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SDC's Ex-Post Evaluation: Water for Livelihoods (W4L) in Pakistan

Project No. 7F-07815 (2011-2020)

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I Evaluation Process

The Swiss Agency for Development and Cooperation (SDC) is part of the Swiss Federal Department of Foreign Affairs (FDFA) and implements Switzerland's official development assistance, with head office in Bern.

Evaluations commissioned by the SDC's Board of Directors were introduced in 2002 with the aim of providing an independent assessment of SDC activities. These Evaluations adhere to the OECD DAC Evaluation Standards and are part of the SDC's concept for implementing Article 170 of the Swiss Constitution, which requires Swiss Federal Offices to analyse the effectiveness of their activities.

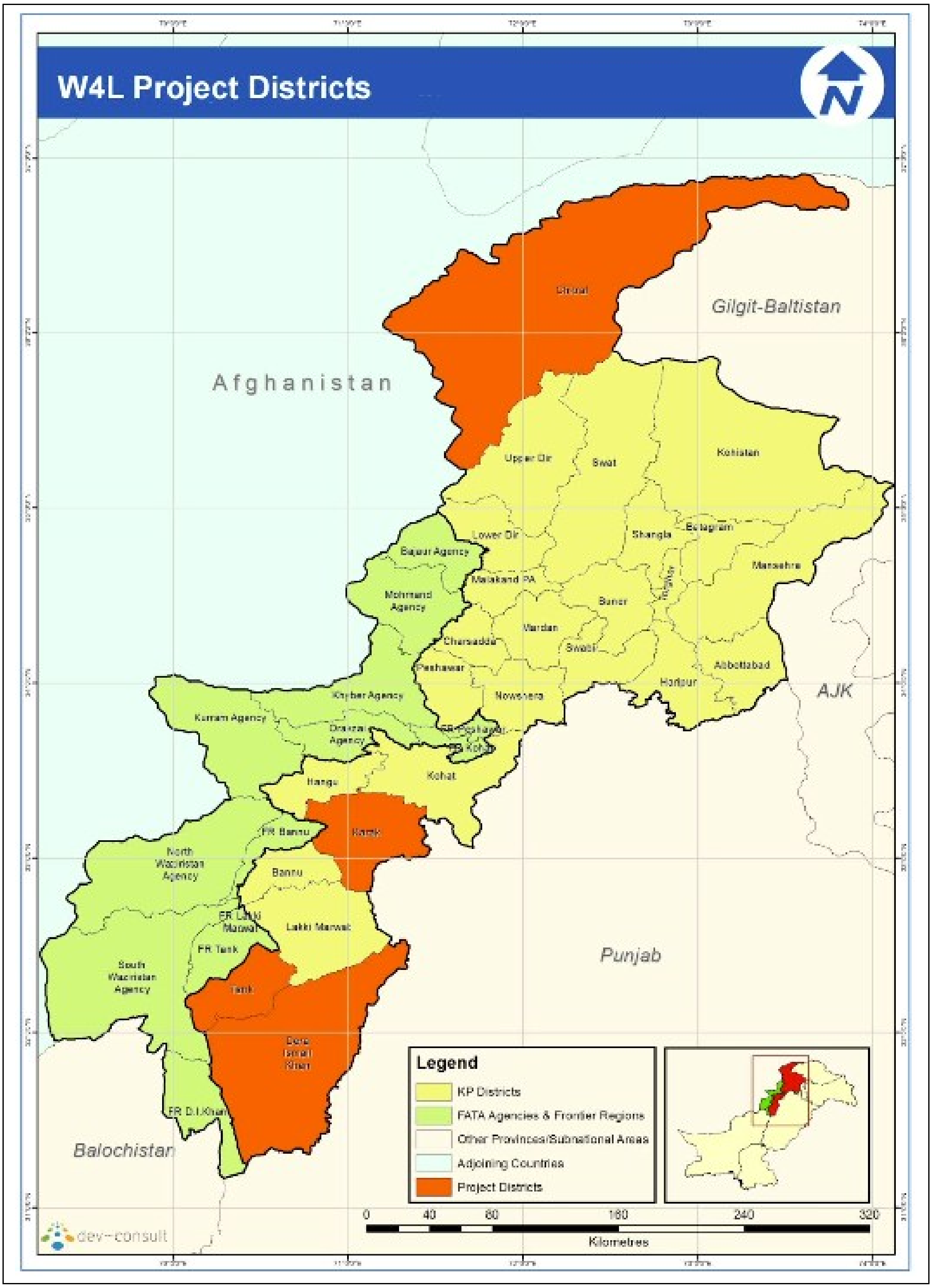
The Evaluation and Controlling Specialist Service is responsible for mandating and managing large-scale independent thematic and institutional evaluations as well as evaluations of Swiss Cooperation Programmes. The Evaluation and Controlling Unit commissions the evaluation, taking care to recruit independent evaluators and manages the evaluation process. The responsibility for individual project evaluations on the other hand is assumed by the operational units both at headquarters and in the field. Since project evaluations are usually conducted mid or end-term of a project cycle with a focus on project steering and project planning, the OECD DAC criteria of Impact and Sustainability are often assessed at a likelihood level with limited suitability for accountability purposes in these two criteria. In 2024, the Evaluation and Controlling Specialist Service was therefore mandated to conduct a series of 8-10 ex-post project evaluations between 2025 and 2028 with a special focus on longer-term impact and sustainability. The evaluations conducted under this mandate will serve the evaluation purposes of institutional learning on the aggregated level, while they will at the same time strengthen accountability towards the Swiss Parliament and Public.

The present evaluation was carried out according to the evaluation standards specified in the Terms of Reference. The Evaluation and Controlling Unit oversaw the evaluation process, including validating the evaluation methodology as laid out in the Inception Report and commenting on the evaluation findings. Further details regarding the evaluation approach are available in the evaluation report and its annexes.

II Evaluators' Final Report

Table of Contents

Figure 1: Map of Khyber Pakhtunkhwa (KP) Province of Pakistan with highlighted project districts (from Sarfraz *et al*., 2017). In 2018, the FATA agencies and frontier regions were absorbed into KP Province and Chitral district was split into Upper Chitral and Lower Chitral.



Acronyms, abbreviations and glossary

ADB	Asian Development Bank.
ATT	Average Treatment effects for the Treated subpopulation (in DDD analysis).
Catchment	An area within which all water flows to a common destination.
CCA	Climate change adaptation.
CHF	Swiss Franc.
DCC	District Coordination Committee.
DDD	Triple difference-in-difference, a variant of DiD-based causal estimation analysis in which sub-populations within treated and untreated populations are compared.
DiD	Difference-in-difference (DiD) causal estimation analysis.
DI Khan	Dera Ismail Khan District.
DRM	Disaster risk management.
DRR	Disaster risk reduction.
Effectiveness	As an evaluation criterion, the extent to which an intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups (OECD, 2019).
FATA	Federally Administered Tribal Areas (of Pakistan, 1947-2018).
GESI	Gender equity and social inclusion.
GLOF	Glacial lake outburst flood.
Helvetas	Helvetas Swiss Intercooperation (Swiss Association for International Development Cooperation).
HKH	Hindu Kush-Himalayan (sub-region of the Greater Himalayan region).
Impact	As an evaluation criterion, the extent to which an intervention has generated or is expected to generate significant positive or negative, intended or unintended, higher-level effects (OECD, 2019).
IWRM	Integrated water resource management. "A process which promotes the coordinated development and management of water, land, and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of ecosystems." (Water Knowledge Hub, 2026).
Kanal	A unit of area equal to *ca* 506 m^2 (1/20th of a hectare, 1/8th of an acre).
Kharif	The summer/monsoon crop season in Pakistan.
KP	Khyber Pakhtunkhwa (a province of Pakistan, sometimes 'KPK').
Nazim	The chief elected official of a local government unit in Pakistan.
NCG	Nordic Consulting Group.
NDVI	Normalized Difference Vegetation Index.
ODA	Official development assistance.
P&DD	Planning and Development Department (of KP Province).
PBS	Pakistan Bureau of Statistics.
PCRWR	Pakistan Council for Research on Water Resources.

PHED	Public Health Engineering Department.
PKR	Pakistan Rupee (CHF 1 = PKR 103 in Jan 2017).
PSLM	Pakistan Social and Living Standards Measurement.
PTI	Pakistan Tehreek-e-Insaf, one of Pakistan's three main political parties, along with the Pakistan Muslim League-Nawaz (PML-N) and the Pakistan People's Party (PPP).
Rabi	The winter crop season in Pakistan.
Rod-kohi	Traditional spate irrigation system (*rod-kohi* = 'of or from hill torrents'). Sometimes *rudh kohi*, *rod khoy*.
SDC	Swiss Agency for Development and Cooperation.
Sustainability	As an evaluation criterion, the extent to which the net benefits of an intervention continue, or are likely to continue (OECD, 2019).
Tehsil	A subdistrict with a designated administrative centre and responsibility for land revenue, elections and executive functions.
ToC	Theory of change.
ToR	Terms of reference.
UC	Union Council. These were the smallest administrative unit in Pakistan and although replaced in 2013 by Village and Neighbourhood Councils, they remain an important legacy unit for the management of geospatial and biophysical data.
UNDP	United Nations Development Programme.
WASEP	Water and Sanitation Extension Services (of the Aga Khan Foundation).
WASH	Water, sanitation and hygiene (sector).
Watershed	A line of terrain marking the division between catchments.
W4L	Water for Livelihoods project (Pakistan).
WNR	Water as a natural resource (sector).
WSS	Water supply system.
WUA	Water users' association.
WUG	Water users' group.
WUMP	Water use management [sometimes 'master'] plan.

Executive Summary

Purpose of the evaluation and the project

This is the final report of the ex-post evaluation of the Water for Livelihoods (W4L) project in Khyber Pakhtunkhwa (KP) Province of Pakistan, which was funded by the Swiss Agency for Development and Cooperation (SDC) and implemented by Helvetas Swiss Intercooperation (Helvetas) in 2011-20. The project aimed to make livelihoods more secure for all, while making life easier (particularly for women), healthier (particularly for children), and more prosperous (particularly for farmers).

Approach and methods of the evaluation

The evaluation: (1) examined records of W4L design and implementation; reconstructed its theory of change (ToC); (2) positioned that ToC in relation to principles of Integrated Water Resource Management (IWRM); (3) assessed the long-term impact and sustainability of system changes induced by W4L in the post-2020 period; and (4) prepared contribution stories to highlight local system change impacts.

This was done by reviewing project documents, interviewing knowledge-holders, conducting two inclusive stakeholder workshops in Pakistan, and analysing household survey and remote sensing data for lasting socioeconomic effects (increased ownership of irrigated land, reduced time spent collecting water, health gains from safer drinking water) and biophysical effects (extent of croplands, evapotranspiration and greening of vegetation linked to irrigation).

Findings of the evaluation

The W4L project sought to demonstrate new approaches to improving water systems at local level through small-scale infrastructure investment and especially through enhanced water governance, thus informing and helping to shape higher-level policy and capacity in the sector. By reconstructing the ToC for W4L and comparing it with a ToC for IWRM, the evaluation confirmed that W4L was likely to result in progress on the key aims of IWRM, and that W4L was therefore well designed.

As for implementation, the evaluation confirmed some key conclusions of the SDC's end of project report (EoPR) in 2020, specifically that W4L had, in target communities: achieved its main objective and all its inter-linked outcomes and outputs; succeeded in improving equity, access and efficiency in the water sector with no harm to local ecosystems; and enabled the establishment and development of inclusive Water User Groups (WUGs) and Water User Associations (WUAs) within and across communities.

In particular, the WUGs and WUAs had: allowed for physical results to be sustained through effective operation and maintenance; strengthened solidarity and problem-solving ability; and enhanced community capacity to advance local development priorities in cooperation with government, including those contained in community-prepared Water Use Management Plans (WUMPs).

The result for target communities had been transformative, with major long-term and sustained benefits: from drinking water supply schemes, in reducing drudgery (especially for women and girls) and waterborne diseases such as childhood diarrhoea; from irrigation schemes, in increasing farmland area and productivity for the particular benefit of smallholders; and from protective infrastructure, in enhancing environmental security, especially against flooding hazards.

As noted above, W4L was primarily designed as a water governance and IWRM project rather than an infrastructure delivery programme, so its irrigation and drinking water infrastructure interventions were limited in scale and intended to demonstrate innovative approaches and practices for wider uptake and replication.

Thus, over the four target districts, W4L's **irrigation** interventions reached only about 3% of the total rural population, or 5% of irrigated land area, and its **drinking water** interventions reached only about 8% of the total rural population. It was therefore not expected that direct biophysical or socioeconomic impacts of W4L would be detectable at macro scale. But the evaluation team did hypothesize that such traces would be found locally, and undertook household survey and remote sensing analyses to test this. It was found that relevant data were available only at district and UC level, however, so while the analysis was of methodological interest (being potentially useful in other evaluations) it detected no W4L impacts at these levels. As well as W4L's limited reach, other factors that may have masked its influence on aggregate-level data (to which other evaluations should be alert) include parallel water sector investments across districts by government and other donors, and differential weather events across and within districts during the project.

The evaluation confirmed the EoPR's conclusion that W4L had made important progress in its third phase (2018-20) in building partnerships to promote IWRM through policy, strategy and capacity development in KP Province. Despite this, and some informal replication of the IWRM approach, the EoPR's expectation of wide and transformative replication was not realised. Instead, progress stalled with a general loss of momentum when the project ended in 2020. Continuing activity of WUAs and the momentum of influence on ideas, policy and legislation in the water sector of KP Province facilitated by Helvetas were nevertheless recognised as important long-term impacts of W4L.

Conclusions of the evaluation

The evaluation therefore concluded: (1) that W4L was a **very effective and impactful** intervention at local level; (2) that it made **exemplary arrangements for sustainability** of its impacts at local level; (3) that it offered **many useful insights, examples and lessons** that could have been (and could still be) valuable to those who seek to promote IWRM at all levels and scales of governance; and (4) that the post-2020 **loss of momentum offers lessons** for why and how to ensure continuity - in other ways than through project funding if necessary - for good efforts to resist and adapt to the effects of global heating and climate change.

1. Introduction

Mandate and evaluation team

This Draft Final Report concerns the third of several ex-post evaluations to be done in 2024-28 by the Nordic Consulting Group (NCG) under mandate to the Swiss Agency for Development and Cooperation (SDC). Like the previous ex-post evaluations, it will contribute to accountability towards the Swiss Parliament and public, as well as to learning by SDC and other institutions. No specific terms of reference (ToR) are applied to the individual evaluations, so this evaluation followed the generic ToR of the SDC mandate to NCG, as modified through dialogue and agreement with SDC during its Inception Phase.

An ex-post evaluation is undertaken after an intervention has ended (in the case of this suite of SDC ex-post evaluations, typically four to six years after) and aims to detect and assess its contribution to any significant and durable changes. Such long-term effects are obtained though projects and partnerships that achieve certain things while in operation ('effectiveness') and by doing so change how the target system works ('impact') in ways that persist ('sustainability').

This ex-post evaluation focuses on the W4L project in North-Western Pakistan, which ran from 2011 to 2020. It was undertaken by a team of five experts: Dr Julian Caldecott (Team Leader); Dr Athar Khan (National Consultant); Ms Humera Qasim Khan (National Consultant); Mr Erik Hedegaard Knudsen (Data Specialist); and Mr Lars Christian Oxe (Evaluation Expert).

Structure of the report

Chapter 2 outlines the baseline, general approach and methodology, drawing on the overall SDC/NGC mandate as adapted to the distinctive context and features of W4L. **Chapter 3** is a brief account of the project's background and context, and the principles and practices of IWRM as a way to promote equity and sustainability in the water-livelihood nexus. **Chapter 4** presents findings on W4L from during its period of operation, including a reconstructed ToC. **Chapter 5** focuses on the long-term impact and sustainability of W4L, as revealed through interviews, workshops and analysis of household surveys and remote imagery. And finally, **Chapter 6** offers answers to the evaluation questions, including lessons learned from W4L that could contribute to meeting the universal challenge of adapting to climate change.

The text is followed by **annexes** that present details on: the evaluation matrix (**1**); the evaluation interviews (**2**); the evaluation workshops (**3**); the analysis of household survey data (**4**); the analysis of remote sensing data (**5**); contribution stories on W4L's community impact (**6**); biophysical conditions and participatory methods for IWRM and planning (**7**); aims and achievements of W4L Phase 1 (**8**); aims and achievements of W4L Phase 2 (**9**); themes, processes and achievements of Phase 3 (**10**); theories of change for W4L and IWRM (**11**); and names of interviewees and workshop participants (**12**, for internal SDC use only). All documents cited in text and annexes are in the list of **references** at the report's end.

2. Approach and methods

2.1 Baseline, expectations and approach

Baseline

The evaluation team began by reviewing W4L documents, including the *End of Project Report* (EoPR) which summarised SDC's perception of conditions at the end of W4L (SDC, 2020, p. 9). Five conclusions of the EoPR established a baseline for this evaluation. First, that W4L had **achieved its main objective** and all its inter-linked outcomes and outputs. Second, that it had **changed frame conditions** to improve equity, access and efficiency in the water sector without harming ecosystems. Third, that it enabled the **effective development of community duty bearers** - Water User Groups (WUGs) and Water User Associations (WUAs) - that had allowed for results to be sustained and successful approaches scaled up. Fourth, that the **consolidation phase was successful** in building IWRM capacity and networks, and in mainstreaming the IWRM approach within government, and that these successes could be replicated and scaled up in future. And finally, that project **results were being effectively institutionalised** by partnerships with various levels of government and with NGOs, research institutions, and academia.

Expectations

The baseline statements were used to craft key evaluation questions (see Section 2.2) with the following expectations. First, that the **effectiveness** of W4L would have come from its various infrastructure and capacity-building functions being put into effect. Second, that its **impact** would have come mainly from improved water governance. And third, that its **sustainability** would have come mainly from: the continued functionality of the WUAs; applied knowledge flowing through networks of key stakeholders and being mainstreamed through guidelines, policies, training, and procedural norms; and the institutionalisation of results through various partnerships.

Approach

For evaluation purposes, it is necessary to assess to what extent the baseline statements in the EoPR are supported by evidence, and whether the effects described continued to exert influence in the development of IWRM in Pakistan in 2020-26.Thus, the general approach of the evaluation was to collect and triangulate evidence from multiple qualitative and quantitative data sources related to changes in the expected outcomes during and after the project period. Of interest too was whether unexpected positive or negative effects occurred, how results aligned with the intervention logic, and the extent to which other, non-W4L, causative factors were involved in observed changes.

2.2 Evaluation questions and matrix

The evaluation matrix (Annex 1) lists five evaluation questions (EQs) that structured the search for various kinds of evidence to support evaluation judgements. It also notes the chief points of contact between each EQ of this evaluation and the generic EQs for the 2024-2028 SDC/NCG ex-post evaluation mandate (NCG, 2025). The EQs target: the achievements of W4L in promoting participatory water governance (**EQ1**); the achievements of W4L in promoting improved delivery of irrigation and drinking water (**EQ2**); the long-term impact of W4L in shaping relevant post-project frame conditions and processes (**EQ3**); observable signs that W4L had lasting socioeconomic and biophysical effects in the project areas (**EQ4**); and lessons learned of value in promoting IWRM and climate change adaptation (**EQ5**).

2.3 Interviews with W4L knowledge-holders

Security issues meant that international team members could not travel to the project areas, so two national consultants were tasked with a number of remote and in-person interviews with key W4L knowledge-holders in Pakistan. Annex 2 gives details of the interview strategy, covering its rationale, how the interviewees were selected, how the interviews were conducted, constraints and limitations of the interview process, and a summary of knowledge obtained from the interviewees. Twelve individuals were interviewed whose names are in Annex 12 for internal SDC distribution only.

2.4 Workshops with post-W4L stakeholders

The two national consultants were further tasked with organising, facilitating and reporting on two evaluation workshops for post-W4L stakeholders in KP Province, at Peshawar for those from DI Khan, Karak and Tank districts, and at Chitral for those from (Lower) Chitral district. Annex 3 gives details of the workshop strategy, covering its rationale, how participants were selected, how the workshops were conducted, constraints and limitations of the interview process, and a summary of knowledge obtained from the workshops. The names of the 45 workshop participants are listed in Annex 12 for internal SDC distribution only.

2.5 Use of causal estimation analysis

Difference-in-difference (DiD) causal estimation analysis is a statistical technique used to test whether a particular kind of intervention has caused changes in systems, by comparing over time the relevant attributes of two groups of otherwise similar systems: a treatment group and a control group (in this case, locations with and without W4L in KP Province). It can also help to disentangle the effects of various simultaneous influences that may have contributed to any observed change, with variants of the technique used as appropriate to different datasets and questions (Box 1). The DiD approach was used to test the possible effects of W4L in the socioeconomic domain using household survey data (Annex 4), and in the biophysical domain using remote sensing data (Annex 5).

Two important points apply to both analyses and mean that care is needed to interpret findings in relation to other sources of information. First, a **strength** of the design is that DiD allows for control of pre-existing differences and of common trends over time between treated and non-treated areas (although not for differential shocks in the post-W4L period). This makes it possible to isolate the contributions of W4L from the broader effects of provincial policy changes, climate and environmental events, and interventions funded by other donors. But second, an important **weakness** of the design is that data collected at district and Union Council (UC) level cannot be used by DiD analysis to support conclusions on impact at local level. Only if local impacts aggregated sufficiently to change outcomes at higher level would they have revealed themselves using this methodology.

2.6 Contribution analysis and stories

Documenting achievements of the W4L project in line with its reconstructed ToC creates an opportunity to consider how multiple elements of W4L all contributed to progress and to tell one or more contribution stories. These can be told where there are clear case descriptions before and after the intervention, as well as good reasons to expect particular attributable system changes. The clarity of the W4L's purpose and ToC suggested that this could be a useful way to help reveal the influence of W4L. Such contribution stories were developed to convey a sense of community-level transformative impact (Annex 6). The causal estimation analyses also help to clarify W4L's contribution to change relative to other influences and actors.

Box 1 - Use of three variants of DiD analysis
Technique 1: simple difference-in-difference (DiD). This foundational model was used: (a) in the analysis of household survey data, to compare evidence from rural households in W4L and non-W4L districts; and (b) in the analysis of remote sensing data, to compare W4L districts/UCs with non-W4L districts/UCs. It was chosen as an appropriate way to answer the question of how W4L localities fared when compared to non-W4L localities. Despite the model's merits for causal identification, it cannot rule out heterogenous shocks specific to each district. **Technique 2: Callaway–Sant'Anna staggered DiD**. This was used to take account of the fact that one district (Tank) was added to the W4L group after the other districts, but it shows numerous pre-trend violations which make causal attribution difficult. **Technique 3: triple difference-in-difference (DDD)**. This was used to compare the trajectories of difference between urban and rural households in W4L and non-W4L districts. An expectation of such differences meant that four groups had to be considered in the analysis (rural-treated, urban-treated, rural-control, urban-control), and the DDD model was chosen as an appropriate way to answer the question of whether the difference between rural and urban changed differently in W4L districts than in non-W4L districts over time. Since the comparison was between groups within districts, this approach enabled the analysis to exclude district-wide shocks, thus raising the level of confidence with which effects could be attributed to W4L. For this reason, where results diverged between the simple DiD and DDD techniques the latter findings were considered more trustworthy.

3. Background and context of W4L

3.1 Water security context

The nexus of climate change, water scarcity and water security is now seen as a major constraint on equity, livelihoods and sustainability throughout SW Asia (Mfarrej, 2025). Several approaches for preserving and restoring water security have been applied in the region and elsewhere, including integrated water resource management (IWRM) and participatory water use management plans (WUMPs), which were both key elements in W4L and are described in Annex 7 along with the biophysical context to which they were applied through W4L.

As elsewhere in the region, water security is recognised as a key national concern in Pakistan, rooted in neglect, exploitation and mismanagement of water resources under conditions that combine inadequate water availability with deteriorating water quality, rising demand and the pressures of climate change and population growth (Ahmad et al., 2023; Nazli et al., 2024; Mansoor, 2025). In the highlands of NW Pakistan especially, the same nexus and its consequences pose critical challenges to sustainable development (Nizami & Ali, 2017; Nizami et al., 2019; Nizami et al., 2020). The W4L project was conceived and implemented in this emerging context, which has shaped its continuing influence and that of partner institutions and actions.

3.2 Administrative context

The W4L project was implemented in close cooperation with government line agencies and local government representatives. The project addressed local capacity challenges, both in terms of organisation and competencies, as its effectiveness and sustainability would depend on local government to continue using the existing WUMPs for informing and prioritising investments from own sources and from development partners. The project therefore had to adapt to the changing distribution of powers between the various levels of government in Pakistan, with the 18th Amendment to Pakistan's Constitution in 2010 being particularly significant (Box 2).

Box 2 - Devolution in Pakistan.

Pakistan is a federation of provinces, but the Independence of India Act (1947) ensured that its successive constitutions (in 1956, 1962, 1971, 1973) "remained federal in form but unitary in spirit" (Mukhtar, 2013, p. 2). The need for local governments was acknowledged, but their functions were performed by provincial governments and sub-provincial tiers were long seen only as extended arms of provincial government so their role was limited until they were empowered under the 2001 Local Government Ordinance. This created a three-tier local government structure, comprising districts, *tehsils*/towns and UCs, with elected *nazims* (leaders or mayors) and councils. Most public services previously delivered by provinces were devolved to local governments, including substantial financial powers.

With the return to power of elected governments in 2008, the 2001 devolution was largely reversed. The 18th Amendment to Pakistan's Constitution, passed in April 2010, was a major reform that strengthened provincial governments by transferring responsibilities and funds from the federal government (Shah, 2012). It also reinforced the requirement that each province establishes a local government system and devolve political, administrative and financial responsibility to elected local representatives.

Implementation of this devolution to local entities below the provincial level would depend on the interpretation and priorities of the provincial authorities (Shah, 2012). However, the 18th Amendment was driven more by political considerations than a concern for effective service delivery, so moves to achieve bottom-up accountability are incomplete and many would say unfinished. The consequences include: **capacity bottlenecks**, from uncorrected and deep-rooted weaknesses in subnational capacity; **asymmetric responsibilities**, due to inadequate financial transfers for non-salary recurrent and development budgets; and **misaligned priorities**, with a strong bias towards infrastructure rather than, for example, health, education and environmental sustainability (Mukhtar, 2013).

In 2010, the 18th constitutional amendment allowed provinces to decide on the structure of local government and the powers of districts, *tehsils* and UCs. The KP Province Local Government Acts (LGAs) of 2012 and 2013 devolved powers more strongly than in other provinces by giving local government control of 30% of provincial development spending (Rehman, 2019). The 2013 LGA devolved to the district level responsibility for the Public Health Engineering Department (PHED), and hence for drinking water supply and sanitation facilities in rural areas. It also replaced UCs with village and neighbourhood councils (GoKP, 2013). This devolution of powers was followed by elections for the local tiers of government in 2015.

As noted in the EoPR for W4L Phase 1 (SDC, 2013a), the devolution of water governance under the 2012 LGA was seen as an opportunity to ensure institutional anchorage of the project, since it made village councils (previously UCs) responsible for drinking water supply and district councils responsible for major public works related to water, including irrigation. The W4L project facilitated the establishment of District Coordination Committees (DCCs) in the target districts, with the role of approving and overseeing implementation of WUMPs, with a view to the DCCs becoming a hub of planning and coordination in the districts (Sarfraz *et al.*, 2017).

But the earlier LGAs were amended in 2019 to abandon elections for district councils and mayors, and to restore provincial control of the PHED (Rehman, 2019). Thus, with W4L starting in 2011 and ending in 2020, most of the project was implemented during times of administrative uncertainty as new legislation was prepared, debated and put into effect (Sarfraz *et al.*, 2017). The KP Province IWRM Strategy of 2019 to some extent took into account the increased level of provincial authority, but also proposed to establish District IWRM Planning and Execution Committees, which seem to have been intended as the continuation of the DCCs.

3.3 Implementation context

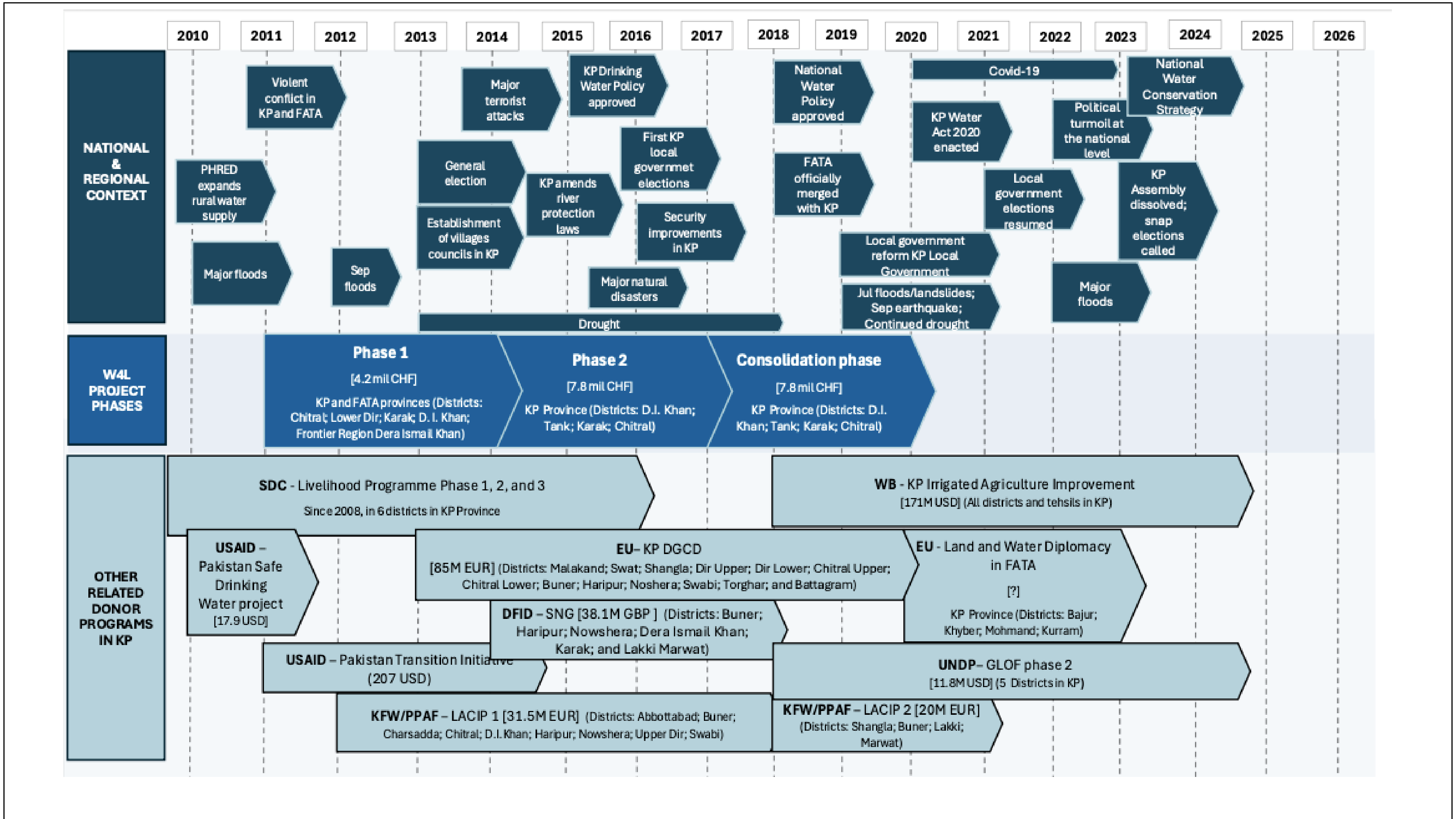
The W4L project was implemented in a period of profound transformation and recurring crises (Figure 2). It emerged in a province still recovering from the catastrophic 2010 floods (Climate Diplomacy, 2026), while facing violent conflict in KP Province and FATA (GSP, 2026). Moreover, the political landscape shifted with the 2013 general elections, which brought PTI to power in KP Province and initiated the governance reforms noted in Section 3.1, culminating in local government elections in 2015.

The later years of W4L implementation, however, were associated with improved security conditions, the merger of FATA and KP Province (in 2018), and the approval of KP Province's Drinking Water Policy (2015) and Pakistan's first National Water Policy (2018). But Pakistan's environment remained dynamic into the post-project period, being marked by further governance reforms including the landmark KP Province Water Act 2020, but also by severe external shocks such as COVID-19 lockdowns, the 2022 floods, political instability, and economic crisis.

Throughout implementation, W4L operated alongside substantial parallel investments from other donors in overlapping geographic areas and thematic sectors. These included: the Pakistan Safe Drinking Water Project (USA); the KP Irrigated Agriculture Improvement loan (World Bank); the Livelihood Support and Promotion of Small Community Infrastructure Programme (LACIP) in DI Khan and Chitral, supported by the Pakistan Poverty Alleviation Fund and KfW (Germany); the Sub-National Governance Programme (SNG) supported by DfID (UK); the Pakistan-KP District Governance and Community Development Programme supported by the EU; and the UNDP project Scaling-up of Glacial Lake Outburst Floods Risk Reduction in Northern Pakistan.

The activity of these and other government and development cooperation schemes were expected to contribute to the challenge of attributing particular socioeconomic and biophysical changes to W4L, thus focusing the evaluation's attention on contribution analysis using causal estimation analysis and contribution stories (Annexes 4, 5 and 6).

Figure 2: Timeline of W4L and other donor-funded projects, and major events in Pakistan and KP Province



3.4 Design of W4L

Strategy

Participatory IWRM is often accomplished through WUAs facilitating the development of WUMPs (Annex 7). The WUA role is crucial, and relevant experience goes back many years in Pakistan, including in KP Province where it was formalised in the WUA Ordinance of 1981 (GoKP, 1981). More recently, the KP Province government released an IWRM planning manual for WUA facilitators (GoKP, 2019) to guide the process of establishing local WUAs with at least 30% membership by women and defined roles for all participants. This was to enable implementation of the KP Province government's IWRM strategy (GoKP, 2020), which aims to promote the structured participation of women and men through their WUAs. The strategy calls for establishing WUAs at *tehsil* and town levels, building their capacity to operate as institutions and to manage water issues, recognising their right to participate in district-level IWRM planning, and including WUA representatives in district IWRM committees (GoKP, 2020, p. 23). This model is rooted in past experience but was influenced by W4L experience and inputs as it evolved during the 2010s.[1]

Conception

The W4L project was conceived in 2010 (SDC, 2010), but its presentation was postponed pending the 2011 Act of Parliament that raised Swiss official development assistance (ODA) to 0.5% of gross national income by 2015, including increased allocations to water and climate action (SDC & SECO, 2012). By 2010, SDC had been working on enhanced livelihoods through sustainable natural resources management in KP Province (formerly North West Frontier Province) since 1966. The successful elements of four such SDC-funded projects had already been used to inform a Livelihoods Programme that was launched in 2008. This targeted six districts of KP Province (Chitral, Swat, Buner, Haripur, Karak and DI Khan), but in 2010 it was decided to transition to a new arrangement during 2011.

This process flowed from two decisions by the Swiss Federal Council (SDC, 2017): in 2008, that Pakistan would no longer be a priority country for SDC's bilateral cooperation; and in 2009, that SDC would continue engaging with the Afghanistan-Pakistan border region. These decisions would lead to two significant outcomes. First, the **Livelihoods Programme would merge** into a new Regional Programme Hindukush (2010-14), covering NW Pakistan (SDC, 2015), and eastern Afghanistan (SDC, 2012a). And second, that **the new W4L project would inherit** three of the Livelihoods Programme districts (Chitral, Karak and DI Khan) and add another (Lower Dir).

In all four districts, while also piloting some work in the Federally Administered Tribal Areas (FATA),[2] it would undertake a set of activities to improve access to safe drinking water and reliable irrigation water in poor, remote and water-scarce communities (SDC, 2010). It would aim to make livelihoods more secure for all, while making life easier (particularly for women), healthier (particularly for children), and more prosperous (particularly for farmers).

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1 The IWRM facilitators' manual was co-produced and co-published by Helvetas Swiss Intercooperation while the strategy document itself states that W4L "provided technical and financial support for the development of sectoral papers as well as for the strategy. Helvetas also assisted in the consultative process. Being long-standing partners of the Provincial Government, and highly committed stakeholders in water sector, the provincial government is thankful to SDC and Helvetas for this partnership." (GoKP, 2020, p. VII). Influence of an intervention on the content of such documents is material to the findings of any ex-post evaluation.

2 The FATA were established in 1947 and from north to south comprised Frontier Region DI Khan and the South and North Waziristan, Kurram, Orakzai, Khyber, Mohmand and Bajaur agencies. All were dissolved into KP province in 2018 through a constitutional amendment. Chitral district was split into Upper Chitral and Lower Chitral at the same time.

Proposal

As the funding became available and objectives became clear, the W4L entry proposal was prepared (SDC, 2011a). This was for a five-year project from Aug 2011 to Jul 2016, with a budget of CHF 10.50 million. The Phase 1 credit proposal followed (SDC, 2011b). This was for the first two years and CHF 4.23 million, and was later extended to the end of 2013 at no extra cost in line with SDC, 2012b. The goal of Phase 1 was to "contribute to improving and securing livelihoods and increasing food security of communities in [KP Province] and FATA in Pakistan through sustainable, secure and equitable access to water." The Phase 1 credit proposal was explicit on the links between W4L and the Livelihoods Programme and earlier water-related projects in KP Province. Thus, W4L was expected to use the lessons learned as well as the same districts and existing staff and NGO/Government partners to allow the scaling up and transfer of previous experience to similar agro-ecological zones "without having to invest limited resources in feasibility studies and/or inception periods." (SDC, 2011b: 3).

4. Findings on W4L during implementation

4.1 W4L Phase 1: water infrastructure

Progress of W4L was included in the *Review of SDC Water-oriented Activities* (Guidotti & Kilchenmann, 2013), where 80 schemes were listed with almost 13,000 beneficiaries in Chitral, DI Khan, Karak and Lower Dir districts. Six of the schemes in Karak were inspected in May 2013, with positive findings apart from a questionable design in one case and doubtful sustainability in another (*Ibid*, p.27). Project performance was reviewed in the *End of Phase 1 Report* (SDC, 2013a) based on an external review (Merz *et al*., 2013). These reports confirmed that the project was institutionally anchored in the KP Province Planning and Development Department (P&DD) and operated closely with district line agencies, while Helvetas Swiss Intercooperation was the main implementing organisation and eight local NGOs facilitated all stages of the project with partner communities.

Summaries of outcomes, outputs and activities foreseen in the Phase 1 credit proposal are presented in Annex 8, along with progress against logframe-defined targets as reported by Merz *et al*. (2013) and SDC (2013a). Progress highlights included: that new irrigation had brought extra land into cultivation, while enabling increased production and/or diversification of crops; that improved water supplies had saved much labour time (see also Zarif & Salim, 2013); that protection works meant that fewer people were displaced by floods; that new irrigation schemes and agreements on water rights had reduced water conflicts within and between villages; that increased community capacity to build, operate and maintain water and disaster risk reduction (DRR) infrastructure was acknowledged by government line agencies; and that increased incomes, diversified food availability and reduced water-borne diseases were reported and attributed by communities to W4L.

4.2 W4L Phase 2: water governance

Changing conditions

Two developments would affect the design of any subsequent phase (SDC, 2013a). The first was that security issues had caused the project to withdraw from Lower Dir District (as well as the Frontier Region of DI Khan within FATA), with the allocated funds being used instead for activities in the other three districts (SDC, 2013a, p. 7/5). The credit proposal for W4L Phase 2 therefore introduced Tank district as an alternative focal district, justified by its important water catchment services for urban areas (SDC, 2013b, pp. 5, 26). The other influential change was the devolution of water governance by the 2012 LGA (see Section 3.2), which was seen as offering opportunities for W4L to work closely with newly-empowered local government.

Proposal, paradigm and progress

The credit proposal for Phase 2 specified that it would run from Jan 2014 to Dec 2017 with a budget of CHF 6.24 million (SDC, 2013b). Its goal was slightly different to Phase 1's and was to "contribute to agricultural development, food security and livelihoods and thus enhance rural local economies in ecologically fragile, semi-arid and poor districts in [KP Province] through sustainable, safe and equitable access to water." The Phase 2 logframe did not specify quantitative targets in the same way as in Phase 1. This was because of a change in paradigm - from an activity-focused project to a stakeholder-driven participatory programme (Helvetas, 2013, p. 23).

In the Phase 2 model, therefore, the WUAs with the district governments would be the driving forces of change, making decisions on water interventions in irrigation, drinking water and water system protection based on agreed criteria and guidelines. The WUAs would be supported in implementing infrastructure investment in line with their WUMPs (SDC, 2013b). Thus, Phase 2 would focus on 'soft' institutional, educational, and partnership-based aspects of capacity building. It would operate in the context of the Local Government Act 2012, which had recently empowered the local level of government.

Summaries of outcomes, outputs and activities foreseen in the Phase 2 credit proposal are presented in Annex 9, along with progress against logframe-defined targets as reported by Sarfraz *et al*. (2017) and SCOP (2017). Good progress had been made, especially on water infrastructure schemes, with nearly 8,900 households gaining improved irrigation and almost 225,000 people gaining improved drinking water access, and all physical targets were expected to be achieved by project's end. Good progress was also reported on participatory development planning, with eight WUMPs prepared covering over 225,000 households in 40 UCs, while it was claimed that a mind-set change had been achieved among "communities as well as line departments in a conservative socioeconomic landscape towards community based water resource management" (Sarfraz *et al*., 2017, p. 2).

4.3 W4L Phase 3: mainstreaming and integration

Seeking transformation

The W4L Consolidation Phase (2018-20) aimed "to improve the frame conditions on ‘equitable access to water’ through an integrated approach to water management." (SDC, 2020: 3/9). The themes, processes and achievements of this Phase 3 are presented in Annex 10. There were three intended outcomes: **mainstreaming the IWRM approach** within KP Province government departments; **enabling local actors to draw support from official channels** and elsewhere for effective water governance and management systems, in line with WUMPs and the IWRM approach; and **managing knowledge** generated by W4L for use by water sector actors among government line agencies, local government, WUAs, communities and academia.

All three outcomes would contribute to consolidating a transformation[3] of water management systems in KP Province. The first was the most strategic. It required all institutions relevant to water management to be fully involved in developing an IWRM Strategy for KP Province. This responded to the release of a National Water Policy (GoP, 2018), which called on the provinces to develop frameworks for effective water governance and was followed by national IWRM implementation guidelines (Fatima *et al*., 2021) and a National Water Conservation Strategy (GoP, 2023). KP Province was an early responder in this process. With technical support from W4L, it formed an IWRM Core Working Group and Steering Committee to formulate its IWRM Strategy (GoKP, 2020), in line with which a KP Province Water Resource Regulatory Authority was later established (GoKP, 2022).

Consequences of shifting paradigms

The consequences of shifting paradigms between the phases are summarised in Table 1. **Phase 1** focused on the direct delivery of water system improvements (irrigation, drinking water, flood protection), and on laying the foundations for new and more effective participatory water governance and knowledge management arrangements. **Phase 2** then focused on deepening and strengthening arrangements for participatory water governance and knowledge management, while supporting parallel actions to deliver further water system improvements. And the subsequent **Consolidation Phase** focused almost entirely on the further development and mainstreaming of participatory water governance and knowledge management arrangements.

[3] ***Transformation* refers to *multidimensional system change***, in which so many alterations are made to the entities ('moving parts') and relationships in a system that fundamental change occurs in how it works (e.g., in how people relate to each other and to their environment) and its emergent properties (e.g., greenhouse gas emissions, water catchment functions, resource management decisions). See Caldecott & Olding (2022) for an application of these concepts to the SDC climate action portfolio.

Table 1: Evolving paradigms, objectives and focal actions of W4L, 2011-2020

	W4L Phase 1, 2011- 2016	W4L Phase 2, 2014-2017	W4L Consolidation Phase, 2018-2020
Paradigm	A *project* to implement activities in line with the logframe (Helvetas, 2013).	A *programme* to support other actors in their own activities in line with their holistic water use management plans (WUMPs), while building their capacity and promoting both knowledge management and adaptive flexibility (Helvetas, 2013).	As for Phase 2, but focused on: (i) mainstreaming IWRM in KP Province government; (ii) enabling local actors to draw on diverse sources to support water governance and management systems; and (iii) managing knowledge for use by all water sector actors.
Main objective	Contribute to improving and securing livelihoods and increasing food security of communities in KP through sustainable, secure and equitable access to water (SDC, 2013a).	Contribute to agricultural development, food security and livelihoods and thus enhance rural local economies in ecologically fragile, semi-arid and poor districts in KP through sustainable, safe and equitable access to water (SDC, 2013b).	Equitable access to water through integrated management in ecologically fragile, semi-arid and poor districts of KP Province for enhancing rural economies (SDC, 2020).
Focal actions	11 drinking water schemes reach 945 households; 19 irrigation water schemes reach 3,472 households; disaster risk reduction (DRR) structures protect 4,091 households; 255 ha of land protected against flooding (Annex 8).	Prepare WUMPs (8 in 4 districts); establish and strengthen WUAs and WUGs (17 WUAs, 801 WUGs); promote GESI; reduce water conflicts; train professionals; water quality testing; sanitation training; promote DRR; influence policy; manage knowledge (Annex 9).	Mainstream IWRM (consultation forum, subsector reports, district planning workshops); provide technical support to local water governance and management systems; manage knowledge (strategic research products); promote GESI; conflict-sensitive programme management; promote catchment-level 'One Water' approaches; demonstrate innovative role of WUAs and WUGs as key local actors (Annex 10).
Parallel actions	Establish WUAs and disaster risk management committees; deliver weather early warnings to farmers; establish development partners & local NGOs in target areas; secure government counterparts; promote GESI; promote participatory water governance (Annex 8).	39 irrigation schemes to expand irrigated areas; 47 drinking water schemes to supply clean drinking water (Annex 9).	None.

Reconstructing the W4L Theory of Change

The evaluation applied a theory-based approach, which required the reconstruction of W4L's theory of change (ToC) to reflect its evolution over time in response to shifting contexts, policy priorities and the momentum of reform. Despite these changes, seven thematic **clusters of activities/outputs** are seen where W4L investment was made and whose effects persisted cumulatively throughout W4L's lifecycle. These are illustrated in Figure 3, along with their associated **outcome areas** and contributions to a **trajectory toward impact**.

The evaluation aimed to gather evidence that these sequences were followed during W4L itself, and that their cumulative impact left traces in multiple systems that could still be detected. In addition, Annex 11 presents a general ToC for IWRM, and a list of assumptions and logical steps applicable to any IWRM intervention. Comparing the W4L and IWRM ToCs, as is done in Annex 11, shows how and why the actions taken through W4L were likely to result in progress towards achieving the key aims of IWRM, thus tending to confirm the evaluation team's impression that W4L was marked by a very high quality of design and implementation.

Figure 3: Evaluation reconstruction of the W4L Theory of Change (ToC).

Clusters of activities/outputs	Outcome areas	Trajectory toward impact
1. Water User Associations: increase capacity for participatory IWRM planning and action.	Local participation in decisions strengthens citizen participation and accountability mechanisms.	More effective and responsive institutions support improvements across the IWRM sector and enhance local social, economic and ecological systems.
2. Disaster Risk Reduction: mainstreaming, planning and direct support for flood protection of lands and households.	Flood protection for lands and households increases livelihood security; policy influence.	Increased livelihood security enhances local social and economic systems and rewards participation.
3. Water Use Management Plans (WUMPs): enable planning for all aspects of IWRM.	Clarified water rights and collective accountability within water catchment areas; reduced and avoided water conflict; policy influence.	Catchment-wide agreements enable more holistic and effective IWRM which enhances local social, economic, cooperative and ecological systems.
4. Knowledge management: ways and means to manage and share information on weather, agroecology and climate.	Knowledge products and tools for early warning, up-scaling, replicating or tailoring anchored institutionally; policy influence.	Consolidation and institutionalisation of best practices and knowledge enhances local social, economic, cooperative and ecological systems.
5. Institutional networking: structured and active collaboration with multiple official and NGO partners.	Shared know-how and a culture of experience-sharing strengthens actors' capacity for strategic planning and management; policy influence.	Policy development and inclusive planning processes allow mainstreaming of all aspects of IWRM and enhance local social, economic & ecological systems.
6. Water system services: direct support for drinking water and irrigation schemes; sanitation and professional training.	Enhanced health and livelihoods from reduced incidence of waterborne disease, more productive farmland and improved nutrition.	More sustainable, safe and equitable access to water enhances local social and economic systems and rewards participation.
7. Gender equity and social inclusion (GESI): effective mainstreaming through standards for structural inclusion of all stakeholders.	With women and men fully consulted and all schemes benefiting small farmers, women and children have enhanced health and livelihoods.	More equitable access to water and diverse life-opportunities enhances local social and economic systems.

5. Findings on W4L after implementation

5.1 Expectations to be tested

As noted in Section 2.1, the evaluation sought evidence with which to test a number of expectations shaped by the W4L *End of Project Report* (SDC, 2020). The latter was concerned with W4L's effectiveness and impact up to 2020, while the present ex-post evaluation aimed to assess the validity of its expectations against evidence for impact and sustainability in the following areas.

- First, on **water systems at the local/community level**:
    - the long-term **impact** of W4L by delivering improvements to water infrastructure, by introducing better irrigation arrangements, improved drinking water supply systems, and greater environmental security from protective investments; and
    - the **sustainability** of W4L in terms of these local improvements to water systems persisting and being maintained since 2020.
- Second, on **water governance at the local/community level**:
    - the long-term **impact** of W4L by inducing or facilitating the establishment of inclusive institutions (WUGs and WUAs) that were able to put IWRM principles into effect by preparing WUMPs, managing implementation, and maintaining the resulting improvements to water systems, while reducing conflict and safeguarding ecosystems that sustain water availability; and
    - the **sustainability** of W4L in terms of these local improvements to water governance persisting and being maintained since 2020.
- Third, on **water governance at the district/province level**:
    - the long-term **impact** of W4L by introducing a trajectory of change that made it more possible for government institutions to put IWRM principles into effect through capacity building, supportive partnerships and knowledge networks, and policy and law; and
    - the **sustainability** of W4L in terms of this trajectory of change on high-level improvements to water governance persisting since 2020.
- Fourth, on other **legacy impacts**, such as:
    - on **replication** of changes introduced by W4L to other locations;
    - on **the influence of new ideas** introduced by W4L; and
    - on **lessons learned** from W4L that could be useful in other contexts or in relation to climate change adaption.

The following sections in this chapter summarise evidence relevant to these four target systems, drawing on findings from the interviews (Annex 2), workshops (Annex 3), causal estimation analyses using data from household surveys (Annex 4) and remote sensing (Annex 5), and the contribution stories (Annex 6). These sources offer very different kinds of evidence and not all are equally useful in supporting judgements in each of the above areas. But they do complement each other, allowing a coherent overall story to be told about the impact and sustainability of W4L.

5.2 Local and community water systems

Drinking water systems improved by W4L

These were often described as having very beneficial effects at local and community level. They enhanced convenience (e.g., by providing 24-hour water availability), continuity (e.g., Tank City was mentioned as having an unprecedentedly consistent water supply in 2020-26), and 'community dignity'. They had the effect of reducing the incidence of waterborne disease, and a greatly reducing the burden on those (mostly women and girls) who had previously been responsible for collecting water, often from far away.

Co-benefits included increased awareness of hygiene and sanitation, and increased participation by women in community decision-making and WUMP development. This increased participation was partly because they had more free time and energy, and enthusiasm, and partly because W4L insisted on women's inclusion in WUGs. The transformative effects of drinking water improvements are also prominent in the contribution story on *Water for Empowerment in the Arandu Valley of Chitral* (Box 3).

The quantitative causal estimation analysis found that during most of the project's implementation period rural households in W4L districts gained more from improved drinking water access than urban households did (Annex 4). This difference declined during the later part of the project implementation period, however, and by the end of the project both urban communities in W4L districts and non-W4L districts in general had reached the same level of drinking water access as the W4L beneficiaries had done a few years earlier. Evidence from 2023 confirmed that the convergence continued after the project ended in 2020.

Box 3: Improving drinking water access in Arandu Valley, Chitral.
Godibar village in Lower Chitral used to struggle with safe drinking water. Women and girls had to walk long distances over rough and sometimes unsafe terrain to collect river water, which was often polluted or affected by floods and landslides. In 2011, the Water for Livelihoods (W4L) Project, funded by SDC and implemented by Helvetas, was launched in the Arandu Valley. The project worked carefully with local leaders and helped create space for women to take part in community discussions. Over time, women formed their own water user groups and made clear that clean drinking water was the community's top priority. As a result, a drinking water supply scheme was proposed and agreed locally, and it then installed 39 water standposts across the village, serving all 84 households. This made daily life much easier, especially for women and girls. They no longer had to spend hours fetching water, families became healthier, and women had more time for farming, kitchen gardening, poultry, and household activities. The project also brought wider change. Women became more confident, organised, and active in local decision-making. The Godibar story shows how improving access to clean water transformed lives, restored dignity, created opportunities and fostered lasting social change, especially for women. *See the full contribution story in Annex 6*.

Irrigation systems improved by W4L

Benefits confirmed from mini dams, water ponds, pipeline systems, inlet/outlet structures, *Rod Kohi* channels, etc. included increased areas of effective cultivation (e.g., by about 126.5 ha at one locality and 162 ha at another) and increased agricultural productivity on farmland. Reliable irrigation also allowed communities to diversify crops, contributing to improved agricultural stability, resilience and food security. Co-benefits mentioned at the workshops included improved livelihoods, and the resolution of long-standing issues of siltation, inadequate storage capacity, and inefficient water distribution and use. Interviewees confirmed that improved water infrastructure had yielded sustained benefits from increased agricultural productivity, and emphasised the added value of integrating high-efficiency and solar-powered irrigation systems. The transformative effects of improved irrigation systems are also prominent in the contribution story on *Reviving the Deenwah Nullah in Tehsil Daraban of DI Khan* (Box 4).

These effects are partially confirmed in the quantitative causal estimation analysis, which detected a momentarily significant increase in the share of farmers owning or using irrigation in W4L project districts at the beginning of the project compared to other districts in KP province (Annex 4). This difference disappears at later stages, however, which may indicate that non-W4L localities caught up although other influences (such as flooding) were also at work. No significant district-level effects were seen among the other irrigation-related indictors of irrigated land area, vegetation greenness and evapotranspiration.

Box 4: Restoring spate irrigation in Daraban, DI Khan.

The people of Tehsil Daraban had depended for generations on the Deenwah Nullah for farming, livestock, and their livelihoods. The water system was managed through the traditional *Rudh Kohi* system, where communities shared and maintained floodwater irrigation based on long-standing water rights.

Over time, however, repeated floods and heavy sediment damaged the *nullah* ('watercourse'). The channel became blocked, water stopped reaching many villages, and the irrigated area fell from more than 11,000 acres to only about 1,200 acres by 2015. Farmland turned barren, livelihoods suffered, and many families had to leave for towns and cities to find work. The *nullah* became known locally as *madfoon* ('buried'), and later *badmash* ('unruly'), because of the damage caused by uncontrolled floodwater.

When W4L began working in the area, communities saw a chance to bring the old system back to life. With support from Helvetas, the local Water User Groups contributed thousands of hours of labour, removed large amounts of silt, repaired the channel, and helped restore the flow of water.

By 2017, the Deenwah Nullah had once again become a lifeline for eight villages in Daraban. More than 2,500 additional acres of land could be irrigated, bringing the total back to around 3,700 acres. Fields that had been unused for years returned to production, improving food security, incomes, and confidence among farmers.

See the full contribution story in Annex 6.

Protective infrastructure installed by W4L

Protective infrastructure has evidently had a critical role in reducing flood risks, safeguarding agricultural land and community assets. In the 2022 floods, W4L infrastructure protected several villages and facilitated the mounting of rapid and effective local responses. Both workshop participants and interviewees emphasised the value of multi-functional or dual-purpose interventions (such as infrastructure with flood control and irrigation functions), particularly in enhancing resilience and reducing vulnerability to climate-related risks.

Sustainability of local infrastructure improvements

Workshop participants were clear that all W4L infrastructure - whether for drinking or irrigation water or environmental security - continued to function fully, to meet essential water needs across multiple settlements and their populations (e.g., about 1,500 in two localities, 10,000 in another), and to generate the on-going benefits as listed above. The key to this sustainability is that most WUGs and WUAs also continued to function (see Section 5.3).

5.3 Local and community water governance

Local water governance and sustainability

The inclusive, multi-tier institutional system of WUGs (for village implementation and management) and WUAs (for area oversight and coordination) was seen by workshop participants and interviewees as offering a strong foundation for IWRM. All WUGs and *tehsil*-level WUAs were trained under W4L in water management, agriculture and hygiene, and this greatly strengthened community capacity and enabled them to manage systems independently. Moreover, workshop participants and interviewees confirmed that all these institutions continued to function well, at all scales between 19 and 119 villages in DI Khan and Tank, and between 800 and 10,000 individuals in Chitral.

The WUGs act to correct operational problems, reflecting strong ownership and responsiveness. They effectively fulfil the roles of local operation, management, maintenance and repair of water infrastructure, ensuring equitable water distribution, as well as maintaining regular coordination with government departments (especially PHED), which continue to provide technical support such as pump operation, pipeline maintenance, and repair services that the WUGs cannot handle. The WUAs also remain active and are responsible for overall operation, maintenance, and management of schemes. Interviewees emphasised that community-level institutions continue to have a lasting impact on water management practices, livelihoods, and local governance.

Local water governance and planning

The WUAs were reported to have been considerably strengthened in role and capacity as a result of W4L. With input from the WUGs, they develop integrated WUMPs and coordinate their implementation with government planning processes, including collaboration with multiple departments for scheme approval. Interviewees stressed the importance of the highly adaptive, flexible, context-driven and locally-appropriate IWRM planning model used by W4L, which adopted valleys as the basic planning unit in Chitral, but watersheds in DI Khan, and *tehsils* in Tank. The governance model helps with technical challenges, land-related issues, and social disputes during implementation, and continues to support effective operation and maintenance. Community ownership is strong and maintenance responsibilities are effectively handled at the local level. All systems remain operational and are managed by local community institutions.

Local water governance, disasters and conflict

Collaboration between WUAs and WUGs promotes social cohesion and collective problem-solving capacity, and this is valuable in disaster management (e.g., in the 2022 floods, the WUAs and WUGs enabled communities to manage the situation effectively) and in preventing and resolving water conflicts (e.g., interviewees estimated a 70-80% decline in water conflicts in the W4L areas). The reduction in conflicts over water among farmers was attributed to W4L on the grounds that the irrigation interventions meant that water distribution was better-controlled, that there was more participation in decisions about where it was to be sent and when, and that there was more productive farmland available which often benefited smallholders.

Local water governance and inclusion

Annex 6 describes the inclusion of women, youth and vulnerable populations in W4L arrangements. Overall, increasing women's involvement, whether through formal groups or indirect participation, enhanced the effectiveness and sustainability of water schemes by promoting inclusive decision-making, strengthening community ownership, and improving health, education, and social outcomes at the household level. Similarly, the active involvement of youth contributed positively to local innovation, improved productivity, community ownership, and the longer-term sustainability of project interventions. And vulnerable populations including remote rural households and smallholders were among the primary beneficiaries of the W4L project, both in terms of direct access to services and broader socioeconomic improvements.

Local transformation overview

Taken together, the Arandu Valley (Box 3) and Deenwah Nullah (Box 4) contribution stories show how W4L, acting in collaboration with the communities, addressed critical water challenges while also strengthening resilience, dignity, social inclusion and sustainable livelihoods in rural KP Province. By establishing water infrastructure schemes and community-based water governance systems, the project improved access to safe water, strengthened local institutions, and played a significant role in restoring livelihoods that continue to function well beyond the project’s life. The empowerment of women in Godibar and rehabilitation of farmland in Deenwah stand as inspiring examples of the broader impact achieved through the 47 water supply and 39 irrigation projects implemented by Helvetas across four districts of KP Province.

5.4 District and province water governance systems

Contributions to policy development

Interviewees stressed that W4L had facilitated policy development by demonstrating the validity of several approaches that were innovative in the context of KP Province. These included: (1) the consensus-building effects of consultative and participatory processes (e.g., the process of developing the KP Province IWRM Strategy); (2) the utility of applying IWRM-aligned practices in water-scarce districts and of integrating water, energy and agriculture in planning; and (3) the value of evidence-based policy development supported by the University's Climate Change Centre. An enabling effect on policy development was also seen from the strengthening of training curricula and institutional capacity by W4L. Overall, W4L created an influential model by combining community ownership, appropriate technology and integrated planning. Ex-post, the project had a lasting influence, including on the KP Province Water Act (2020), and on the intention to expand the W4L approach to other districts through watershed planning using digital mapping.

The conceptual legacy of W4L

A key role of W4L in KP Province was to demonstrate practical IWRM approaches in ways that government officials could recognise as being useful, alongside capacity building, in meeting their own needs to deliver on policy commitments. Impacts of this sort are among the most valuable results of development cooperation because of the long-term impact that new ideas and capacities can have when they help to shape government policies, strategies and laws. This was done most effectively in five ways, by showing: (1) that sustained collaboration between government institutions, development partners and communities is necessary; (2) that integrated, participatory approaches have proven value; (3) that community-led models are highly cost-effective (with up to 45% savings relative to top-down approaches); (4) that local and often traditional knowledge is an important resource for designing interventions and systems properly; and (5) the effectiveness of combining traditional and IWRM-based water management systems (such as integrating *rod-kohi* systems with modern IWRM approaches). A particularly impactful concept shift that W4L and Helvetas introduced was that of treating water as an economic good, while maintaining access to adequate drinking water as a fundamental human right.

Sustainability of W4L at the district and province level

A number of persistent challenges were identified by interviewees, all of which can be traced to three key issues. The first issue is that of **project continuity**, because when W4L ended in 2020 and funding was discontinued, Helvetas did not have the resources to continue intense and continuous dialogue on IWRM with the KP Province government. This inhibited the development of the institutions proposed in the IWRM strategy (such as a groundwater authority) that would have been responsible for promoting IWRM at the district and especially the provincial level. Despite this limitation on institutionalisation and mainstreaming, there was continued influence on provincial policy frameworks, and the WUAs were officially registered and continued to engage with government and investors. Continuation of momentum established through preparation of district-level IWRM plans in the four W4L districts also contributed to the development of water governance plans in additional districts (e.g., Charsadda and Mansehra) under later partnerships, such as the Water Resource Accountability in Pakistan (WRAP) initiative.[4]

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[4] https://www.iwmi.org/projects/wrap/

The second issue is **resistance to change**, which is linked to the first, in that more complete institutionalisation of IWRM within government could have helped to overcome resistance to the adoption and scaling up of W4L-developed community IWRM approaches. As it was, these processes were inhibited by low awareness of their benefits, risk-averse attitudes among rural people, and the high costs involved in changing ways of farming and managing water. And the third issue is **climate change**, a pervasive process that impacts the farming calendar by changing the timing of seasonal events, making hazards less predictable and often more intense, and altering the availability of long-term resources such as groundwater. These effects raise the level of risk for farmers, deterring them from investing time, energy and money in innovative practices that depend on seasonal weather and water availability conditions that may not be there when needed.

5.5 Answering evaluation questions 1-4

EQ1: effectiveness of W4L on water governance

This EQ was framed to ask about the short-term achievements of W4L in promoting participatory water governance and associated, necessary, capacity and policy development. In ToC terms, it relates especially to item 1 (WUAs) in Figure 3. This was the focus of W4L Phase 2 at the local/community level, where its **achievements were robust and comprehensive**. In a somewhat different sense, to do with policy, legislation, institutionalisation and capacity building, it was also the focus of W4L Phase 3 at district/provincial level, where it had **important strategic effects** that included: (1) supporting the development of KP Province's IWRM Strategy; (2) validating the integration of traditional knowledge into government plans, projects and sectoral strategies; (3) establishing a Climate Change Centre oriented to policy-relevant research at the University of Peshawar; and (4) training and awareness-building on the IWRM approach among government departments.

EQ2: effectiveness of W4L on water system management

This EQ was framed to ask about the short-term achievements of W4L in promoting improved delivery of (reliable, high-quality and sustainable) irrigation and drinking water for intended livelihood and health benefits, along with infrastructure designed primarily or alongside other purposes to protect community lands and other assets against floods. In ToC terms, this relates especially to items 2 (DRR) and 3 (WUMPs), and local dimensions of item 6 (water system services) in Figure 3. This was the focus of W4L Phase 2, where **achievements were robust and comprehensive** among targeted communities.

EQ3: Long-term impact and sustainability of W4L

This EQ was framed to ask about W4L having shaped the conditions and arrangements for all aspects of water system governance and management that prevailed in 2026. Here, water systems are considered in the broadest sense, from ecological to infrastructural, behavioural and institutional, and the focus is equally on the local/ community level and the district/provincial level.[5]

Considering first the local/community effects, in ToC terms these relate especially to items 1 (WUAs) and 3 (WUMPs) in Figure 3. Here it was found that for both water governance and water system management at the local/community level, there was robust evidence that **W4L had initiated a transformative trajectory of excellence**.

Considering water governance at the district/province level, this includes the development of policies and legislation to validate and mandate IWRM approaches, the institutionalisation and mainstreaming of formal responsibilities to promote and implement those approaches, and the building of capacities to do so. In ToC terms, these effects relate especially to items 4 (knowledge management) and 5 (institutional networking). Here, there is **robust evidence for strong impact during the project**, but the end of W4L in 2020 meant a **loss of momentum**

5 The dimension of district/province water system impact is more appropriately addressed under EQ4.

that prevented replication of project achievements to the extent anticipated, even though the provincial IWRM strategy outlined a pathway for doing so.

EQ4: large-scale socioeconomic and biophysical change

This EQ was framed to ask about W4L having exerted such an influence on water supply and irrigation that objective markers of change could be seen in biophysical conditions. In practice, however, the evaluation team decided that other lines of enquiry had confirmed that dams and irrigation channels, some of quite large scale, had been built to service groups of communities, and that these still existed and continued to exert local influence. It was therefore considered that it would be more useful to ask whether available time-series data on socioeconomic and biophysical attributes could be used to shed light on broader impacts by W4L (Table 2).

In ToC terms these district/province effects relate especially to the broader dimensions of item 6 (water system services) and item 7 (GESI) in Figure 3. Apart from a transitory acceleration in access to drinking water in W4L districts relative to non-W4L districts, **neither the socioeconomic nor the biophysical analyses found robust evidence of district-wide effects by W4L**. Its absence should be understood in light of the fact that W4L operated in villages within four districts (one of which changed from Lower Dir to Tank between phases 1 and 2), reaching on average only 8.4% of the rural population for drinking water and 2.9% of rural households for irrigation. Thus, the absence of a detectable signal at district and UC levels does not preclude meaningful impact for direct beneficiaries at local level, for which there is abundant evidence.

Table 2: Evidence of impact and sustainability from the causal estimation analysis

Evaluation questions	Evidence from causal estimation analysis
EQ1. To what extent did W4L improve water governance during and immediately after the project?	Neither the household survey nor the remote sensing analysis could capture water governance outcomes directly, but see EQ3 for evidence from proxy indictors.
EQ2. To what extent did W4L improve water system management during and immediately after the project?	**Partial evidence was found**, but this was constrained by the limited geographic reach of W4L's village-level interventions relative to the larger administrative units used in this analysis. • The analysis of **household survey data** at the district level (Annex 4): ○ *found evidence* that W4L improved rural drinking water access (RDWA) by about 22% during the implementation period, after accounting for district-wide shocks such as the 2010 floods through a triple difference-in-difference (DDD) specification; ○ *found evidence* that there was a significant but temporary increase in the proportion of farmers using irrigation within W4L districts from the start of the project, but that this effect faded over time as there was a similar increase in non-W4L districts as farmers in non-W4L districts 'caught up'; and ○ *found no evidence* that W4L had any effect on the area of land irrigated, on the time spent by households in fetching drinking water, or on reported incidents of childhood diarrhoea. • The analysis of **remote sensing data** at the UC and district levels (Annex 5): ○ *found no evidence* that W4L had any effect on vegetation greenness (NDVI) or evapotranspiration as proxies for increased irrigation.
EQ3. To what extent did W4L influence current water governance and water system management arrangements?	**Evidence was found of a temporary effect during W4L implementation**. • A positive difference of 39% in improved RDWA between W4L and non-W4L districts was found in 2014-15, which can be attributed to the effects of W4L Phase 1. • This positive difference declined during W4L Phases 2 and 3 to reach 10% by 2019-20, indicating that the relative advantage of W4L districts was lost as non-W4L districts reached similar levels of improved RDWA.[6] • Data from the 2023 Pakistan Census showed that improved RDWA stood then at 81% in W4L districts and 82% in non-W4L districts, indicating that the convergence in improved RDWA continued after W4L ended.

[6] Urban households within W4L districts also experienced a recovery in drinking water access in 2019-20.

Evaluation questions	Evidence from causal estimation analysis

EQ4. To what extent did W4L leave detectable markers of significant biophysical change in the project areas?	See text on the change of focus to a search for evidence of broader socioeconomic and biophysical effects.
	• The analysis of **remote sensing data** (Annex 5).
	  ○ *found no evidence* that either vegetation greenness (NDVI) or evapotranspiration increased in W4L districts relative to non-W4L districts at either the UC or district level; **but two caveats apply**:
	  ○ that *changes in evapotranspiration were detected* at district level, but the data are considered unreliable due to pre-trend violations and monsoon cloud interference in the satellite measurements; and
	  ○ that *qualitative (descriptive) evidence indicates* that both vegetation greenness and evapotranspiration did increase over time in W4L and non-W4L areas, a shared trajectory that may have resulted from region-wide drivers such rising carbon dioxide (CO_2) concentrations in the air,[7] warming temperatures extending growing seasons, shifts in monsoon rainfall patterns, and the broader expansion of irrigation.

EQ5. What lessons from W4L can inform subnational, national and international efforts to promote IWRM and climate change adaptation?	**The causal estimation analysis could not detect district-level impact**. • *Across its target districts, W4L reached directly only* 2.9% of rural households with irrigation improvements and 8.4% of the rural population with drinking water improvements, and had major impacts at local and community level but without necessarily being expected to produce detectable impact at the UC or district levels. • *Interventions seeking transformative impact at larger scale* would need to operate at greater geographical scale, or work through institutional and policy channels that amplify reach beyond their direct beneficiaries, or else, having developed district-level IWRM plans as W4L did, would need longer-term continuity to facilitate their application and potential replication.

7 CO_2 in the air increased from about 390 parts per million (ppm) in 2010 to about 430 ppm in 2025 (https://scripps.ucsd.edu/bluemoon/co2_400/mlo_full_record.png), and this is known to affect plant growth (Ainsworth *et al*., 2025; Dakora *et al*., 2025).

6. Conclusions and lessons learned

6.1 Evaluation question 5: lessons on climate change

The fifth evaluation question was framed to ask about the strengths and weaknesses of the W4L approach and lessons learned that could help SDC and Pakistan design their responses to the growing hazards of global heating. The relevance is that issues of climate change and water management are deeply entangled, for the following reasons among others: (1) that rainfall patterns are changing so the viability of rainfed agriculture is becoming increasingly uncertain; (2) that drier regions are tending to desiccate, reducing the availability of water over potentially large areas; (3) that rainfall is increasingly erratic, being delivered more often in storms and high-intensity downpours; and (4) that many catchment ecosystems, often already degraded, are in transition to new forms and in the process becoming less able to intercept rainfall, protect soils and recharge aquifers.

These factors put rising value, respectively, on high-efficiency irrigation systems, on flood protection, on water capture and transport, and on the protection and restoration of catchment ecosystems. Ways and means to meet these needs are urgently sought, and **W4L successfully demonstrated a number of these** that may well be applicable in many different geographic contexts.

Thus, under the broad aim of promoting community-based IWRM, W4L showed that communities can organise themselves effectively to become enthusiastic planners, managers and maintainers of water systems, in partnership with governments, and in the process introducing government officials to new ideas. The latter include the value of local participation and ownership, and the utility of locally-adapted planning that integrates traditional and ecological knowledge, rather than centralised, one-size-fits-all programming. In the context of any given locality, grassroots engagement is needed to introduce, test and demonstrate a raft of new ideas (as W4L did in Phases 1 and 2). But to change outcomes at a scale large enough to match the power and spread of climate change, replication, institutionalisation and mainstreaming of the lessons learned are all essential.

6.2 W4L as an exemplary project

The W4L project was in many ways exemplary in demonstrating how to promote and apply the principles of IWRM in practical ways that educated, empowered and met the needs of communities and governments. For communities, these needs include sustainable water supplies and services, while for governments they include ways to ensure the delivery of public goods more cost-effectively than by other means. As it developed, despite considerable violence and other challenges in its environment, W4L focused in Phase 1 on delivering infrastructure that was appreciated as useful by its beneficiaries in target communities. Then, having built trust among its various stakeholders, it concentrated in Phase 2 on consolidating governance arrangements and building capacities that would ensure sustainability. This was facilitated by the wave of devolution that followed legislative changes in 2012-13, and which meant that important components of the administrative anchorage of the IWRM approach matched the devolved responsibilities of districts.

6.3 Lessons from the loss of momentum

In 2019, devolution in KP Province was reversed. This was during Phase 3 of W4L, when the project was seeking to institutionalise and mainstream within government systems the principles that it had validated. But important administrative roles in relation to water system management now shifted back to the provincial level, weakening the link between communities and their government partners. Significant progress was nevertheless made in Phase 3, especially on provincial IWRM strategy, water legislation and knowledge management. With more time, this could have ensured that the necessary capacities were established at appropriate levels within the executing departments, enabling them to sustain and scale the model effectively beyond the project's lifespan. But at only two years, in the context of changing administrative responsibilities, Phase 3 of W4L could not build fully on the momentum created by its earlier local successes, or on the credibility that they had earned within the provincial government. It was not even long enough to allow for alternative ways to be found to enable continuation of the processes that had begun, and hence to avoid a sudden loss of momentum from 2020.

Such continuity arrangements might have involved government budgeting, other donors, one or more large NGOs that could have been core-funded and project-funded to continue work in the area, well-supported knowledge-management and capacity-building academic and other institutions and networks, intergovernmental policy dialogue, and/or ongoing small-grants programmes with their characteristic flexibility and responsiveness. There are many options, but all demand focus and enough time to organise. Meeting the climate challenge in any country and globally is essentially about all institutions becoming much more serious about demonstrating the necessary changes in small systems where they can, and then setting up ways to replicate and scale the proven advances, multiplied indefinitely. The experience of W4L is a rich source of knowledge for the first part of this, and a warning with regard to the second.

Annex 1: The evaluation matrix

<table>
<tr><th>Judgement criteria and key performance indicators</th><th>Sources of information</th><th>Methods of data collection/analysis</th></tr>
<tr><td colspan="3">EQ1. To what extent did W4L improve water governance during and immediately after the project?</td></tr>
<tr><td colspan="3">This relates to the water governance outcomes aspect of generic EQ 1 of the 2024-2028 SDC/NCG ex-post evaluation mandate: 'What were the main achievements (outcomes) at the time of project completion?'</td></tr>
<tr><td>• Evidence of institutional changes among WUAs and other actors likely to result in more inclusive participation and reduced conflict.
• Evidence of capacity changes among WUAs and other actors likely to result in better informed and more equitable decisions.
• Evidence of attitude changes among WUAs and other actors likely to result in protection and/or restoration of catchment ecosystems.</td><td>• W4L progress and status reports and review documents.
• KP Province government data and reports.
• Interviews with Helvetas staff, government officials and other key informants.
• Discussions at knowledge-holder workshops.</td><td>• Content analysis of key documents.
• Triangulation among qualitative and quantitative data sources.
• See Sections 2.3 (Interviews with W4L knowledge-holders), 2.4 (Workshops with W4L district stakeholders), 2.5 (Use of causal estimation analysis) and 2.6 (Contribution analysis and stories).</td></tr>
<tr><td colspan="3">EQ2. To what extent did W4L improve water system management during and immediately after the project?</td></tr>
<tr><td colspan="3">This relates to the water system management outcomes aspect of generic EQ 1 of the 2024-2028 SDC/NCG ex-post evaluation mandate: 'What were the main achievements (outcomes) at the time of project completion?'</td></tr>
<tr><td>• Evidence of investments that resulted in changes likely to increase the extent and reliability of irrigation water supply.
• Evidence of investments that resulted in changes likely to enhance the quality and reliability of drinking water supply.
• Evidence of investments that resulted in changes likely to promote other positive effects on water systems (e.g. flood management, catchment protection and/or restoration).</td><td>• As above.</td><td>• As above.</td></tr>
<tr><td colspan="3">EQ3. To what extent did W4L influence current water governance and water system management arrangements?</td></tr>
<tr><td colspan="3">This relates to three generic EQs of the 2024-2028 SDC/NCG ex-post evaluation mandate:
○ to the water governance and water system management outcomes aspect of generic EQ 3: 'To what extent have the outcomes achieved been sustained, scaled-up or replicated 3-6 years after project completion?'
○ to the capacity-building outcomes aspect of generic EQ 4: 'How has the project contributed to strengthening of capacities and to what extent have these been sustained?'
○ to the cumulative self-sustaining impacts aspect of generic EQ 5: Which impacts have been achieved after project conclusion?</td></tr>
</table>

Judgement criteria and key performance indicators	Sources of information	Methods of data collection/analysis
• Evidence that W4L affected the functionality of the WUAs (i.e., in developing and implementing WUMPs, forming and operating agreements among stakeholders, preventing and resolving disputes) as duty bearers of communities in the water sector. • Evidence that W4L affected the flow of applied knowledge (about all aspects of IWRM) based on networking (i.e., through dialogue, forums, joint activities) among key stakeholders. • Evidence that W4L affected the mainstreaming (i.e., through guidelines, policies, training, procedural norms) of the IWRM approach within government line departments, and hence the frame conditions and replication of new governance arrangements. • Evidence that W4L affected the institutionalisation of results through partnerships established with provincial and federal governments, NGOs, research institutions, and academia. • The above to include evidence on the strengthening of capacities and the systems in place to maintain capacity strengthening.	• As above.	• As above.
EQ4. *To what extent did W4L leave detectible markers of significant biophysical change in the project areas?*		
This relates to the *sustained biophysical outcomes* aspect of generic EQ 3 of the 2024-2028 SDC/NCG ex-post evaluation mandate: 'To what extent have the outcomes achieved been sustained, scaled-up or replicated 3-6 years after project completion?'		
• Evidence of changes in water-borne diseases, irrigation taxes, irrigated areas, land-use change and flood protection and resilience outcomes, with triangulation and interpretation to test W4L impact hypotheses.	• Remote images and their interpretation. • Maps of biophysical and socioeconomic changes and their interpretation. • W4L and KP Province government data and reports. • Data on water-borne diseases, irrigation taxes, irrigation areas, land-use change and flood protection and resilience (from sources in text). • Interviews and workshop records.	• Internet searches for remote imagery and maps. • National consultants access publicly available imagery and maps within Pakistan. • See Section 2.5 (Use of causal estimation analysis), Annex 4 (Analysis of household survey data) and Annex 5 (Analysis of remote sensing data).

Judgement criteria and key performance indicators	Sources of information	Methods of data collection/analysis
EQ5. *What lessons from W4L can inform subnational, national and international efforts to promote IWRM and climate change adaptation?*		
This relates to two generic EQs of the 2024-2028 SDC/NCG ex-post evaluation mandate: ○ generic EQ 2: 'To what extent are the project outcomes still relevant and aligned with similar/related interventions?' ○ generic EQ 6: 'What were the potentials for replicability in the same geographical context or elsewhere?'		
• Evidence on strengths and weaknesses of the W4L approach (as a stand-alone project, in the context of SDC and Pakistan, in comparison with other projects, and against the increasing hazards posed by global heating and geopolitical uncertainty). • Evidence on the on-going relevance of the approaches taken by W4L, the lessons available to be learned from it, and the alignment between what W4L achieved and the current priorities of SDC, Pakistan and the international development cooperation community.	• All findings and conclusions.	• Comparative analysis of need in other areas and the strengths and weaknesses of W4L. • Particular focus on whether and how W4L lessons can be helpful to SDC and Pakistan, and in the HKH sub-region and elsewhere.

Annex 2: Interviews with W4L knowledge-holders

A2.1 Interview methodology

Rationale of the interview strategy

The framing assumption was that W4L's impacts would primarily emerge from strengthened water governance, particularly through enhanced institutional capacities and reforms aimed at ensuring equity, access and efficiency in water management, while safeguarding ecosystems. At the same time, it was assumed that the sustainability of W4L could be judged from three key assessments: whether the WUAs were still active and effectively engaged in planning, coordination, and conflict resolution; whether IWRM knowledge generated by W4L was still being used in an applied ways, shared through stakeholder networks, and integrated into government systems; and whether outcomes had been institutionalised through partnerships with government institutions, NGOs, and academic and research organizations. These lines of enquiry map onto evaluation questions and, along with notes for discussion developed in advance in dialogue with the Europe-based team, were used to guide semi-structured interviews, which were then tailored according to the roles and responsibilities of W4L partners.

Selection and representativeness of interviewees

Selection of informants sought to ensure representation across key holders of knowledge about W4L and the broader IWRM framework. The aim was to cover policy, institutional, technical and community dimensions to allowing triangulation of findings. Priority was therefore given to individuals who met at least one of the following criteria: direct involvement in policy formulation; engagement in project implementation and concerned with institutional adoption and scaling pathways; representing staff associated with community-level implementation and outcomes; and experts contributing to relevant academic, research, or knowledge systems. The identities of these individuals are protected in line with SDC confidentiality requirements, so interviewees are named only in Annex 12 for SDC use alone.

Interview design and conduct

The semi-structured format ensured that all interviews covered core evaluation themes consistently, including sustainability, policy uptake, and institutional performance, while still allowing flexibility for respondents to elaborate on issues specific to their roles and experiences. This balance between structure and openness was essential for capturing comparable insights across stakeholders as well as nuanced, context-specific perspectives obtained through iterative questioning and discussion.

Thematic areas explored during the interviews were aligned with W4L objectives and with OECD/DAC evaluation criteria. Thet included: **post-project sustainability and legacy**, on whether interventions continued to function after project closure; **policy uptake**, on the extent to which W4L concepts were integrated into planning instruments such as government PC-1 forms for infrastructure projects; **institutional coordination**, on how different departments interacted under the IWRM framework; and **community participation**, which was a central pillar of the W4L approach.

In addition, technical effectiveness of interventions, such as irrigation systems and water infrastructure, was assessed alongside broader challenges related to scaling, financing, and long-term sustainability. Each interview was documented in detail, capturing both factual information and interpretive insights. Emphasis was placed on recording not only what was implemented, but also how stakeholders perceived the effectiveness, relevance, and sustainability of those interventions over time.

Constraints and limitations

The interview process encountered the following constraints that influenced both the depth and scope of data collection. First, many people who had been involved in the design and early implementation phases of W4L had since been transferred, retired, or reassigned to different roles, and could no longer be found. Second, the water and agriculture sectors in KP Province have been influenced by multiple donor-funded initiatives and government reforms over time, so it was not always straightforward to isolate impacts that could be attributed to W4L.[8] Respondents often referred to broader sectoral improvements, requiring careful probing and cross-verification to distinguish project-specific contributions from wider systemic changes.

Third, recall bias is a common challenge in ex-post assessments, since personal recollections, although valuable, may be influenced by subjective interpretation or incomplete recall of events, particularly in relation to timelines, sequencing of interventions, and comparative effectiveness. Fourth, water resource management in KP Province involves multiple departments, including irrigation, agriculture, soil conservation, and public health engineering, each operating within its own mandate and reporting structure. This sometimes resulted in fragmented or partial viewpoints, making it challenging to construct a unified institutional narrative around IWRM implementation and project influence. And finally, the evaluation had little capacity to visit and verify field-level observations. While the interviews (and workshops) included stakeholders from the W4L districts, direct site visits to all intervention areas were not feasible within the scope of this exercise. As a result, some community-level findings rely on reported evidence rather than direct observation.

Despite these issues, the evaluation achieved broad and balanced coverage across stakeholder groups and regions, and the use of triangulation helped to validate key findings. The overall quality and consistency of responses provide a sufficiently robust basis for drawing credible conclusions about the project's long-term outcomes and institutional impacts.

A2.2 Summarised interview observations

The full record of interview observations is available as a supplementary annex, but at over 10,600 words its volume is too large for easy reference so a summary is presented in Table A2.1.

[8] This is partially corrected for by the causal estimation analysis introduced in Section 2.5 with details in annexes 4 and 5.

Table A2.1: Summary of evidence from the interviews.

Target systems	Evidence from interviews (consolidation of distinct statements from interviewees)
Local/community water systems	• **Impact**. (1) Adoption of high-efficiency irrigation systems. (2) Integration of solar-powered water pumps for some uses. (3) Improved water infrastructure (small dams, storage systems, efficient irrigation systems). (4) Sustained benefits in terms of improved agricultural productivity. (5) Greater resilience to climate variability through dual-purpose (flood control + irrigation) infrastructure.
Local/community water governance	• **Impact**. (1) Participatory community engagement was a key strength. (2) Stronger WUAs resulted. (3) Strong community ownership resulted through revived local institutions. (4) Enhanced livelihoods. (5) 70-80% reduction in water conflicts. (6) Highly adaptive, flexible, context-driven and locally-appropriate IWRM planning model, (valley-based in Chitral, watershed-based in DI Khan, and *tehsil*-based in Tank). (7) Strong foundation for IWRM through multi-tier institutional systems (WUGs, WUAs), extensive capacity building, and integration of health, hygiene, and water management. • **Sustainability**. (1) Community-level institutions remain functional in 2026 and continue to manage water systems effectively. (2) Sustained benefits in terms of functional WUAs and reduced water conflicts. (3) Lasting impact on water management practices, livelihoods, and local governance.
District/province water governance	• **Impact**. (1) There were positive effects from integrating policy and implementation. (2) There were positive effects from stronger training curricula and institutional capacity. (3) Participatory policy design was a key strength. (4) There was dtrong alignment between W4L interventions and IWRM principles, particularly in improving water use efficiency and integrating water-energy-agriculture systems. (5) There was a shift toward (water-energy-agriculture) integrated intervention packages. (6) Contributions were seen to policy development. (7) Strong foundations were built for IWRM through institutional development, capacity building, and locally appropriate planning approaches. (8) An influential model was created by combining community ownership, appropriate technology and integrated planning. (9) The strategy development process was highly consultative, involving multiple government departments and resulting in sectoral alignment. • **Sustainability**. (1) IWRM-aligned practices were advanced in water-scarce districts. (2) A replicable model was developed that has influenced policy discourse and development initiatives. (3) The process of developing IWRM Strategy was inclusive and effective in building consensus. (4) The University's Climate Change Centre contributed to evidence-based policy development.
Other legacies (replication, concepts)	• **Introducing new concepts**. (1) Helvetas introduced key conceptual shifts, including treating water as an economic good while maintaining drinking water as a fundamental human right (the Durban principle had a high conceptual impact). (2) Other ideas introduced and validated by W4L include: that sustained collaboration between government institutions, development partners and communities is necessary; that community-led models are highly cost-effective (up to 45% savings); that local knowledge is important in system design; that integrated, participatory approaches are valuable; and that it is effective to combine traditional and IWRM-based water management systems (e.g. traditional *Rod Kohi* systems with modern IWRM approaches). • **Sustainability**. (1) Ex-post, the project had a lasting influence, including on the KP Province Water Act (2020) and expansion of the W4L approach to newly-merged districts through GIS-based watershed planning.

Target systems	Evidence from interviews (consolidation of distinct statements from interviewees)
Persistent challenges	• **Resistance to change**. (1) Reluctance by farmers to adopt more efficient irrigation due to low awareness, high costs and conservative attitudes. (2) Reluctance by government to grant formal recognition of the value of traditional systems. • **Weak institutionalisation and scaling.** (1) Limited scaling of rainwater harvesting and recharge systems. (2) Resource limitations for scaling. (3) Incomplete institutionalisation weakens scaling mechanisms. (4) Absence of formalised district-level structures inhibits scaling up. (5) Limited influence of new models on broader policy frameworks. • **Weak mainstreaming and coordination.** (1) Incomplete mainstreaming of IWRM principles. (2) Weaknesses in institutional coordination. • **Lack of continuity**. (1) After Helvetas left in 2020 there was a lack of resources for facilitation, technical backstopping, and capacity-building support at the same level as before, so the IWRM Strategy had no effective facilitator; results included that no dedicated regulatory authority was established, that the rate of reform and mainstreaming (of IWRM and the Durban principles) slowed down, that implementation remains largely stalled, and that continuity is undermined by staff turnover and loss of institutional memory. • **Climate change**. (1) Climate risks and impacts are a general concern. (2) Climate variability makes planning difficult. (3) Climate variability affects system reliability. (4) Climate-related disasters and competing political priorities may reduce the ability to institutionalise and sustain the project's gains over time.

Annex 3: Workshops with post-W4L stakeholders

A3.1 Workshop methodology

Rationale

The two evaluation workshops were designed to generate a structured and evidence-informed understanding of stakeholder perspectives on key dimensions of project performance and sustainability. They were expected to contribute to validating evaluation findings and capturing grounded insights on the durability of W4L outcomes. They therefore had the following specific aims: to produce community-level experiences and perceptions of W4L interventions; to assess the functionality and long-term viability of WUGs and WUAs; to examine the extent to which knowledge and practices generated by W4L had been internalised, sustained and used by community institutions and local partners; and to identify lessons learned, persistent gaps, and opportunities for scaling and replication.

Selection and representativeness of participants

Participants in both workshops were chosen from among people with direct and sustained engagement in W4L and post-W4L water management arrangements. The following selection criteria were used: active membership in WUGs at the village level; active membership in WUAs at UC, *tehsil*, or district level; experience in the operation, maintenance and/or governance of W4L-supported schemes; and involvement in project planning, implementation, and/or capacity-building activities.

Workshop participants represented a cross-section of community institutions with key roles during and after W4L. During the project, participants were actively engaged in: planning and prioritisation of schemes through WUMPs; community mobilisation and participatory decision-making; contributing labour, local resources and/or supervision of scheme implementation; and coordination with government departments and implementing partners. In the post-project phase, their roles had evolved toward sustaining project outcomes, including: operation and maintenance of water infrastructure; water allocation management and conflict resolution; institutional coordination with relevant government agencies; and resource mobilisation for repair, rehabilitation, and expansion of schemes.

The Peshawar workshop on 8 April 2026 included 29 men from DI Khan, Karak and Tank districts. These areas in southern and central KP Province all have semi-arid, water-scarce, and flood-prone environments (Table A3.1). Hence these districts highlight the importance of community-based water management in fragile and resource-constrained settings. Representation across multiple institutions enabled comparison of different institutional arrangements, including village-level WUGs, WUAs, *tehsil*-level associations, and district-level coordination mechanisms.

The Chitral workshop on 13 April 2026 included 14 men and two women from (Lower) Chitral district, a mountainous region characterized by glacier-fed and rain-dependent systems, where livelihoods depend heavily on smallholder agriculture (Table A3.1). The area is hazard-prone, with frequent floods, landslides, avalanches, and earthquakes. These sites reflect high-altitude contexts where water management is closely linked to seasonal variability, glacial dynamics, and terrain constraints. The Chitral workshop therefore provided insights into the performance of W4L in mountain settings, including valley-based planning and multi-village coordination.

Both workshops included participants with direct, lived experience in a great diversity of agro-ecological conditions to which different W4L interventions had to be adapted. A similarly wide range of experience was therefore captured by the workshops, to the extent possible in events of such limited duration. This offered high analytical value because it enabled comparison across technical models and institutional arrangements, strengthening the assessment of sustainability and scalability.

Workshop design and conduct

Both workshops started with an explanation by the evaluation team of W4L's objectives, outcomes, and intended impacts. Participants were then oriented to the participatory tools for their use in assessing Helvetas' contributions, the socio-economic outcomes of W4L, and the current status of legacy and related interventions. The participants were then divided into groups (see Table A3.1), each choosing its own leader, and each group was tasked to use the tools to assess project performance across five criteria: institutional memory, implementation processes, sustainability, gender inclusion, and impacts. Supervised and facilitated where necessary by the evaluation team, each group sought collectively to review evidence, outcomes and answers to questions embedded within the topics for discussion. The group work concluded with plenary presentations, enabling cross-validation of findings and collective reflection.

Constraints and limitations

Only two of 45 workshop participants were women, with none in the Peshawar workshop. This was despite both a reportedly strong record of women's involvement in all aspects of W4L and an evaluation policy to include women proactively among informants. The same policy had led to the appointment of a man and a woman to the evaluation team in Pakistan, because it was appreciated that willingness to participate and discuss was likely to be strongly gendered for traditional and cultural-religious reasons.

One finding from of the workshops, however, was that formal participation of women in W4L meetings and institutional platforms had always been constrained by contextual and logistical barriers including limited mobility, cultural norms, and practical constraints such as safety concerns during travel, particularly in adverse weather conditions involving heavy rains, floods, and landslides. Travel delays were of particular concern to women and their families because of the risk of women being stranded overnight among strangers and far from help. This turned out to be an important factor in the Peshawar workshop, since severe rains discouraged women's participation.

A3.2 Summarised interview observations

The full record of workshop group observations is available as a supplementary annex, but at over 6,900 words its volume is too large for easy reference, so a summary is presented in Table A3.2.

Table A3.1: Workshop groups from diverse locations in four districts of KP Province.

Group and workshop	District	Locations	Membership	Agro-eco zone	Environmental features and key risks	Types of W4L interventions
Group 1 Peshawar	DI Khan	Chodazam, Tehsil Daraban	WUAs & WUGs	Semi-arid, water-scarce, flood-prone.	Mixed water systems; spate irrigation; canal-based systems.	Drinking water supply, canal irrigation, spate irrigation systems.
Group 2 Peshawar	DI Khan	Sheikh Haider and Darban Zam	WUAs & WUGs	Semi-arid, water-scarce, flood-prone.		
Group 3 Peshawar	Karak	Takht-e-Nasrati	WUAs & WUGs	Rain-fed, water-scarce.	Limited water availability; reliance on storage and local governance.	Small dams, water storage systems, community-based water management.
Group 4 Peshawar	Tank	Tank Zam command area	WUAs & WUGs	Semi-arid, flood-prone.	Spate irrigation systems; district-level coordination	Irrigation & urban water supply systems, WUA coordination.
Group 5 Peshawar	Karak	Chontra	Chontra Water User & Welfare Organisation	Rain-fed, water-scarce.	Limited water availability; reliance on storage and local governance.	Small dams, water storage systems, community-based water management.
Group 1 Chitral	Lower Chitral	Garm (Garam) Chashma	WUAs & WUGs	Mountainous, glacier-fed.	Flood risks; terrain constraints.	Water supply systems, flood protection schemes.
Group 2 Chitral	Lower Chitral	Shisko UC	WUAs & WUGs	High-altitude, rain-dependent.	Seasonal variability; irrigation dependency.	Irrigation canals, water supply interventions.
Group 3 Chitral	Lower Chitral	Kalash Valley (valleys)	WUAs & WUGs	Mountainous, culturally distinct Kalash people.[9]	Integrated water management needs; terrain challenges.	Water supply, protection bunds, check dams
Group 4 Chitral	Lower Chitral	Arandu (Arundu) Valley	WUAs & WUGs	High-altitude, agro-dependent.	Agricultural expansion pressures.	Irrigation systems, domestic water supply.

9 See: IUCN (undated); Masood (2024)

Table A3.2: Summary of evidence from the workshops.

Target systems	Evidence from workshops (consolidation of distinct statements from groups)
Local/community water systems	**Impact**: • **Differential benefits for women**. (1) Time savings for households, particularly women and children. (2) Women's participation in decision-making and prioritization of schemes increased, contributing to improved household water access and hygiene. • **Improved drinking water other benefits**. (1) Improved dignity with water in the village. (2) Tank City with unprecedentedly consistent water supply 2020-26. • **Improved drinking water health benefits**. (1) Reduced waterborne diseases. (2) Drinking water - 24-hour water supply, reduced waterborne diseases, increased awareness on hygiene and sanitation, reduced water collection burden, particularly for women. • **Protective infrastructure benefits**. (1) In the 2022 floods, W4L infrastructure protected several villages and facilitated rapid local response. (2) Enhanced resilience from flood protection structures. Improved flood protection. (3) Protective infrastructure has played a critical role in reducing flood risks, safeguarding agricultural land and community assets. (4) Emphasis on the multi-functional benefits of interventions, particularly in enhancing resilience and reducing vulnerability to climate-related risks. • **Irrigation benefits (mini dams, water ponds, pipeline systems, inlet/outlet structures, Rod Kohi channels)**. (1) Increased agricultural productivity, improved water efficiency, improved livelihoods, improved resilience, expansion of cultivable land, resolved long-standing issues of siltation, resolved long-standing issues of inadequate storage capacity, resolved long-standing issues of inefficient water distribution. (2) Six irrigation canals enabled the cultivation of ca 162 ha of land. (3) Reliable irrigation has allowed communities to diversify crops and increase productivity. Improved agricultural stability. (4) Enabled the cultivation of ca 126.5 ha of land, contributing to improved agricultural productivity and food security. **Sustainability**: • **Continued functionality of drinking water infrastructure**. (1) All W4L infrastructure continue to function and generate on-going benefits. (2) All components of the large W4L drinking water supply scheme remain fully functional and continue to meet essential domestic water needs across multiple settlements. (3) All W4L interventions continue to function effectively and currently serve ca 1,500 households. (4) All W4L interventions continue to function effectively and currently serve more than 10,000 individuals. • **Continued functionality of irrigation infrastructure**. (1) All schemes (irrigation channels, water supply systems, bunds, livestock ponds, and mini dams) remain operational. (2) All W4L interventions continue to function effectively and currently serve ca 1,500 households. (3) All W4L interventions continue to function effectively and currently serve more than 10,000 individuals.
Local/community water governance	**Impact**: • **Disaster management**. (1) In the 2022 floods, the WUAs and WUGs enabled communities to manage the situation effectively. • **Reduced conflict**. (1) W4L interventions (water ponds, pipeline systems, Rod Kohi channels) reduced conflicts among farmers, particularly in *Rod-Kohi* areas.

Target systems	Evidence from workshops (consolidation of distinct statements from groups)
	• **Other governance impacts**. (1) Inclusive institutional mechanisms, including women's groups and youth participation, improve planning. (2) implementation and sustainability. (3) Multi-tier institutional structure (central committee for all areas and village committees for local implementation and management). (4) Greater social cohesion (stronger collaboration and collective problem-solving capacity), **Sustainability**: • **Continued WUG functionality**. (1) All WUGs were trained and strengthened under W4L and continue to function effectively, with clear roles in operation, maintenance, and management of schemes under community ownership and self-reliance. (2) The WUGs take immediate corrective action on operational issues, reflecting strong ownership and responsiveness. (3) While many WUGs and committees remain active, some O&M committees have become inactive, indicating uneven performance and highlighting the need for continued institutional support and monitoring. (4) Structured operation and maintenance (O&M) mechanisms, including regular financial contributions from landowners to support repairs and upkeep. • **Continued WUA functionality**. (1) WUAs remain active and continue to promote equitable water distribution by supporting communities in planning, conflict resolution, and WUMP facilitation. • **Coordination with government**. (1) WUGs and WUAs remain active and maintain regular strong coordination with government departments (especially PHED), which continue to provide technical support such as pump operation, pipeline maintenance, and repair services. (2) Continued success depends on sustained coordination with government departments and ongoing institutional support. (3) Strong integration of W4L interventions into WUMPs and government planning processes, including collaboration with multiple departments for scheme approval and implementation. • **Capacity building**. (1) Training provided under W4L, particularly in water management, agriculture, and hygiene, has strengthened community capacity and enabled them to independently manage systems. • **Other sustainability**. (1) The governance model helps with technical challenges, land-related issues, and social disputes during implementation, and continues to support effective operation and maintenance. (2) Community ownership is strong and maintenance responsibilities are effectively handled at the local level. (3) All systems are currently operational and are managed by local community institutions. (4) Young people are actively involved in O&M and awareness activities, which is seen as helping to ensure long-term sustainability and institutional continuity.
District/province water governance	• **WUMP priorities**. (1) WUA members mentioned follow up and advocacy for WUMP priorities with concerned departments and other donor organizations.
Other W4L legacies	• **WUA recognition**. (1) WUAs are government-registered bodies at tehsil and district level, and represent communities in water-related matters.
Persistent challenges	• **Population growth**. (1) This is placing increasing pressure on existing infrastructure.

Annex 4: Analysis of household survey data

A4.1 Methodology for household survey data

The analysis draws on the Pakistan Social and Living Standards Measurement (PSLM) survey, conducted by the Pakistan Bureau of Statistics (PBS). The PSLM is a nationally representative repeated cross-section household survey. Crucially for this analysis, the district-level rounds of the survey are designed to produce estimates that are statistically representative at this level[10], with sample sizes of roughly 75,000–80,000 households per round across Pakistan. Seven district-level rounds were used: 2004-05, 2006-07, 2008-09, 2010-11, 2012-13, 2014-15, and 2019-20. To compare similar households, which are part of the same political system and are relevant to the analysis of W4L, the analysis was restricted to households in Khyber Pakhtunkhwa (KP) Province.

As the PSLM is a repeated cross-section dataset, meaning that different households are sampled in each wave, the analysis can only identify population-level changes within districts but not within the same household. However, as the focus of the analysis is on identifying potential ex-post impacts of W4L, it is not a problem, since it allows the analysis to assess whether higher level effects have been achieved on the district level. Moreover, the PSLM categorises a household either as rural or urban, and as W4L specifically targeted rural households, the analysis can more closely investigate the main target group of the programme.

To investigate outcomes related to W4L five questions targeting four specific outcomes relevant for the programme were chosen (see Table A4.1). The categorical response categories associated with questions relating to drinking water and time to drinking water, were collapsed into binary indicators before being used in the statistical analysis:

- **Improved water source.** Following WHO and UNICEF's JMP classification of drinking water[11], the following sources were coded 1 for improved: Tap (in or outside the dwelling), hand pump, motor pump/tubewell, covered/protected well, filtration plant, and packaged water. Unimproved facilities were coded 0 and include: open well, river/stream/pond/spring, tanker truck, and other.
- **Basic water-collection time.** According to the JMP classification if "a round trip to collect water takes 30 minutes or less, then it is classified as a basic drinking water service. If water collection from an improved source exceeds 30 minutes, it is categorised as a limited service"[12]. Therefore, if respondents use 30 minutes or less to fetch water or have water sources within their household the variable was coded as 1, and coded 0 otherwise.

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10 Using stratified sampling at the district level focusing on urban and rural domains, this becomes possible

11 JMP (2026 a)

12 JMP (2026 b).

Table A4.1: PSLM survey questions used.

Outcome	Question	Response categories
Source of drinking water	What is the main source of drinking water for the household?	1. Tap (in home / courtyard) 2. Tap (outside the home) 3. Hand pump 4. Motorised pump / water motor 5. Covered (protected) well 6. Open well 7. River, stream, pond, spring 8. Tanker truck / water vendor 9. Other *(2019-20 wave adds: filtration plant; mineral/bottled water)*
Time to drinking water	How long does it take to fetch drinking water (one way)?	1. 0–14 minutes 2. 15–29 minutes 3. 30–44 minutes 4. 45–59 minutes 5. 60 minutes or more *(2019-20 bins shift to 1–15, 16–30, 31–45, 46–60, 60+)*
Child diarrhoea	Has any child under 5 in the household had diarrhoea in the last 30 days?	1. Yes 2. No *(2019-20 wave asks about the last 15 days)*
Irrigated land: ownership	Does the household own or cultivate any irrigated land?	1. Yes 2. No
Irrigated land: area	How many acres of irrigated land does the household own or cultivate?	Numeric (acres)

A4.2 The reach of W4L per district

W4L was primarily implemented at the village level[13], but the PSLM survey population data are at the district level. Quantifying the share of the rural district population that the programme actually reached was done using the *External Review of Project Water for Livelihoods Phase 2* (Sarfraz *et al*., 2017), which in its Appendix 8 lists all drinking and irrigation infrastructure supported by W4L, and the number of beneficiaries, households, and fields irrigated (see Table A4.2). It should be noted that this is a **conservative estimate** of reach, since it includes neither Phase 1 infrastructure nor people and fields indirectly affected by W4L. A similar table by Guidotti & Kilchenmann (2013) is used here to compare the number of households reached.

The reach of W4L among rural communities at district level was limited (Table A4.2). For **drinking water** schemes, the project reached an overall mean of 8.4% of the rural population (about a third in Tank but only 4-6% in the other districts). For **irrigation** schemes, it reached an overall mean of 2.9% of rural households (10% in Tank but only 2-3% in the other districts). The proportion of field area reached by W4L irrigation enhancement was about 27% in Tank and Karak, but only 2-3% in Chitral and DI Khan, with an overall mean of 4.8%. Other than for households reached by irrigation in DI Khan, these numbers are all higher than those reported by Guidotti & Kilchenmann (2013).[14] This may be due to W4L including flood-protection infrastructure and livestock ponds in response to the 2010 floods.

[13] This claim is confirmed by Guidotti & Kilchenmann (2013) and Sarfraz *et al*. (2017).

[14] Households are the unit of analysis in the 2013 review.

Table A4.2: W4L beneficiaries among rural district populations.

	2017 Census (rural population and HH only)		W4L rural drinking water beneficiaries		W4L irrigation beneficiaries		Irrigated area (acres)		
District	**People**	**HH**	**People**	**% people**	**HH**	**% HH**	**W4L**	**FAO**	**% area**
DI Khan	1,264,901	150,220	50,435	4.0	2,611	1.7%	11,286	362,908	3.1
Tank	344,720	37,317	115,719	33.6	3,725	10.0%	8,446	31,363	26.9
Karak	655,150	67,784	41,275	6.3	1,154	1.7%	1,275	4,764	26.8
Chitral	397,568	54,556	17,260	4.3	1,376	2.5%	786	51,729	1.5
Overall	**2,662,339**	**309,877**	**224,689**	**8.44**	**8,866**	**2.9**	**21,793**	**450,764**	**4.8**

Notes. (a) HH = household(s).

Sources: (a) Sarfraz *et al*. (2017); (b) 2017 Pakistan Census (population, rural households); (c) FAO AQUASTAT / GMIA for irrigated area.

A4.3 Socioeconomic analysis

Identifying the effects of W4L

In order to estimate the causal effect of W4L on the outcomes described in Table A4.2, the analysis applies Difference-in-Difference (DiD) statistical modelling to create a counterfactual situation, where W4L was not implemented, thereby allowing the analysis to control for both time invariant and time varying confounders under the parallel trends assumption. Allowing the analysis to isolate the effect of W4L on the outcome of interest, and hereof ensure that any observed differences in outcomes can be credibly attributed to the program itself, rather than to background trends or pre-existing differences between treated and control districts.

Three different DiD model specifications are applied, allowing the analysis to assess the robustness of the findings. All models use wave 2008-09 as the reference wave, since the 2010 floods prevents 2010-11 as stable base year. This reference wave is therefore omitted from the regression to prevent multicollinearity. Hence, the coefficients in the model represents the average difference in Y_t between targeted W4L districts and non-targeted ones relative to the 2008-09 wave.[15]

The first DiD specification used is the normal DiD statistical models described below, and estimated using OLS:

$$Y_{dt} = \gamma_d + \lambda_t + \sum_{\tau=-q}^{-1} \gamma_\tau D_{d\tau} + \sum_{\tau=0}^{m} \delta_\tau D_{d\tau} + \epsilon_{dt}$$

- $\boldsymbol{Y_{dt}}$: The outcome of interest (improved access to drinking water, time to drinking water, irrigation, and children with diarrhoea) for district *d* in year *t*.
- $\boldsymbol{\gamma_d}$: District fixed effect, absorbing all time-invariant differences across districts (geography, baseline agro-ecology, soil type).
- $\boldsymbol{\lambda_t}$: Year fixed effect, absorbing time-varying shocks common to all districts in a given year (national weather patterns, KP Province-wide policy changes, regional climate events).
- $\boldsymbol{D_{u\tau}}$: An event-time indicator equal to 1 when *d* is τ years away from W4L finished water infrastructure in 2011-12 wave, and 0 otherwise. Event time is measured relative to each district's treatment year (2012-13 for all treated districts; $D_{d\tau}$ is always 0 for control districts).

15 Cunningham, S. (2021).

- $\boldsymbol{\gamma_\tau}$ **(for τ = −q, …, −1)**: Estimated coefficients on pre-treatment year leads. They measure whether treated districts differed from the control group in the years *before* W4L treatment began.
- $\boldsymbol{\delta_\tau}$ **(for τ = 0, …, m)**: Estimated coefficients on the post-treatment lags. These are the dynamic treatment effects: the W4L impact at the year of treatment (τ = 0), one year after, two years after, and so on.
- $\boldsymbol{\gamma_\tau}$ and $\boldsymbol{\delta_\tau}$ coefficients are interpreted as differences relative to the reference period.
- $\boldsymbol{\epsilon_{ut}}$ **Or** $\boldsymbol{\epsilon_{dt}}$: Error term, capturing unobserved variation. Standard errors are clustered at the district level.

The second model specification is the staggered DiD model, which is an extension to the normal model, which allows the model to account for variation in the treatment year. A relevant feature for this analysis, as the district Tank was first included in the second phase of W4L. However, it has been shown that adapting the normal OLS model to this context biases the estimates, and therefore the analysis applies the Callaway–Sant'Anna[16] estimation method. The approach segments treatment groups into treatment timing cohorts and estimates normal DiD models for each cohort. In this analysis there are to cohorts: 2012-13 and 2014-15. Hereafter are the coefficients estimated using weighted averages based on the cohort share of whole treated group.

The third specification is the triple difference-in-difference (DDD). This specification uses the fact that within the treated districts specific groups received treatment. As established in previous sections, W4L focused on rural populations within districts, and as the PSLM survey segments participants into rural or urban within each district, it is possible to create another counterfactual group, i.e., urban respondents within treated districts. This allows the analysis to control for district specific time shocks. Whereas the $\boldsymbol{\lambda_t}$ only controls for time shocks common to all districts.[17]

$$Y_{djt} = \gamma_{dj} + \lambda_{jt} + \mu_{dt} + \sum_{\tau=-q}^{-1} \gamma_\tau \left(D_{d\tau} \times R_j\right) + \sum_{\tau=0}^{m} \delta_\tau \left(D_{d\tau} \times R_j\right) + \psi X_{djt} + \epsilon_{djt}$$

- Y_{djt}: the outcome of interest for district d, subgroup j (rural/urban), and wave t.
- γ_{dj}: district-by-subgroup fixed effects. This generalises the district fixed effect γ_d from the normal DiD specification by allowing it to differ between the rural and urban subgroups, thereby absorbing all time-invariant rural–urban differences within each district (geography, baseline agro-ecology, soil type, and any structural rural–urban divide specific to that district).
- λ_{jt}: subgroup-by-wave fixed effects. This generalises the wave fixed effect λ_t from the normal DiD specification by allowing it to differ between the rural and urban subgroups, thereby absorbing common time trends that affect rural and urban populations differently across all KP Province districts (e.g., national rural development programs, KP Province-wide policy changes that hit rural and urban areas at different rates).
- μ_{dt}: district-by-wave fixed effects. This term is unique to the DDD specification and is what differentiates it from the normal DiD. It absorbs any district-specific shock in a given wave that hits the rural and urban subgroups equally (district-wide floods, district-specific policy changes, regional climate events). Because of this term, the DDD does not rely on parallel trends across districts in the same way the normal DiD does.
- $D_{d\tau}$: an event-time indicator equal to 1 when district d is τ waves away from W4L treatment, and 0 otherwise. Event time is measured relative to each district's treatment year. $D_{d\tau} = 0$ in all waves for control districts.

16 Callaway & Sant'Anna (2021).

17 Cunningham (2021).

- R_j: rural subgroup indicator, equal to 1 if the household is rural and 0 if urban. The rural subgroup is the population W4L actually targeted; the urban subgroup acts as the within-district comparison group.
- γ_τ (for $\tau = -q, \dots, -1$): pre-treatment lead coefficients on the rural × event-time interaction. They test whether the rural–urban gap in treated districts was already evolving differently from the rural–urban gap in control districts before W4L started. These are the DDD pre-trend / placebo coefficients.
- δ_τ (for $\tau = 0, \dots, m$): post-treatment lag coefficients. They measure the dynamic triple-difference treatment effects, i.e. the differential change in the rural–urban gap in treated districts relative to control districts at each event-time.
- γ_τ and δ_τ coefficients are interpreted as differences relative to the reference wave (2008-09). The reference wave is held consistent across all three DiD specifications.
- ϵ_{djt}: error term, capturing unobserved variation. Standard errors are clustered at the district level.

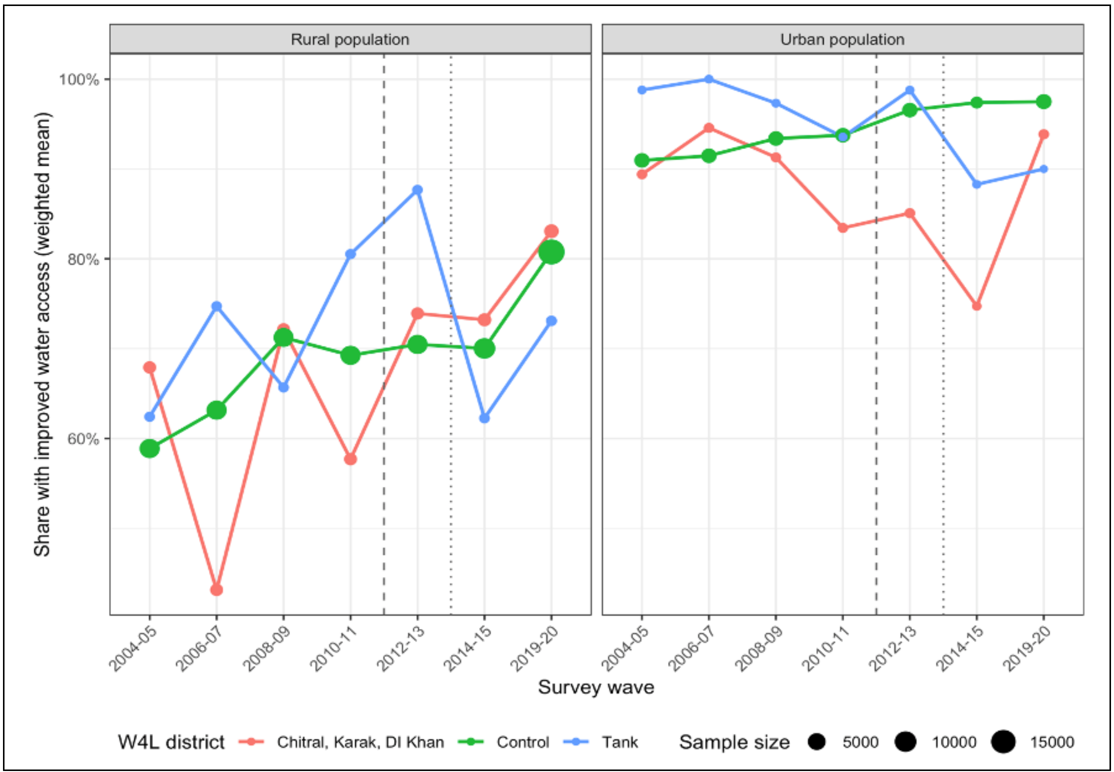
Improved access to water, 2004-20

Improved access to water has steadily been growing in the W4L districts throughout the studied period. Table A4.3 and Figure A4.1 display the share of households reporting improved drinking-water sources per W4L targeted districts and control districts between rural and urban households. In rural areas, W4L districts begin from a substantially lower baseline than control districts and converge over time. In urban areas the picture is dominated by Tank's small sample, which collapses to n = 30 in 2019-20 and produces a discontinuity that is almost certainly sampling noise rather than real change.

Table A4.3: Respondents with access to improved water sources, pooled.

PSLM wave	Improved water - control group	Improved water - W4L group	Difference
2004-05	66.2%	65.4%	-0.009
2006-07	69.2%	68.4%	-0.008
2008-09	74.9%	70.3%	-0.046
2010-11	73.6%	62.1%	-0.115
2012-13	76.9%	77.1%	0.003
2014-15	66.9%	69.8%	0.030
2019-20	80.2%	77.7%	-0.025

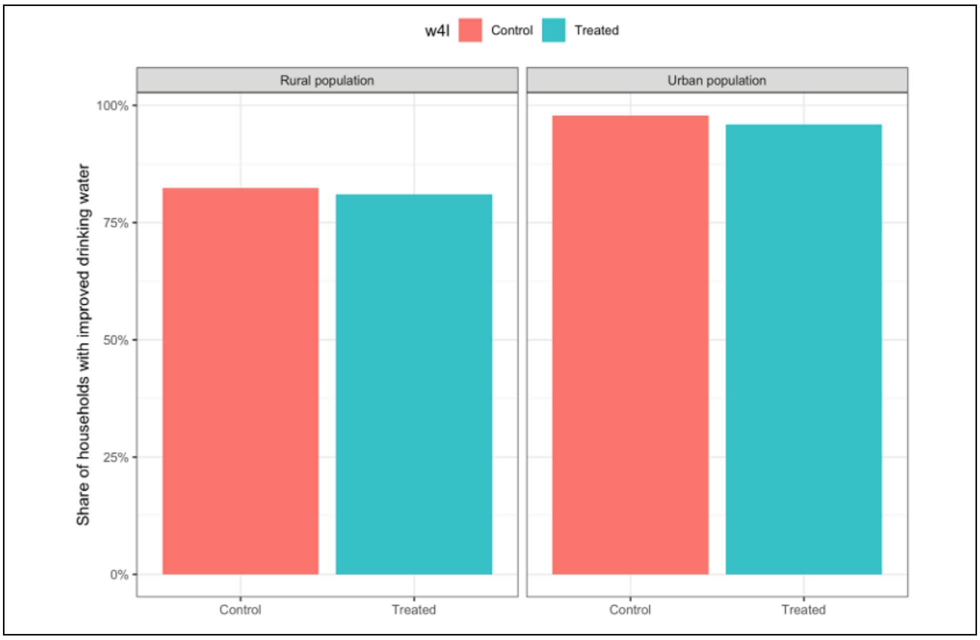
Figure A4.1: Improved access to water across survey waves.



Ex-post analysis: the 2023 census

To extend the time horizon of analysis beyond the 2019-20 PSLM wave, the 2023 Pakistan Population & Housing Census was used to provide district-level water-source tabulations. Being purely descriptive, this cannot support a DiD claim on its own, but it can indicate whether the convergence pattern continued beyond 2019-20. Following the same approach as in the previous analyses, only districts within KP Province were selected. Figure A4.2 shows that the share of rural households within the treated districts with improved water sources was 81%, whereas for the control group it was 82%.

Figure A4.2: Improved water, 2023 Pakistan Population & Housing Census.



Improved irrigation

The analysis of irrigation outcomes is restricted to households that own agricultural land, since the binary indicator and acreage outcomes are only meaningful for landholders. The triple DDD specification is not appropriate here, because filtering to landholders excludes most urban households, leaving the urban comparison cell too thin to identify the rural-urban gap.

The data in Tables A4.4 and A4.5 and displayed in Figure A4.3 show that apart from Tank the W4L districts have more farmers with irrigated land compared to the control group. A similar pattern is seen for irrigated land area. This could indicate a potential effect; however, the amount of irrigated land was already high before the intervention period. This could reflect the W4L's choice of areas with existing *rod-kohi* (spate) irrigation systems for rehabilitation work.

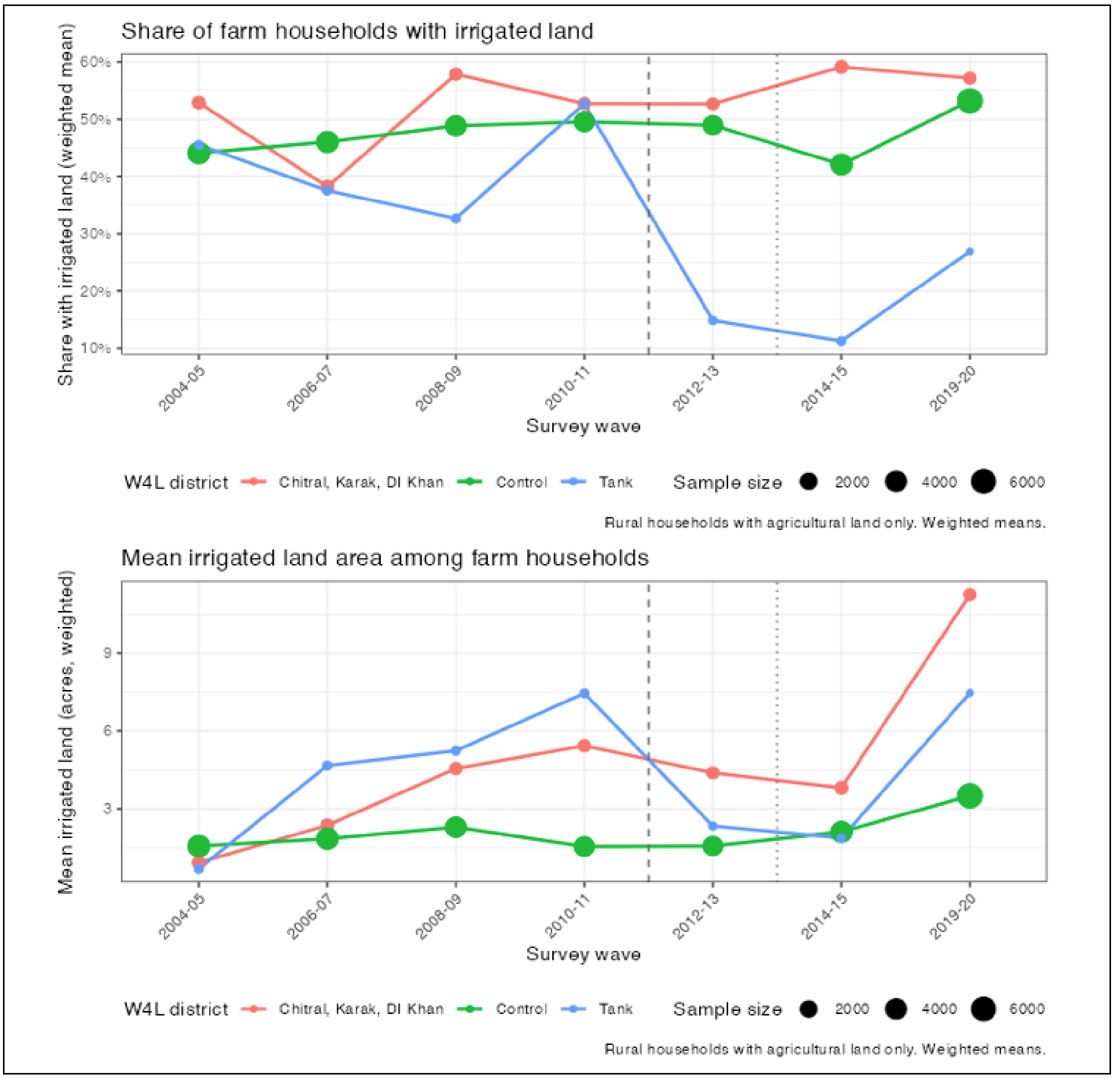
Table A4.4: Irrigation among treated and control group.

PSLM wave	Share of farmers using irrigation - control group	Share of farmers using irrigation - W4L group	Difference
2004-05	41.6%	54.4%	0.128
2006-07	45.9%	58.4%	0.125
2008-09	46.9%	59.7%	0.128
2010-11	49.5%	57.3%	0.078
2012-13	47.9%	60.8%	0.130
2014-15	37.1%	66.5%	0.293
2019-20	55.4%	62.8%	0.074

Table A4.5: Acres of irrigated land (conditional on irrigating).

PSLM wave	Irrigated acres - control group	Irrigated acres - W4L group	Difference
2004-05	3.57	1.77	-1.80
2006-07	4.56	4.21	-0.35
2008-09	4.10	5.24	1.14
2010-11	3.43	7.32	3.89
2012-13	4.64	8.97	4.32
2014-15	5.40	6.49	1.09
2019-20	5.99	13.62	7.63

Figure A4.3: Irrigation across survey waves.



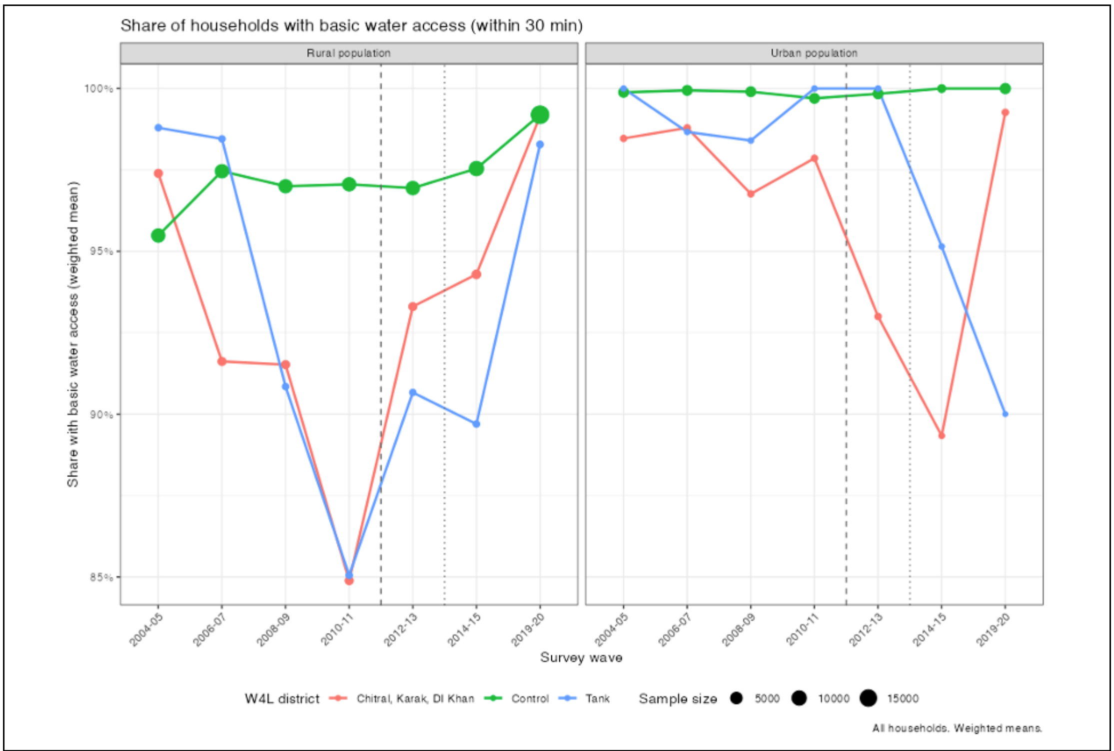
Time to water

Data in Table A4.6 and displayed in Figure A4.4 shed light on whether the time spent by households on fetching water has improved, comparing W4L and control group and sub-populations. What is evident is that rural households in the W4L districts were particularly affected by the 2010 floods, as a sizeable drop in improved access to water is seen, compared to the control group. However, both groups have recovered and are now on the same level as the control group. The same pattern is not witnessed among urban households (and the decrease in recent years may be a sampling error).

Table A4.6: Time spent on getting water.

PSLM wave	Share improved - control group	Share improved - W4L group	Difference
2004-05	97.9%	92.2%	-0.057
2006-07	96.1%	96.7%	0.005
2008-09	97.5%	91.7%	-0.058
2010-11	97.5%	87.8%	-0.098
2012-13	97.5%	93.3%	-0.042
2014-15	96.6%	94.8%	-0.018
2019-20	99.1%	99.1%	-0.001

Figure A4.4: Time to water.



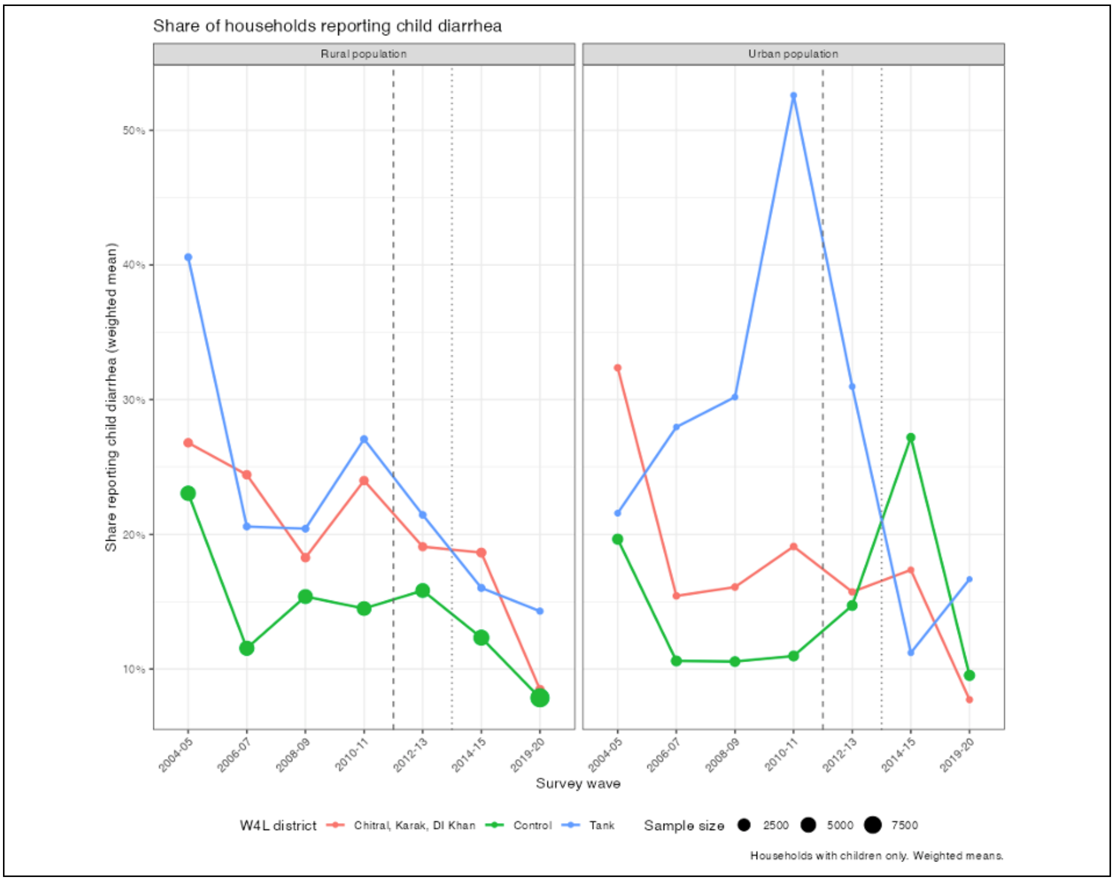
Childhood diarrhoea

Data in Table A4.7 and displayed in Figure A4.5 concern the prevalence of childhood diarrhoea, which however are only recorded for households with children under five. Note that the recall window is 30 days for waves 2004-05 through 2014-15 but 15 days in 2019-20. This asymmetry mechanically lowers prevalence in the final wave but does not bias the final DiD estimate because it affects treatment and control symmetrically. Across rural households, fewer children than in urban ones were reported to have experienced diarrhoea. It also reveals that the target group in the beginning were more exposed to diarrhoea than compared to the control group. Among urban households there was a similar decrease, but in this case it is characterised by sudden spikes in prevalence. Even if W4L improved access to water sources, a detectable effect on child diarrhoea at the district level would have required W4L to reach a sufficient share of households with children under five, and to improve not just access but also water quality.

Table A4.7: Prevalence of childhood diarrhoea, pooled.

PSLM wave	Children with diarrhoea - control group (%)	Children with diarrhoea - W4L group (%)	Difference
Improved water	13.4	14.0	0.007
Improved water	23	24.5	0.015
Improved water	11.6	15.9	0.043
Improved water	13	21.4	0.084
Improved water	15.4	15.9	0.005
Improved water	13.4	18.1	0.047
Improved water	8.4	7.2	-0.011

Figure A4.5: Prevalence of childhood diarrhoea.



A4.4 DiD analysis

Tables A4.8, A4.9 and A4.10 in the sections below present the headline estimates from each estimation strategy across all five outcomes. They make it possible to assess the statistical significance of the results, the parallel trends assumption, and if it confirmed, the causal effect of W4L. The simple DiD and the triple DDD analyses apply only to Chitral, DI Khan and Karak, due to the late inclusion of Tank. However, Tank is included in Callaway-Sant'Anna DiD estimation.

Simple DiD across outcomes

In most cases, the parallel trends assumption can be confirmed when looking at the pre-treatment coefficients. For improved water and time to water, the event time -3 coefficient is close to zero and insignificant, suggesting that treated and control districts were on similar trajectories in the years immediately before treatment.

However, the event time -1 coefficient for improved water is large and significant (−0.134***), which reflects the 2010 flood shock that disproportionately affected treated districts - this is a concern for the parallel trends assumption and a motivation for using the DDD specification. For child diarrhoea, the pre-treatment event time -1 coefficient is also significant (0.087*), indicating that treated districts were already experiencing rising diarrhoea prevalence before the programme, which undermines causal interpretation for this outcome.

Among the post-treatment coefficients, only the share of farmers using irrigation shows a momentary significant effect at event time +1 (0.122*), before the control group catches up again by event time +2. For improved water, time to water, and irrigated acres, no statistically significant post-treatment effect of W4L can be established. The overall picture is consistent with the programme's limited district-level reach: even if W4L improved outcomes for its direct beneficiaries, the effect is too diluted at the district level to be distinguishable from zero.

Table A4.8: Simple DiD (rural sample): event-time coefficients across outcomes.

	Improved water	Time to water	Irrigated land	Irrigated acres	Child diarrhoea
Event time -4	0.047 (0.048)	0.074* (0.027)	0.007 (0.042)	-3.074 (3.704)	-0.002 (0.034)
Event time -3	0.003 (0.050)	-0.007 (0.026)	-0.002 (0.042)	-0.941 (1.628)	0.043 (0.025)
Event time -1	-0.134*** (0.033)	-0.047 (0.043)	-0.067 (0.041)	2.888+ (1.494)	0.087* (0.040)
Event time +0	0.041 (0.132)	0.022 (0.035)	-0.033 (0.045)	3.412 (3.460)	-0.004 (0.039)
Event time +1	0.063 (0.079)	0.044 (0.027)	0.122* (0.050)	-0.728 (3.856)	0.026 (0.038)
Event time +2	0.006 (0.038)	0.063 (0.034)	-0.105 (0.073)	5.305 (3.506)	-0.012 (0.060)
N.	77,176	77,178	35,946	17,128	42,277
R^2	0.167	0.032	0.308	0.021	0.035

Notes. (a) + = p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. (b) Reference period: 2008-09. SEs clustered at district level. Sample: rural households only. Irrigation specifications additionally restrict to landholders (and irrigators for acres). (c) * = p<0.10, ** p<0.05, *** p<0.01. (c) N = number of observations.

Callaway-Sant'Anna staggered DiD across outcomes

Using the Callaway-Sant'Anna staggered DiD model, which now includes Tank as a separate treatment cohort, shows that it is not possible to confirm the parallel trends assumption in any of the investigated outcomes. Multiple pre-treatment coefficients are large and statistically significant - for example, improved water at event time -4 (0.104***) and event time -1 (−0.106***), and irrigated land at event time -4 (−0.162***). The implication is that treated and control districts were already diverging before W4L started, and the post-W4L coefficients may reflect a continuation of these pre-existing trends rather than an effect of W4L itself.

The overall average treatment effects for the treated subpopulation (ATTs) are positive and statistically significant for improved water (0.136***), time to water (0.084***), irrigated land (0.068***), and child diarrhoea (−0.063***), which are in the expected direction. However, because the parallel trends assumption is violated, these estimates cannot be credibly attributed to W4L. They may instead reflect the recovery trajectory of treated districts following the 2010 floods, or other district-specific trends unrelated to the programme. This motivates the triple DDD specification, which uses the rural-urban gap within districts as a third difference to absorb district-specific shocks.

Table A4.9: Callaway-Sant'Anna staggered DiD: event-study aggregations across outcomes.

	Improved water	Time to water	Irrigated land	Irrigated acres	Childhood diarrhoea
Event time -4	0.104*** (0.037)	-0.022** (0.010)	-0.162*** (0.054)	9.257*** (1.509)	-0.051 (0.045)
Event time -3	-0.067*** (0.018)	-0.079*** (0.009)	0.000 (0.024)	1.758** (0.729)	0.025 (0.021)
Event time -2	0.028 (0.017)	-0.000 (0.011)	0.014 (0.024)	1.096 (1.312)	-0.017 (0.018)
Event time -1	-0.106*** (0.018)	-0.036*** (0.011)	-0.093*** (0.025)	2.479 (2.466)	0.052*** (0.020)
Event time +0	0.090*** (0.019)	0.052*** (0.011)	0.043 (0.026)	0.101 (2.602)	-0.066*** (0.019)
Event time +1	0.158*** (0.018)	0.092*** (0.010)	0.186*** (0.025)	-1.056 (2.508)	-0.025 (0.019)
Event time +2	0.161*** (0.018)	0.108*** (0.010)	-0.024 (0.027)	3.812 (2.655)	-0.097*** (0.020)
Overall ATT	0.136*** (0.016)	0.084*** (0.009)	0.068*** (0.022)	0.952 (2.402)	-0.063*** (0.017)

Notes. (a) Callaway-Sant'Anna estimator with never-treated control group, doubly robust estimation, varying base period (g - 1). (b) Bootstrapped SEs in parentheses. Sample: rural households only (irrigation specifications additionally restricted to landholders/irrigators; diarrhoea restricted to households with children under five). (c) * p<0.10, ** p<0.05, *** p<0.01). (d) ATT = average treatment effects for the treated subpopulation.

Triple DDD across outcomes

The DDD specification is reported only for outcomes where the rural-urban contrast is possible to make: improved water, time to water, and childhood diarrhoea. Irrigation outcomes are excluded because filtering to landholders eliminates most urban observations and the third difference cannot be reliably identified. It is only when it comes to improved water that the parallel trends can be confirmed, and we see a statistically significant effect. This indicates that W4L caused the rural–urban gap in improved-water access in treated districts to close by roughly 18% in 2012-13, 39% in 2014-15, and 10% in 2019-20, relative to the gap in control districts and to the 2008-09 reference wave; aggregated as an event-study average, W4L closed the rural–urban gap by about 22% in treated districts. Robustness tests using a linear DDD model and bootstrapped standard errors pointed to a tentative finding that there was a positive impact on rural improved-water access during W4L implementation. This effect can be diluted, however, by urban households in W4L districts having reduced access to water in the studied period. A similar effect can be seen when it comes to time to water, but the parallel trends assumption cannot be confirmed. Thereby, we cannot say if this increase is caused by W4L.

Table A4.10: Triple DDD: event-study aggregations using rural-urban gap as third difference.

	Improved water	Time to water	Childhood diarrhoea
Event time -4	0.118*** (0.040)	0.085*** (0.019)	-0.092 (0.057)
Event time -3	0.014 (0.037)	0.002 (0.019)	-0.029 (0.051)
Event time -2	0.063 (0.038)	0.038* (0.022)	-0.052 (0.050)
Event time -1	— (ref.)	— (ref.)	— (ref.)
Event time +0	0.179*** (0.039)	0.074*** (0.022)	-0.021 (0.051)
Event time +1	0.386*** (0.054)	0.181*** (0.036)	0.095 (0.070)
Event time +2	0.102*** (0.034)	0.073*** (0.017)	-0.010 (0.048)
Overall ATT	0.222*** (0.034)	0.109*** (0.020)	0.021 (0.044)

Notes. (a) Triple difference estimator (Ortiz-Villavicencio & Sant'Anna 2025) using rural-urban gap within districts as third difference. (b) Universal base period (2008-09 / event time -2). Bootstrapped SEs in parentheses. Tank excluded due to thin urban cells. Diarrhoea sample restricted to households with children under five. (c) * p<0.10, ** p<0.05, *** p<0.01.

Annex 5: Analysis of remote sensing data

A5.1 Methodology for remote sensing data

Locating W4L intervention Union Councils

Appendix 8 of the External Review of Project Water for Livelihoods Phase 2 (Sarfraz et al., 2017) lists all irrigation infrastructure supported by W4L at the village level, and these were all manually geolocated at the Union Council (UC) level. The UCs are the smallest administrative unit in Pakistan and are therefore ideal to use when aggregating remote sensing GIS data. Three web-based tools were used to identify villages and their related UCs.[18]

Sources and kinds of remote sensing data

Having geolocated irrigation infrastructure, the analysis used spatial polygons for all UC and districts in Khyber Pakhtunkhwa province together with four publicly-available sets of remote-sensing data in 2004-23: MOD13Q1, MOD16A2GF, CHIRPS and LGRIP30.

Normalised Difference Vegetation Index (MOD13Q1). This Moderate Resolution Imaging Spectroradiometer (MODIS) product provides 16-day composites of the Normalised Difference Vegetation Index (NDVI) at 250 m spatial resolution. The NDVI index ranges from -1 to 1, where higher values indicate more denser and healthier vegetation, and lower values indicate stressed vegetation. NDVI is a widely used proxy for above-ground vegetation density and the general health of plants, i.e., greenness. Importantly, it can therefore be used as an indicator of improved agricultural productivity caused by, among others, improved irrigation[19]. However, it should be noted that the accuracy of the measure when detecting small scale fields is lower.

Evapotranspiration (MOD16A2GF). This MODIS product provides a composite measure of actual evapotranspiration[20] at 500 m resolution (accumulated to seasonal totals in mm). This responds directly to water availability and is used here as a complementary indicator to NDVI, capturing the water-flux dimension of agricultural activity rather than greenness alone. It therefore allows the analysis to capture the increased use of water in connection with increased irrigation.[21]

Rainfall - CHIRPS. The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) product provides daily precipitation estimates at approximately 5 km resolution, summed to seasonal totals. CHIRPS is included as a climate control in all regression specifications, recognising that NDVI and evapotranspiration both respond directly to precipitation. CHIRPS performs less reliably in mountainous terrain with sparse rain-gauge coverage, which affects estimates for Chitral in particular.

Cropland mask - LGRIP30. The Landsat-derived Global Rainfed and Irrigated-cropland Product (LGRIP30) provides a 30 m binary mask distinguishing irrigated cropland, rainfed cropland, and non-cropland for the year 2015. LGRIP30 is used both to mask NDVI and ET aggregations to cropland pixels only, and to compute polygon-level shares of any cropland, irrigated cropland, and rainfed cropland. Because LGRIP30 reflects a single reference year, it cannot capture changes in cropland extent over the analysis period.

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18 (1) https://earth.google.com; (2) https://jsims.com.pk/SchoolsData/Schools.aspx; and (3) https://tools.paintmaps.com/map-cropping/PK/4-1108692157/samples.

19 (a) Burke & Lobell (2017). (b) Ambika *et al*. (2016).

20 Evapotranspiration is the combined transfer of water from the land surface to the atmosphere through evaporation from soil and water surfaces and transpiration from vegetation, expressed as a depth of water (millimetres) over a given area and time period.

21 (a) Asoka & Mishra (2020). (b) Sun *et al*. (2026).

These data sets were accessed through the Google Earth Engine, and using UC and district polygons as units for aggregation, seasonal and annual mean values were calculated. To capture activities related to increased farming activity and thereby irrigation, two crop seasons [22] were chosen: *Rabi* (winter, November–April) and *Kharif* (summer/monsoon, May -October). [23] For both crop seasons and the annual one, two aggregate statistics were produced for each UC and district: a cropland-masked mean (averaging only over pixels classified as cropland by LGRIP30[24]) and a full-polygon mean covering the entire UC or district. Allowing the analysis to investigate crop-specific signals and UC-wide or district-wide changes.

A5.2 Descriptive analysis

Union Councils

Figures A5.1 and A5.2 show annual NDVI and evapotranspiration in fields in the UCs where W4L was active per crop season and annually. We see that the mean NDVI score in 2009 before the project began was 0.213, which increased to 0.272 in 2023 - a similar trend is also present for the mean evapotranspiration - indicating that crops have become slightly healthier and more water from crop fields is being emitted into the air. Overall, these are signs of increased irrigation.

Comparing these results with non-W4L UCs in the same districts, we firstly see in Figure A5.3 that W4L UCs are less cultivated (mean = 40.6%) than non-W4L UCs (mean = 53.1%). This is due to a low degree of cultivation in the targeted districts in Chitral, which have very small amounts of agriculture[25]. Figure A5.4 depicts the development in NDVI and evapotranspiration in both W4L targeted UCs and non-targeted UCs, which shows that non-targeted UCs from the beginning and throughout the studied period had both higher NDVI and ET values than targeted UCs. Which can be explained by non-targeted UCs are more cultivated. This also shows that W4L was active in water-scarce UCs that had and still have the lowest extent of irrigation.

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22 Raza (2026).

23 *Kharif* evapotranspiration values for Pakistan are unreliable because of persistent monsoon cloud cover, which affects the MOD16 gap-fill algorithm; these data are used as a robustness check rather than a primary outcome.

24 Twenty-five UCs, concentrated in urban Peshawar and the Kohistan mountains, contain no LGRIP30 cropland pixels and are excluded from cropland-masked analyses. None of these are in W4L districts. A small additional set of UC–year cells is missing for evapotranspiration only, due to MOD16's vegetation-density screening.

25 This difference in cropland share also means that the cropland-masked NDVI and evapotranspiration aggregations for treated UCs are averaging over fewer pixels, which increases measurement noise and makes effect detection harder. Therefore, the analysis also conducts an entire analysis of NDVI and evapotranspiration, which is not restricted to cropland areas.

Figure A5.1: Mean NDVI distribution in cropland by year and season (W4L UCs).

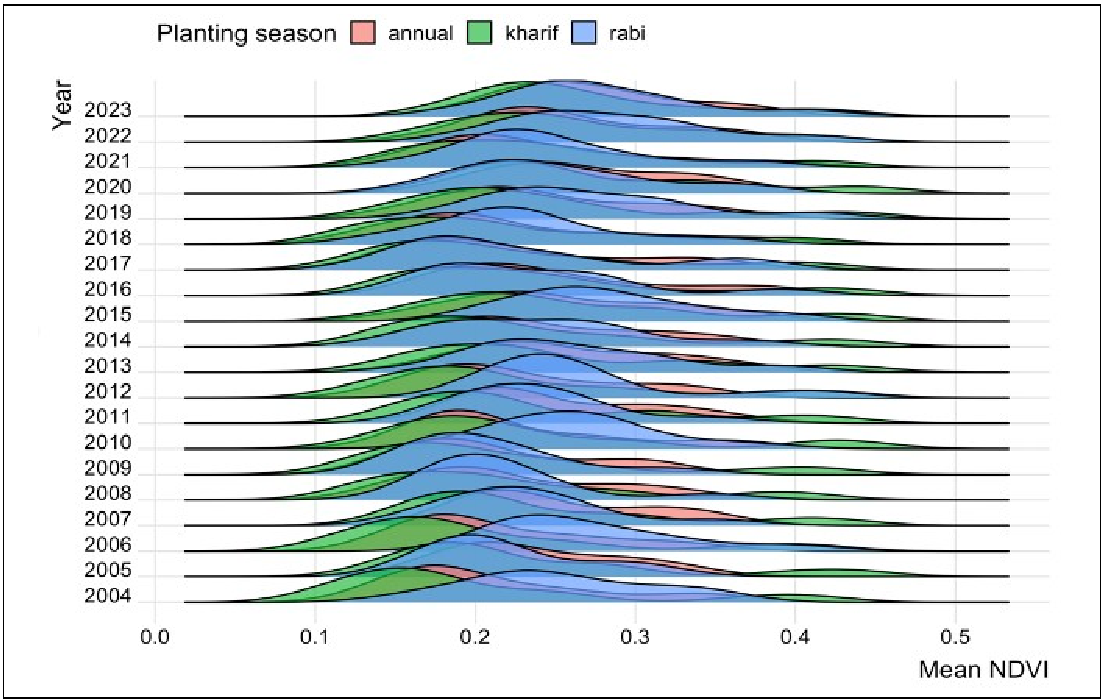


Figure A5.2: Mean evapotranspiration in cropland by year and season (W4L UCs).

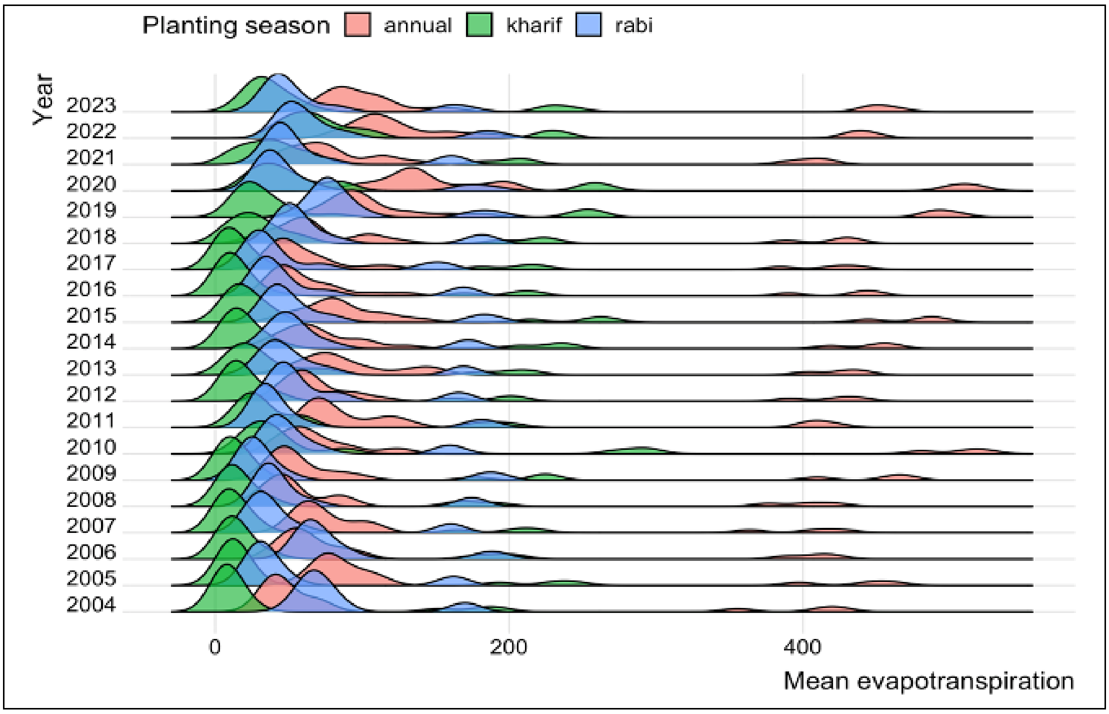


Figure A11.3: Cropland share density (W4L vs non-W4L UCs).

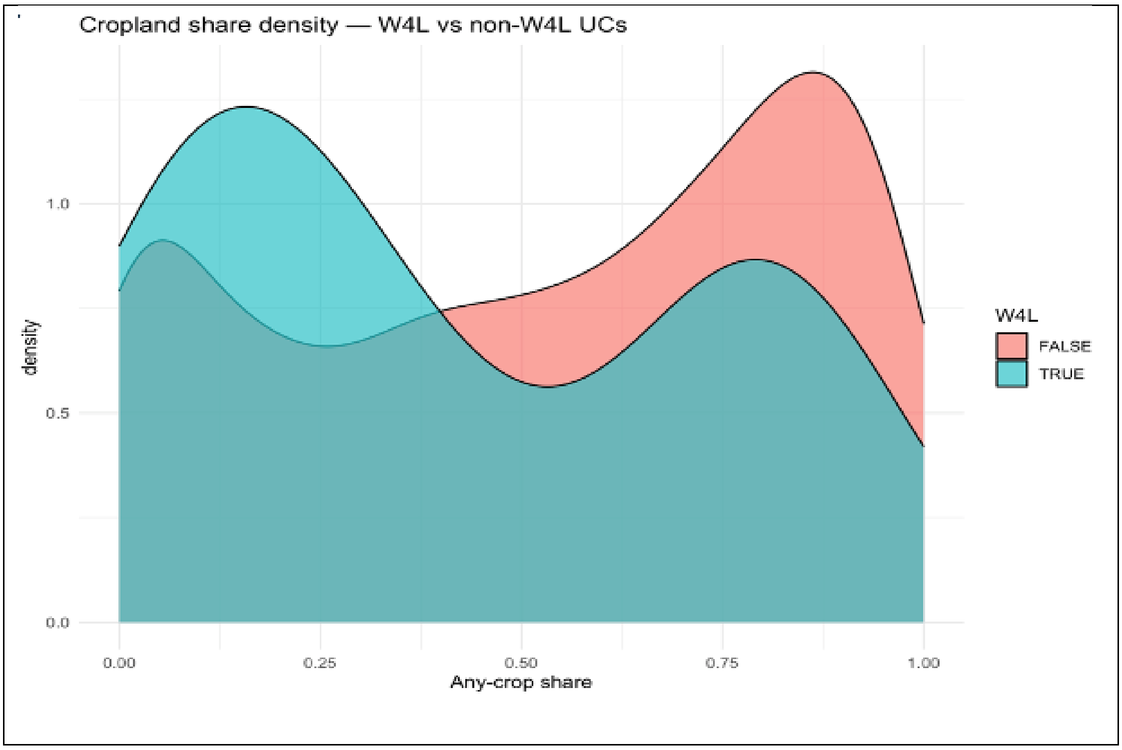
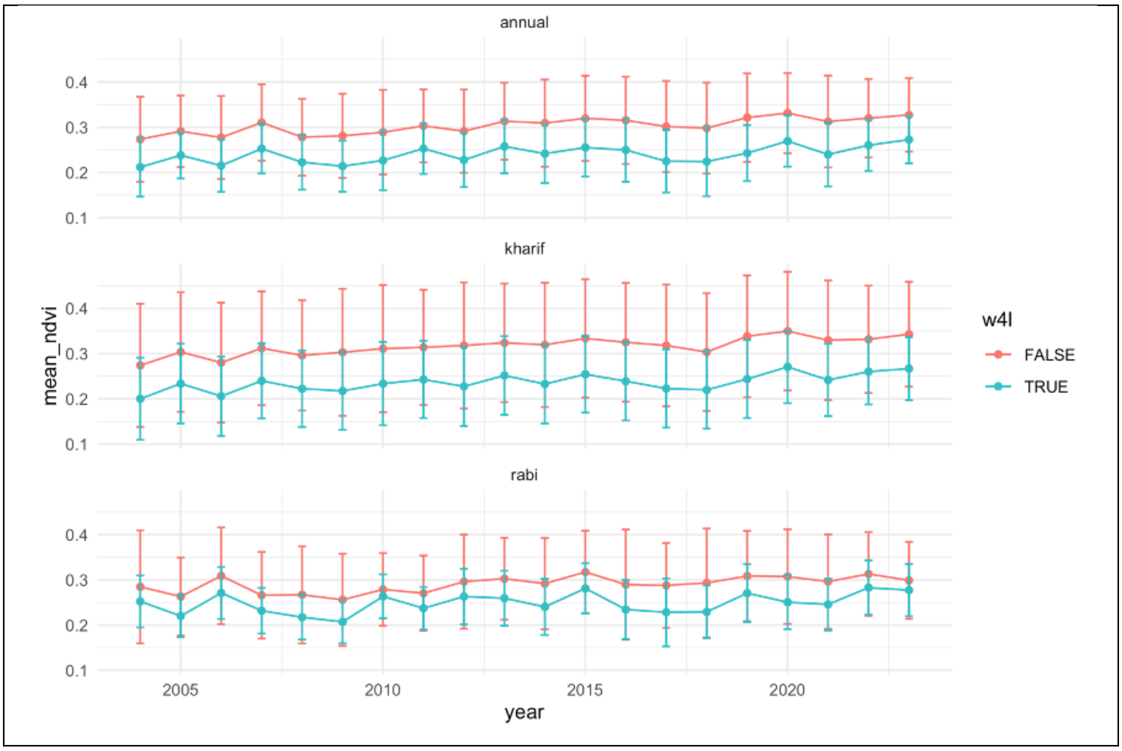


Figure A11.4: UC-level cropland NDVI by season and year (Chitral, Karak, DI Khan and Tank).



Districts

Rather than comparing within-district UCs, this next phase of analysis treats each W4L district as one unit of analysis, exposing district-level characteristics. Figures A5.5 and A5.6 display the annual NDVI and evapotranspiration in crop fields in the four W4L districts of Chitral, Karak, DI Kahn, and Tank, for each crop season and also annually. Before the start of W4L, the mean NDVI in 2009 was 0.246, which increased to 0.293 in 2023. A similar increase is seen for evapotranspiration, which increased from 155 mm in 2009 to 185 mm in 2023. These changes are consistent with the logical expectation that cropland plants would become healthier and emit more water with increased irrigation.

The share of land used for agriculture is similar in W4L and non-W4L districts in KP Province (Figure A5.7): 40% (standard deviation = 0.2) and 42% (standard deviation = 0.3) respectively. This makes them comparable when it comes to agricultural exposure. Figure A5.8 displays mean levels of NDVI and evapotranspiration across different crop seasons and annually for W4L and non-W4L districts in KP Province. It can be seen that non-W4L districts had a higher level of NDVI and evapotranspiration in both the first and last year of the examined period. Notably, both groups seem to follow a similar trajectory, indicating province-wide common shocks.

Figure A5.5: Mean NDVI in cropland by year and season (W4L districts).

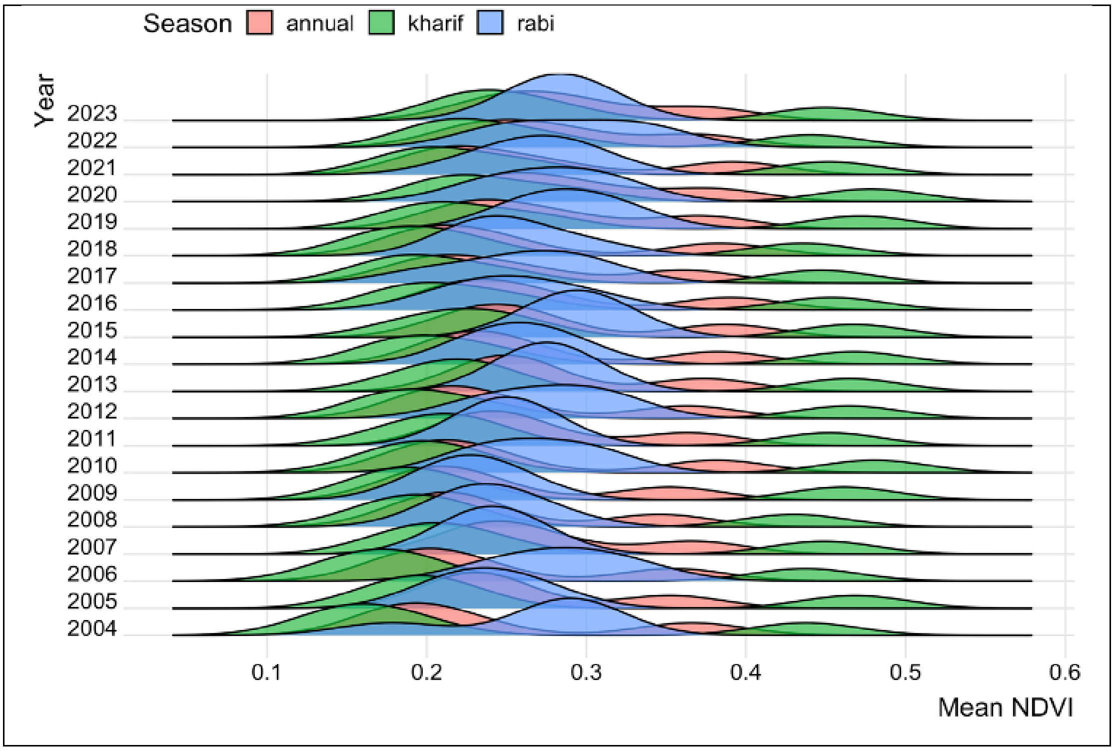


Figure A5.6: Mean evapotranspiration in cropland by year and season (W4L districts).

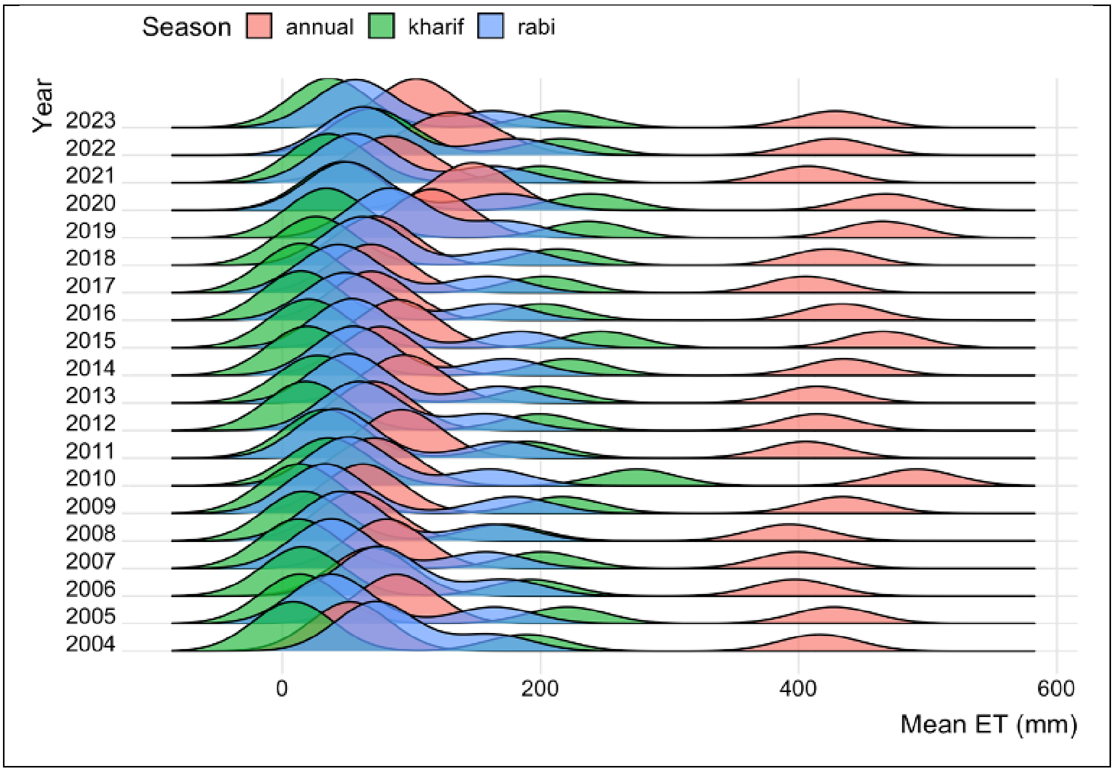


Figure A5.7: Cropland share density (W4L vs non-W4L districts).

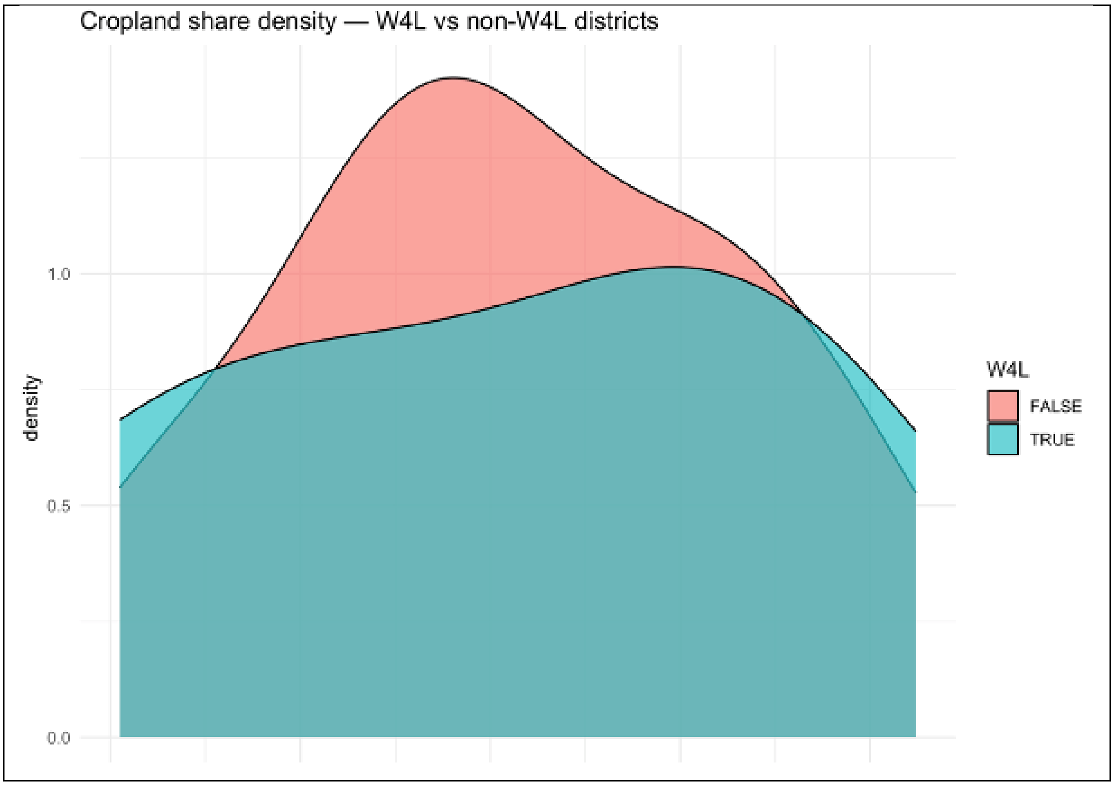
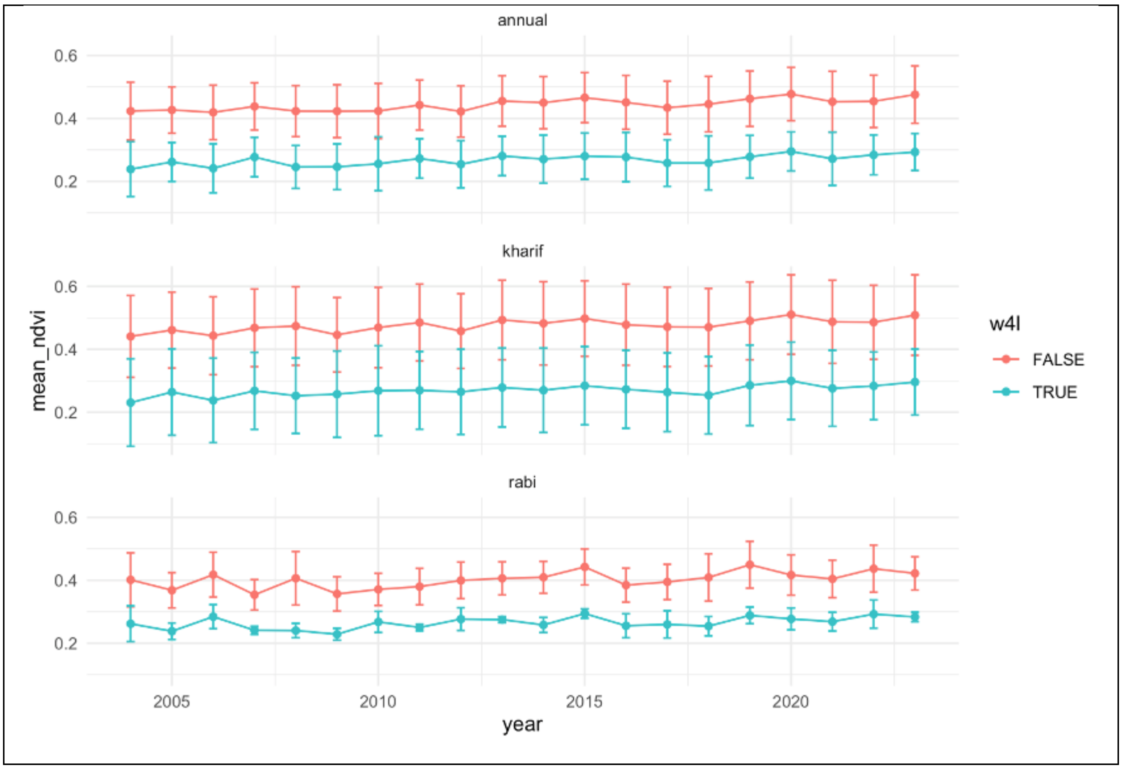


Figure A5.8: District-level cropland NDVI by season and year (W4L vs non-W4L districts).



A5.3 Difference-in-Difference analysis

Hypotheses tested

To test the hypothesis that irrigation facilities supported by W4L would cause an increase in NDVI or evapotranspiration, two groups or data are compared. Tables A5.1 to A5.4 show the result of comparing difference-in-difference (DiD) models for UCs within W4L districts per season, and whether this only applies to identified crop fields or to the whole UC. Tables A5.5 to A5.8 are similar, but show the result of DiD models on the district level, comparing W4L districts and non-W4L districts in KP Province.

In this analysis, 2014 is used only as a reference in order to prevent multi-colinearity when running the model, and the data from that year are therefore excluded. It was chosen as it falls two years before the completion of W4L irrigation infrastructure in 2016, allowing for clear pre- and post-treatment windows. It should be noted that the household analysis takes the 2008-09 PSLM data as its reference and defines treatment onset as beginning with the 2012-13 wave (Annex 4). This difference reflects the distinct logic of each analysis: the household analysis captures the start of W4L activities, while the GIS analysis focuses on the completion of all physical infrastructure, after which changes in vegetation and water use would become detectable by satellite. As a robustness test the statistical analysis was also conducted using the same specification as the household analysis.

The pre-treatment coefficients (γ_τ for years 2004-15) test whether treated and control units were on similar trajectories before W4L infrastructure was completed. If these coefficients are close to zero and statistically insignificant, this supports the parallel trends assumption, that ensures that post-treatment divergence can be attributed to the programme rather than pre-existing differences. The post-treatment coefficients (δ_τ for years 2016-23) estimate the dynamic treatment effects. A positive and significant post-treatment coefficient would indicate that W4L UCs or districts experienced higher NDVI or evapotranspiration relative to the control group after infrastructure completion. Rainfall (CHIRPS) is included as a time-varying control to absorb the direct effect of precipitation on vegetation and evapotranspiration[26].

[26] Cunningham (2021).

Standard errors are clustered at the district level. As treated UCs fall within only four districts, the number of clusters is small, which may lead to over-rejection of the null hypothesis. The results should therefore be interpreted with this caveat in mind.

The UC model

$$Y_{ut} = \gamma_u + \lambda_t + \sum_{\tau=-q}^{-1} \gamma_\tau D_{u\tau} + \sum_{\tau=0}^{m} \delta_\tau D_{u\tau} + \beta_1 x_{ut} + \epsilon_{ut}$$

The district model

$$Y_{dt} = \gamma_d + \lambda_t + \sum_{\tau=-q}^{-1} \gamma_\tau D_{d\tau} + \sum_{\tau=0}^{m} \delta_\tau D_{d\tau} + \beta_1 x_{dt} + \epsilon_{dt}$$

- $\boldsymbol{Y_{ut}}$ **OR** $\boldsymbol{Y_{st}}$: The outcome of interest (cropland/total NDVI or ET) for UC *u* or district *d* in year *t*.
- $\boldsymbol{\gamma_u}$ **OR** $\boldsymbol{\gamma_d}$: UC or district fixed effect, absorbing all time-invariant differences across UCs (geography, baseline agro-ecology, soil type).
- $\boldsymbol{\lambda_t}$: Year fixed effect, absorbing shocks common to all UCs and districts in a given year (national weather patterns, KP Province-wide policy changes, regional climate events).
- $\boldsymbol{D_{u\tau}}$: An event-time indicator equal to 1 when *u* OR *d* is τ years away from W4L finished water infrastructure in 2016, and 0 otherwise. Event time is measured relative to each UC's treatment year (2016 for all treated UCs; $D_{u\tau}$ is always 0 for control UCs).
- $\boldsymbol{\gamma_\tau}$ **(for τ = −q, …, −1)**: Estimated coefficients on pre-treatment year leads. They measure whether treated UCs or districts differed from controls in the years *before* W4L treatment.
- $\boldsymbol{\delta_\tau}$ **(for τ = 0, …, m)**: Estimated coefficients on the post-treatment lags. These are the dynamic treatment effects: the W4L impact at the year of treatment (τ = 0), one year after, two years after, and so on.
- $\boldsymbol{\gamma_\tau}$ and $\boldsymbol{\delta_\tau}$ coefficients are interpreted as differences relative to the reference period.
- $\boldsymbol{x_{ut}}$ **Or** $\boldsymbol{x_{dt}}$: Time-varying control variables (rainfall in millimetres from CHIRPS).
- $\boldsymbol{\beta_1}$: coefficient on the rainfall control
- $\boldsymbol{\epsilon_{ut}}$ **Or** $\boldsymbol{\epsilon_{dt}}$: Error term, capturing unobserved variation. In both models standard errors are clustered at the district level.

Results at Union Council level

Tables A5.1 to A5.4 present all four UC-level specifications, showing that the pre-treatment coefficients are largely insignificant, supporting the parallel trends assumption. The few coefficients that reach marginal significance ($p < 0.1$) are scattered across seasons and years without an apparent pattern.

However, the post-treatment coefficients (2016 onwards) also show no consistent positive effect of W4L on either NDVI or evapotranspiration. For NDVI, some post-treatment coefficients are positive (e.g., *Rabi* 2023 in Table A5.1: +0.030, $p < 0.1$) while others are negative (e.g., Annual 2019 in Table A5.2: −0.010, $p < 0.05$). For evapotranspiration, the post-treatment coefficients are uniformly insignificant at the UC level. The R^2, which measure the model's explanatory power, are very low across all specifications (0.02–0.06), indicating that the year × W4L interactions explain very little of the within-UC variation. This implies that year-to-year changes in NDVI and evapotranspiration within these UCs are dominated by factors other than W4L, such as weather variability and broader agricultural trends.

This null finding is consistent with either of two similar interpretations: that W4L had no UC-wide impact, or that the localised improvements in W4L villages were too small to be detected. The robustness test confirms the above findings.

Table A5.1: NDVI (cropland only).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	0.020	0.007	0.014+	0.016*	0.001	0.002	0.035	0.016	0.021+	0.009	0.015	-0.002	-0.008	-0.012	0.015+	-0.006	0.001	0.020	0.030+	-0.000*
Std. err.	(0.013)	(0.012)	(0.006)	(0.005)	(0.005)	(0.004)	(0.016)	(0.008)	(0.007)	(0.005)	(0.010)	(0.013)	(0.008)	(0.019)	(0.006)	(0.004)	(0.004)	(0.015)	(0.009)	(0.000)
Kharif	0.012	0.016	0.011	0.013	0.011	0.000	0.007	0.013	-0.004+	0.013*	0.006+	-0.001	-0.011	0.001	-0.009	0.007	-0.003	0.015*	0.010	0.000**
Std. err.	(0.011)	(0.011)	(0.012)	(0.007)	(0.007)	(0.009)	(0.015)	(0.006)	(0.002)	(0.004)	(0.002)	(0.008)	(0.005)	(0.002)	(0.009)	(0.003)	(0.004)	(0.004)	(0.005)	(0.000)
Annual	0.006	0.014	0.005	0.009	0.012	0.000	0.005	0.017	0.004	0.011**	0.003	0.002	-0.010	-0.008	-0.011*	0.005	-0.006	0.008+	0.013	0.000
Std. err.	(0.009)	(0.008)	(0.008)	(0.007)	(0.007)	(0.004)	(0.011)	(0.007)	(0.002)	(0.002)	(0.002)	(0.006)	(0.007)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)	(0.000)

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: UC	FE: year
Rabi	2000	0.903	0.896	0.038	0.027	-8111.1	-7355.0	0.03	X	X
Kharif	2000	0.976	0.975	0.030	0.019	-9772.2	-9016.1	0.02	X	X
Annual	2000	0.961	0.958	0.032	0.021	-10151.1	-9395.0	0.02	X	X

Table A5.2: NDVI (whole UC).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	-0.002	0.000	0.002	0.003	-0.006	-0.007	0.023	0.012	0.011	0.010+	0.016+	-0.010+	-0.008	-0.016	0.010	-0.000	0.000	0.021	0.024	-0.000
Std. err.	*(0.002)*	*(0.013)*	*(0.008)*	*(0.009)*	*(0.004)*	*(0.006)*	*(0.021)*	*(0.011)*	*(0.006)*	*(0.004)*	*(0.007)*	*(0.004)*	*(0.008)*	*(0.013)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.015)*	*(0.011)*	*(0.000)*
Kharif	-0.000	0.010	-0.000	0.003	0.001	-0.003	0.004	0.009	-0.006+	0.012+	0.007	-0.003	-0.014*	-0.005	-0.006	0.011*	-0.001	0.012*	0.010+	0.000
Std. err.	*(0.012)*	*(0.011)*	*(0.015)*	*(0.008)*	*(0.006)*	*(0.008)*	*(0.013)*	*(0.007)*	*(0.002)*	*(0.004)*	*(0.003)*	*(0.003)*	*(0.005)*	*(0.002)*	*(0.009)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.004)*	*(0.000)*
Annual	-0.004	0.002	-0.004	-0.001	0.001	-0.005	-0.001	0.010	-0.001	0.008+	0.004	-0.001	-0.016*	-0.010*	-0.010*	0.006+	-0.004	0.008+	0.013	0.000
Std. err.	*(0.010)*	*(0.008)*	*(0.010)*	*(0.008)*	*(0.008)*	*(0.005)*	*(0.012)*	*(0.008)*	*(0.004)*	*(0.003)*	*(0.003)*	*(0.004)*	*(0.003)*	*(0.003)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.007)*	*(0.000)*

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: UC	FE: year
Rabi	2000	0.961	0.958	0.037	0.027	-8962.2	-8206.1	0.02	X	X
Kharif	2000	0.966	0.964	0.028	0.018	-10345.7	-9589.5	0.02	X	X
Annual	2000	0.975	0.973	0.036	0.026	-10717.2	-9961.1	0.02	X	X

Table A5.3: Evapotranspiration (cropland only).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	8.616	-1.488	6.741	4.756	3.706	0.637	3.344	5.298	3.302	0.814	-1.095	-3.493	-5.083	-1.584	7.485	-3.236	-1.252	4.263	-1.937	0.046*
Std. err.	(3.865)	(3.170)	(5.155)	(3.318)	(3.694)	(4.529)	(2.491)	(4.154)	(3.712)	(1.438)	(3.904)	(2.822)	(2.865)	(3.905)	(3.859)	(2.354)	(1.222)	(4.960)	(2.344)	(0.010)
Kharif	1.854	0.791	0.971	0.831	5.079	-1.763	-1.886	-1.357	-1.637	2.669	-3.298	-1.585	-1.463	-2.200	-4.277	1.908	-0.201	-0.753	2.344	0.044*
Std. err.	(5.503)	(5.554)	(2.377)	(2.311)	(4.164)	(4.924)	(8.365)	(7.208)	(4.163)	(3.905)	(7.853)	(2.639)	(2.196)	(4.341)	(4.928)	(7.156)	(8.086)	(12.964)	(5.984)	(0.011)
Annual	-3.001	7.738	3.479	4.319	7.717	3.201	-2.950	-0.494	5.176	3.250	-1.149	-5.404	-5.723*	-8.874	-3.213	10.387	-8.996	-1.162	8.512	0.056
Std. err.	(10.653)	(4.971)	(6.650)	(2.166)	(4.648)	(4.003)	(15.038)	(7.241)	(3.066)	(3.663)	(5.741)	(8.284)	(1.405)	(6.761)	(7.665)	(11.775)	(10.121)	(11.969)	(7.669)	(0.025)

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: UC	FE: year
Rabi	2000	0.973	0.971	0.059	0.049	14424.8	15180.9	8.33	X	X
Kharif	2000	0.971	0.968	0.024	0.013	16338.0	17094.2	13.44	X	X
Annual	2000	0.985	0.984	0.043	0.033	17413.9	18170.0	17.58	X	X

Table A5.4: Evapotranspiration (whole UC).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	7.175	-2.737	4.445	2.250	1.821	-0.266	2.574	4.877	1.438	-0.007	-0.592	-4.263+	-6.381	-1.727	7.074	-2.942	-2.621	4.122	-2.539	0.042*
Std. err.	*(3.300)*	*(3.337)*	*(4.280)*	*(3.394)*	*(2.198)*	*(4.236)*	*(2.115)*	*(3.703)*	*(2.707)*	*(1.430)*	*(3.897)*	*(1.790)*	*(4.176)*	*(3.425)*	*(3.546)*	*(1.902)*	*(1.804)*	*(5.091)*	*(1.847)*	*(0.013)*
Kharif	-0.432	-1.709	1.050	0.004	6.285	-5.072	-6.113	2.068	-3.760	4.848	-5.584	-2.445	-2.683	-2.116	-3.978	3.389	2.441	2.100	4.214	0.041*
Std. err.	*(5.201)*	*(6.273)*	*(2.604)*	*(1.470)*	*(6.525)*	*(6.816)*	*(11.870)*	*(9.239)*	*(4.395)*	*(4.913)*	*(10.058)*	*(3.029)*	*(2.610)*	*(3.270)*	*(3.996)*	*(5.261)*	*(7.949)*	*(11.564)*	*(5.380)*	*(0.012)*
Annual	-7.290	4.180	2.038	1.198	5.807	-1.574	-7.877	3.608	1.797	4.126	-2.970	-7.128	-7.583*	-9.503	-2.075	11.708	-6.284	1.316	9.770	0.053
Std. err.	*(11.355)*	*(5.024)*	*(5.473)*	*(0.912)*	*(3.445)*	*(5.065)*	*(18.568)*	*(10.079)*	*(4.077)*	*(4.079)*	*(8.253)*	*(9.868)*	*(2.330)*	*(6.428)*	*(6.190)*	*(9.038)*	*(9.204)*	*(9.847)*	*(6.364)*	*(0.024)*

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: UC	FE: year
Rabi	2000	0.979	0.978	0.057	0.046	14208.4	14964.5	7.89	X	X
Kharif	2000	0.965	0.963	0.023	0.012	16766.4	17522.5	14.96	X	X
Annual	2000	0.986	0.985	0.040	0.029	17565.7	18321.8	18.27	X	X

Results at district level

Tables A5.5 and A5.6 show NDVI results at district level, revealing a mixed picture. Several pre-treatment *Rabi* coefficients are significant (e.g., 2005, 2007, 2009, 2010 in Table A5.5), which raises concerns about the parallel trends assumption for that season. In the *Kharif* and Annual specifications, the pre-treatment coefficients are more stable but still show occasional significance. The post-treatment NDVI coefficients are uniformly small and insignificant across all seasons. This does not support a detectable effect of W4L on vegetation greenness at the district level.

The evapotranspiration results in Tables A5.7 and A5.8 are more complex. The pre-treatment coefficients for the *Kharif* season show large, highly significant values in multiple years (e.g., 2004: +42.97***, 2005: +28.76***, 2009: +28.38*** in Table A5.7). This constitutes a clear violation of the parallel trends assumption for the *Kharif* evapotranspiration specification, meaning the post-treatment coefficients cannot be interpreted causally. The Rabi evapotranspiration specification shows fewer pre-treatment concerns.

Notably, the post-treatment *Kharif* and Annual evapotranspiration coefficients turn large and significantly negative in later years (e.g., 2019: −40.23***, 2020: −34.31***, 2023: −53.55*** in Table A5.7). This pattern is difficult to reconcile with a positive W4L irrigation effect. Several explanations are possible. First, as noted above (footnote 20) *Kharif* evapotranspiration values are unreliable due to monsoon cloud cover affecting the MOD16 gap-fill algorithm, and these results should be treated as a robustness check rather than a primary finding. Second, the 2022 Pakistan floods, which caused widespread destruction across KP Province, may have disrupted agricultural activity and damaged irrigation infrastructure in treated districts, depressing evapotranspiration values in 2022 and 2023. And third, it is possible that broader climate or groundwater trends are driving differential changes between the treated and control groups that have nothing to do with W4L.

Given the pre-trend violations, the *Kharif* and Annual evapotranspiration specifications cannot support causal claims. The robustness test confirms the above findings.

Table A5.5: NDVI (cropland only).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	0.011	0.021***	0.017	0.039**	-0.015	0.023**	0.048*	0.022*	0.029	0.020*	0.003	0.022	0.017	-0.004	-0.010	0.012	0.015	0.007	0.013	-0.000
Std. err.	(0.037)	(0.005)	(0.025)	(0.013)	(0.018)	(0.008)	(0.019)	(0.008)	(0.024)	(0.008)	(0.006)	(0.016)	(0.011)	(0.018)	(0.018)	(0.009)	(0.011)	(0.021)	(0.013)	(0.000)
Kharif	-0.001	0.011+	0.006	0.008	-0.010	0.017**	0.009	-0.006	0.013*	-0.001	-0.001	0.003	0.004	0.000	0.002	0.001	0.001	0.004	-0.000	0.000***
Std. err.	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)	(0.007)	(0.009)	(0.008)	(0.007)	(0.012)	(0.014)	(0.000)
Annual	-0.005	0.015+	0.002	0.019*	0.003	0.003	0.012*	0.010	0.011**	0.005	-0.005	0.005	0.005	-0.006	-0.005	-0.001	-0.001	0.008	-0.004	0.000+
Std. err.	(0.006)	(0.008)	(0.003)	(0.008)	(0.005)	(0.005)	(0.005)	(0.007)	(0.003)	(0.007)	(0.003)	(0.004)	(0.008)	(0.006)	(0.009)	(0.010)	(0.007)	(0.011)	(0.012)	(0.000)

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: DISTRICT	FE: year
Rabi	520	0.934	0.925	0.063	0.022	-2435.6	-2159.1	0.02	X	X
Kharif	520	0.995	0.994	0.124	0.086	-3140.8	-2864.3	0.01	X	X
Annual	520	0.988	0.987	0.056	0.015	-3067.6	-2791.1	0.01	X	X

Table A5.6: NDVI (whole UC).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	0.020	0.020**	0.019	0.034***	-0.003	0.021***	0.042***	0.025***	0.037*	0.019*	0.001	0.026**	0.009	0.008	-0.002	0.009	0.016*	0.017	0.012+	-0.000
Std. err.	*(0.015)*	*(0.006)*	*(0.014)*	*(0.006)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*	*(0.015)*	*(0.008)*	*(0.010)*	*(0.008)*	*(0.010)*	*(0.009)*	*(0.018)*	*(0.009)*	*(0.007)*	*(0.019)*	*(0.007)*	*(0.000)*
Kharif	-0.004	0.009*	0.007	0.007+	-0.005	0.012*	0.002	-0.001	0.013*	0.001	-0.001	0.005	0.002	-0.002	0.002	0.001	0.002	0.006	0.002	0.000**
Std. err.	*(0.010)*	*(0.004)*	*(0.010)*	*(0.004)*	*(0.005)*	*(0.005)*	*(0.005)*	*(0.005)*	*(0.006)*	*(0.006)*	*(0.007)*	*(0.004)*	*(0.007)*	*(0.006)*	*(0.009)*	*(0.009)*	*(0.004)*	*(0.007)*	*(0.009)*	*(0.000)*
Annual	-0.008	0.015***	0.005	0.014**	0.004	0.005	0.005	0.011***	0.013*	0.007	-0.005	0.001	0.005	-0.010	-0.001	0.001	-0.004	0.008	-0.000	0.000
Std. err.	*(0.009)*	*(0.004)*	*(0.007)*	*(0.005)*	*(0.005)*	*(0.004)*	*(0.008)*	*(0.003)*	*(0.005)*	*(0.004)*	*(0.005)*	*(0.005)*	*(0.008)*	*(0.007)*	*(0.008)*	*(0.010)*	*(0.006)*	*(0.008)*	*(0.009)*	*(0.000)*

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: DISTRICT	FE: year
Rabi	520	0.974	0.971	0.059	0.017	-2516.0	-2239.5	0.02	X	X
Kharif	520	0.993	0.992	0.055	0.013	-3021.1	-2744.6	0.01	X	X
Annual	520	0.990	0.989	0.043	0.001	-3002.1	-2725.6	0.01	X	X

Table A5.7: Evapotranspiration (cropland only).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	-3.233	-4.054+	-0.790	-0.045	-6.889***	-2.312	2.040	-2.031	2.616	1.525	-2.069	-3.009	4.123	-0.386	-9.019	-4.663	-3.145	-5.273	4.117	0.035***
Std. err.	*(6.664)*	*(2.312)*	*(5.247)*	*(2.002)*	*(1.447)*	*(6.302)*	*(2.937)*	*(4.417)*	*(4.456)*	*(1.137)*	*(3.054)*	*(3.592)*	*(3.052)*	*(2.380)*	*(5.741)*	*(3.223)*	*(3.066)*	*(3.717)*	*(3.885)*	*(0.007)*
Kharif	42.971***	28.763***	8.778	20.302***	-0.496	28.380***	-5.159	-11.887	31.079***	-16.460*	2.267	11.400*	3.955	-4.282	-40.226***	-34.309***	-15.515	-14.706	-53.553***	0.044**
Std. err.	*(8.426)*	*(4.934)*	*(7.051)*	*(4.154)*	*(10.171)*	*(7.231)*	*(11.196)*	*(10.550)*	*(8.122)*	*(6.947)*	*(7.102)*	*(4.242)*	*(4.118)*	*(6.097)*	*(5.860)*	*(5.855)*	*(9.286)*	*(14.242)*	*(7.723)*	*(0.014)*
Annual	48.937***	37.124***	1.373	23.802*	1.242	24.724***	-1.078	-9.018	32.852***	-11.096	-1.930	15.848**	0.892	-2.836	-41.040***	-45.518***	-16.115	-10.509	-58.168***	0.018
Std. err.	*(5.891)*	*(7.705)*	*(8.782)*	*(10.493)*	*(6.334)*	*(6.505)*	*(14.887)*	*(12.179)*	*(5.970)*	*(9.466)*	*(5.153)*	*(4.309)*	*(7.285)*	*(6.181)*	*(6.913)*	*(10.400)*	*(10.331)*	*(18.063)*	*(11.418)*	*(0.011)*

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: DISTRICT	FE: year
Rabi	520	0.969	0.964	0.104	0.064	3435.0	3711.5	5.81	X	X
Kharif	520	0.984	0.981	0.288	0.257	4408.6	4685.1	14.81	X	X
Annual	520	0.988	0.987	0.262	0.229	4509.9	4786.4	16.32	X	X

Table A5.8: Evapotranspiration (whole UC).

*Each season has two rows: the bold row gives the estimate; the row labelled "Std. err." gives the standard error in parentheses. Shaded columns (2016 onwards) correspond to the years following completion of W4L irrigation infrastructure. Significance: + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Coefficients (year × W4L interactions and rain control)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	2020	2021	2022	2023	rain_mm
Rabi	-2.402	-3.438	0.013	0.041	-4.839**	-2.777	1.874	-2.459	1.450	-0.311	-2.495	-0.710	4.460	-0.505	-6.632	-4.039	-2.619	-4.738	2.872	0.032***
Std. err.	*(6.663)*	*(2.343)*	*(4.251)*	*(1.534)*	*(1.319)*	*(6.433)*	*(2.327)*	*(4.001)*	*(4.200)*	*(1.057)*	*(4.092)*	*(3.232)*	*(2.898)*	*(2.261)*	*(5.076)*	*(3.161)*	*(2.416)*	*(4.070)*	*(3.259)*	*(0.008)*
Kharif	36.329***	24.050***	5.590	19.285**	0.606	24.014**	-6.842	-10.906	26.682**	-12.570	3.104	10.258*	3.235	-4.586	-38.874***	-32.729***	-12.834	-16.170	-49.632***	0.059***
Std. err.	*(8.009)*	*(4.644)*	*(7.137)*	*(5.628)*	*(11.459)*	*(6.766)*	*(15.337)*	*(12.816)*	*(7.502)*	*(9.348)*	*(9.398)*	*(4.359)*	*(4.744)*	*(5.149)*	*(7.320)*	*(5.971)*	*(9.548)*	*(12.026)*	*(7.059)*	*(0.012)*
Annual	42.781***	34.400***	3.627	27.137*	3.759	26.290***	-1.047	-5.675	31.762***	-8.013	3.119	17.390***	5.697	-1.916	-35.621***	-37.416***	-11.842	-10.112	-51.850***	0.027*
Std. err.	*(6.060)*	*(8.121)*	*(9.111)*	*(12.352)*	*(7.821)*	*(6.696)*	*(18.936)*	*(14.807)*	*(5.951)*	*(10.909)*	*(7.089)*	*(4.599)*	*(6.955)*	*(4.873)*	*(6.432)*	*(9.624)*	*(9.373)*	*(15.261)*	*(9.186)*	*(0.012)*

Model statistics

	Num.Obs.	R2	R2 Adj.	R2 Within	R2 Within Adj.	AIC	BIC	RMSE	FE: DISTRICT	FE: year
Rabi	520	0.981	0.979	0.083	0.042	3398.3	3674.8	5.61	X	X
Kharif	520	0.982	0.980	0.264	0.232	4421.7	4698.2	15.00	X	X
Annual	520	0.989	0.987	0.224	0.190	4530.0	4806.5	16.64	X	X

Annex 6: Contribution stories

A6.1 Water for Empowerment in the Arandu Valley of Chitral

Godibar in the Arandu Valley of Lower Chitral was once a place where women and girls had to make multiple trips each day over difficult terrain to fetch river water. Hard physical labour and personal safety had always been an issue for women as a result. And the water obtained was often of poor quality and unsafe due to pollution and the effects of floods and landslides.

In 2011, the Water for Livelihoods (W4L) Project, funded by SDC and implemented by Helvetas, was launched in the Arandu Valley. It started with dialogue and trust-building among community leaders, and the premise that women should be fully involved. To overcome traditional resistance to this, Helvetas employed a culturally-sensitive awareness strategy in which women were made aware of their rights and roles in development, while men were sensitised men to the rights of women and the case for their participation in all consultations around development plans.

In this way, Helvetas gradually created space for women to participate in discussions and decisions, which encouraged them enough to set up Women's WUGs. These were separate from men's WUGs, but were equally engaged in identifying and prioritizing community needs. Nothing like this had ever been seen in the Arandu valley. It created an environment in which women could help shape the emerging WUMPs, and they made sure that the problem of access to clean drinking water was addressed as the most urgent need. A proposed drinking water supply scheme was then endorsed at the Village Council level.

The scheme involved installing 39 water standposts at convenient locations among all 84 households of Godibar. Once completed, it transformed the life of village, and particularly the lives of women and girls. Freed from hard, dangerous work fetching water, and with less illness from water-borne diseases, women were empowered to achieve a better balance between caring for their families and other productive activities, such as kitchen gardening, farming, poultry-raising and cleaning.

Beyond physical relief, the project sparked a deeper social change. Women in Godibar are now confident, organised, and actively involved in decision-making processes at the village level and in the forums of broader local governance. Thus, the W4L initiative improved living conditions and also empowered women to recognise their potential and claim their role in shaping their community's future. This story shows how W4L was able to transform lives, restore dignity, create opportunities and foster lasting social change through a particular approach to improving access to clean water.

A6.2 Reviving the Deenwah Nullah in Tehsil Daraban of DI Khan

The people of Tehsil Daraban had relied for generations on the water flowing in the Deenwah Nullah, which was managed through a customary water governance system known as *Rudh Kohi*. Under this centuries-old practice, farmers collectively managed rainwater and maintained irrigation channels according to traditional water rights. Elders still recall a time when the Deenwah Nullah was the main source of water for over 11,000 acres of farmland, a population of livestock numbering hundreds of thousands, and the livelihoods of the whole population.

But, over the years, recurring floods and accelerated sedimentation had gradually destroyed the irrigation system. Heavy silt repeatedly blocked the *nullah*, while floodwaters damaged earthen bunds and diverted the natural flow of water. As the width and depth of the channel diminished, water scarcity intensified across the villages. Communities that had depended on the system for generations lost access to their historically-recognised water rights, and by 2015 the irrigated area had declined to barely 1,200 acres.

The collapse of the irrigation system devastated local livelihoods as farmlands were covered by scrub forest. Agricultural production declined sharply, fertile lands turned barren, and many families were forced to migrate seasonally to urban centres in search of work, or else to adopt new livelihood strategies such as livestock rearing. The situation became so critical that local communities began referring to the Deenwah Nullah as *madfoon* ('buried') under sediment. Repeated floods and the failure of temporary repair structures later earned it another name: *badmash* ('unruly'). And eventually, the government declared the *nullah* beyond repair and ineligible for maintenance funding. With the original channel blocked, floodwaters began carving destructive new pathways, damaging infrastructure, settlements, and agricultural land throughout the area.

When W4L arrived in the midst of this crisis it was seen as a beacon of hope by communities determined to reclaim their ancestral water rights. Despite the enormous technical and environmental challenges, and showing how ambitious a WUMP can be, the rehabilitation of the Deenwah Nullah became the highest priority of the community's WUMP. Newly-established WUGs then mobilised local resources, organised collective action, and worked closely with Helvetas to restore the historic irrigation system.

The rehabilitation effort demanded extraordinary community commitment. Through more than 2,800 hours of earth cutting, extensive silt removal using tractors, and over 1,600 subsidised labour days, local people succeeded in reviving the Deenwah Nullah. By 2017, the 'buried' and 'unruly' *nullah* had been transformed once again into a lifeline for the people of Daraban. The restoration enabled the irrigation of more than 2,500 additional acres of agricultural land, bringing the total irrigated area back to about 3,700 acres.

The revival of the Deenwah Nullah transformed both the livelihoods and the morale of local people. Lands that had been uncultivable for decades were brought back into production, increasing food security and household incomes. The process also restored dignity, confidence and hope among farmers long deprived of their historical share of water resources.

Today, the Deenwah Nullah stands as a powerful example of how community-driven action, combined with institutional support, can bring a traditional water system back from the dead. Much more than a story of infrastructure rehabilitation, it is a tale of resilience, collective identity, and the preservation of centuries-old water use rights for future generations.

A6.3 Representativeness of the contribution stories

Taken together, the Arandu Valley and Deenwah Nullah contribution stories demonstrate how W4L, acting alone in collaboration with the communities, addressed critical water challenges while also strengthening resilience, dignity, social inclusion and sustainable livelihoods in rural KP Province. By establishing water infrastructure schemes and community-based water governance systems, the project improved access to safe water, strengthened local institutions, and played a significant role in restoring livelihoods that continue to function well beyond the project's life. The empowerment of women in Godibar and rehabilitation of farmland in Deenwah stand as inspiring examples of the broader impact achieved through the 47 water supply and 39 irrigation projects implemented by Helvetas across four districts of KP Province.

This remarkable transformation in rural livelihoods and local governance was made possible through a transparent, inclusive, and thoughtfully-designed implementation process. The project placed strong emphasis on community mobilisation, participatory planning, capacity building, and the meaningful inclusion of women in decision-making processes. The continued active operation and maintenance of these schemes reflect the success of the project in building strong and capable local water governance institutions that were fully prepared to take ownership and sustain the interventions after the project's completion.

A6.4 Contributions of W4L to particular sub-populations

Women and W4L

Women's participation in W4L varied across districts but consistently contributed to improved water governance and household well-being. In Karak (including Takht-e-Nasrati and Chontra), women's Water User Groups were formally established, enabling active involvement in decision-making, prioritisation of drinking water schemes, and community planning. Women received training on health, hygiene, and water management, which led to improved sanitation practices and presumably contributed to a reduction in waterborne diseases. In Tank and DI Khan, particularly in *Rod Kohi* areas, women's participation was more gradual due to socio-cultural constraints; however, through female mobilisers and community engagement, women increasingly contributed to discussions on water access, sanitation, and household-level water use. Their role became especially important in ensuring equitable distribution and supporting community cohesion.

Across all locations, access to reliable and clean water significantly reduced the time and physical burden on women, allowing them to engage more in household management, childcare, and in some cases livelihood activities. In Chitral, where community structures were organized at valley level, women participated mainly through awareness sessions on hygiene and water safety, contributing to improved health outcomes. Overall, women's involvement whether through formal groups or indirect participation enhanced the effectiveness and sustainability of water schemes by promoting inclusive decision-making, strengthening community ownership, and improving health, education, and social outcomes at the household level.

Youth and W4L

The evaluation findings suggest that youth played a significant and multifaceted role in the implementation and sustainability of W4L interventions. In the traditional rural context of KP Province, as in many parts of Pakistan, community elders commonly serve as decision-makers, advisors, and custodians of communal resources, while younger members of the community are generally responsible for operational, technical, and implementation-related tasks. This culturally-embedded division of roles was also reflected in the implementation structure of the W4L project.

During workshop discussions on participation, inclusion, and distribution of project benefits, the evaluation specifically explored the respective roles of men, women, children, youth, WUGs, WUAs, and relevant government departments in relation to water supply and irrigation interventions. Evidence gathered through interviews, focus group discussions, and project documentation consistently indicates that youth constituted a major operational force driving the implementation and later managing the W4L schemes in their respective villages and valleys.

Young men frequently contributed labour as part of the community contribution to infrastructure development, including irrigation channels, protection structures, and water supply schemes. This contribution is well documented in project progress reports and was repeatedly acknowledged by community stakeholders during the field mission. In many cases, WUGs and WUAs were composed predominantly of younger members, while overall leadership and oversight often remained with respected community elders. Similarly, women's groups established under the project largely comprised younger women and adolescent girls.

The evaluation further observed that young men and young women generally possess higher literacy and educational levels than older community members. Consequently, youth often assumed responsibility for organisational management, record keeping, financial administration, communication with implementing agencies, and coordination of meetings and community activities. Informant 8 at interview also highlighted several examples where literate young women from project areas confidently participated in workshops in Peshawar, delivered presentations, and interacted effectively with external stakeholders and foreign delegates.

These examples demonstrate the project's contribution to enhancing confidence, visibility, and leadership capacities among rural youth, particularly women.

Beyond institutional and organizational functions, youth also played an important role in promoting the adoption of improved water management practices, climate-smart agriculture, operation and maintenance of community infrastructure, and broader community mobilization efforts. The evaluation findings indicate that their active involvement contributed positively to local innovation, improved productivity, community ownership, and the longer-term sustainability of project interventions.

Vulnerable populations and W4L

The evaluation did not undertake a dedicated or fully disaggregated assessment of all vulnerable groups, but the findings nonetheless provide important insights when interpreted within the broader socio-cultural context of rural KP Province.

The evaluation observed that traditional kinship and social support systems continue to play a strong role in these communities. For example, in cases where a male household head has died, responsibility for the family is generally assumed by another senior male member of the extended family structure. Similarly, persons with disabilities are typically cared for within the household and broader family network. While these arrangements provide social protection, they may also reduce the visibility of certain vulnerable categories within formal project targeting frameworks.

The evaluation found stronger evidence regarding the project's contribution to the resilience and livelihoods of smallholders and remote rural communities. Irrigation channels and water infrastructure developed under W4L enabled previously uncultivated or flood-affected land to be reclaimed and brought back under production. Smallholder farmers were therefore among the principal beneficiaries of the irrigation interventions, as improved water access directly supported livelihood recovery, agricultural productivity, and household food security.

Communities located in remote and geographically marginalized areas emerged as primary beneficiaries of the project. These communities are heavily dependent on natural resources and historically face limited access to potable water, irrigation systems, health facilities, and post-disaster rehabilitation services. They are also disproportionately vulnerable to floods, droughts, and climate-related shocks.

The evaluation mission found that interventions such as clean drinking water schemes, irrigation channels, and flood protection bunds significantly improved living conditions and strengthened local resilience in these under-served areas. Overall, the evidence is that vulnerable populations including remote rural households, smallholders, women, and youth were among the primary beneficiaries of the W4L project, both in terms of direct access to services and broader socioeconomic improvements.

Annex 7: Biophysical context and water management

Biophysical context

The scale, distinctiveness and biosphere-wide influence of the Greater Himalayan system are comparable to those of the northern and southern polar regions, so the region has been described as Earth's 'Third Pole' (UNEP, 2022). It encompasses the Tibetan Plateau and mountainous areas that include the Pamir-Hindu Kush of Tajikistan, Kyrgyzstan, Afghanistan and Pakistan, the Hengduan of SW China, the Tienshan of Kazakhstan, Kyrgyzstan, Uzbekistan and NW China, the Qilian of China, and the Himalayas of Bhutan, China, India, Nepal, Bangladesh and Myanmar. A Hindu Kush-Himalayan (HKH) subregion is often distinguished to cover the contiguous mountain systems from Afghanistan to Myanmar.[27]

This whole landform resulted from the collision of the Indian and Eurasian tectonic plates, which began about 55 million years ago and continues today. Its geology is therefore fragile and unstable, earthquakes are common, and much of its surface is held together by permafrost. Huge amounts of water are held in glaciers amid the high mountains that trap monsoon rainfall.

As in the true polar regions, global heating is progressing much faster here than the global average (Pepin *et al*., 2015; ICIMOD, 2023). Based on Copernicus satellite observations, every country in Central Asia experienced temperatures 2-3 C higher in 2025 than their 1981-2010 seasonal averages (AFP, 2025). The region's permafrosts and glaciers are therefore melting rapidly, undermining its physical integrity. The resulting landslides mean that streams are blocked by fallen rock, creating lakes of glacial melt-water that eventually break through as glacial lake outburst floods (GLOFs).

More generally, altered patterns of heat, cold, rainfall, groundwater storage and surface and subsurface drainage are changing the region's water balance and compromising water security at all scales. In the HKH subregion, which includes NW Pakistan where W4L was located, settlements are increasingly vulnerable to floods and landslides, the desiccation of aquifers and the failure of streams and springs.

These effects can be addressed by local people, local governments and national actors, but only if adequate water governance and international cooperation arrangements are in place. Events in innumerable localities within the HKH subregion also add up to affect major downstream river systems that include the Indus, Brahmaputra, Ganges, Yellow and Yangtze. These together support the lives and livelihoods of over two billion people.

Integrated water resources management

The approach known as integrated water resources management (IWRM) aims to ensure that the social, economic, and environmental perspectives of multiple sectors and stakeholders are taken into account in all decisions that affect the quantity, quality, continuity and sustainability of water supply for all users. Thus a key need is for coordination among sectors and the involvement of local communities in making decisions, with the aim of developing and maintaining water infrastructure (e.g., dams, reservoirs, canals, irrigation networks), promoting efficient irrigation methods (e.g. drip irrigation and precision agriculture), and ensuring regional hydrological analysis and accurate data collection on water quantity and quality to support reliable monitoring systems (Ahmad *et al*., 2023).

Another key factor is that with global heating and climate change an increasing challenge (Nizami *et al*., 2020), investing in climate-resilient infrastructure, early warning systems for floods and droughts, and water storage and harvesting arrangements are vital. Meanwhile, nature-based solutions are recognised as key to preserving and restoring the capacity of natural ecosystems to absorb and release water at rates that are useful and safe, while also recharging groundwater and protecting soils (IUCN, 2020; Collins *et al*., 2025).

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[27] See: The Hindu Kush Himalaya (https://www.icimod.org/who-we-are/the-hindu-kush-himalaya/).

Such interventions can help mitigate the impacts of climate change, ensure sustainable water availability, and conserve natural capital and co-benefits such as biodiversity, while increasing landscape-level connectivity and resilience (Ashraf, 2024).

Participatory arrangements for IWRM

Collective arrangements for promoting cooperation in managing competing claims for water access and use are documented to more than two millennia ago in India and North Africa, and continue in the modern world (Sagardoy, 1986). Allowing for a great diversity of detail in their arrangements over time and between places, two broad categories of water user associations (WUAs) exist: 'traditional', which focus on agreeing and managing water distribution arrangements, and 'modern', which manage distribution, operation and maintenance and are also responsible for repaying financial investment in the water systems themselves (*Ibid*.).

As well as the recognition that WUAs are a variant of public, local and community participation in sustainable development planning and implementation, which is now seen as essential (Sebunya & Gichuki, 2024; Davis *et al*., 2025), there is a large literature on the operation of both kinds of WUAs in many countries. This includes Pakistan, where the role of WUAs in IWRM and related development cooperation experience goes back many years (e.g. Byrnes, 1992; Chaudhry, 1996; Mekonnen *et al*., 2015; Ahmed *et al*., 2025), and where it has long been formalised, for example in the Khyber Pakhtunkhwa (KP) WUA Ordinance of 1981 (GoKP, 1981).

Water use management plans

The WUMP methodology dates back in the HKH subregion to about 2007, when it was developed by Helvetas for the Finnish-supported Rural Village Water Resources Management Project in Nepal (Helvetas, 2007; ICIMOD *et al*., undated). It is a holistic, participatory, and inclusive planning process that takes an integrated approach to the management of water resources and uses at the village level.

A WUMP therefore specifies the total water budget for its planning unit, in Nepal the village development committee (VDC), and explores potential uses for it. It empowers marginalised groups to claim their rights to an equitable share of water within and between communities. The WUMP also helps local bodies with annual and periodic planning and project prioritisation.

The WUMP is typically prepared through a 17-step process that includes social mobilisation, the formation of inclusive management committees, capacity building for everyone involved, and, as a final step, social assessment using various participatory rural appraisal tools.

Simultaneously, the technical part of the process evaluates the capacity of all water resources and their potential uses. In a workshop facilitated by NGO staff, the community discusses suggestions formulated by the two participatory assessments, prioritises possible projects, and formulates plans. VDC representatives decide which plans can be implemented using their own resources and which need external support. The WUMP process then involves organising a workshop to present these plans to various organisations and seek their commitment and support. The prioritised projects are implemented according to the WUMP.

The plan also contains a series of long-term activities including maintenance during the course of its implementation, and there is sufficient latitude to allow the community to rectify its original plans in order to put into practise lessons learned during earlier phases and to continue to review and modify the plan as needed.

After a strong emphasis on water infrastructure delivery in W4L Phase 1 (2011-13), the focus of Phase 2 (2014-17) was on water governance and WUMPs. This was encouraged by what was seen as an opportunity to take advantage of the devolution of water governance in KP Province after 2012 by working closely with newly-empowered local government. Thus, the WUMPs would be based on "a holistic, participatory, and inclusive planning process which can support the devolution process" (SDC, 2013a: 8/5). Comparable reactions to similar governance changes are known from other water sector projects in the Himalayan region.[28]

[28] In Nepal, for example, the Finnish-supported Rural Village Water Resources Management Project (RVWRMP, 2006-2022) and Rural Water Supply and Sanitation Project (RWSSP, 2008-2019) both took advantage of the devolution of powers to the municipal level by Nepal's 2015 Constitution (consolidated in the 2017 elections), to work closely with the empowered municipalities and communities. They were able to develop Water Use Master Plans (in RVWRMP) and WASH and Water Safety Plans (in RWSSP), with the municipalities, and achieved major and sustainable improvements in WASH service delivery and ultimately national policy on WASH and climate change adaptation (Caldecott *et al*., 2026).

Annex 8: W4L Phase 1 aims, activities and achievements

Table A8.1: Foreseen outcomes, outputs and main activities of W4L Phase 1.

Goal: *Contribute to improving and securing livelihoods and increasing food security of communities in KPK [i.e., KP Province] and FATA in Pakistan through sustainable, secure and equitable access to water*.	
Outcomes foreseen	**Key outputs expected and main activities foreseen**
1. Irrigation water. Village communities increase the availability of irrigation water in rain-fed areas and, together with local authorities, contribute to improved water governance and together with local authorities in order to.	**1.1. Village communities have improved the functioning of existing and established new irrigation systems, retention dams and small water ponds**. *Activities*: participatory assessment of irrigation needs and opportunities; prioritisation and discussion with stakeholders; design and cost work to be done; and develop and sign memoranda of understanding with community groups covering roles and responsibilities for construction, operation and maintenance. **1.2. Village communities are piloting low cost techniques (e.g. micro irrigation methods) and have improved soil and water conservation and have enhanced infiltration capacity of watersheds [= catchments]**. *Activities*: participatory assessment of desertification trends; prioritisation and discussion of findings with stakeholders; introduce micro-catchment water harvesting and afforestation techniques; and agree rights, obligations and benefit sharing arrangements.
2. Drinking water. Village communities have equitable access to safe drinking water.	**2.1. The poor and remote communities have means to store and/or prepare safe drinking water**. *Activities*: participatory assessment of drinking water needs, locations, water quality, water sources; discussion of findings with stakeholders; design and cost work to be done; develop and sign memoranda of understanding with community groups covering roles and responsibilities for construction, operation and maintenance. **2.2. Water user groups (WUGs) are aware of their obligations and have exercised their right of access to water**. *Activities*: discussion with stakeholders on WUGs' rights (up-, mid- and downstream); capacity-building activities for WUGs (focus on negotiation and lobbying skills); participatory SWOT analyses on existing water distribution codes and procedures; participatory identification of priority policy issues for dialogue and negotiation; participatory mobilisation of strategic partners for strengthening community negotiation capacity; participatory advocacy of positive change in the traditional (*Rod-kohi*) water distribution system; and implement water distribution schemes.
3. Disaster risk management (DRM). Village communities protect their assets (houses, livestock, agriculture land, etc.) against water related threats such as floods and extreme droughts.	**3.1. Village communities have taken charge to manage critical watersheds and thereby reduced the threats of damages from accelerated run off causing flash floods**. *Activities*: participatory (with communities and experts) identification of erosion-prone locations and potential soil conservation measures; develop and sign memoranda of understanding with community groups on roles and responsibilities for the protection of sites and operation and maintenance; and implement erosion-control and reinforcement schemes (e.g. check dams/gabion structures, bio-engineering).

	3.2. Community-based DRM committees have enhanced their capacities in reducing risks and managing disasters. *Activities*: set up and train village DRM committees (with cross visits to Livelihood Programme villages); support communities in emergency preparedness planning; strengthen community indigenous early warning systems; and provide necessary tools and equipment to disaster-prone communities. **3.3. Village communities have successfully installed simple and low cost DRR measures and devised a mechanism to maintain and (if possible) replicate them**. *Activities*: assess disaster risks in project areas; participatory prioritisation of disaster-prone village; document baselines and conduct feasibility of DRR measures; design and cost work to be done; hold public meetings to present the warning ('climate forecast') system; develop and sign memoranda of understanding with community groups on roles and responsibilities for construction, operation and maintenance; and implement DRR schemes. **3.4. In close collaboration with the Livelihoods Programme, a well-coordinated system for climate forecast is in place which allows farmers to adapt their agricultural production**. *Activities*: provide equipment (to measure rainfall, temperature and air variations) where needed; organise workshops to establish coordination arrangements with government; train line agency staff in each district on using the system; and seek feedback from farmers on the timeliness of information flows. **3.5. In close collaboration with the Livelihoods Programme, locality-specific early warning systems are devised using local and scientific means, and function for floods and droughts**. *Activities*: document indigenous early warning systems (if not already done); share information with specialised institutions and seek ideas on early warning systems; devise ways and means for indigenous and scientific knowledge to be managed and made available at village level; and train communities on using the system.
4. Knowledge management. Development actors (local NGO partners, government line departments, community-based organisations, etc.) gain adequate management capacities and specific water sector-related know-how and knowledge and use these experiences for up-scaling interventions in the Pakistan-Afghanistan border areas.	**4.1. Implementing partners and local NGOs have established an operational base in the areas of intervention**. *Activities*: agree terms and conditions for building capacity among local NGO partners; develop and sign a memorandum of understanding with the Planning and Development Department on project implementation; agree partnership arrangements with the Pakistan Meteorological Department, Global Change Impact Study Centre, World Resources Institute and others; hold regular Project Steering Committee meetings; and establish ToRs and draft/share background papers. **4.2. Development actors namely NGOs, local and provincial (not excluding national) departments, and specialised private entities have established a network with shared know-how**. *Activities*: seek to ensure that specialised organisations, NGOs and government institutions collaborate on all project interventions; provide opportunities for project partners to meet, share knowledge and network; engage all partners in preparing annual workplans and progress reports; and encourage self-initiatives through synergy between partners (with their own resources or external support). **4.3. Adequate data [are] acquired for the region – including the currently included districts – on climate scenarios for up-scaling, replicating or tailoring interventions**. *Activities*: liaise with specialised institutions; identify data sources in target districts (or nearby) and verify their quality; build the capacity of data collection centres if needed; establish databases and future scenarios for monitoring against; devise recommendations for adaptation

	in agriculture and DRR measures based on scenarios; and share databases across borders to enhance regional (subnational and international) cooperation. **4.4. Implementing partners have documented situation-specific experiences and shared them on a regular basis**. *Activities*: seek to establish a culture of frequent experience sharing through thematic events, joint annual work-planning, exchanges on processes; seek to ensure that staff and partners follow Conflict Sensitive Programme Management principles (SDC, 2006); regularly publish case studies, thematic papers, briefs, etc.; and conduct internal and external review events/missions.
Source: SDC (2011b: p. 1).	**Source**: adapted from SDC (2011b: logical framework).

Table A8.2: Logframe targets and achievements of W4L Phase 1.

W4L Phase 1 targets	**W4L Phase 1 achievements**
2,400 households in 30 villages with access to clean drinking water.	945 households reached by 11 drinking water schemes.
4,300 households with irrigation water in 66 villages.	3,472 households reached by 19 irrigation water schemes.
WUAs, each based on multiple WUGs, set up and able to influence policy.	WUAs raising issues of rights and tenure with government authorities.
4,500 households in 45 villages protected from floods/droughts.	4,091 households protected by disaster risk reduction (DRR) structures.
2,250 acres (911 ha) of land protected from floods.	630 acres (255 ha) of land protected by dams, gabions, tree planting, etc.
45 villages with disaster risk management (DRM) committees/plans.	19 villages reached by DRR training and DRM planning.
Weather early warning system reaches farmers with timely information.	Government meteorology updates shared via local radio in DI Khan.
Development partners and local NGOs well established in target areas.	Memoranda of understanding and active collaboration with multiple official and NGO partners.
Government counterparts available and fully supportive.	Excessive government workloads preclude much co-working.
Gender equity and social inclusion (GESI) mainstreamed effectively.	Both genders fully consulted and all schemes benefit small farm owners or tenants, women and children.
Participatory water governance promoted effectively.	WUAs involved in project activities and voice water rights in public forums.
Sources: Merz *et al*. (2013); SDC (2013a).	

Annex 9: W4L Phase 2 aims, activities and achievements

Table A9.1: Foreseen outcomes, outputs and main activities of W4L Phase 2.

Goal: *Contribute to agricultural development, food security and livelihoods and thus enhance rural local economies in ecologically fragile, semi-arid and poor districts in KPK [i.e., KP Province] through sustainable, safe and equitable access to water*.	
Outcomes foreseen	**Key outputs expected and main activities foreseen**
1. Water users jointly with district governments contribute to appropriate strategies and frame conditions which protect water resources efficiently and ensure sustainable use for people and food on a water catchment scale.	**1.1. District authorities and water users dispose of WUMPs which are based on water rights and collective accountability within water catchment areas**. *Activities*: prepare WUMPs and have them vetted by district steering and coordination committees; ensure that WUMPs are institutionalised and functional, with steering/coordination committees; use WUMPs to facilitate and guide increased government funding allocated to the water sector; and use WUMPs to drive an increase in the proportion of women having access to water (for drinking, domestic use, agricultural and livestock purposes). **1.2. District authorities have reformed traditional regulatory systems including administrative rules on financing, participation and decision making of/by stakeholders**. *Activities*: seek to ensure that traditional water management systems are recognised in government rules and policies relating to water management at district level; promote appropriate policy changes (with up-scaling at *tehsil*, district and eventually provincial level); and promote changes to regulatory frameworks in favour of equitable water distribution.
2: District authorities and departments involved as well as water user organizations are empowered and capable to offer quality services for (and engage in implementation and maintenance of necessary investments in) drinking water and irrigation schemes in line with their revised mandates.	**2.1. Operational capacities and skills of service providers are strengthened and implement water-linked infrastructure for water harvesting, water use for irrigation and drinking water and protection against natural hazards**. *Activities*: encourage and enable the formation and registration of water user associations (WUAs) and their involvement in WUMP implementation with district authorities; seek to confirm that services offered by government technical departments are appropriate in scope and nature; develop proposals for schemes on water conservation, harvesting and efficient use; improve quality standards for water infrastructure; seek to confirm that services offered by the private sector on construction, maintenance and operation of infrastructure are appropriate in scope and nature. **2.2. WUAs assume the ownership on WUMPs and arrange for efficient maintenance and financing in line with reformed mandates and standards**. *Activities*: seek to ensure: (a) that WUAs are mobilising quality planning and advocacy services for their members; (b) that WUAs are coordinating private technical and legal services; (c) that policy notifications from district or provincial authorities are based on feedback from WUAs; (d) that adequate resources are available (from allocation and/or generation) for WUMP implementation; (e) that WUAs' executive bodies include a target proportion of women, youth, landless, etc.; and (f) that quality standards of water infrastructure are in place. **2.3. District and local authorities share new skills and knowledge on reformed water governance with other water users and service providers**. *Activities*: seek to ensure: (a) that all relevant data and

	documents are held securely and accessibly by an appropriate institution; (b) that knowledge events result in at least 10 joint initiatives by various actors for water sector development; (c) that all relevant thematic papers, policy briefs and case studies are available to key stakeholders and the public; and (d) that demand for knowledge material is met by web-sites and regular publications (e.g. news magazine) on water governance.
Source: SDC (2013b: p. 1).	**Source**: adapted from SDC (2013b: logical framework).

Table A9.2: Themes and achievements of W4L Phase 2.

W4L Phase 2 themes	W4L Phase 2 achievements
Preparing WUMPs.	Eight WUMPs were prepared in the four districts,[29] covering 40 Union Councils, 107 Village Councils, 496 villages and over 225,000 households.
Establishing and strengthening WUAs and WUGs.	17 WUAs were formed (representing 801 WUGs: 400 male groups, 357 female groups, 44 mixed groups), as well as four apex WUAs, with major investment by the project in building WUA and WUG organisational capacities and skills. The total executive body membership of the 17 WUAs was 238 persons, of which 77 were classified as 'poor' (53 of 179 men, 24 of 59 women).
Promoting GESI.	Staff, resources and tools were dedicated to identify and include poor and vulnerable, and to ensure ca 43% women participation in WUMP processes, with women organising themselves around benefits offered by water schemes.
Reducing water conflicts.	Irrigation schemes helped create consensus through community institutions which has in turn helped in resolving water related conflicts. About 20% percent of such conflicts are resolved using community dispute resolution mechanisms.
Expanding irrigated areas.	There was a reported 137% increase in water distribution efficiency and a 32% increase in cropped land from 39 irrigation schemes, supplying 21,793 acres (8,820 ha) for the benefit of 8,866 households.
Supplying clean drinking water.	47 drinking water schemes were established, supplying 224,689 community members. Most (ca 70%) responded to women's concerns as direct access to nearby drinking water is their top priority. The availability of clean drinking water has reduced diseases and medical expenses.
Training professionals.	214 professionals (16 women 198 men) were trained on specific topics e.g. irrigation scheduling, cost benefits analysis of community-based schemes, efficient water application techniques, groundwater (monitoring, instrumentation and data collection), water governance, dispute resolution of water resources, WUMP planning process, partnership in water sector development, drought prediction and mitigation, and Institutional Development and Organizational Strengthening.
Ensuring high water quality.	Pre- and post-scheme water quality testing by PCRWR or WASEP; water ponds cleaned (e.g. in Tank); UNESCO and PCRWR have added filtration plants to some drinking water supplies. No evidence of testing for natural uranium[30].
Sanitation.	1,604 women and children were trained in health and hygiene including safe handling of drinking water at domestic level, with some enthusiasm for behavioural change. But neither sanitation (i.e. separation of sewage and drinking water systems) nor hygiene

[29] Gobor Valley (Chitral), Birir Village Council (Chitral), Shishikoh Valley (Chitral), Arandu Union Council (Chitral), Tank Zam (Tank), Takht-e-Nasrati Tehsil (Karak), Karak Tehsil (Karak), Daraban Tehsil (DI Khan).

[30] Mineral resources of Karak District include salt mines since antiquity, as well as oil, gas and uranium. The latter is associated with high levels of uranium in drinking water (70% of 285 groundwater samples exceeded the WHO 'safe' threshold of 30 μg/l), which may be causing an increased prevalence of kidney dysfunction, bone disorders, liver diseases and cancer risk, especially in shallow-aquifer areas (Saddiq *et al*., 2025; see also Ali *et al*., 2019).

W4L Phase 2 themes	W4L Phase 2 achievements
	(i.e. prevention of direct or indirect faecal contamination of domestic environments, food and water) are prominent in W4L reports and seem to be folded into the GESI process as a women's issue.[31] A more comprehensive approach was recommended.
Disaster risk reduction.	Mountain irrigation systems (in Chitral) were designed for disaster resilience (though lining and alignment), but DRR was generally weakly mainstreamed and a more comprehensive approach was recommended.
Influencing policy.	W4L "made deliberate choices to create space for larger-scale policy impact by picking up topics/themes such as ground water monitoring; climate change assessment and adaptation". The WUMP process involved more than 10,000 stakeholders, "creating a great sense of ownership of the process and the product as well as window for further policy advocacy through continued dialogue." The Project Steering Committee was seen as potentially becoming a "custodian of the community centred approach, [in line with] the government's community driven local development policy." W4L "initiated the Water Policy dialogue with [the KP Province] government for the formulation of provincial water policy."
Managing knowledge.	W4L collaborated with the Research and Development Foundation Hyderabad Sindh (on drought mitigation), the Spate Irrigation Network (on *Rod-Kohi* systems), the Water and Environment Forum (on climate change and water), the Hisaar Foundation (recommendations for national water policy), the Climate Change Centre at the University of Agriculture (on knowledge management for water and climate change issues), the PCRWR (on safe drinking water) and the International Water Management Institute in Lahore (on groundwater monitoring). W4L partners recognised that the WUMPs offer a major knowledge resource to support a comprehensive provincial IWRM strategy, but also that the entire subject of water and climate change resilience was still under-addressed and under-documented. The DI Khan District administration recognised an urgent need to develop a Water Resources Information System.
Sources: SCOP (2017); Sarfraz *et al*. (2017).	

[31] The training-based W4L approach to sanitation and hygiene can be contrasted with the more intensive system used by Finnish-supported projects in Nepal (RVWRMP and RWSSP; Caldecott *et al*., 2026). These invested heavily in achieving 'Open Defaecation Free' and 'total sanitation' community status, menstrual hygiene, physical sanitation and hand-washing facilities, etc., but without outcomes that were obviously superior to those of W4L. Cultural differences between the peoples involved may have contributed to this apparent difference in cost-effectiveness. Similarly, however, the Finnish projects found it hard to invest adequately in ecosystem-based resilience-building and climate change adaptation, while for W4L these aspects were central from the start (e.g., Output 2.1 in SDC, 2011b: "Village communities have taken charge to manage critical watersheds [using] ... ecological indicators.").

Annex 10: Themes, processes and achievements of W4L Phase 3

Themes of W4L Phase 3	Processes and achievements of W4L Phase 3
Mainstreaming IWRM.	W4L established a consultation forum with 32 government departments, research institutes, academia, donors, projects and CSOs were consulted. The forum reviewed the draft IWRM Strategy and its planning methodology and recommended a focus on four strategic concerns: *Sustainable Water Resource Management*, *Improved Water Governance*, *Effective Public Private Partnership* and *Improved Knowledge and Awareness on Water*, with coordination as a cross-cutting concern. These recommendations were incorporated in the Strategy, which was approved by the KP Province Cabinet in March 2020. W4L subsector reports (including on Agriculture, Climate Change and Water, Drinking Water & Sanitation, Energy & Hydropower, Forestry, Groundwater, Hydrology, Irrigation, Planning Mechanism of IWRM, Private Sector, Water Productivity, and Water Users and their Organizations) were provided along with details of the WUMP tool to relevant line departments for on-going reference and use. W4L workshops were held with district line departments in the four project districts to enable them to incorporate priorities of respective WUMPs in their respective Annual Development Plans for 2019-2020.
Local water governance and management systems.	W4L provided continuous technical support through its staff and local NGOs to 17 WUAs, 13 of them across all project districts developed their plans of action for 2020. WUA members were trained in conflict management (e.g. alternative dispute resolution, managing cultural differences, negotiation skills), and on technical topics such as beneficial cropping patterns under different climate scenarios and community-based infrastructure schemes. W4L facilitated an IWRM Planning Manual Review Committee which developed and finalised an IWRM facilitator's manual to support implementation of IWRM activities at all levels. In addition, W4L organised training for government departments on using IWRM and WUMP tools in all water sector initiatives.
Managing knowledge.	Four strategic research products were published by W4L and Helvetas: *IWRM Strategy Development in KP*, *Climate Baseline and Scenarios for KP: 1981-2014*, *Efficient use of Fresh Water in Commercial Sector*, and *W4L Impacts on Water Fetching Women in Chitral*. Following its approval, W4L arranged for the KP Province IWRM Strategy to be printed in English and Urdu and widely disseminated to all stakeholders in KP Province and other provinces. An interactive photo album on water experiences in the target districts was also developed and shared widely with relevant stakeholders at different forums, including the project's final event in Peshawar in February 2020.
GESI	Throughout W4L there was a strong focus on the inclusion of women, youth and the poor. Their inclusion in WUGs, WUAs and District Coordination Committees gave them opportunities to participate in community decision-making processes. The project ensured that all 17 WUAs had memberships of at least 30% women and 10% youth (a maximum of 38% youth membership was reached in DI Khan), and seven drinking water and irrigation schemes (with

Themes of W4L Phase 3	Processes and achievements of W4L Phase 3
	a 17% mean community contribution to their budgets) were proposed by women in Chitral, Karak and Tank and initiated through their respective WUAs. In the first half of 2019 alone, 87 women were trained on cropping pattern and alternate dispute resolution. W4L also ensured that the KP Province IWRM Strategy was formulated based on the principle of 'social equity' along with economic efficiency and environmental sustainability.
Conflict-sensitive programme management	W4L was implemented in the fragile context of KP Province, with pervasive potential for religious extremism and violence. The WUMP approach enabled active involvement of small farmers, owners, tenants, men, women, etc. in the decision-making process that strengthened collective ownership and minimised the chances of disputes around water. The alternate dispute resolution mechanism developed amongst the WUGs and WUAs further contributed to curtailing disputes amongst upper, middle and downstream water users.
The 'One water' approach.	W4L led on promoting catchment-level thinking, which stimulated negotiations and the setting of shared priorities at different levels. It also helped in identifying gaps in the regulatory mechanism of line departments, and encouraged and enabled communities and their institutions to shoulder their new roles as duty bearers and decision makers.
Innovations.	IWRM and WUMP models were innovative in the Pakistan context, as were the tailored solutions provided by W4L to local government and its line departments in prioritising and implementing key water schemes. W4L provided new, realistic, adaptable, cost-effective and practical community-based ways to solve water management issues by demonstrating the roles of WUAs and WUGs as key actors at the local level.
Source: Helvetas *et al*. (2020); SDC (2020).	

Annex 11: Comparing the W4L and IWRM theories of change

The ToC for W4L was reconstructed and presented in Section 4.3. This can be compared with the ToC for IWRM in Figure A11.1, which is framed around the following four themes of system change that are always needed to achieve these objectives.

First, improvements to **environmental systems** involve safeguarding and restoring catchment ecosystems for water supply and security, based on the application of ecosystem knowledge.

Second, improvements to **social systems** are focused on improved water governance through informed dialogue, participation and agreement around plans and actions, supported by strong and capable institutions.

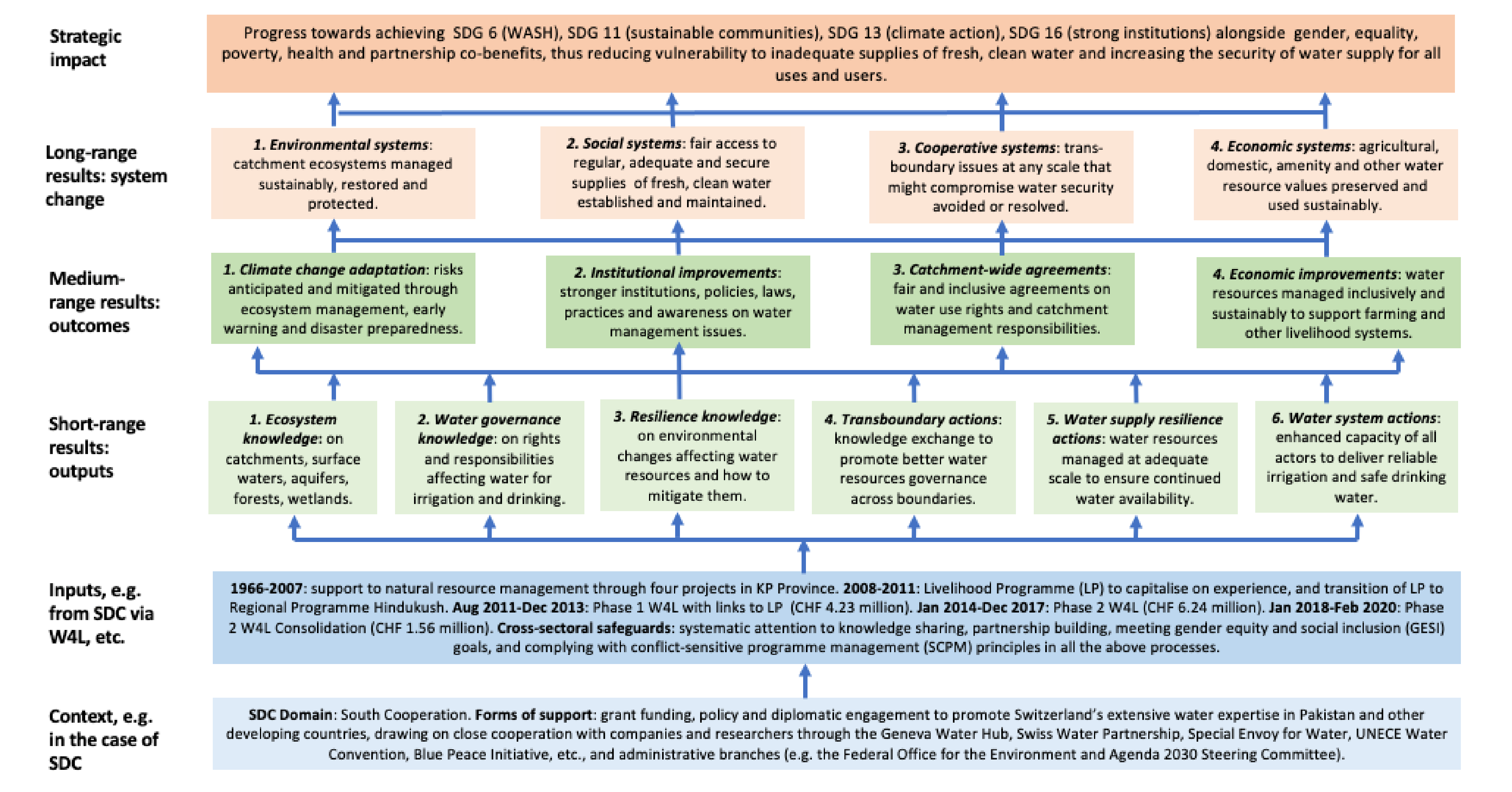
Third, improvements to **cooperative systems** often need participants to share ideas, learn, discuss and decide what to do across social boundaries, in order to ensure that whole water systems (e.g., rather than fragments of catchments and waterways) are managed for collective benefit.

And finally, improvements to **economic systems** require more efficient and sustainable allocation of safe and high-quality water to help ensure that people remain free of water-borne diseases, thus minimising the costs of morbidity and premature mortality, and supporting their farms and businesses.

To achieve sustainable, safe and equitable access to water and its co-benefits requires all four systems to operate well and in harmony with one another. Thus, the **environmental** system is key to sustainability and security, the **social** system to equity, the **cooperative** system to conflict avoidance (where local conditions are vulnerable to upstream or downstream events), and the **economic** system to livelihoods.

Moreover, if each system is to operate well, then the **frame conditions** must be suitable, with policies, laws and institutions favouring sustainable outcomes in line with the interests of rural households and farmers. And the short-range and medium-range results upon which the others depend require adequate capacity for IWRM at all levels of the **system nexus**. The latter includes planning, networking and mainstreaming the IWRM approach, as well as the operation of knowledge-sharing partnerships. Comparing the W4L ToC (Section 4.3) with the IWRM Toc (Figure A11.1), which is done in Table A11.1, shows that W4L was likely to have contributed to fulfilling all the above conditions in its target communities.

Figure A11.1: Diagram of an overall IWRM ToC based on global and Finnish practice, indicating the role of SDC inputs and context.



Source: adapted from Caldecott *et al*. (2026).

Table A11.1: Assumptions and logical steps applicable to any IWRM intervention.

From long-range results (system change) to strategic impact: • **Water governance**: improved laws, policies and practices to avoid and resolve conflicts over water among public and private actors at local, subnational, national and transboundary scales, contributing to continued increased (2017-2023) water governance performance against SDG 6.5.1 (ADB, 2025). • **Water security**: policy support and budget allocations for IWRM enable long-term management of ground waters and catchment, wetland and surface water ecosystems for integrity, quality and biodiversity, contributing to continued increased (post-2013) water-related disaster security (ADB, 2025). • **Political environment**: national circumstances permit policy coordination and consensus around integrated water resource management (IWRM) needs and actions across the country concerned, thus maintaining progress on water governance and water security. • **Geopolitical conditions**: continued support for shared priorities on sustainable development (e.g. SDGs 6, 11, 13, 16) and especially climate change (e.g. Paris Agreement), and do not introduce major new barriers to cooperation (e.g. multilateralism replaced by polycentrism in international relations).
From medium-range results (outcomes) to long-range results (system change): • **Water governance**: use of locally- and inclusively-prepared water use management plans (WUMPs, or similar planning documents) as inputs to local/subnational policy and regulatory development to favour equitable water distribution and sustainable catchment management. • **Water services**: adequate resources are available (from allocation and/or generation) to support the implementation of WUMPs (or similar), while local/subnational authorities share and use new skills and knowledge to maintain quality standards of water infrastructure and functionality. • **Catchment resilience**: water user associations (WUAs, or similar participatory local arrangements for deliberation on water management), WUA associations (or similar arrangements to aggregate local interests and preferences), non-governmental partners and local/subnational and national authorities collaborate and involve regional partners in the protection and restoration of large-scale catchment ecosystems against direct threats, climate change and natural hazards. • **Water knowledge**: national water-related information holdings are managed effectively and accessibly to all users in support of water governance, water services and water catchment resilience actions including disaster early-warning systems of direct use to grass-roots agricultural producers.
From short-range results (outputs) to medium-range results (outcomes): • **Water governance**: district authorities and WUAs (or equivalents) develop and apply WUMPs (or equivalents) based on water rights and collective accountability within catchment areas, while reforming traditional regulatory systems including administrative rules on financing, participation and decision making. • **Water services**: operational capacities and skills of service providers strengthened, enabling delivery of infrastructure for water harvesting, irrigation and drinking water supply, while WUAs (or equivalents) mobilise planning and advocacy services for their members and coordinate private technical and legal services. • **Catchment resilience**: local authorities and WUAs (or equivalents) collaborate in protection and restoration of catchment ecosystems against local threats, climate change and natural hazards. • **Water knowledge**: all relevant data and documents are held securely and accessibly to all by an appropriate institution, and that needs and requests for knowledge material are consistently met.

From development cooperation partner inputs to short-range results (outputs):

- **Water for farming**: participatory assessment of needs and opportunities for irrigation systems, retention dams and ponds, and agreements with community groups on roles and responsibilities for construction, operation and maintenance of community irrigation systems.
- **Managing catchments**: participatory assessment of micro-catchment vulnerability, trials of water harvesting and restoration techniques, and agreements with community groups on rights, obligations and benefit sharing for catchment ecosystem management actions (e.g. check dams, nature-based solutions).
- **Water for drinking**: participatory assessment of drinking water quality, sources and needs by location, and agreements with community groups on roles and responsibilities for construction, operation and maintenance of community water supply systems.
- **Water governance**: WUAs (or equivalents) established, define their needs for rights and negotiation capacity, explore water distribution codes and procedures, identify priorities for change, mobilise strategic partnerships, and advocate positive change in traditional distribution systems.
- **Managing disaster risk**: disaster risk management committees (or equivalents) established and trained to support vulnerability assessment and preparedness, with participatory assessment of practical options and agreements with community groups on roles and responsibilities for implementing those chosen.
- **Disaster early warning**: capacitate participants with training and equipment and promote inter-agency and inter-community cooperation on scientific and traditional environmental monitoring, scenario-building and data sharing, with farmer feedback on timeliness and utility of all information flows.
- **Cross-sectoral safeguards**: systematic attention to knowledge sharing and partnership building, and in all the above processes meeting goals and complying with applicable principles of gender equity and social inclusion and conflict-sensitive programme management.

Source: Caldecott *et al*. (2026).

Table A11.2: The reconstructed W4L and overall IWRM ToCs compared.

W4L activity/output clusters	Short-, medium- and long-range IWRM results
1. **Water User Associations**: increase capacity for participatory IWRM planning and action.	**Short-range results**: 2 (Water governance knowledge). **Medium-range results**: 2 (Institutional improvements). **Long-range results**: 2 (Social systems); 3 (Cooperative systems).
2. **Disaster Risk Reduction**: mainstreaming, planning and direct support for flood protection of lands and households.	**Short-range results**: 1 (Ecosystem knowledge); 2 (Water governance knowledge); 3 (Resilience knowledge); 5 (Water supply resilience actions). **Medium-range results**: 1 (Climate change adaptation); 3 (Catchment-wide agreements). **Long-range results**: 2 (Social systems); 4 (Economic systems).
3. **Water Use Management Plans**: enable planning for all aspects of IWRM.	**Short-range results**: 1 (Ecosystem knowledge); 2 (Water governance knowledge); 3 (Resilience knowledge); 4 (Transboundary actions); 5 (Water supply resilience actions); 6 (Water system actions). **Medium-range results**: 1 (Climate change adaptation); 2 (Institutional improvements); 3 (Catchment-wide agreements); 4 (Economic improvements). **Long-range results**: 1 (Environmental systems); 2 (Social systems); 3 (Cooperative systems); 4 (Economic systems).
4. **Knowledge management**: ways and means to manage and share information on weather, agroecology and climate.	**Short-range results**: 1 (Ecosystem knowledge); 2 (Water governance knowledge); 3 (Resilience knowledge). **Medium-range results**: 1 (Climate change adaptation); 2 (Institutional improvements). **Long-range results**: 1 (Environmental systems); 2 (Social systems); 3 (Cooperative systems); 4 (Economic systems).
5. **Institutional networking**: structured and active collaboration with multiple official and NGO partners.	**Short-range results**: 2 (Water governance knowledge). **Medium-range results**: 2 (Institutional improvements); 3 (Catchment-wide agreements). **Long-range results**: 2 (Social systems); 3 (Cooperative systems).
6. **Water system services**: direct support for drinking water and irrigation schemes; sanitation and professional training.	**Short-range results**: 1 (Ecosystem knowledge); 2 (Water governance knowledge); 3 (Resilience knowledge); 6 (Water system actions). **Medium-range results**: 1 (Climate change adaptation); 2 (Institutional improvements); 4 (Economic improvements). **Long-range results**: 1 (Environmental systems); 2 (Social systems); 3 (Cooperative systems); 4 (Economic systems).

W4L activity/output clusters	Short-, medium- and long-range IWRM results
7. **Gender equity and social inclusion**: effective mainstreaming through standards for structural inclusion.	**Short-range results**: 2 (Water governance knowledge). **Medium-range results**: 4 (Economic improvements). **Long-range results**: 4 (Economic systems).

Annex 12: Interview and workshop participant lists
(internal SDC only)

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