable abstraction and identify recharge opportunities.[63] Pilot initiatives, including rainwater harvesting structures and managed aquifer recharge (MAR) trials, have demonstrated potential in refilling depleted water tables. Institutional capacity is still developing.

While the World Bank (2021) advises setting up consistent monitoring systems that track changes in water levels and quality over time, the NDMA Framework (2022-2030) advocates for including water security into disaster management strategies at the district level.[64] Still, poor coordination between provincial departments, low community knowledge and insufficient upkeep of established infrastructure continue to be implementation challenges.

Both the Climate Change Policy and the UNDP Climate Promise concerned about enabling local populations, mainly women and young people, to contribute in groundwater decision-making may assure long-term success and lessen well and pump overuse.[65] KP's groundwater resilience depends on combining local knowledge with structured institutional support.[66]

D. Component 4: EbA, Pakistan

1. Background and Evolution of EbA in Pakistan

EbA is an approach that focuses on protecting and using nature to help communities cope with the impacts of climate change. Instead of depending only on heavy infrastructure such as dams, drainage channels, or concrete embankments, EbA works with natural systems like wetlands, forests and rangelands to manage water, reduce floods and restore degraded land. It recognizes that healthy ecosystems can act as natural buffers against disasters and that investing in them brings lasting benefits for both people and the environment.

In Pakistan, the concept of EbA has grown steadily over the past decade as the country faces more frequent floods, droughts and heatwaves. The IPCC Sixth Assessment Report (2023)

[61] PCRWR & IWMI (2023). *Groundwater Monitoring Gaps in Northern Pakistan.*
[62] Asian Development Bank. (2023). *Khyber Pakhtunkhwa Cities Improvement Project – Greater Mingora Water Supply Component.*
[63] IWMI & University of Peshawar (2022). *GIS Mapping of Groundwater Potential in KPK Districts.*
[64] National Disaster Management Authority (NDMA). (2022). *National Disaster Risk Reduction Framework 2022–2030.* Islamabad.
[65] UNDP Pakistan. (2022). *Pakistan Climate Promise: Accelerating Action for Adaptation and Resilience.* Islamabad.
[66] World Bank. (2021). *Monitoring and Evaluation for Resilience Programs: Guidance for Practitioners.* Washington, DC.

shows that South Asia, including Pakistan, is highly vulnerable to climate change and that restoring ecosystems can reduce many of these risks. The National Climate Change Policy (2021) takes this scientific understanding and translates it into national priorities. It promotes the use of nature-based and ecosystem-based measures to control floods, recharge groundwater and support agriculture and biodiversity.

Historically, Pakistan's climate adaptation efforts focused on engineering solutions. While these structures provided short term protection, they couldn't always handle the growing intensity of floods and droughts. The devastating 2010 and 2022 floods revealed the limits of concrete infrastructure alone and highlighted how degraded rivers, wetlands and catchments made communities more exposed. This realization led to a shift in thinking among government entities and development partners toward using natural systems as part of climate resilience planning.

The National DRR Framework (NDMA, 2022)[67] reflects this new understanding by identifying the restoration of natural water systems, rangelands and forests as essential for reducing the impacts of disasters. For example, when wetlands are restored or small ponds are maintained, they can absorb floodwater, recharge groundwater and provide safe water for livestock and crops during dry periods. Similarly, tree plantations along riverbanks can slow runoff and prevent erosion. These are all practical examples of EbA in action.

Pakistan's direction also aligns with global commitments such as the Sendai Framework for DRR (2015)[68], which calls for strengthening natural ecosystems as part of disaster preparedness and recovery. This international framework encouraged countries to integrate ecosystem protection into their national disaster management systems. Pakistan has since worked to bring EbA into its provincial and community level adaptation planning.

Several organizations have played an important role in shaping and applying EbA in Pakistan. The UNDP Climate Promise (2022) helped introduce nature-based approaches in local projects that combine climate adaptation with livelihood improvement. The World Bank (2021) has promoted stronger monitoring and evaluation systems so that the benefits of ecosystem restoration can be measured in both environmental and social terms. According to their guidance, EbA programs should track outcomes like improved groundwater levels, reduced flood exposure and stronger community involvement in natural resource management.

Learning from these experiences, projects such as SAFER Pakistan are now putting EbA principles into practice. The project brings together different partners, including ICIMOD, UNICEF and UN Women, to demonstrate how restoring natural systems can support climate resilience. The approach links environmental management with social inclusion, especially the involvement of women and youth in decision-making. The evolution of EbA in Pakistan can be seen in three main stages. First, it started with awareness and pilot projects that connected conservation with adaptation goals. Next, it was formally recognized in national policies such as the 2021 Climate Change Policy and the 2022 Disaster Risk Reduction Framework.

[67] National Disaster Management Authority (NDMA). (2022). National Disaster Risk Reduction Framework 2022–2030. Islamabad.
[68] UNDRR. (2015). Sendai Framework for Disaster Risk Reduction 2015–2030. United Nations Office for Disaster Risk Reduction.

The SAFER Pakistan project's Component 4 directly supports this evolution. It applies EbA solutions such as constructed wetlands, community ponds and managed aquifer recharge in flood-prone and drought affected areas. In KP, these interventions will help manage wastewater, control flooding and improve groundwater quality in places like Charsadda and Nowshera.

In Sindh, especially in Khairpur and Sukkur, EbA will address water scarcity and salinity by creating recharge ponds, rehabilitating wetlands and promoting vegetation that stabilizes soil and supports local livelihoods.

These interventions reflect the core ideas of the National Adaptation Plan (2023), which promotes locally led adaptation and the restoration of degraded ecosystems. By improving water management and restoring natural landscapes, EbA not only reduces disaster risk but also strengthens food security, supports biodiversity and creates opportunities for sustainable livelihoods.

In summary, EbA represents a shift in Pakistan's adaptation journey. It moves from relying solely on engineered infrastructure toward a balanced approach that values nature as a key part of resilience. Healthy ecosystems provide protection, resources and stability to communities that are most at risk from climate change. Through initiatives like SAFER Pakistan, EbA is being transformed from a policy concept into on-the-ground action that helps people and nature thrive together.

2. Core EbA Interventions

EbA in the SAFER package focuses on interventions that are proven in similar climates and socio-economic conditions. Three types are most relevant.

Constructed wetlands for wastewater treatment: Small to medium scale constructed wetlands have been piloted in Pakistan for decentralized sanitation and for treating flood affected wastewater. Studies and case reports[69] from Nowshera and other areas show that designed wetlands significantly reduce biochemical oxygen demand and feacal coliform counts and provide safe reuse options for irrigation and groundwater recharge when properly sited and maintained. The technique is low technology, uses local materials and plants and fits small towns and peri urban settlements. Nevertheless, long term performance could depend on O&M capacity and safeguarding against contamination during floods.

Managed aquifer recharge and landscape recharge measures: EbA approaches that increase infiltration and recharge, such as recharge ponds, *tarai* cleaning and small check dams, have been demonstrated across arid and semi-arid parts of Pakistan. These measures smooth seasonal water availability, raise water tables locally and support dry season water supply for HHs and livestock. The Recharge Pakistan concept and similar proposals[70] show how

[69] Atif Mustafa and Muhammad Afzal, "Constructed Wetlands for Sustainable Wastewater Treatment – Case Studies from Pakistan," in *Constructed Wetlands for Wastewater Treatment in Hot and Arid Climates*, ed. (Cham: Springer, October 2022), pp. 231-241.

[70] WWF-Pakistan, *Recharge Pakistan: Building Pakistan's Resilience to Climate Change through Ecosystem-based Adaptation (EbA) and Green Infrastructure for Integrated Flood Risk Management: Funding Proposal (Version 3.0, 3 August 2023)* (World Wildlife Fund, 2023), accessed October 16, 2025.

combining green infrastructure with community governance yields multiple benefits for water security and flood risk reduction.

Green infrastructure for flood attenuation and micro-climate benefits: Restored wetlands, vegetated buffer strips and agroforestry can slow runoff, trap sediment and raise local humidity and soil organic matter. Pilot and donor projects in Sindh indicate that community ponds and *doras* (small reservoirs) used for managed storage and controlled release reduce vulnerability to short dry spells and can limit salinity intrusion when paired with groundwater-friendly cropping plans. These measures[71] have proven value in the Lower Indus where salinity and waterlogging are major constraints.

3. Local vulnerability and why EbA matters

Charsadda and Nowshera in KP are highly flood prone riverine districts where agriculture and seasonal streams form the backbone of local livelihoods. Studies indicate a strong connection between poverty and vulnerability to climate hazards in these areas, emphasizing that engineering-based flood controls alone can't safeguard poor HHs without restoring natural systems that support water regulation and soil stability. EbA interventions such as constructed wetlands, vegetated drainage channels and small infiltration ponds help reduce disaster risks while improving access to safe water and protecting livelihoods.[72]

Khairpur and Sukkur in Sindh represent the lower Indus Basin's arid zone, where communities face chronic salinity, water scarcity and irregular surface flows. These districts have a long-standing culture of managing communal ponds and *tarai* water bodies for domestic use, livestock and groundwater recharge. Modern climate pressures, including reduced river flows and frequent floods, threaten these systems, making EbA approaches critical. Priorities in these districts include decentralized wastewater treatment, water reuse and the rehabilitation of small surface reservoirs to enhance local recharge and drought resilience. The existing community-managed water systems provide a strong foundation for implementing EbA under the SAFER Pakistan framework.

4. Policy, institutional landscape and entry points

EbA sits comfortably within Pakistan's current policy environment. The National Adaptation Plan identifies ecosystem approaches and community engagement as key pillars. Provincial climate policies, such as the KP Climate Change Policy[73]explicitly encourage integrated approaches that combine natural resource management with social inclusion.

The SAFER project's institutional model, with ICIMOD, UNICEF and UN Women partnering across federal and provincial structures, creates pragmatic entry points for mainstreaming EbA into ongoing water, WASH and rural development programme. This alignment matters for scaling and for ensuring that EbA investments are protected within formal planning processes.

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[71] Adaptation Fund. (n.d.). Sustainable actions for ecosystems restoration in Pakistan - Safer Pakistan. Adaptation Fund. Retrieved October 16, 2025, from https://www.adaptation-fund.org/project/sustainable-actions-for-ecosystems-restoration-in-pakistan-safer-pakistan/

[72] Rana, I. A., Khan, M. M., Lodhi, R. H., Altaf, S., Nawaz, A., & Najam, F. A. (2023). Multidimensional poverty vis-à-vis climate change vulnerability: Empirical evidence from flood-prone rural communities of Charsadda and Nowshera Districts in Pakistan. World Development Sustainability, 2, Article 100064.

[73] Pakistan (Government). (2023, August 15). *National Adaptation Plan 2023*. UNFCCC / Prevention Web. Retrieved [your access date], from https://www.preventionweb.net/publication/pakistan-national-adaptation-plan-2023

Critical institutional considerations include operation and maintenance of NbS infrastructure, local water governance arrangements and gender inclusive management.

Experience from past pilots shows that committees with explicit women and youth representation lead to higher uptake and stronger protection of communal assets. Embedding EbA in local operational plans and linking with Area Water Boards or PHED can create durable management pathways.

5. Lessons, Knowledge Gaps and Synthesis

Experience from EbA projects across Pakistan highlights that technical designs are effective when adapted to local hydrology, yet long term success depends on community ownership and strong governance. Projects that combine physical works with capacity building, clear operation and maintenance plans and local financing show the highest sustainability. Multipurpose interventions such as constructed wetlands that treat wastewater, recharge groundwater and support biodiversity gain broader community acceptance. For Component 4 districts, flood dynamics and sedimentation in Charsadda and Nowshera,[74] require designs that allow for sediment removal and bypass systems, while salinity and high evapotranspiration in Khairpur and Sukkur affect recharge efficiency. Governance remains the main risk as unclear maintenance responsibilities and limited inclusion of women and youth can lead to asset deterioration.

There is also a lack of localized research on nutrient flows from reused wastewater, underscoring the need for targeted monitoring during project implementation. Overall, EbA demonstrates strong potential for these sites by integrating natural systems into climate resilience strategies. Success will depend on technical precision, inclusive community management and sustained coordination under the SAFER Pakistan framework to generate scalable lessons across the Indus Basin.[75]

E. Component 5: Surface Water Conservation in Sindh

1. Historical Background

Sindh's connection with surface water dates back thousands of years, centred around the Indus River, which has shaped its civilization, agriculture and identity. The region's irrigation traditions began over 5,000 years ago during the Indus Valley Civilization at Mohenjo-Daro, where the river's waters supported early settlements and farming systems. Even the name "Sindh" originates from the ancient name of the Indus River, reflecting how deeply the province's history and culture are tied to this vital water source.[76]

[74] https://www.susana.org/_resources/documents/default/2-1557-en-susana-cs-pakistan-2011.pdf

[75] Adaptation Fund. (2024). *Proposal for Pakistan (AFB.PPRC.33. Inf.4)*. Retrieved October 16, 2025, from https://www.adaptation-fund.org/wp-content/uploads/2024/03/AFB.PPRC_.33.Inf_.4-Proposal-for-Pakistan-1.pdf

[76] Pakistan Council of Research in Water Resources. "A Comprehensive Investigation and Spatial Mapping in Canal Command Areas of Sindh." 2023.

2. Ancient Water Management Systems

Historical evidence shows that the region developed extensive irrigation networks that worked in harmony with natural water cycles. The construction of the modern irrigation infrastructure during the British colonial era built upon these ancient foundations, creating what is now one of the world's largest contiguous irrigation systems.[77]

3. Contemporary Surface Water Resources and Management

Sindh's surface water resources are predominantly sourced from the Indus River, which provides the backbone of the province's water security. The province receives water allocation through the Water Apportionment Accord of 1991, which remains the principal document governing inter-provincial water sharing.[78] The total annual water availability varies significantly due to seasonal variations, with 85% of annual river flows occurring during a 90-120 days period from June to September.

The Indus River flows at Guddu Barrage serve as the primary source for Sindh's surface water, with canal diversions historically ranging between 33.94 million Acre Feet (MAF) during Kharif season and 14.82 MAF during Rabi season. In practice, however, actual water diversions frequently fail to meet allocated amounts, primarily due to upstream consumption and climatic variability.[79]

4. Climate Hazards and Disasters Related to Surface Water

Sindh has faced severe floods in 2010, 2011 and 2022, with the 2022 floods[80] being the worst: rainfall 400% above normal, 12 million people affected, 1,092 deaths and 1.9 million homes destroyed. Over 4.4 million acres of farmland were damaged, showing the fragility of Sindh's water infrastructure.[81]

Recurring droughts, especially in 1999-2002 and 2020-2022, caused extreme water shortages (up to 70%) and reduced crop areas.[82] Tharparkar and 7 other districts remain highly vulnerable, prompting communities to adopt water-saving and storage practices for survival.[83]

5. Current and Past Projects Related to Surface Water Conservation

a) World Bank Initiatives

The World Bank has been instrumental in supporting surface water management projects in Sindh. The Sindh Water Sector Improvement Project Phase I (P084302) meant to improve

[77] Food and Agriculture Organization. "Sindh Water Resources Management – Issues and Options." https://www.fao.org/4/af105e/af105e00.pdf
[78] Dawn. "The cultural and agricultural diversity of Umerkot - Business." December 13, 2020.
[79] Food and Agriculture Organization. "Sindh Water Resources Management – Issues and Options."
[80] Research Collective. "Climate Change Vulnerabilities and Climate Action in Sindh Province."
[81] Dawn. "Tackling Sindh's climate crisis - Newspaper." July 7, 2025.
[82] Dialogue Earth. "Floods after drought devastate Sindh's agriculture." September 5, 2022.
[83] PDMA Sindh. "Drought - PDMA_SINDH." July 19, 2023.

irrigation water distribution efficiency and effectiveness across three Area Water Boards, ultimately benefiting 667,000 hectares of irrigated agricultural land and reaching 612,000 beneficiaries. The project achieved significant improvements in conveyance efficiency, increasing from 52% to 58% and improved water delivery equity from 51% to 66%.[84]

b) Government of Pakistan and Provincial Initiatives

The Sindh Water Policy 2023 represents a landmark provincial initiative for comprehensive water resources management.[85] This policy framework addresses multiple aspects of water management, including surface water conservation and emphasizes community engagement, cross-sector collaboration and climate resilient strategies. The National Water Conservation Strategy for Pakistan provides a federal framework for water conservation initiatives, including surface water management. This strategy focuses on the development of managed aquifer recharge systems, rehabilitation of historical water resources and the promotion of NbS for water conservation.

c) ICIMOD and International Partnerships

The ICIMOD-led SAFER Pakistan project, funded by the Adaptation Fund with a budget of $10 million, promotes NbS for surface water conservation across Sindh, GB and KP.[86] It focuses on rehabilitating ponds and waterways under Component 5 (Surface Water Conservation) to improve water availability, conservation structures and community practices through integrated resource management.[87]

d) Community-Based and NGO Initiatives

Among NGOs, SCOPE has been active since 1994, developing 17 ponds for people and livestock in Mithi, Chachro and Diplo (Tharparkar) to enhance rainwater harvesting and storage.[88] Similarly, the Pakistan Water Partnership (PWP)[89] implemented 533 water harvesting sites in Tharparkar, capturing over 154 million cubic meters of runoff through earthen reservoirs and community-led water management, significantly improving local water security.[90]

F. Recent and Ongoing Projects

The KWSSIP improves Karachi's water and sewerage systems, including surface water treatment and distribution, to strengthen urban water management.[91] The Chotiari Reservoir

[84] World Bank. "Pakistan-Sindh-Water-Sector-Improvement-Project."
[85] Sindh Irrigation Department. "Sindh Water Policy." July 21, 2023
[86] Diplomat Nepal. "ICIMOD and Pakistan Sign Agreement to Launch SAFER Pakistan Project." August 4, 2025.
[87] The Nation. "ICIMOD approves $10m in climate financing for Indus River restoration." October 14, 2024.
[88] DryNet. "Access to Clean Water in Remote Parts of Sindh Province." October 9, 2015. https://dry-net.org/initiatives/access-to-clean-water-in-remote-parts-of-sindh-province/
[89] Pakistan Association for the Advancement of Science. "Exploring Surface Runoff Potential and Water Harvesting."
[90] Global Water Partnership. "A Model of Desert Development in Tharparkar, Pakistan."
[91] Karachi Water and Sewerage Services Improvement Project. "World Bank Team Visits Different Project Sites of KWSSIP." May 13, 2025.

Project (2002-2007) enhanced surface water storage and distribution through the Makhi-Farash Link Canal, reducing losses and improving efficiency in the lower Nara canal system.[92]

F.1. Sanghar District

Several key projects are being implemented across Sindh to enhance surface water management, conservation and climate resilience. The Sindh Water and Agriculture Transformation (SWAT) project, implemented by the World Bank, Sindh Irrigation Department (SIDA) and Nara Area Water Board (AWB), focuses on canal lining and reshaping (such as Akram Wah reaches RD 0-37 km), building water control structures (like weirs and regulators) and improving watercourses in 15 pilot Farmer Organizations (including Heran Distributary). This project aims to reduce seepage by 40% and enhance productivity by 20% to 30%, benefiting 20,000 HHs, including 751 HHs in Chotiario. It runs from 2023 to 2028, with procurement ongoing and pilots completed in 2024.[93]

The SAFER Pakistan project, led by ICIMOD, the Adaptation Fund and the Government of Sindh, emphasizes NbS for flood and drought resilience. It involves the rehabilitation of 2 *doras* (in Sinjhoro: Sethar Pir and Sanghar: Chotiario Village) and 1 pond (on Chotiario Road), along with lining, silt traps, solar pumps and water quality sensors. The project ensures 33% participation of women and youth in management committees. Running from 2025 to 2028, it began feasibility studies in early 2025 and construction in mid-2025, directly helping 5,260 people (including 2,577 women and 2,451 children) and supporting 751 HHs in salinity-prone regions.[94]

The Sindh Flood Emergency Rehabilitation Project (SFERP), managed by the World Bank and Government of Sindh (PH&CD), targets restoration of communal water supply schemes and drainage systems to reduce waterlogging, with added flood-resilient pond components. The project, active from 2023 to 2027, has achieved 70% completion after the approval of the Environmental and Social Screening Report (ESSR) in November 2023, helping about 10,000 people in Sanghar by improving post flood water storage and supply reliability.[95]

The National Water Conservation Strategy Initiatives, implemented by PCRWR and the Government of Sindh, include rainwater harvesting pilots and canal sedimentation control measures in the Nara system. Running from 2023 to 2027, it achieved its 2024 annual targets, benefiting ~2,000 HHs in Sanghar through improved groundwater recharge and water conservation.[96]

[92] Dawn. "The cultural and agricultural diversity of Umerkot - Business." December 13, 2020.
[93] Government of Sindh, Sindh Water and Agriculture Transformation Project: Implementation progress report. Government of Sindh, Irrigation Department.
[94] Adaptation Fund. (2024). Sustainable actions for ecosystems restoration in Pakistan (SAFER Pakistan) project proposal. Adaptation Fund.
[95] World Bank. (2025). Sindh Flood Emergency Rehabilitation Project: Mid-term review report. World Bank Group.
[96] Pakistan Council of Research in Water Resources. (2023). Water conservation initiatives in Sindh province: Annual assessment report. PCRWR.

F.2. Tharparkar District

The SAFER Pakistan project (ICIMOD, Adaptation Fund, GoSindh) is restoring 6 *doras* and 1+ pond across Chachro, Islamkot, Mithi and Deeplo with embankments, filtration, solar pumps and sensors. Active from 2025-2028, it benefits 39,845 people (5,692 HHs), including minorities, improving water access and livestock conditions.[97] The SWAT project (World Bank, SIDA, Nara AWB) supports rainwater diversion, drought monitoring (HAI) and watercourse lining in border FOs. Running 2023-2028, it benefits approximately 5,000 HHs, enhancing flow efficiency by 20%.[98]

The Dua Foundation focuses on community pond rehabilitation, *tarai* cleaning and rainwater tanks, reducing scarcity for ~10,000 people under its 2023-2025 projects.[99] The Sindh Coastal Resilience Project (IFAD, GoSindh) plans flood-resilient *doras*/ponds and drainage systems for *tarai* protection (2024-2029), benefiting approximately 15,000 people and aligning with Country Strategic Opportunities Programme (COSOP) 2023-2027.[100]

F.3. Umerkot District

The goal of the SAFER Pakistan project, a collaboration between ICIMOD, the Adaptation Fund, and the Government of Sindh, is to restore 2 *doras* in Doronaro and Umerkot and 1 pond in Haji Sher Khan Mangrio. The restoration work includes installing lining, culverts, pumps, and monitoring systems, with a notable 33% involvement of women in the project. Running 2025-2028, it benefits ~10,000 people (mostly women) and 15,000 HHs via solar systems, helping reduce salinity for Hindu and Kolhi communities.[101]

The SWAT project (World Bank, SIDA, Left Bank AWB) involves upgrading Akram Wah, constructing regulators and developing FO subprojects for watercourses and ponds, with smart subsidies for water efficient crops. Operating 2023 to 2028, it has 60% canal works completed, benefiting approximately15,000 HHs and saving 10-25% water through land leveling.

The SFERP project (World Bank, PH&CD) works on restoring water supply schemes, ponds and drainage under a flood-resilient framework. From 2023-2027, it achieved 80% implementation by late 2025, benefiting ~5,000 people with improved post-flood water access.[102] The Restoring Social Services & Climate Resilience project (AWARE NGO) focuses on pond and *tarai* rehabilitation and rainwater harvesting in desert areas. Active 2023-2025, with 3 sites in operation, it supports approximately 2,000 HHs, improving resilience for minority communities in Umerkot.

[97] ICIMOD. (2025). SAFER Pakistan project: Sustainable actions for ecosystems restoration implementation guidelines. International Centre for Integrated Mountain Development.
[98] World Bank. (2022). Sindh Water and Agriculture Transformation Project: Project appraisal document. World Bank Group.
[99] Dua Foundation. (n.d.). Water projects in Tharparkar: Community Pond rehabilitation and water access initiatives. Dua Foundation.
[100] International Fund for Agricultural Development. (2023). Sindh Coastal Resilience Project: Design and implementation framework. IFAD.
[101] ICIMOD. (2025). SAFER Pakistan project: Sustainable actions for ecosystems restoration implementation guidelines. International Centre for Integrated Mountain Development.
[102] World Bank. (2022b). Sindh Flood Emergency Rehabilitation Project: Environmental and social safeguards report. World Bank Group.

Annex 4: Mapping of overlapping/complementing interventions Matrix of ongoing and past related projects by location and theme, opportunities for synergy and avoiding duplication

The SAFER Pakistan baseline assessment (Annex 4) mapped more than 60 ongoing or recently completed interventions across Gilgit-Baltistan, Khyber Pakhtunkhwa, and Sindh through 31 key informant interviews with provincial departments, PDMAs/GBDMA, PHED, Irrigation, NGOs, and donors.

This mapping exercise was cross-checked against the official complementarity matrix presented in Annex 10 of the approved SAFER Pakistan Project Document (ProDoc). While both matrices serve the same strategic purpose, ensuring additionality and avoiding duplication, they are distinct in scope, methodology, and level of detail:

Aspect	ProDoc Annex 10 (2023)	Baseline Annex 4 (Oct 2025)
Scope	National / large-scale flagship programmes (Living Indus, Recharge Pakistan, GLOF-II, 4RF, Clean Green Pakistan, GCF/FAO agriculture project, World Bank flood-recovery projects, etc.)	District- and village-level ongoing interventions (including smaller NGO/INGO pilots, provincial department schemes, and donor sub-projects)
Source	Desk review + consultations during project design	Primary data from 31 fresh KIIs conducted in 2025
Granularity	Programme-level	Specific sites, ponds/doras, recharge structures, EWS stations, exact villages
Purpose	Strategic alignment at design stage	Operational de-duplication and field-level coordination during implementation

The two matrices are therefore **complementary rather than duplicative**. The ProDoc matrix provides the macro-level framework that justified project approval, whereas the baseline matrix translates that framework into concrete, geo-referenced coordination actions on the ground.

Key findings from the synchronisation exercise:

- No geographic overlap was identified with the large flagship programmes listed in ProDoc Annex 10 (Recharge Pakistan, GLOF-II Phase II, Living Indus sites, World Bank/Sindh Flood Emergency Rehabilitation Project ponds, SWAT canal-lining sites, etc.).
- Minor overlaps exist only with small NGO/district-level pilots (e.g., isolated ponds rehabilitated by SRSO, HANDS, Qatar Charity, or Galiyat Development Authority Spring structures). These have been explicitly excluded from SAFER target lists or converted into co-management arrangements.

Specific Recommendation:

- Formally share the updated Annex 4 matrix with the coordination platforms of Living Indus, Recharge Pakistan, GLOF-II, 4RF Provincial Cells, and the World Bank/ADB resilience projects by Q1 2026.
- Sign simple Letters of Collaboration (LoC) or seat-on-committee arrangements with at least five key ongoing initiatives (suggested: Recharge Pakistan, GLOF-II, Sindh Irrigation Department/SWAT, Galiyat Development Authority, and PDMA-Sindh) to enable joint monitoring, shared community committees, and exchange of water-quality/glacier data.
- Establish a light "SAFER Coordination Desk" within the Project Management Unit tasked with updating the complementarity matrix annually and reporting overlaps/synergies to the Project Steering Committee.

By institutionalising these coordination mechanisms, SAFER Pakistan will not only honour the complementarity commitments made in the Project Document but will actively contribute to a more coherent national climate-resilience portfolio in the Indus Basin.

This matrix focuses on ongoing and past projects related to SAFER Pakistan's Project, based exclusively on KIIs from with different government department/NGOs/INGOs. It identifies synergies (e.g., data sharing, sustainability of infrastructure) and strategies to avoid duplication (e.g., targeting uncovered valleys). This operational-level matrix complements and updates the strategic complementarity overview presented in Annex 10 of the approved SAFER Pakistan Project Document (2023). It is based on 2025 field interviews and serves as the project's live de-duplication and coordination tool.

Table 50: Mapping of overlapping/complementing interventions Matrix

Project /Organization	Implementing/Partner Organization(s)	Location(s)	Theme(s)	Time Period	Brief Description	Opportunities for Synergy	Risks of Duplication/Avoidance Strategies	Reference
Scaling-up of GLOFs Risk Reduction (GLOF-II)	UNDP, Ministry of Climate Change (MoCC), Forest, Wildlife & Environment Department (Government of Gilgit-Baltistan)	GB (Haramosh, Basho, Ghandus, Khaplu, Barah, Shishper, Ghulkin, Hussaini, Shimshal, Darkut, Badswat, Sosot, Terishing, Parihsing, Muthat)	Cryosphere Risk Reduction; Early Warning Systems (EWS); Community Resilience	2019-2025 (ending December 2025)	Installs EWS (200 sites, 144 active with sensors, GSM, satellite) and builds small-scale infrastructure and community capacity.	Since GLOF-II is going to end by DEC-2025, therefore SAFER Project can take initiatives for sustainability of existing infrastructure constructed under GLOF Project.	Target unserved valleys for SAFER's CB-MEWS.	Key Informant Interview GLOF-II Project
PMD Hydrometeorological Monitoring Network	Pakistan Meteorological Department (PMD)	175 Sensors of EWS in GB which uses Hydrometeorological parameter GB (Shimshal, Gulkin, Shishper, Darkut, Soshat, Hispar, Batswat, Perihsing, Rupal, Haramosh, Strangbut-Basho, Shigar, Ghandus, Khaplu, Braldu, Muthat, Tata)	Cryosphere Risk Reduction; EWS Integration	Ongoing	Uses 175 hydrometeorological sensors for data collection, shared with GBDMA.	Capacity Building in weather forecast. It is suggested remaining valleys which are vulnerable may be covered by safer project		Key Informant Interview Regional Meteorological Center Gilgit
EVK2CNR Weather Monitoring Stations (in collaboration with GB-EPA)		Gilgit-Baltistan (ecologically diverse zones: Ghizer, Nagar, Hunza; based on altitudinal gradients)	Environmental monitoring (e.g., glacier assessments, pollution tracking affecting cryosphere); Climatological observations; Support for long-term climate impact assessments and EWS	Ongoing	Approximately 20 automated weather stations deployed; Regular data collection for environmental compliance and risk assessments; Lessons: Strategic location based on accessibility and gradients improves data quality; Integration with regulations (e.g., GB Climate Change Adaptation Action Plan) enhances enforcement	1. **Joint Environmental Risk Assessments** Combine SAFER's technical expertise and GB-EPA's local mandate to map glaciers, springsheds, wetlands, and vulnerable aquifers. Develop valley-level resilience profiles to guide interventions. 2. **Conservation-Linked Early Warning Systems (EWS)** Expand glacial hazard and ecosystem-triggered EWS, linking sensor data (e.g., from springs, ponds) to community alerts. Co-train youth/women as local monitors under joint EWS protocols. 3. **Ecosystem-Based Adaptation & Water Security** Restore degraded springsheds, ponds, and wetlands to improve water availability and buffer flood risks. Integrate nature-based solutions for wastewater treatment, especially in peri-urban Gilgit. 4. **Policy Advocacy & Institutional Strengthening** Feed SAFER's field evidence into GB's climate/environmental policy. Build institutional		Key Informant Interview Environment Protection Department

						capacity of GB-EPA and Regional staff to mainstream ecosystem-based adaptation into valley development plans and regulations. 5. **Youth, Gender & Community Engagement** Launch valley-specific "Resilience Champions" programs led by women and youth. Link EbA actions with livelihoods (e.g., eco-tourism, NTFP value chains) for inclusive impact.		
Past EWS in Shigar	Not specified	GB (Shigar)	Cryosphere Risk Reduction; EWS	Past (5 years ago, non-functional)	EWS site established but no longer works.	Establish functional CB-MEWS.	Focus on revival in Shigar.	Key Informant Interview with LSO Shigar Fort
Khyber Pakhtunkhwa Irrigated-Agriculture Improvement Project	World Bank, Government of Khyber Pakhtunkhwa (Irrigation Department)	Khyber Pakhtunkhwa (including Chitral)	Irrigation Improvement; Water Management; Climate-Resilient Agriculture	2019-Ongoing	Improves irrigation infrastructure, strengthens small farmers' skills, supports value addition to products, enhances water and agriculture productivity, and builds climate-resilient community water management systems.	Complement SAFER's groundwater management and surface water conservation components by integrating climate-adaptive irrigation techniques and community engagement in water user associations.		Key Informant Interview with Water Management Chitral
National Program for Improvement of Watercourses in Pakistan (KP-Component)	Ministry of National Food Security & Research, Provincial Agriculture Departments (On Farm Water Management), Government of Khyber Pakhtunkhwa	Khyber Pakhtunkhwa (canal irrigated areas)	Watercourses Improvement; Irrigation Efficiency; Farm Water Management	2019-2024 (Phase-II)	Improves watercourses (up to 50% of length), constructs water storage tanks, provides laser land levelers, enhances irrigation efficiency, and supports sustainable agriculture.	Align with SAFER's springshed revival and groundwater management by incorporating water conservation structures and training for water user associations to boost adaptive capacity.		Key Informant Interview with Water Management Chitral
UNDP GLOF Project 2011-2016 **NDMA Glacial Lake Monitoring**	National Disaster Management Authority (NDMA), Pakistan Meteorological Department (PMD)	Northern Pakistan (including Chitral's lakes, e.g., Reshun Lake; 36 lakes monitored)	Glacial Lake Monitoring; Early Warning; Disaster Risk Reduction	Ongoing	Monitors 36 glacial lakes via satellites and ground sensors, issues alerts (e.g., Booni 2024), and coordinates with PDMAs for GLOF risk management.	Collaborate on data sharing and integration with SAFER's EWS for enhanced real-time monitoring and community alerts in vulnerable valleys.		Key Informant Interview with Water Management Chitral
Springshed Management in Abbottabad and Galiyat	Galiyat Development Authority (GDA)	Nathia Gali (Garang Nala), Donga Gali, Khanaspur, Changlagali, Namli Maira, Thandiani	Springshed Revival; Water Resource Management; Community Engagement	Ongoing	Manages 9 key springs for community consumption and tourism, using infrastructure like wing walls, taps, tanks, and filtration units; o 6 springs located in **Nathia Gali (Garang Nala)**	Collaborate with SAFER's springshed revival component to install water filtration plants, enhance community engagement, and develop rainwater harvesting policies;		Key Informant Interview with Galiyat Development Authority

					○ 1 spring in **Donga Gali** ○ 1 spring in **Khanaspur** (used for lifting water) ○ 1 spring in **Changlagali**			
Tube Well-Based Water Supply Schemes in Nowshera	Public Health Engineering Department (PHED) Nowshera	Nowshera	Groundwater Management; Water Supply; Flood Resilience	Ongoing	Manages 95% tube well-based drinking water supply, with 5% from gravity systems and springsheds; gradually converting tube wells to solar power every year. *Also constructed protection walls along drainage channels to safeguard infrastructure from flood damage.*	Collaborate with SAFER's groundwater management and resilient community water services to scale solar conversions, enhance flood protection, and introduce ecosystem-based adaptations like solar pumps recharge ponds or constructed wetlands.	Already in collaboration with UNICEF so no risk of overlapping	Key Informative interview PHED Department Nowshera
Tube Well-Based Water Supply Schemes in Charsadda	Public Health Engineering Department (PHED) Charsadda	Charsadda	Groundwater Management; Water Supply; Flood Protection	Ongoing	Relies 100% on tube wells with declining water table due to drought; faces load shedding and low voltage issues; lacks groundwater level monitoring, water quality data, and flood protection infrastructure; no pond or water channel development.	Synergize with SAFER's groundwater management to implement monitoring systems, flood protection, and pond/channel development for recharge; engage youth in maintenance.	Already in collaboration with UNICEF so no risk of overlapping	Key Informative interview PHED Department Charsadda
Lead line handpump	We Care Foundation	**Ali Muhammad Mucharo Village**	Water Management	2019-2025 (ending December 2025)	Installation of two lead-line hand pumps, one located at the village center and the other at the nearby mosque.	Synergize with SAFER's groundwater management by incorporating solar pumps into broader water conservation strategies and community empowerment programs.		Field Visit Documentation
Solar Pump	Qatar Charity	**Chotiario**	Water Management	2025	Two solar panels have been installed along with one motor and a backup battery.	Synergize with SAFER's groundwater management by incorporating solar pumps into broader water conservation strategies and community empowerment programs.		Field Visit Documentation
Solar Pump	All Nations Charity	**Hashim Khoi Village**	Water Management	2025	Two solar panels have been installed along with one motor	Synergize with SAFER's groundwater management by incorporating solar pumps into broader water conservation strategies and community empowerment programs.		Field Visit Documentation

Annex 5: Ethical Approval Documents and Consent Forms

A. Statement of Consent for Household Surveys

My name is _____ and I am working with Sheher Saaz, conducting this survey on behalf of the SAFER Pakistan Project, which is supported by ICIMOD, UN Women, and UNICEF. This survey is part of a multisectoral climate resilience assessment focused on understanding water, sanitation, climate-related risks, and community preparedness across selected areas in Pakistan.

A total of 2,100 households will be surveyed as part of this national effort. The purpose is to help organizations and government agencies improve services related to water, sanitation, hygiene (WASH), and climate adaptation in your community and across Pakistan.

Your participation in this survey is entirely voluntary. The interview will take approximately 30 minutes to complete. You may choose to skip any question or stop the interview at any time, without giving a reason. All the information you share will be kept strictly confidential and will be used only for research and planning purposes. Your name or personal information will not be shared with anyone, and the data will be reported only in an aggregated form.

1. If you agree, we may contact you again by phone to follow up on this survey.
2. Do you voluntarily agree to participate in this interview?
3. ☐ Yes ☐ No
4. Are you willing to be contacted by phone in the future?
5. ☐ Yes ☐ No
6. If (Yes) note the Contact number _____
7. If (No), move to the Next question.

B. Statement of Consent for Focus Group Discussions

Good morning/afternoon. My name is _____ and I am with Sheher Saaz, conducting this focus group discussion for the SAFER Pakistan Project, supported by ICIMOD, UN Women, and UNICEF. This discussion is part of a multisectoral climate resilience assessment to understand water, sanitation, hygiene (WASH), and climate adaptation needs in your community.

Your participation is voluntary and will take approximately 60 minutes. You may skip any question or leave the discussion at any time without explanation. All information shared will be kept strictly confidential, used only for research and planning, and reported in aggregated form without identifying individuals.

We may take photographs during this discussion for project documentation and reporting purposes. Photos will be used solely for the SAFER Pakistan Project and will not be shared publicly without your permission.

Consent Questions:

1. Do you voluntarily agree to participate in this focus group discussion? ☐ Yes ☐ No

2. Do you consent to photographs being taken during this discussion for project documentation? ☐ Yes ☐ No

3. If you agree, we may contact you for follow-up discussions. Are you willing to be contacted by phone in the future? ☐ Yes ☐ No If (Yes), note the Contact number: _____ If (No), proceed to the discussion.

C. Statement of Consent for Community Survey

Statement of Consent

My name is _____ and I am working with Sheher Saaz, conducting this survey on behalf of the SAFER Pakistan Project, which is supported by ICIMOD, UN Women, and UNICEF. This survey is part of a multisectoral climate resilience assessment focused on understanding risks and community preparedness in selected areas in Pakistan.

The purpose is to help organizations and government agencies improve services related to Surface water conservation in your community.

Your participation in this survey is entirely voluntary. The interview will take approximately 10-15 minutes to complete. You may choose to skip any question or stop the interview at any time. All information will be kept strictly confidential and used only for research and planning purposes. Your name or personal information will not be shared, and data will be reported in aggregated form.

Do you voluntarily agree to participate in this interview? ☐ Yes ☐ No If (Yes), proceed. If (No), end the survey.

D. Statement of Consent for Key Informative Interviews

Purpose: Purpose: Good morning/afternoon. Thank you for your time. We are from Sheher Saaz, conducting a baseline assessment for the **SAFER Pakistan project**. This project, led by ICIMOD with UNICEF and UN Women, aims to help communities become more resilient to climate change impacts like GLOFs.

The purpose of this interview is to understand the important work your department is already doing and along with to identify and map out similar existing interventions to ensure the SAFER project complements these efforts and avoids any duplication. Your expert insights are very valuable and will help guide the project's future support. All information will be kept confidential.

Consent Statement: I confirm that the purpose of this interview has been explained, and I consent to participate. Information will be used solely for the SAFER baseline assessment and kept confidential.

Annex 6: Cleaned Datasets and GIS Files

https://drive.google.com/drive/folders/1k69Wxi44Ud1ZlCyNOQXpwvSCBrunJDuG?usp=drive_link

Annex 7: Mapping of Surveyed Villages

https://drive.google.com/drive/folders/1g6p1AC4AAsXi_cvNe1UKJ6mW41Y_sxlh?usp=drive_link

Annex 8: Transcripts of Community Discussions, FGDs/KIIs)

https://drive.google.com/drive/folders/1HAntNutBENImJ8_Ih0EqztJ5TCDIwsze?usp=drive_link

Annex 9: List of stakeholders engaged

This annex provides a comprehensive list of stakeholders engaged during the baseline assessment for the SAFER Pakistan Project. Engagements primarily consisted of KIIs conducted. The list is organized by region (KP, GB, and Sindh) and focuses on provincial and local government departments, NGOs, and community organizations. A total of 31 unique stakeholders were engaged across the target regions.

GB:

S. No	Organization/Department	Location/District	Type of Engagement
1	GB Disaster Management Authority	Shigar	KII
2	Local Support Organization	Shigar	KII
3	Local Government	Shigar	KII
4	District Council	Shigar	KII
5	Provincial Meteorological Department	Gilgit-Baltistan	KII
6	GLOF Department	Gilgit-Baltistan	KII
7	Environmental Protection Department	Gilgit-Baltistan	KII

KP:

Sr. No	Organization/Department	Location/District	Type of Engagement
1	PHED	Charsadda	KII
2	PHED	Nowshera	KII
3	TMA	Charsadda	KII
4	TMA	Nowshera	KII
5	Galiyat Development Authority	Galiyat	KII
6	PHED	Swat	KII
7	Shama Welfare Organization	Nowshera and Charsadda	KII
8	Global Earth Welfare Organization	Nowshera and Charsadda	KII
9	Water Management Department	Lower Chitral	KII

Sindh:

Sr. No	Organization/Department	Location/District	Type of Engagement
1	PHED	Sanghar	KII
2	TMA	Sanghar	KII
3	Deputy Commissioner (DC) Office	Sanghar	KII
4	Hands NGO	Sanghar	KII
5	Qatar Charity	Sanghar	KII
6	PHED	Mirpurkhas	KII

7	Human Appeal NGO	Tharparkar	KII
8	Penny Appeal NGO	Sujawal	KII
9	PHED	Khairpur	KII
10	Public Relations Officer	Khairpur	KII
11	PPHI District Program Officer	Khairpur	KII
12	Assistant District Council	Khairpur	KII
13	PHED	Umerkot	KII
14	SARSO	Umerkot	KII
15	Sami Foundation	Umerkot	KII

Notes:

- All engagements adhered to ethical protocols, including informed consent and data privacy.
- This list represents key informants from government departments, NGOs, and local organizations directly involved in KIIs. Additional stakeholders (e.g., community groups) engaged via FGDs or surveys are documented in the main report.
- Full transcripts and details are available in Annex 7.

Annex 10: Data Collection Tools (Survey Instruments, Interview Guides, Protocols Etc.)

https://docs.google.com/document/d/1bY2ZTIUd4tIgXWuPNvOcvAZgWCpFNgxp/edit?usp=drive_link&ouid=102966765643599460544&rtpof=true&sd=true

Annex 11: Photos and Field Documentation

ENUMERATOR'S TRAINING SESSIONS:

District Charsadda & Nowshera



District Lower Dir



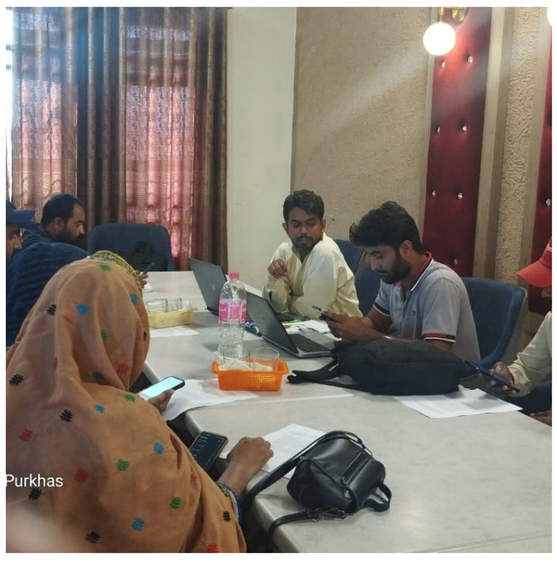
District Umer Kot



District Swat



District Mirpur Khas



COMPONENT 1: CRYOSPHERE DISASTER RISK REDUCTION

FGD Alchori (Male)



FGD Bahrain



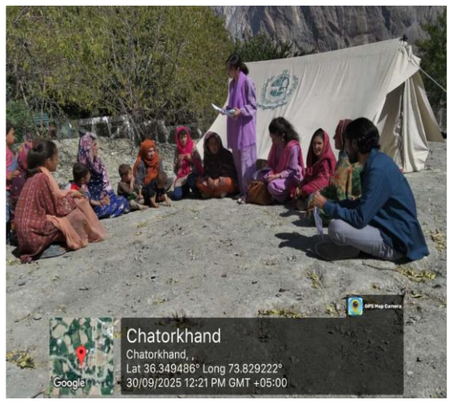
FGD Shigar Fort (Female)



FGD Shigar Fort (Male)



FGD Gupis (Female)



FGD Gupis (Male)



FGD Kalash



FGD Alchori (Female)



FGD Kalam



Ghizer Household Survey



COMPONENT 2: SPRINGSHED REVIVAL AND MANAGEMENT

Banda Jaggian FGD (Male)



Nathiagali Underground Water Tank



Mardan Babuzai FGD



Timergara Underground Water Tank



Bandagai Talas FGD



Solar Water Supply System, Barham (Swat)



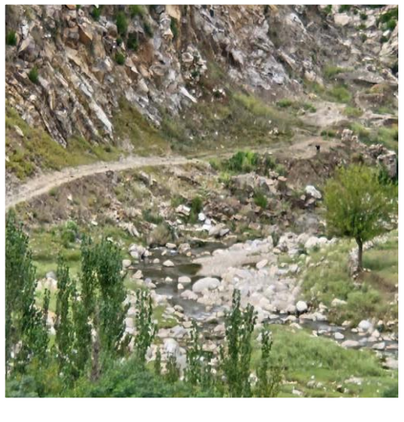
Timergara FGD



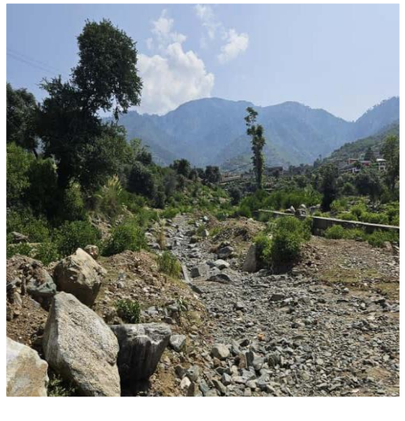
Springshed Site, Barham



Springshed Site, Bandagai Talas



Springshed Site, Timergara



COMPONENT 3: GROUNDWATER MANAGEMENT (KPK)

Water Supply System, Khat Kallay



Qandil FGD



Katozai FGD



Solar Water Supply System, Kaka Sahib



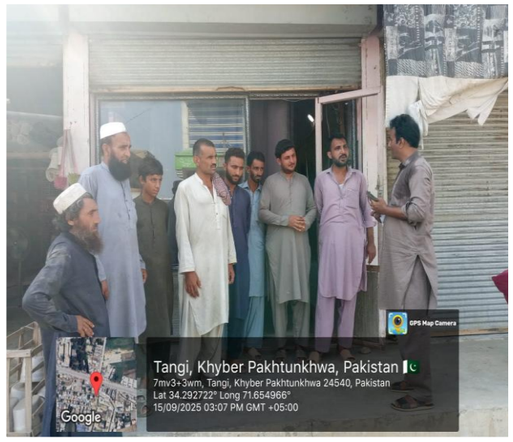
Langar Kallay FGD



Fatehpur FGD



Tangi Nusratzai FGD



Kotlai Swat-Khwar FGD



WSS, Hoti Khel



FGD Nowshera



WSS Site, Kot Baba Gulabad



WSS Site, Matta Daman



COMPONENT 3: GROUNDWATER MANAGEMENT (SINDH)

FGD, Ali Muhammad Macharo



FGD (Female), Bag Water



Hand Pump, Kahalsa Wah



Pond Site, Mohammad Khan Pali Poto



FGD, Din Muhammad Chang



FGD, Abdul Aziz Khan



FGD, Haji Farooq Jhinji



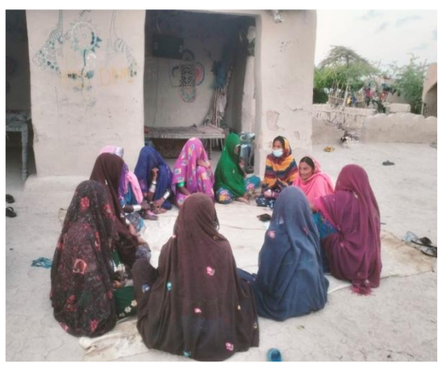
FGD, Haji Wahid Bux



FGD, Hashim Khoi



FGD, Jan Muhammad Burgari



Pond Site, Mufti Asad Ali



FGD, Kohli-Nanji



COMPONENT 3: GROUNDWATER MANAGEMENT (SINDH) Cont…….

UNICEF WASH Facility, Wahid Bux



Hand Pump, Ali Muhammad Macharo



Water Solar System, Hashim Khoi



Water Pump, Sonarasti



COMPONENT 4: ECOSYSTEM-BASED ADAPTATION

FGD (Female), Qazi Bhutto



Tangi Household Survey



Pabbi Household Survey



FGD (Male), Wah Burira



Tangi Household Survey



FGD (Female), Anb



Wetland Site, Tangi



FGD (Female), Pabbi



COMPONENT 5: SURFACE WATER CONSERVATION

Water Pond, Chotiaro



Water Pump, Chotiaro



FGD, Chotiaro



Hand Pump, Sher Khan Mangrio



FGD, Sher Khan Mangrio



FGD, Karam Khan Mari



WSS, Khariwah



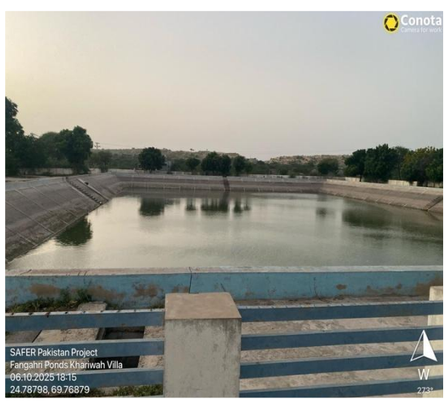
Non-functional Tank, Khariwah



FGD, Khariwah



Pond Site, Tamachi je very



Underground Tank,



FGD, Tamachi



KEY INFORMATIVE INTERVIEWS

PHED, Swat



Penny Appeal NGO, Sujawal



PHED, Charsadda



DC Office, Sanghar



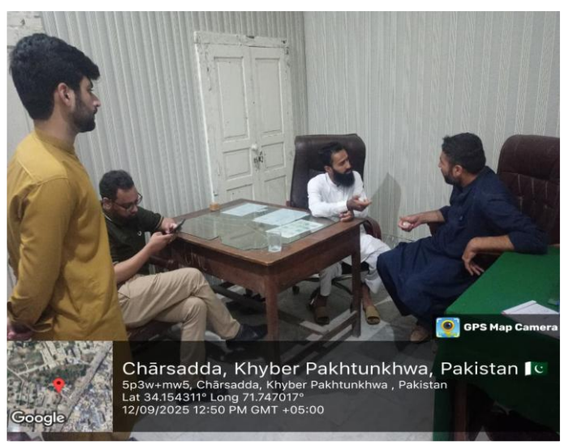
Hands NGO, Sanghar



GDA, Abbottabad



TMA, Charsadda



TMA, Sanghar



PHED, Sanghar



KEY INFORMATIVE INTERVIEWS (Cont…..)

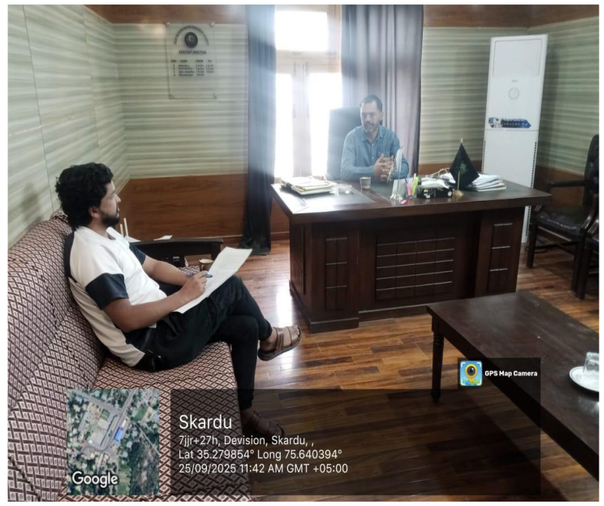
Human Appeal NGO, Tharparkar



PHED, Nowshera



GBDMA, Skardu



Sindh Rural Support Organization



PHED, Umer Kot



SAMI Organization NGO



Annex 12: Bibliography and References

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